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G. D. FORBES ET AL

2,624,852

BACKING FOR DELAY LINE CRYSTALS

Filed March 4, 1946

FIG. 1

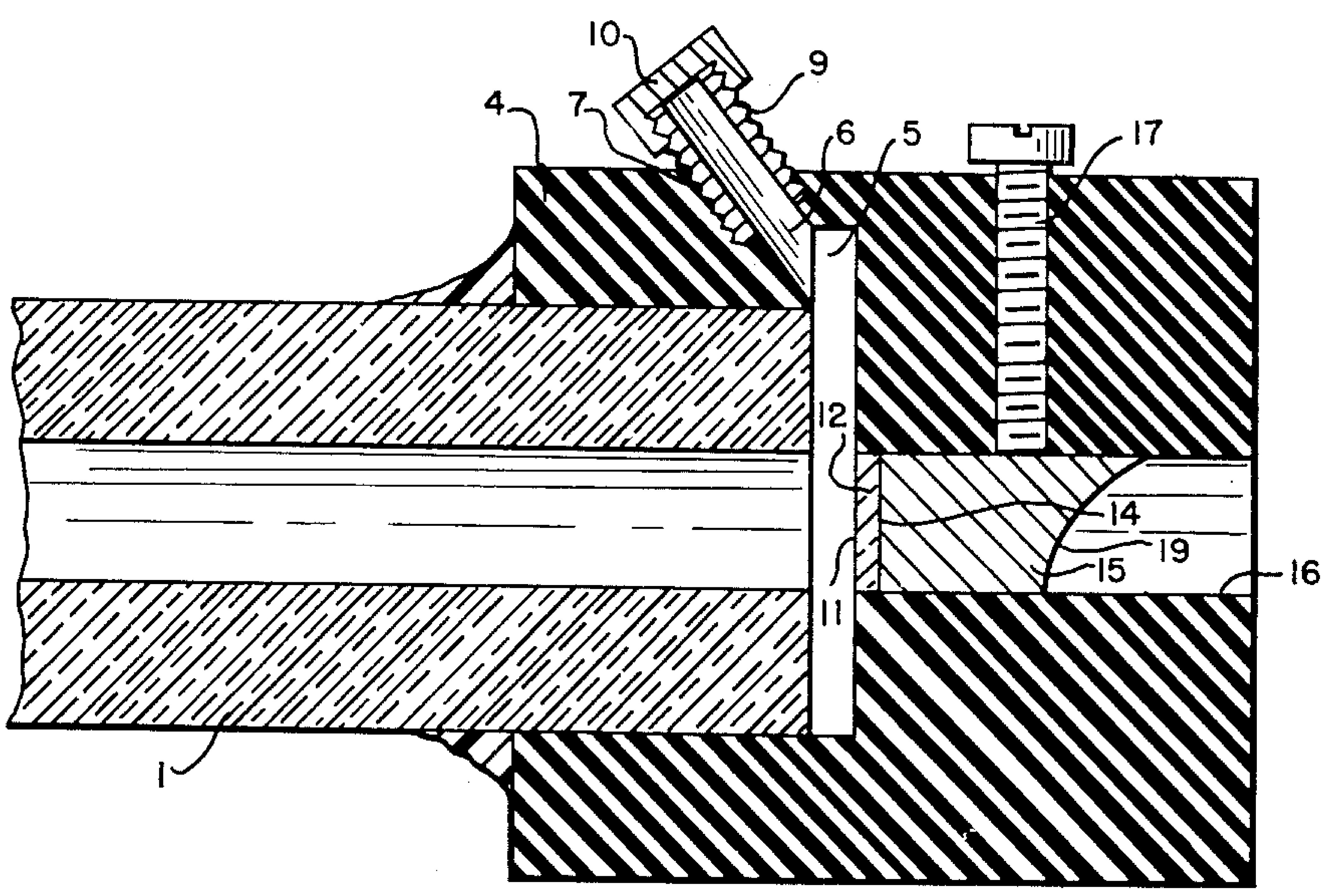
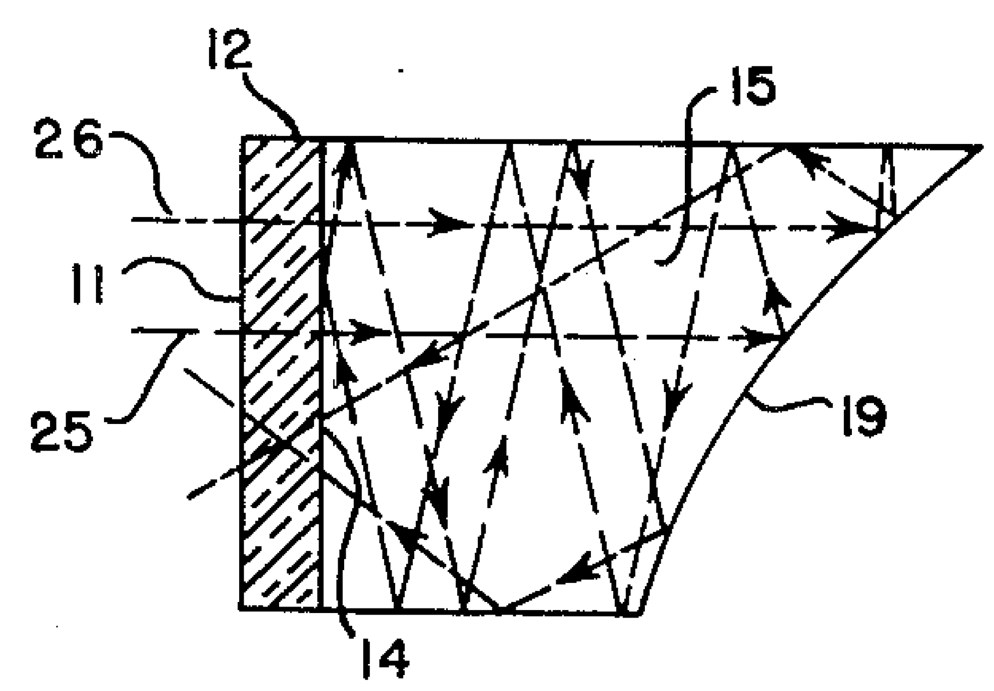


FIG. 2



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BACKING FOR DELAY LINE CRYSTALS

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5 Claims. (Cl. 310—8.2)

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This invention relates to electrical equipment, and more particularly to apparatus adapted to delay an electrical signal or impulse for a predetermined time interval. Such apparatus is often called a delay line.

The present invention is adapted to be used with a supersonic type delay line wherein an electrical signal is converted into mechanical vibrations which are transmitted through a liquid medium. The transmitted vibrations are received and reconverted back into an electrical signal which thus has been delayed in time by an amount substantially equal to the time required for the vibrations to pass through the liquid medium.

One system of this character is disclosed in the pending U. S. patent application of the present inventors, Serial No. 608,310, filed August 1, 1945, now Patent Number 2,423,306 on a "Transmission Line." The electrical signal, which may be a voltage pulse, is applied to a piezo-electric crystal, which sets up mechanical vibrations in a liquid column. The opposite end of the column bears against another crystal, in which the mechanical vibrations set up electrical potentials which exactly reproduce those applied to the first crystal. A relatively long time differential will exist between the original and the reproduced potentials because the velocity of transmission of the mechanical vibrations through the liquid column is quite slow. By properly proportioning the delay circuit, successive signals may be seen simultaneously and compared as to size and shape on the usual C-R tube screen.

The crystals employed for the line are cut to vibrate in the region of 10 to 30 megacycles, since the signal to be delayed is commonly a modulated carrier having a frequency within this range. The crystals are very thin, and are subject to breakage when the apparatus is roughly handled or when any unusual pressure is exerted on them, as by movement or centrifugal pressure of the liquid used in the line.

The present invention provides a so-called backing member (solid end cell) for the crystal which will attenuate certain unwanted mechanical vibrations which otherwise might be harmful to the crystal. The backing member or end cell is so shaped that mechanical vibrations received therein from the crystal and from extraneous sources continue to travel through many internal reflections, until substantially dissipated.

The objects of this invention include:

Providing a form of delay line less susceptible to breakage;

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Providing an end cell adapted to withstand rough treatment;

Providing means for utilizing very thin piezoelectric crystals without danger of fracture; and

Providing time delay means having improved performance characteristics.

The invention may be better understood by reference to the drawing, in which:

Fig. 1 is a partial view of a supersonic delay line incorporating the improved end cell;

Fig. 2 is a view of the solid end cell of the invention.

Referring now to Fig. 1 of the drawing, there is illustrated a portion of a hollow glass tube 1 which is rigidly mounted in a block 4 of insulating material, such as "Bakelite." Within block 4 adjacent the end of tube 1 is an enlarged chamber 5 which communicates with a passage 6 through which the liquid medium, such as mercury, may be inserted into the tube. Passage 6 may be tapped at 7 to receive a threaded metal tube 9 which is closed by a cap 10. Tube 9 constitutes a terminal which connects electrically through the mercury filling of passage 6 and chamber 5 to the exposed face 11 of a piezoelectric crystal 12. Crystal 12 is mounted, as shown, in block 4 adjacent chamber 5. Abutting obverse face 14 of crystal 12 is a backing member 15 of lead or other equivalent material having a high degree of attenuation for mechanical vibrations. Backing member 15 and crystal 12 are intimately associated in any suitable manner such as by solder, and are disposed in a bore 16 in the block 4. Member 15 is held in position by means such as a screw 17, which serves also to provide an electrical connection to the side 14 of the crystal 12.

Backing member 15 is so shaped that crystal-generated mechanical vibrations impinging thereon travel through multiple reflection paths as illustrated in Fig. 2 at 25 and 26 until they have become substantially attenuated. For this purpose, the end 19 of member 15 opposite crystal 12 is cut to the shape of an irregular curve, not critical in its shape, but so formed that the mechanical energy will be reflected back and forth within the member a number of times and thus attenuated to a large degree before finally being reflected to the crystal. With a curve of irregular shape, the energy which finally arrives at the crystal consists of components having generally out of phase relationships with each other. Thus the stress imposed on the crystal therefrom is negligibly small. A portion of the energy is entirely attenuated within the member and thus never reaches the crystal.

It will be understood that other arrangements, such as a plurality of facets or compound curves may be used to produce satisfactory results.

The result of such design is that the mechanical force against the crystal is small, and in consequence the induced piezo-electric potential is small. This effect will occur regardless of the degree of attenuation achieved in the block material. It will, of course, be most effective when the material used has a high attenuation effect on supersonic waves, and when it is a good acoustic match for the crystal (usually made of quartz). Lead and tin are examples of metals possessing these qualities to a high degree. It will be understood also that a portion of energy reflected back toward the crystal will strike at less than that critical angle of incidence, and so will not penetrate it, but will again be reflected back into the backing.

What is claimed is:

1. A component for a supersonic delay line, consisting of a solid backing member formed of material having a high degree of attenuation for mechanical vibrations, said member having a planar face on one end, the opposite end being curved to produce multiple internal reflections of vibratory waves impinging on said planar face, a piezo-electric crystal adapted to vibrate within the supersonic frequency range, conductive means for securing said crystal intimately to said planar face, and means for making electrical connections to said crystal.

2. A supersonic delay line component comprising a piezo-electric crystal adapted to vibrate substantially in the range between 10 mc. and 30 mc., a solid backing member formed of material having a high degree of attenuation for mechanical vibrations and one end thereof having the

shape of an irregular curve so as to produce multiple internal reflections of vibrating waves introduced therein through said crystal, whereby substantial portions of said waves reflected back toward said crystal will impinge thereon out of phase with each other, the other end of said member being planar, and means for securing said crystal to the planar end of said backing.

3. In a supersonic type delay line, a piezo-electric crystal adapted to vibrate in the range between 10 mc. and 30 mc., a backing member of material having a high attenuation for mechanical vibrations and one end thereof having the shape of a compound curve so as to cause multiple internal reflection of such vibrations, the other end of said member being planar, and means for securing said crystal intimately to the planar end of said backing member.

4. The delay line of claim 3 wherein the material of said backing member is composed of lead.

5. The delay line of claim 3 wherein the material of said backing member is composed of tin.

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REFERENCES CITED

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

UNITED STATES PATENTS

Number	Name	Date
2,001,217	Scofield	May 14, 1935
2,015,836	Bechmann	Oct. 1, 1935
2,415,832	Mason	Feb. 18, 1947
2,447,061	Franklin	Aug. 17, 1948
2,448,352	Carlin	Aug. 31, 1948