

Jan. 17, 1956

E. G. JAMES ET AL
CRYSTAL CONTACT DEVICES

2,731,561

Filed Feb. 8, 1950

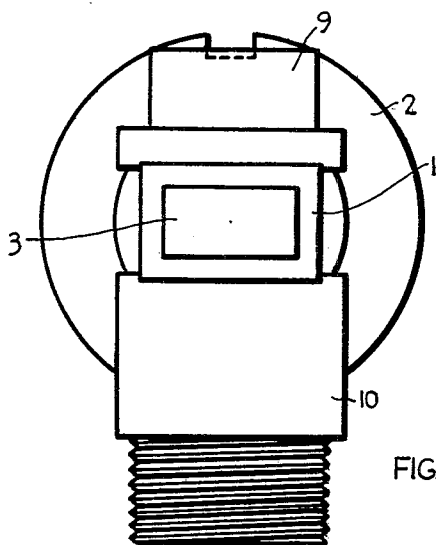
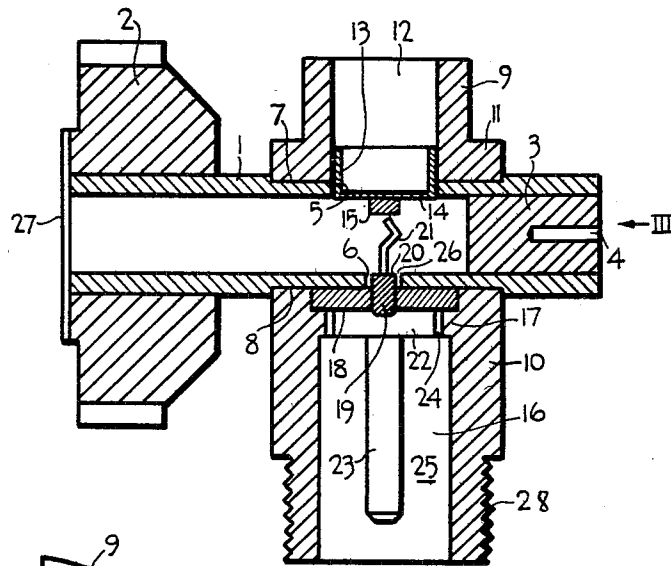
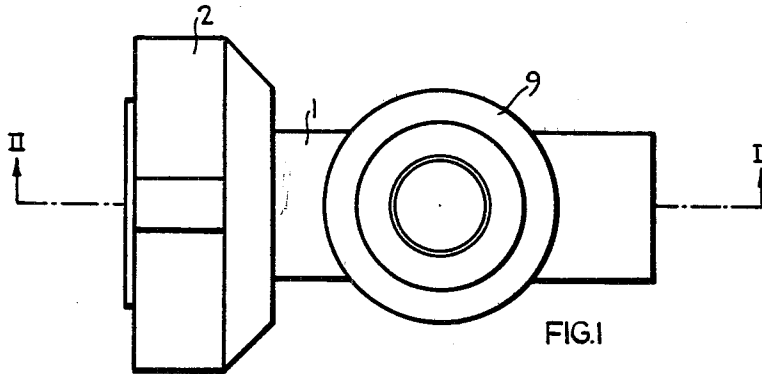


FIG. 2

FIG. 3

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CRYSTAL CONTACT DEVICES

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Application February 8, 1950, Serial No. 143,134

Claims priority, application Great Britain February 10, 1949

1 Claim. (Cl. 250—31)

The present invention relates to crystal contact devices.

More particularly the invention relates to crystal contact devices adapted for use at frequencies at which it is practicable to use electromagnetic waveguides.

One object of the present invention is to provide an improved form of crystal contact device suitable for use in conjunction with circuits utilizing electromagnetic waveguides.

A further object of the invention is to provide such a crystal contact device particularly adapted for use at millimetre wavelengths.

According to the present invention a crystal contact device comprises in combination a section of waveguide electrically terminated at or adjacent to one end and adapted to be coupled at the other end to a further section of waveguide, an intermediate portion of the wall of said waveguide being provided with a pair of apertures opposite to one another, a crystal element supported adjacent to one of said apertures by a supporting member secured to the outside of said waveguide, a metal member or whisker, co-operating with said crystal element, supported adjacent to the other of said apertures by a further supporting member secured to the outside of said waveguide, one of the co-operating members being effectively electrically connected to said waveguide whilst the other co-operating member is insulated therefrom, and a co-axial output plug or socket in which the inner contact is electrically connected to the insulated co-operating member whilst the outer contact is electrically connected to the waveguide and thereby to the other co-operating member.

The waveguide may be provided at the open end or between the open end and the co-operating crystal element and metal member or whisker with a window of dielectric material fixed in a plane substantially perpendicular to the longitudinal axis of the waveguide to form a hermetic seal across the waveguide.

The output plug or socket and/or the unterminated end of the waveguide may be provided with chokes to stop stray radiation therefrom. Preferably the termination of the waveguide is made adjustable to enable the device to be correctly matched during manufacture.

One embodiment of the present invention, as applied to a crystal contact device adapted for use as a mixing device at millimetre wavelengths will now be described by way of example with reference to the three figures of the accompanying drawing in which

Figure 1 is a plan view of the device,

Figure 2 is a section on the line II—II of Figure 1 and

Figure 3 is an end elevation in the direction of the arrow III in Figure 2.

Referring to the drawings, the crystal contact device includes a portion of waveguide 1 of a suitable silver alloy and of rectangular cross section having internal dimensions of 0.28 and 0.14 inch, one end of which is provided with a brass coupling flange 2 by which the

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portion of waveguide 1 can be connected to further portions of waveguide (not shown) forming part of a circuit with which the device is to be associated. The other end of the waveguide is closed by a brass plug 3 which is a sliding fit in the waveguide 1. The plug 3 is provided with a screw threaded hole 4, coaxial with the longitudinal axis of the waveguide, in which an adjusting screw may be fitted so as to enable the position of the plug 3 in the waveguide to be moved during manufacture. At like intermediate positions along the two wider sides of the waveguide circular holes 5 and 6 respectively are provided. Parts 7 and 8 of each of the wider sides of the waveguide adjacent to the holes 5 and 6 respectively are recessed by a circular end-miller of greater diameter than the holes and coaxial therewith. Secured in these recesses 7 and 8, for example by soldering or by means of a synthetic resin plastic cement, are two cylindrical members 9 and 10 which are of silver plated brass. The member 9 has a flange 11 the external diameter of which is such that it will fit into the recess 7 before being secured therein. An axial hole 12 extends through the member 9 and the internal diameter of the hole 12 is equal to the internal diameter of the hole 5 in the side of the waveguide 1. Fitted within the hole 12 is a hollow circular metal cylinder 13 of, for example, silver plated nickel closed at the end 14 nearest to the waveguide 1, the external diameter of the cylinder 13 being such that it is a force fit within the member 9. The end 14 carries a crystal element 15, for example of silicon. The other cylindrical member 10 also has an axial hole 16 and the external diameter of the member 10 is such that it will fit into the recess 8 before being secured therein. An annular protrusion 17 projects into the hole 16 close to the end of the member 10 which is secured to the waveguide 1 and the portion of the hole between the protrusion 17 and the waveguide 1 is of slightly larger diameter than the diameter of the rest of the hole. Fitted within this portion of the hole 16 between the protrusion 17 and the waveguide 1 is a ceramic disc 18, a spindle 19 is fitted through the centre of the disc 18 and passes through the hole 6 so that the end 20 of the spindle 19 is flush with the inside surface of the waveguide 1. Secured to the end 20 is one end of a flexible metal whisker 21, the free end of which is pointed and is in contact with the crystal element 15. The spindle 19, a collar 22 and a rod 23 are a single part of brass, the collar 22 being in register with the protrusion 17 but spaced therefrom by a gap 24 and the spindle 19 and rod 23 being colinear but on opposite sides of the collar 22. The rod 23 and the member 10 constitute the inner and outer contacts respectively of a coaxial output socket 25 of the device, the outside of the member 10 being formed at one end with a screw thread 28 on to which may screw the coupling of a female coaxial plug co-operating with the socket 25.

At the frequency of the electromagnetic energy to be propagated through the waveguide 1, the dimensions of the protrusion 17, the disc 18 and the gap 26 between the spindle 19 and the waveguide 1 are such that there is effectively a short-circuit across the gap 26. The end of the waveguide 1 adjacent to the coupling flange 2 is provided with a window 27 of a suitable dielectric material, such as mica, to form a hermetic seal across the waveguide 1.

One method of assembling the crystal contact device is to solder one end of the whisker 21 into a hole (not shown) in the end 20 of the spindle 19 and then fit the spindle 19 and the whisker 21 in position on the ceramic disc 18. The disc 18 is then secured in the end portion of the member 10, for example by means of a synthetic resin plastic cement, and the member 10 is soldered

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and the disc 18 attached by further plastic cement in the recess 8 in the side of the wave guide 1. The other member 9 is soldered in its recess 7, and the cylinder 13 to which the crystal 15 has been secured is forced into the member 9 until the point of the whisker 21 makes contact with the crystal 15 at the desired contact pressure. In its final position the end 14 may project slightly into the waveguide 1.

The position of the crystal 15 and the whisker 21 relative to the closed end of the waveguide 1 are chosen so that the device will be substantially matched to the circuit with which it will be associated, but the matching is finally adjusted by movement of the plug 3. When the device has been tuned by movement of the plug 3 for operation at a particular frequency, the adjusting screw is removed from the hole 4 and the plug 3 soldered in position. Thus the crystal 15 and whisker 21 are hermetically sealed in the device by the plug 3, the window 27, the securing of the ceramic disc 18 and the metal cylinder 13 in the members 10 and 9 respectively, and the fixing of the members 9 and 10 in the recesses 7 and 8 in the waveguide 1.

When the device is used as a mixer, or frequency changer, the electromagnetic waves of the different frequencies which are to be mixed are fed into the flanged end of the waveguide 1, and voltages at frequencies equal to the sum and difference of the frequencies of the electromagnetic waves are developed across the coaxial output socket 25, from which they may be applied by coaxial cable to a utilization device.

It will be understood that the wave guide connecting flange 2 and the coaxial output socket 25 may take many forms. Thus, for example to improve the effective coupling to members to which they may be connected, they may be provided with half-wavelength chokes of known kind to reduce stray radiation.

The spindle 19 may project into the waveguide and it is then preferable, so that the device may operate efficiently over as wide a band of frequencies as possible, that the part of the spindle within the waveguide shall taper down to the point where the whisker 21 is secured.

Although in the arrangement described the end of the waveguide 1 remote from the flange 2 has been described as closed by a moveable plug 3, the waveguide 1 may be closed by a part through which passes a metal screw so as to project into the interior of the waveguide 1. In this case matching would be effected by movement of this screw and, after adjustment, this screw then being secured in position by means of plastic cement. Moreover,

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although in the arrangement described the whisker was supported from the side of the waveguide adjacent to the output socket, the position of the crystal element and the whisker may be interchanged.

It will be appreciated that the present invention provides a crystal contact device, particularly adapted for use at millimetre wavelengths, in which the device is of relatively simple construction and is adjusted during manufacture so that it can be connected to an operating circuit and is ready for use without further adjustment.

What we claim is:

A crystal contact device for use at millimetric wavelengths comprising an elongated one-piece length of waveguide of uniform cross-section along its total length, said wave guide having a fixed preadjusted termination, means to couple the end of said waveguide section remote from said termination to a further section of waveguide, a crystal element, a mounting for the crystal element alone secured solely to one side of the waveguide on one side of the longitudinal axis thereof, a metal whisker bearing against the crystal element, a mounting for the metal whisker alone secured solely to the side of the waveguide opposite to the side to which the mounting for the crystal element is secured and on the other side of the longitudinal axis of the waveguide, and a coaxial output coupling having inner and outer contacts which are electrically connected one to the crystal element and the other to the metal whisker.

References Cited in the file of this patent

UNITED STATES PATENTS

2,378,944	Ohl	June 26, 1945
2,419,613	Webber	Apr. 29, 1947
2,423,390	Korman	July 1, 1947
2,427,087	Carlson	Sept. 9, 1947
2,460,109	Southworth	Jan. 25, 1949
2,484,256	Vaughn	Oct. 11, 1949
2,491,971	Hall et al.	Dec. 20, 1949
2,563,613	Ohl	Aug. 7, 1951
2,673,930	Matare	Mar. 30, 1954

FOREIGN PATENTS

970,555	France	Jan. 5, 1951
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OTHER REFERENCES

"A Microwave Frequency Standard," Telpey & Goldberg, Proc. I. R. E., vol. 35, No. 9, Sept. 1947, pp. 965-969.