

April 11, 1950

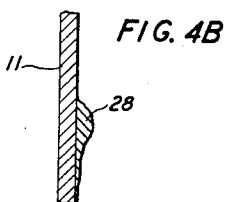
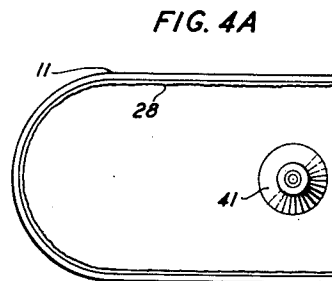
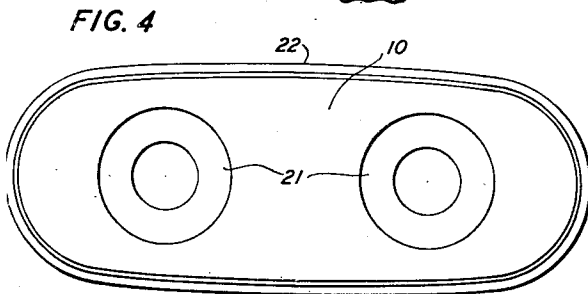
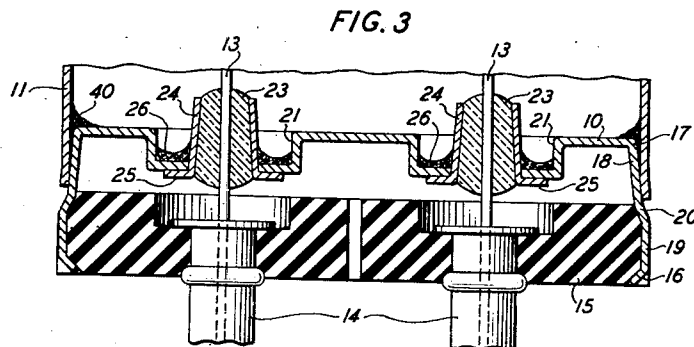
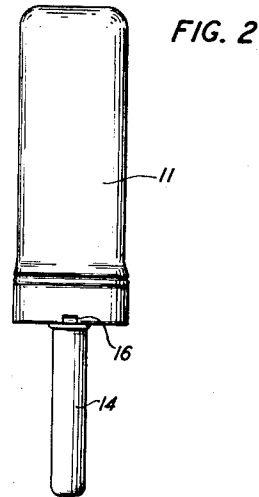
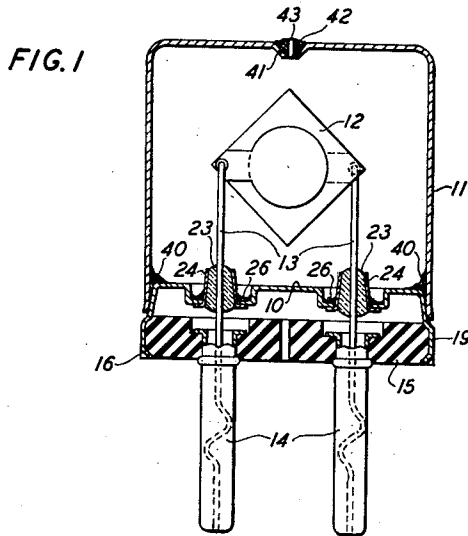
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METALLIC CASING FOR ELECTRICAL UNITS

Filed Sept. 26, 1944

3 Sheets-Sheet 1



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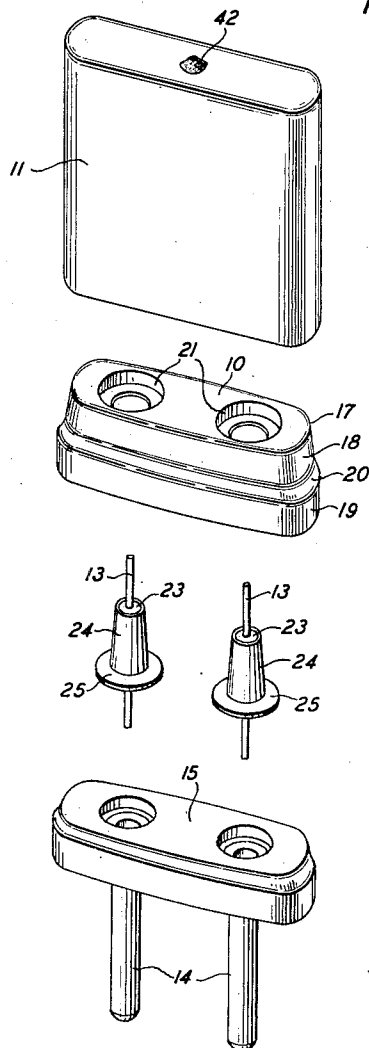
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METALLIC CASING FOR ELECTRICAL UNITS

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FIG. 5



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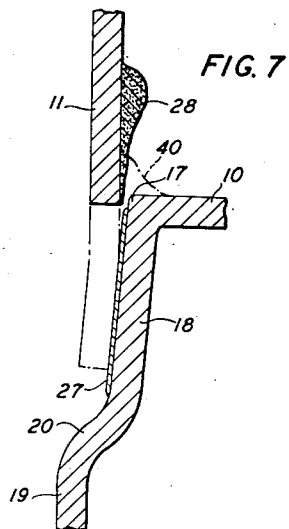
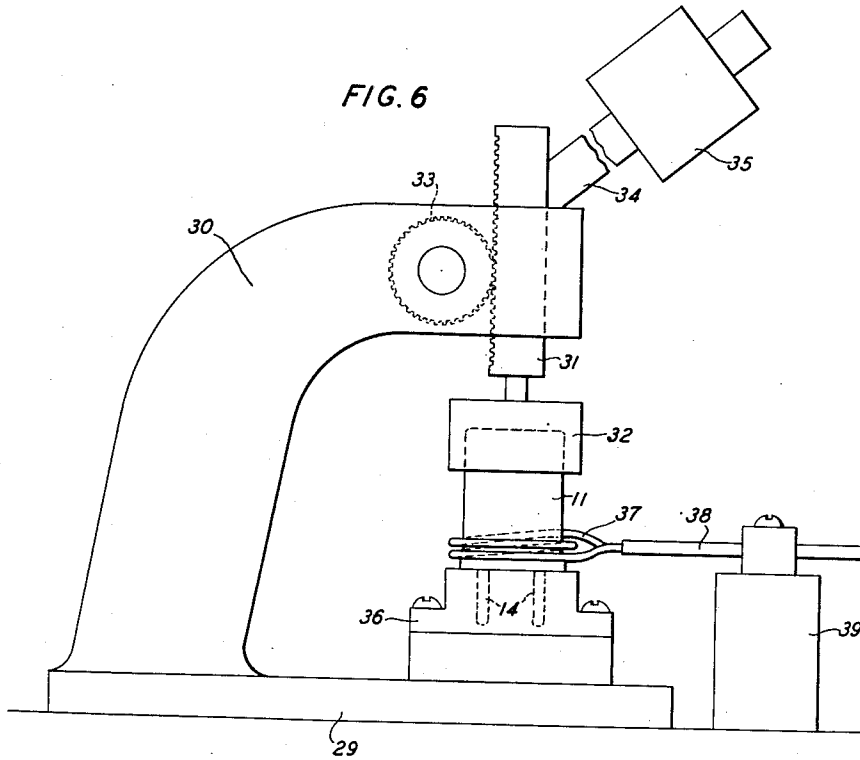
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METALLIC CASING FOR ELECTRICAL UNITS

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3 Sheets-Sheet 3



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METALLIC CASING FOR ELECTRICAL UNITS

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6 Claims. (Cl. 171-327)

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This invention relates to metallic casings for electrical units and more particularly to such casings of the vacuum sealed type employing soldered joints.

In the electrical arts and especially in the communication field, containers or receptacles are necessary for housing delicate units which are susceptible to deterioration by air or temperature changes which create oxidizing conditions to vary the characteristics of the units. This is particularly true, for example, in piezoelectric quartz crystal elements which are accurately tuned to definite frequencies to maintain constant control in communication equipment at such frequencies. Such receptacles, in addition, must meet certain requirements as to strength of material, limited mounting space, rugged construction and low manufacturing cost consistent with the operating conditions and efficiency attainable in practice, and also withstand rough handling during shipment and service.

Such requirements have been attained with favorable results heretofore by enclosing the crystal elements in a molded phenolic casing of rectangular configuration to form a compact and efficient assembly for normal operating conditions. However, under extremely low temperature and pressure conditions or similar high temperature and pressure environments usually encountered in airborne craft over different climate zones and altitudes and also in undersea craft, the protective casing of the crystal element must withstand greater operating conditions and usage so that the efficiency of the element is not impaired. Furthermore, it is desirable that the improved casing should be mechanically interchangeable with the phenolic casing so that the same mounting space may be utilized.

The primary object of this invention is to protect the electrical unit or specifically the crystal element in a metallic casing having a mechanically strong and vacuum-tight solder joint to maintain the operating efficiency of the unit or element at the highest peak.

A further object of the invention is to form the seal of the metallic casing without the use of soldering flux so that contamination which varies the frequency characteristic of the crystal element is avoided.

Another object of the invention is to reinforce the mechanical joint of the casing to insure a strong vacuum-tight connection which will withstand rough handling and torsional stresses.

Further objects of the invention are to facili-

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tate the mounting of the crystal element in the casing and eliminate injurious vapor atmosphere during the sealing operation.

Another object of the invention is to overcome oxidation difficulties in the sealing of the components of the casing and facilitate the fusing of the sealing medium in the joint.

In accordance with the general aspects of this invention, a vacuum tight sealed joint is effected in a metallic protective casing of an electrical mount or unit by providing a hollow base portion containing hermetically sealed conductors, the base portion extending into a can or body portion and forming a solder seal between the joint surfaces in combination with an overflow cast dam of solder seated in the cavity adjacent the top of the base where the base diverges from the inner surface of the body portion.

A feature of this invention relates to the formation of the solder seal without the use of any flux medium and thereby eliminating injurious vapor conditions which would deleteriously affect the characteristics of the electrical unit enclosed in the casing.

Another feature of the invention relates to the method of forming a mechanical and vacuum-tight seal between the components of the casing by high frequency heating and pressure whereby the body portion is forcibly pressed down on the base portion during the heating of the solder material on the inner edge of the body portion and the body portion is expanded over the base portion to induce the solder mass to flow in a direction opposite to the pressure force thereby collecting the mass at the top of the joint between the body and base where it forms a "cast dam" ring which fills the cavity formed by the divergent surfaces of the components of the casing.

Another feature of the method involves the wiping or shearing action of the body portion against the surface of the base portion to insure the removal of the tough oxide film on the molten solder whereby proper fusion of the seal is produced.

In a specific embodiment of the invention the vacuum-tight seal is applied to a protective casing for a piezoelectric quartz crystal element mounted on conductors extending from the base and the conductors are secured to terminal pins on a mounting block fitted into the hollow base portion. In this arrangement the base has a rectangular or oval configuration with a beveled surface to form a compact narrow unit with the conductors in line and sealed into wells

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formed in the top of the base, the flange portion of the conductor seals being surrounded by a mass of high melting point solder to hermetically seal the openings in the wells. The outer ends of the conductors are threaded through terminal pins mounted on an insulating block reentrant with respect to the base portion and the block is secured to the base by crimping the edge over the block. The crystal unit is attached to the opposite ends of the conductors and is bridged across the space between the conductors in a vertical plane coincident with the axis of the base portion.

The cover or can portion of the casing, which is also of rectangular configuration to coincide with the base, is provided with a band of solder on the inner edge which is formed thereon to provide a mass of solder which is utilized during the sealing operation, the seal being formed without the use of a fluxing medium thereby avoiding the introduction of spurious vapors or gases which attack the crystal element and vary the frequency characteristics thereof.

A feature of the mechanical coupling of the can and base is the related contours of the contact surfaces of the beveled portion of the base and the sides of the cover. The long sides of the base in addition to the taper originating at the top thereof, are provided with a bulge of large radius while the corresponding sides of the can are parallel so that in joining the components together the can is stretched and expanded over the beveled portion of the base to prevent the molten solder flowing out of the joint. Consequently the solder is forced into the cavity between the conjoint surfaces of the can and base and finally collects in a cast ring around the top of the seal within the casing. This arrangement reinforces the mechanical strength of the seal between the lateral surfaces of the base and can but at the same time protects the cast ring seal against mechanical strain which might disrupt the vacuum-tight joint provided by the cast solder ring. After the completion of the solder joint between the can and base the casing may be highly evacuated or filled with dry air and the can sealed at the top.

The construction provides a permanently vacuum-tight protective casing for the crystal element which can withstand abnormal temperature and altitude changes without detrimental effects to the element and the mounting may be readily applied as a replacement for the former molded casing of the crystal element since it will have the same dimensions.

These and other features and advantages of the invention will be more apparent from the following detailed description and accompanying drawings which show one specific form of the invention.

Fig. 1 is a view in cross-section of the complete assembly of the device in accordance with this invention and shows the ring seal between the base and cover of the casing;

Fig. 2 is an end view in elevation of the device shown in Fig. 1;

Fig. 3 illustrates in enlarged cross-section a fragmental assembly of the base and cover and the mounting of the conductors in the base of the casing;

Fig. 4 is a plan view of the base showing the curvature of the side walls of the beveled portion;

Fig. 4A is a partial plan view of the open end of

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the cover or can and showing the parallel side walls thereof for comparison with the curved walls of the base in Fig. 4;

Fig. 4B is an enlarged portion of the cover in cross-section showing the solder layer applied to the inner surface of the open end of the cover;

Fig. 5 shows the various elemental details of the assembly in perspective and exploded fashion in their related positions to evolve the assembly as shown in Fig. 1;

Figure 6 illustrates the method of forming the seal by heating and pressure in a press fixture utilized in this invention; and

Fig. 7 is an enlarged cross-sectional view of portions of the cover and base of the casing to illustrate the relation thereof prior and after the sealing operation, the portion in dotted line showing the stretching of the cover and the formation of the cast solder ring at the top of the seal.

Referring to the drawings and particularly to Figs. 1 to 3, inclusive, the metallic protective casing of this invention consists of two principal components, namely, a hollow rectangular base or cap portion 10 and a cooperating cover, can or body portion 11 which forms a receptacle or casing enclosing an electrical device, for example, a piezoelectric quartz crystal element 12 which is supported within the casing on the inner ends of a pair of parallel conductors 13. The conductors are sealed in the base portion 10 and extend outwardly from the base and are secured to terminal pins 14 to detachably fit the crystal casing into a socket mounting of communication equipment in which it is desired to attain frequency control. The terminal pins are secured to a rectangular insulating block 15 which is fitted into the bottom of the base portion 10 and is secured therein by crimping portions of the base around the block, as shown at 16.

Since the piezoelectric crystal is usually of rectangular configuration and conveniently mounted parallel to the axis of the casing, it is preferable to shape the protective casing around the crystal element to provide a compact mounting assembly and therefore the base and body portion conform to a rectangular configuration having a narrow or small dimension coincident with the thickness of the element and a larger width and height parallel to the surfaces of the element so that the unit requires limited space in mounting and the proposed assembly may be substituted as replacement for the phenolic casing of prior devices. Since the metallic casing of this invention is primarily intended to be hermetically sealed by solder it is preferable to form the base and body portion of materials suitable for soldering, such as copper or brass or copper-plated steel, although other metals may be utilized in forming the casing of the crystal element.

The base portion 10 is drawn in hollow form to provide a peripheral shoulder 17 which continues as a downwardly extending tapered or beveled wall portion 18 and terminates in a rim portion 19 perpendicular to the top surface of the base, the beveled wall 18 and the rim portion 19 being joined by an angular ledge or shelf portion 20. The flat top of the base is also provided with a pair of wells or depressions 21 which are spaced in alignment across the long dimension of the base, the wells being reentrant with respect to the hollow base portion to provide recess cavities for the reception of the in-

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5 insulated conductors 13 extending through the base. As shown in Fig. 4, the base is also shaped in such a manner that the end walls have a curvature of small radius while the long side walls have a curvature of large radius thereby giving the side walls a slightly bulged configuration, as shown at 22. The cover or body member 11, on the other hand, is drawn with flat sides while the ends conform to the contour of the ends of the base portion, as shown in Fig. 4. Of course, the base may be reversed with respect to the cover so that the conductors extend through a wall portion which is flush with the open end of the cover. In this form no mounting block is required since the conductors function as the terminals of the device. The hermetically sealed conductors extending through the base are formed by applying a highly vitreous bead of glass 23, such as borosilicate glass, to the conductor 13 and simultaneously sealing the bead in a metallic eyelet 24 provided with a flange portion 25. The conductor 13 and eyelet 24 are preferably formed of an iron-nickel-cobalt alloy obtained commercially under the trade name "Kovar," this alloy having a coefficient of expansion which is compatible with the borosilicate glass bead 23 which forms the hermetic seal of the conductor. These seals may be formed of other compositions, such as lead glass, for the insulating portion of the seal hermetically wetted to a copper eyelet with a conductor formed of a suitable sealing metal, such as "Dumet" wire which has a coefficient of expansion compatible with the lead glass bead sealed in the eyelet. The sealed conductor assembly is preferably introduced in the wells 21 of the base through the hollow end of the base so that the flange 25 of the eyelet abuts against the lower apertured wall of the well and is preferably spot-welded thereto at distributed points to hold the seal conductor in position. A ring of high melting point solder, such as 95 per cent lead and 5 per cent tin, having a melting point of approximately 550° F. is placed in the well 21 around the tapered wall of the eyelet 24 and is heated by high frequency induction for about 1½ to 3 seconds to flow the solder in the bottom of the well and thereby form a hermetic and vacuum-tight seal 26 which fills the bottom of the well and adheres to the side walls, the bottom walls and the tapered eyelet. The high frequency heating thoroughly fuses the solder ring to the metal parts in the well. All traces of flux are completely removed after this operation so that no dangerous vapors can be emitted from the solder joint during the practical operation of the device.

Preliminary to forming the joint between the can or cover member 11 and the base 10, the beveled surface 18 of the base and the inner open end of the cover are provided with a coating or film 27 of solder to produce the main vacuum-tight joint in the casing. The tapered or beveled surface 18 of the base portion is thoroughly cleaned to a bright finish between the shoulder 17 and the ledge 20 and a thin film of solder, of low melting point, such as a eutectic solder composition of approximately 32 per cent lead, 50 per cent tin and 18 per cent cadmium is applied, the composition having a melting point of approximately 300° F. so that this solder may be rendered molten at a temperature which will not disturb the high melting point solder seals around the conductors in the wells. The solder film may be applied to the beveled surface by any well known technique, such as dipping or

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heating with an iron. In preparing the solder film on the beveled surface, it is essential to remove all traces of flux incorporated in the solder or applied to the copper surface to induce wetting action in the solder film. If flux vapors are permitted to enter the casing they usually condense on the crystal surface and thereby vary the frequency characteristics of the crystal so that it is unstable in operation. The solder film on the bevel surface of the base member 10 is only of sufficient thickness to form a wetting surface for the subsequent solder joint to be formed when the body member is applied over the beveled surface. The solder coating of the inner open end or skirt portion of the cover member 11 requires a different treatment since a wide band 28, as shown in Fig. 4B, of solder is applied thereto to form a coating preferably of the shape shown of the low melting point solder, in which the solder mass is heavier at the inner portion of the band. Of course, the solder coating must be processed to remove all traces of flux used in applying the solder to the surface. If desired, immediately after forming the solder film 27 on the base member and the solder coating 28 on the cover member 11, these components may be placed in an air-tight jar or desiccator so that the solder film and coating are maintained under controlled atmospheric conditions to prevent rapid oxidation of the solder surface. However, if this precaution is not taken some surface oxidation will occur but will not necessarily be detrimental to the fusing of the seal in the joint between the cover and base of the casing.

The method of forming the sealed joint between the cover and base of the casing is shown in Figs. 6 and 7 and involves a press fixture having a base 29 provided with an angular standard 30 supporting a geared rack plunger 31 carrying a recessed cap 32 at one end and cooperating with the gear 33 on the standard secured to a lever arm 34 carrying an adjustable weight 35. The base is provided with a mounting block 36 having apertures to receive the terminal pins 14 of the base portion 10 of the casing and a high frequency heating coil 37 is mounted in an arm 38 secured to a mounting block 39 supported to one side of the press. The method of sealing involves the placing of the assembled base with the crystal element supported on the conductors in the block 36 and arranging the high frequency coil around the base adjacent the beveled wall portion 18 thereof. The cover member 11 is set on the shoulder 17 of the base and the cap 32 of the press engages the top of the can to apply a pressure thereon due to the weight 35 on the lever coupled to the plunger 31 of the press.

It will be noted in connection with Figs. 4 and 4A that the different shapes of the cover 11 and the base 10 will prevent the cover from sliding down over the base or beveled portion 18, since the dimensional length and width of the base and cover are slightly different. Furthermore, the mass of solder 28 on the inner surface of the cover member 11 also prevents the cover slipping over the base portion. This is an essential feature of the mechanical and vacuum-tight seal produced in the joint between the cover and base of the casing of this invention. When the cover is placed in position over the base in the press with the coil 37 surrounding the soldered surfaces of the cover and base, the current in the coil is turned on to heat the solder film and coating 27 and 28, respectively, by induction heating for 2 to 3 seconds thereby rendering the excess

solder coating 28 molten and relieving the frictional hindrance imposed on the cover adjacent the base. When the solder coating 28 is in a molten state the pressure imposed on the cover member 11 by the weight 35 of the press causes the cover to be stretched and pressed downwardly over the beveled surface 18 of the base, as shown in dotted line in Fig. 7, thereby forming a substantially strong mechanical seal over a large area between the substantially parallel surfaces of the cover member 11 and the base 10 which are substantially parallel to the axis of the casing. The stretching or expanding of the cover over the base also produces a shearing action on the contacting surfaces of the molten solder coating 28 and the film 27 so that any tough film of oxide thereon is broken and proper fusion of the solder surfaces is accomplished. Another function of the stretching of the cover over the beveled surface of the base is to force the excess solder coating 28 to flow upwardly as the expanded portion of the cover is forced down over the beveled surface thereby preventing the excess solder from leaking out or flowing downwardly during the heating cycle. The fusion of the solder coating 28 and the film 27 occurs, at the temperature and time specified, without the use of any fluxing agent, either retained in the solder or subsequently applied to the joint so that the solder flow is entirely due to the rapid heating of the solder mass in the joint. The excess solder collects in the crevice formed by the shoulder 17 of the base and the inner wall of the cover member 11 and settles as a cast dam ring 40 at the highest point of the solder seal where it is less likely to be injured by fracture due to rough handling or mechanical strain. The strength of the mechanical joint as specified is realized by a test tried in removing the cover 11 from the base while the solder is still in a molten state. The pulling force necessary to separate these parts is between 20 to 30 pounds.

Another feature of this arrangement is that the solder material reinforces the mechanical joint due to the large surface contact of the cover and base and provides a vacuum-tight sealed joint which will maintain the initial atmosphere condition in the casing around the crystal element. The top of the casing is also provided with a vent hole formed by a central depression 41 in which is deposited a small bead of solder 42 which may be drilled at 43 to permit the interior of the casing to be highly evacuated or filled with dry air after which the bead is rendered molten to seal the opening 43 therein. The breather opening 43 also equalizes the pressure in the casing during the soldering cycle.

The invention has been described in connection with a specific casing with a piezoelectric crystal element mounted therein, the casing being of a definite configuration and provided with a pair of terminal pins for connecting the crystal to any suitable circuit. However, it is, of course, understood that the invention is not limited to this specific construction since the mechanical and hermetic seal of the casing may be applied to metallic casings of other forms for various electrical devices, such as coils, condensers, transformers, electron discharge devices, switching elements and similar delicate structures requiring a protective casing which maintains a vacuum-tight seal between the components of the casing. Similarly, such various devices may require more than two terminal pins so that the sealed conductors extending within the casing

may be multiplied to provide the required connection to the electrodes or components of the element mounted within the casing. The invention is therefore to be construed as including such modifications so that the scope of the invention is only to be limited by the appended claims.

What is claimed is:

1. A solder sealed metallic casing for an electric translating device comprising a hollow cap member having a flat portion provided with a plurality of depressions, said flat portion having a shoulder continuing as a beveled wall and terminating in a rim perpendicular to said flat portion, insulated conductors sealed in said depressions and extending parallel to the axis of said cap member, an insulating block fitted into said rim portion, a plurality of terminals carried by said block and attached to one end of said conductors, an electric translation device supported by said conductors on the other side of said cap member, a metallic enclosure member surrounding said device and engaging said beveled wall, and a vacuum-tight solder seal within said enclosure including a cast solder ring set in the crevice formed by said shoulder and the inner wall of said enclosure member.
2. A solder sealed metallic casing according to claim 1 in which the conductors are sealed in said depressions by means including a solder filling.
3. A solder sealed metallic casing according to claim 1 wherein the conductors are sealed in the depressions by means including a solder filling of high melting point and the cast solder ring is of low melting point solder.
4. A solder sealed metallic casing comprising a cap member having a flat portion provided with a plurality of depressions, said flat portion having a shoulder continuing as a beveled wall, metallic eyelets soldered into said depressions, conductors insulatingly extending through and supported by said eyelets, a quartz crystal unit supported by said conductors beyond said cap member and bridging the space therebetween, a terminal block recessed in said cap member and held therein by crimping at distributed points, terminal pins projecting from said block for receiving the opposite ends of said conductors, a metallic enclosure member surrounding said unit and engaging said beveled wall, and a vacuum-tight solder seal within said enclosure including a solder ring set in the crevice formed by the shoulder and the inner wall of said enclosure member.
5. A metallic housing for a piezoelectric crystal element comprising a hollow base portion, a pair of conductors extending through said base portion parallel to the axis and hermetically sealed thereto, a piezoelectric element supported by and extending between said conductors beyond said base portion, said base portion having a peripheral beveled wall extending downwardly from the top thereof, a metallic cover member enclosing said element and having an open end engaging said beveled wall, and a flux-free solder seal filling the joint between said cover and beveled wall, said seal terminating in an internal cast dam ring filling the crevice formed at the shoulder of said base portion above said beveled wall.
6. A vacuum-tight metallic casing for a piezoelectric crystal element comprising an oval-shaped hollow base portion having a pair of depressed wells reentrant with respect to said hollow base portion and disposed in line with the long dimension of said base portion, metallic eye-

lets soldered in said wells, conductors hermetically and insulatingly sealed in said eyelets and extending in parallel relation beyond said base portion and perpendicular thereto, a crystal element attached to said conductors and supported above said base portion, said base having a downwardly extending beveled wall terminating in a rim, an insulating block fitted into said rim and crimped thereby, a pair of terminal pins secured to said block in line with said conductors and embracing said conductors, a cover member enclosing said element and forming a metallic wide band joint over said beveled wall portion, and a vacuum-tight solder seal reinforcing said joint internally and terminating in a cast ring adjacent the inner edge of said base portion.

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