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E. G. JAMES ET AL

2,597,734

ELECTRICAL CRYSTAL CONTACT DEVICE

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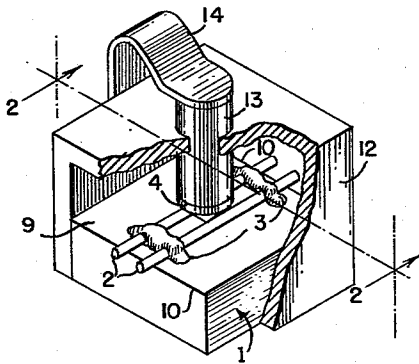


FIG. 1

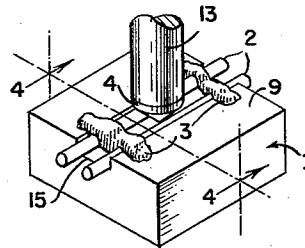


FIG. 3

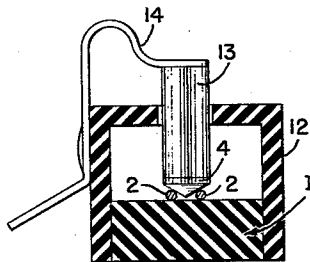


FIG. 2

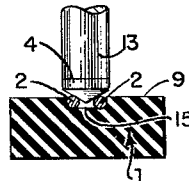


FIG. 4

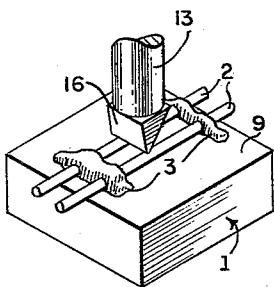


FIG. 5

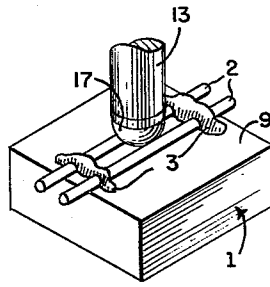


FIG. 6

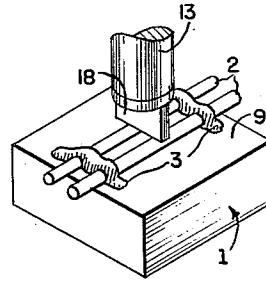


FIG. 7

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## UNITED STATES PATENT OFFICE

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## ELECTRICAL CRYSTAL CONTACT DEVICE

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5 Claims. (Cl. 175—366)

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## General

The present invention is directed to electrical crystal contact devices. More particularly, the invention relates to electrical crystal contact devices of the kind comprising an element of semiconducting crystalline material co-operating with at least two metallic contact members or wires which each makes substantially point contact therewith, the element and the contact members preferably being housed in a suitable protective container.

Electrical crystal contact devices of the type which include two contact members having two contact points in spaced engagement with the surface of the crystalline element are known in the art and are frequently used for amplification of electrical signals. For certain applications of these devices, such as transistor-type repeaters, the spacing of the points of contact substantially affects the repeater characteristics. Accordingly this spacing must be accurately determined. Heretofore it has been relatively difficult to construct such devices in a manner which lends itself to the use of inexpensive mass-production techniques and yet which provides an accurate predetermined spacing of the points of contact.

It is an object of the present invention, therefore, to provide a new and improved electrical crystal contact device which avoids the above-mentioned disadvantage of prior such devices.

It is another object of the invention to provide an electrical crystal contact device which has an accurate spacing between the contact points engaging the semiconducting crystal of the device and yet which is relatively inexpensive to manufacture.

In accordance with a particular form of the invention, an electrical crystal contact device comprises a body of insulating material, and at least a pair of wires supported in substantially parallel relation and with a predetermined substantially uniform spacing therebetween by that body at at least two spaced points along the length of each of the wires. The contact device further includes a resilient member, a terminal, and a crystalline element in engagement with the terminal and maintained in contact by the member in yielding engagement with a small portion of the outer peripheral surface of each of the wires at a position along the length of and intermediate the ends of each of the wires.

For a better understanding of the present invention, together with other and further objects thereof, reference is had to the following description taken in connection with the accompanying

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drawing, and its scope will be pointed out in the appended claims.

Referring now to the drawing, Fig. 1 is an enlarged perspective view of an electrical crystal contact device in accordance with the present invention; Fig. 2 is a sectional view of the device of Fig. 1 taken along the line 2—2; Fig. 3 is an enlarged perspective view of a crystal contact device in accordance with a modified form of the invention; Fig. 4 is a sectional view taken along the line 4—4 of Fig. 3; and Figs. 5-7, inclusive, are enlarged perspective views of additional modifications of the present invention.

## Description of Fig. 1 contact device

Referring now more particularly to Fig. 1 of the drawing, the electrical crystal contact device thereof comprises a body such as a rectangular block 1 of insulating material such as ceramic or synthetic resin plastic. At least a pair of wires 2, 2 are supported in substantially parallel relation and with a predetermined spacing therebetween by the block 1 at at least two spaced points along the length of each of the wires. An extremely quick and economical way of securing the wires 2, 2 to the block 1 to produce a substantially uniform spacing between the wires comprises winding at least two turns of wire around four adjacent sides of the block and securing at least two of those turns in position on a flat surface 9 of the block by means of small patches 3, 3 of insulating cement. These patches preferably have a small separation therebetween and may be positioned near opposite edges 10, 10 of the block 1. The cement patches 3, 3 preferably engage corresponding spaced points along the length of each of the wires 2, 2. The turns of wire mentioned above are preferably wound on the block 1 by any suitable coil- or grid-winding machine, thus not only assuring a very accurate spacing between convolutions but also accomplishing this operation in a manner which lends itself to inexpensive mass-production techniques. It may be stated, by way of example, that the wires 2, 2 may have a diameter of 0.05 millimeter and that the longitudinal axes thereof are spaced 0.1 millimeter apart. To avoid any discrepancies in pitch which may occur with reference to the few turns near the beginning and the end of a winding, it is preferable to wind more than two turns on the block 1.

All of the turns which were wound on the block 1 are next severed near the edges 10, 10 and then removed from the block so that only the two wires 2, 2 remain secured thereto by the cement

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patches 3, 3 as represented in Fig. 1. Two adjacent ends of the wires 2, 2 preferably extend a small distance beyond the block to facilitate their connection in a suitable electrical circuit (not shown).

The electrical crystal contact device also includes a crystalline element 4 maintained in contact with a small portion of the outer peripheral surface of each of the wires 2, 2 at a position along the length of and intermediate the ends of each of the wires, preferably, intermediate the cement patches 3, 3. This crystalline element may comprise a suitable material such as germanium and may have a substantially conical tip, as represented in Figs. 1 and 2, for engagement with the intermediate portions of the wires 2, 2. The crystalline element 4 effectively will have a point of contact with each of the wires 2, 2 and the distance between these two points of contact on the crystalline element will be slightly less than the distance between the longitudinal axes of the wires. It will be manifest that this distance can be accurately determined for a given cone angle and a diameter of wire.

The crystalline element 4 is preferably maintained in a suitable protective container 12 which may have an aperture therein to receive a conductive support 13, the inner end of which is secured to the crystalline element 4. A resilient member, such as a leaf spring 14, may be secured to the container 12 and arranged to engage one end of the support 13 to maintain the crystalline element in yielding engagement with two points on the periphery of the wires 2, 2. The member 14 may also serve as one of the terminals of the electrical crystal contact device for connecting it in circuit with suitable electrical apparatus. It will be clear that the cement patches 3, 3 on opposite sides of the points of contact of the crystalline element 4 with the wires 2, 2 are effective to prevent the force exerted by the member 12 from spreading the wires 2, 2, thus assuring an accurate spacing between the wires at all times.

#### *Description of Fig. 3 embodiment*

Referring now to Figs. 3 and 4 of the drawing there is represented a modified form of an electrical crystal contact device which is similar to that illustrated in Fig. 1 of the drawing. Accordingly, corresponding elements will be identified by the same reference numerals. In the Fig. 3 embodiment of the invention, the block of insulating material 1 is provided with a groove 15 of rectangular cross section extending across the face 9. The groove 15 is so dimensioned that the opposing side walls thereof have a predetermined spacing. The wires 2, 2 are secured in substantially parallel relation within the groove and against the opposing side walls thereof by insulating cement patches 3, 3 at at least two spaced points along the lengths of the wires. The crystalline element 4 and its conductive support 13 may be positioned with relation to the wires 2, 2 as described above in connection with the Fig. 1 device. It will be clear that while the Fig. 3 device assures accurate predetermined spacing between the wires 2, 2 of the device, the construction of the latter does not as readily lend itself to mass-production methods as does the device previously described.

#### *Description of Figs. 5, 6 and 7 devices*

It will be understood that the crystalline element engaging the pair of wires of the crystal contact device may take forms other than the

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conical form considered in connection with the previously described figures of the drawing. For example, Fig. 5 illustrates a crystal contact device employing a crystalline element having a knife edge portion 16. The sharp edge thereof effectively makes a point contact with each of the wires 2, 2. The longitudinal axes of the wires 2, 2 preferably are substantially perpendicular to the plane of the knife edge portion 16. Fig. 6 illustrates a modified form of the invention wherein the crystalline element has a substantially hemispherical tip 17, and Fig. 7 represents a still further modification wherein the crystalline element has a thin planar tip 18 engaging the wires 2, 2 in the manner previously described.

From the foregoing descriptions of the various embodiments of the invention, it will be clear that an electrical crystal contact device embodying the present invention is relatively simple in construction, inexpensive to manufacture and yet is characterized by the accurate spacing between the points of contact of the crystalline element and the two wires which are utilized to connect a portion of the device in an electrical circuit.

While there have been described what are at present considered to be the preferred embodiments of this invention, it will be obvious to those skilled in the art that various changes and modifications may be made therein without departing from the invention, and it is, therefore, aimed to cover all such changes and modifications as fall within the true spirit and scope of the invention.

What is claimed is:

1. An electrical crystal contact device comprising: a body of insulating material; at least a pair of wires supported in substantially parallel relation and with a predetermined spacing therebetween by said body at at least two spaced points along the length of each of said wires; a terminal; and a crystalline element in engagement with said terminal and having a substantially conical tip maintained in contact with a small portion of the outer peripheral surface of each of said wires at a position along the length of and intermediate the ends of each of said wires.

2. An electrical crystal contact device comprising: a body of insulating material; at least a pair of wires supported in substantially parallel relation and with a predetermined spacing therebetween by said body at at least two spaced points along the length of each of said wires; a terminal; and a crystalline element in engagement with said terminal and having a substantially hemispherical tip maintained in contact with a small portion of the outer peripheral surface of each of said wires at a position along the length of and intermediate the ends of each of said wires.

3. An electrical crystal contact device comprising: a body of insulating material; at least a pair of wires supported in substantially parallel relation and with a predetermined spacing therebetween by said body at at least two spaced points along the length of each of said wires; a terminal; and a crystalline element secured in electrical engagement with said terminal and having a thin planar tip maintained in contact with a small portion of the outer peripheral surface of each of said wires at a position along the length of and intermediate the ends of each of said wires.

4. An electrical crystal contact device comprising: a body of insulating material; at least

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a pair of wires supported in substantially parallel relation and with a predetermined substantially uniform spacing therebetween by said body at at least two spaced points along the length of each of said wires; a resilient member; a terminal; and a crystalline element in engagement with said terminal and maintained by said member in yielding engagement with a small portion of the outer peripheral surface of each of said wires at a position along the length of and intermediate the ends of each of said wires.

5. An electrical crystal contact device comprising: a block of insulating material having a substantially flat face and a groove of rectangular cross section extending across said face, the opposing side walls of said groove having a predetermined spacing; at least a pair of wires secured in substantially parallel relation within said groove and against said opposing side walls thereof at at least two spaced points along the length of each of said wires; a terminal; and a crystalline element in engagement with said

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terminal and maintained in contact with a small portion of the outer peripheral surface of each of said wires at a position along the length of and intermediate the ends of each of said wires.

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