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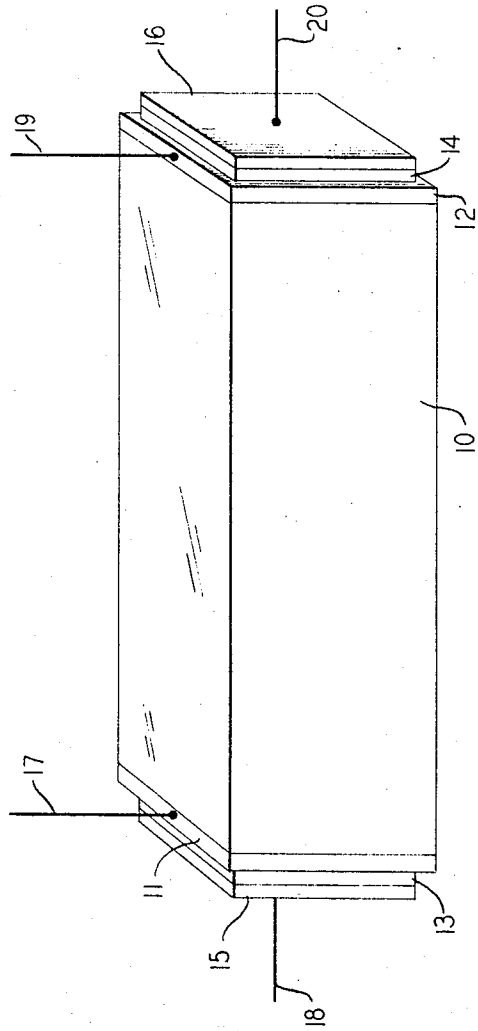

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TEMPERATURE STABLE ULTRASONIC DELAY LINE COMPOSED OF SiO_2 AND MgF_2 AND METHOD OF MAKING SAME

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ABSTRACT OF THE DISCLOSURE

The specification describes a delay line having low temperature sensitivity. It comprises a heterogeneous particulate body of SiO_2 and MgF_2. Since SiO_2 has a negative temperature coefficient of delay and MgF_2 a positive coefficient of delay the materials are mixed in proportions resulting in a zero temperature coefficient.

This invention relates to ultrasonic delay lines which are relatively insensitive to temperature changes.

Excessive variation of delay time with temperature has been a principal consideration in the construction of delay lines. The most satisfactory solution to date takes advantage of certain "zero temperature coefficient" glasses which are found to be effective delay media and are relatively insensitive to normal changes in temperature. However, the glass compositions which exhibit this ability have been found to have chemical instabilities. These instabilities, though small, are sufficient to significantly impair the delicate delay time-temperature relationship.

Consequently, there continues to be a need for an inexpensive material from which delay lines can be easily fabricated and which exhibits a low dependence of delay time with temperature.

This invention is directed to such a delay media and borrows somewhat from the concepts contained in application Ser. No. 601,716, filed Dec. 14, 1966 by J. T. Krause. In that application a zero temperature coefficient material was prepared by joining together two discrete bodies of different acoustic materials, one material having a positive temperature coefficient, the other a negative coefficient. The relative lengths of the two bodies can be selected so that the composite structure exhibits a zero temperature coefficient. Whereas this solution is acceptable, the presence of the boundary between the media is a source of loss and unwanted reflection. According to this invention the problem is overcome by mixing together silicon dioxide and magnesium fluoride in finely particulate form and hot-pressing the mixture into a compact body. Silicon dioxide has an appreciable negative temperature coefficient of delay and magnesium fluoride has a large positive coefficient of delay. When mixed in the proper proportions a composite mixture having a zero temperature coefficient of delay can be produced. These particular compounds do not react appreciably during the hot-pressing operation so that the resulting body is a true physical mixture. It is apparent that for the purpose of the invention each component of the mixture must retain its physical properties.

A body of particulate matter would normally be expected to be very lossy but a compacted body of these

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particular components exhibits surprisingly efficient ultrasonic transmission.

These and other aspects of the invention may be more fully appreciated from a consideration of the following detailed description. In the drawing:

The figure is a perspective view of a compacted particulate delay line made in accordance with the invention.

The novel ultrasonic medium can be described in terms of an ultrasonic delay line, a typical embodiment of which is shown in the figure. The delay medium **10** is composed of a compacted body of SiO_2 and MgF_2. The ends of the delay medium are coated with metal electrodes **11** and **12** and conventional transducers such as quartz or barium titanate, **13** and **14**, are affixed to the electrodes. Metal films **15** and **16** cover the exposed face of the transducer; **17**, **18** refer to the input terminals and **19**, **20** designate the output terminals.

The composite body **10** was made by the following procedure. Particulate SiO_2 and MgF_2 were thoroughly mixed and then pressed at 980° C. and 20,000 p.s.i. for fifteen to twenty minutes. The particle size was 2μ. The appropriate particle size will be somewhat dependent on the frequency of operation anticipated for the device but generally would average less than 5μ. Samples of different SiO_2/MgF_2 weight ratios were measured for temperature dependence of delay time. A composition having a ratio of 0.306 yielded a delay coefficient of +14 p.p.m./° C. and a composition having a ratio of 0.419 yielded a delay coefficient of −13 p.p.m./° C. These ratios are considered to describe the useful range of low temperature coefficient materials. The optimum ratio for a zero TC material lies in the range of 0.35 to 0.38 (accounting for experimental error and other variables). The internal friction of these mixtures, at 1.5 mHz., is comparable and in some cases lower, than that in typical isopaustic glasses. Aging tests show no measurable room temperature aging over an eight week period after heating to 110° C.

What is claimed is:

1. An ultrasonic delay line having low temperature sensitivity comprising a delay medium consisting essentially of a dense heterogeneous mass of SiO_2 and MgF_2 mixed together in a weight ratio of SiO_2 to MgF_2 falling within the range 0.35 to 0.38.

2. A method for making a delay medium having low temperature sensitivity comprising the steps of:

mixing together SiO_2 and MgF_2 in finely particulate form, the particles being less than 5μ in size, and the weight ratio of SiO_2 to MgF_2 being in the range 0.35 to 0.38, and

compacting the particulate mixture at a pressure of at least 20,000 p.s.i. and a temperature of the order of 980° C.

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