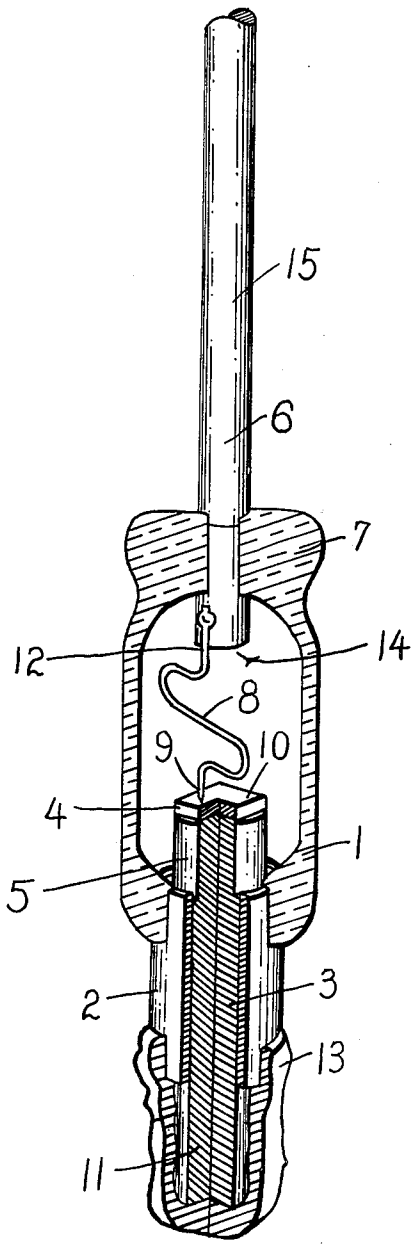
March 17, 1953 J. E. FITCHETT 2,632,042

ELECTRICAL CRYSTAL UNIT

Filed Aug. 25, 1948



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Patented Mar. 17, 1953

2,632,042

UNITED STATES PATENT OFFICE

2,632,042

ELECTRICAL CRYSTAL UNIT

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Application August 25, 1948, Serial No. 46,078

4 Claims. (Cl. 175—366)

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This invention relates to semi-conductor crystal units and the like, for example crystal rectifiers, amplifiers, oscillators and similar devices. The present application describes features claimed in copending applications: Serial No. 46,145, filed August 25, 1948, by Paul E. Gates; Serial No. 46,043, filed August 25, 1948, by Charles J. Ryan; and Serial No. 74,768, filed February 5, 1949, by Ralph B. Collins, Jr., all these applications having the same assignee.

An object of the invention is the achievement of a small, compact, inexpensive crystal unit, hermetically sealed for constant electrical characteristics.

A feature of the invention is the enclosure of the crystal in a glass tube sealed at its ends by metal contact pieces extending therethrough.

Other features, objects and advantages of the invention will be apparent from the following specification taken in conjunction with the attached drawings in which:

The figure shows a device according to the invention.

In the figure, a glass envelope 1, for example of tubular construction, has the metal tube or sleeve 2 sealed therethrough and extending therefrom. A cylindrical metal pin 3 is fitted slidably through the inside of said tube 2 and has the semi-conducting crystal 4 soldered or otherwise connected to the end 5 of said pin 3 inside envelope 1. The end 5 is made of slightly smaller diameter than the remainder of pin 3 because some of the sealing glass may extend over onto the inside of tube 2 near the inside of the envelope 1. A lead-in wire 6 is sealed through the opposite end 7 of envelope 1, and a catwhisker wire 8, for example of the type shown in copending application Serial No. 492,163 of E. T. Casellini, issued October 23, 1951, as Patent 2,572,801. The point 9 of catwhisker 8 is in contact with the surface 10 of crystal 4.

In making the device, the catwhisker 8 may be attached to the lead-in wire 6, and the sleeve 2 sealed to and through the end 7 of glass envelope 1. The pin 3 carrying crystal 4 is pushed through tube 2 until the crystal surface 10 contacts the point 9 with the pressure customary for such a contact. The pressure may be adjusted by pulling out or pushing in the pin 3, the end 11 of said pin being long enough to extend out of tube 2 sufficiently for proper manipulation.

The end 12 of catwhisker 8 may be affixed eccentrically with respect to wire 6, that is, off the longitudinal center line of said wire 6, for example to the outer surface of the wire 6 as shown. This allows the point of contact with the crystal to be

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changed by rotating the pin 3 in tube 2. With crystals which vary in characteristics from point to point this is extremely important; with crystals of uniform characteristics over their surface, it is of lesser importance. The end 12 of wire 8 and the pointed end 9 may be kept in the same straight line for best results, their line being preferably parallel to the longitudinal axis of pin 3.

After the pin 3 has been set at the proper position it may be spot welded to tube 2 at some convenient point, preferably a point near the outer end of tube 2, so that the heat of welding will be as far removed as possible from the crystal 4. A small amount of heat at low temperature sometimes improves the crystal characteristics, but too high a temperature seems to have a deleterious effect, especially if the crystal is of germanium. The pin 3 may then be seam-welded to the tube 2, or they may be soldered together quickly to avoid much heat on the crystal. The pin 3 and tube 2 may be dipped quickly in and out of a pot of solder, for example, the period during which the pin 3 is in the solder being preferably less than a second. A coat of solder 13 will then seal the pin 3 and tube 2, holding them together.

Although air at ordinary atmospheric pressure may be allowed to remain in envelope 1, other or more inert filling gases such as nitrogen or the rare gases may be used with beneficial results.

Germanium and silicon, with small amounts of the proper acceptor or donator impurities, are good crystal materials. Aluminum is a suitable impurity for silicon, tin for germanium. Other impurities may be used, for example, nitrogen with germanium.

The word glass is used herein in a broad sense, including for example hard and soft glasses and fused quartz. The metals used in the tube 2 and wire 6 must, of course be capable of sealing properly to the glass used. With the usual hard glass, "Kovar" metal may be used, for example.

Additional lead-in wires may be sealed through the envelope 1, if desired, to support additional catwhisker contacts to enable the device to be an effective amplifier. These may be side by side, as shown in Amico application Serial No. 40,561; concentric as shown in Koury application Serial No. 39,665, or in some other form; for example, lead-in wire could be sealed through the side of envelope 1 to hold the additional catwhisker with less capacitive relationship between the catwhiskers.

It is found that the crystal 4 may be soldered to pin 3 without harm from heating, although for best results the solder should be applied first to

the pin, and the unit quenched in water, for example, to prevent excessive oxidation, after the crystal 4 has been heated for only a second or two. After the catwhisker 8 is placed in contact with the crystal, further heating above say 90° C. appears to damage the contact between point 9 and crystal surface 10, and it is for this reason that the pin 11 is made long enough so that the quick application of solder 13 will not overheat the crystal contact.

In some cases, the catwhisker may be affixed to the pin 10, and crystal 4 affixed to the end 14 of lead-in wire 6, although to prevent damage of the crystal 4 during the heating necessary to seal the glass 7 to the wire 6, the seal may best be made further away from the end 14 of wire 6, unless the crystal 4 is affixed after the seal is made, which is not always practicable. In some cases, if desired, a tube 2 and pin 3 may be used at each end of the tube, the crystal 4 being held by a pin 3 at one end of the envelope 1 and the catwhisker 8 being held by a similar pin 3 in tube 2 at the other end, with solder such as 13 affixed at that end also. This makes a more complicated device.

The effect of vibration on the unit may be reduced if necessary by filling the space inside the envelope with a cushioning powder.

In one specific embodiment of the invention, the wire 6 was of 0.04 inch diameter, the tube 2 of about $\frac{5}{16}$ inch, and pin 3 of slightly smaller diameter and $\frac{3}{8}$ inches long. Tube 2 was $\frac{3}{8}$ inches long and pin 3 extended $\frac{1}{8}$ inch therefrom. These dimensions are given merely by way of example and not by way of limitation.

A so-called pigtail wire 15 for external connection may be butt-welded to the lead-in wire 14, the weld being just inside the glass seal 7 as shown for strength although it may be welded outside the seal if desired. When the lead-in wire 14 extends outside the seal 7, the pig-tail 15 may be omitted if the crystal is to be used where such connection is not necessary.

The pigtail 15, lead-in wire 14, and catwhisker 8 may be welded together into a single unit before the sealing operation, if desired.

What I claim is:

1. An electrical translator including a glass envelope, a metal tube having one end sealed to one end of said envelope, and a pin extending through said tube and into said envelope, said pin having a sliding fit within said tube and being of reduced cross-section beyond said tube inside the envelope, said pin supporting a semi-conductor element at its innermost extremity and being no larger transversely than said pin.

2. A semi-conductor crystal unit having a glass envelope, a metal tube having one end projecting from said envelope and the other end sealed

to said envelope, crystal diode elements in mutual contact within said envelope, and a pin extending through said tube and supporting one of said elements, said pin being of a sufficient diameter to be slidably received in said tube and being shouldered at a point within said tube and of reduced diameter inward to the innermost end of the pin itself.

3. A semi-conductor crystal unit having a glass envelope, a tube extending from said envelope and having its innermost end sealed thereto, a pin slidably received in said tube and having a portion of reduced diameter extending within said envelope, and a diode element carried by the end of said pin within said envelope, said diode element being no larger transversely than the end of said pin.

4. An electric translator including a glass envelope, a pair of translator elements enclosed therein and in pressure contact with each other, said element including a body of semi-conductor material and a sharp contact element, means rigidly supporting said elements extending through opposite ends of said envelope, said means including a metal fitting sealed to the glass envelope and having a bore of substantial length, the glass of the envelope potentially extending to some extent over the bore, and a pin of substantial length received in said bore and at its inner end supporting one of said translator elements, said pin being of uniform diameter for a major portion of the length that is received in the bore and being of reduced diameter at its inner extremity adjacent the region where the glass of the envelope might obstruct the pin but for the reduction in diameter, said uniform diameter being approximately equal to the diameter of said bore whereby an endwise slidable fit of the pin in the bore is realized preventing appreciable tipping of the pin in the bore without, however, inhibiting admission of the translator element into the envelope in the event that glass of the envelope extends somewhat across the inner end of the bore.

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REFERENCES CITED

The following references are of record in the file of this patent:

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