United State:

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[15] **3,653,746**

[45] **Apr. 4, 1972**

[54] ACOUSTO-OPTIC DEVICE

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[21] Appl. No.: **81,839**

[52] **U.S. Cl.** **350/161**
[51] **Int. Cl.** **G02f 1/34**
[58] **Field of Search** 350/161

[56] **References Cited**

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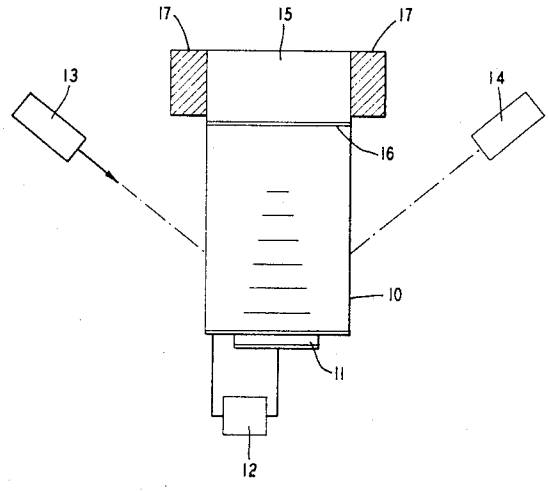
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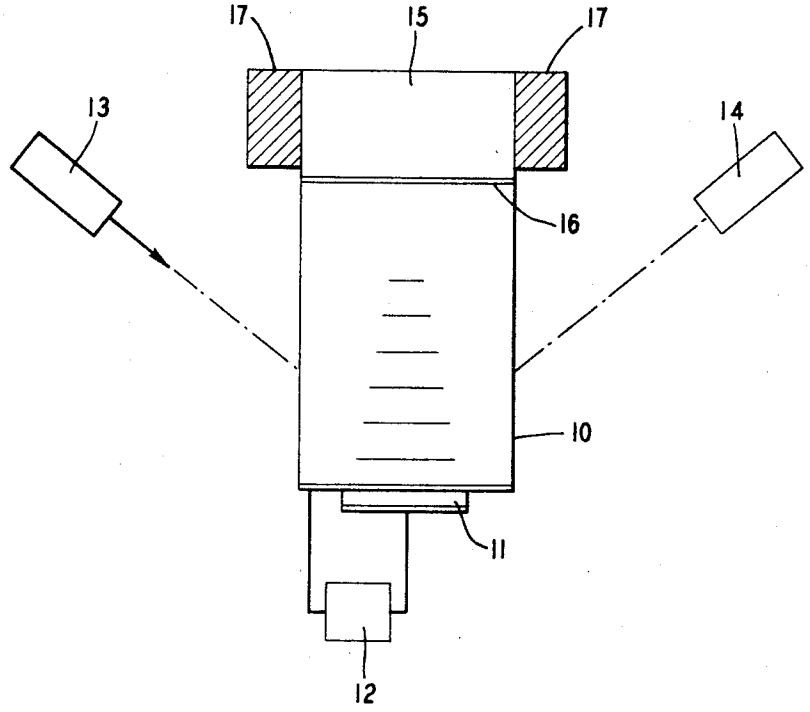
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[57] **ABSTRACT**

The specification describes an acousto-optic device comprising an acoustic medium of lead molybdate and an acoustic-energy absorbing element of beryllium oxide. This combination of materials is optimized for several parameters including thermal expansion, thermal conductivity, mechanical impedance, and acoustic absorption.

2 Claims, 1 Drawing Figure





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ACOUSTO-OPTIC DEVICE

This invention relates to acousto-optic devices, and specifically to materials adapted for such devices that give unexpectedly superior performance.

Of the many acousto-optic materials investigated to date, lead molybdate has been found to be especially effective. As optical beam scanners and modulators find commercial applications, this material could assume considerable prominence in this field.

Recent developments with these devices have indicated a need for extending their operation to higher frequencies and power levels. As this occurs, the problems of unwanted reflections, and of distortions and instabilities due to thermal effects, become severe.

While it is customary to incorporate acoustic absorbing means on such devices to eliminate reflections, the usual approach, using conventional materials, is not adequate to meet the sophisticated requirements now being imposed on lead molybdate acousto-optic devices.

The design of these devices must now take into account several parameters. Specifically, the acoustic absorber must not only dissipate acoustic energy but it must also provide effective heat transfer to avoid thermal perturbations in the acoustic medium. These devices are highly sensitive to temperature changes and, with the high power densities that the absorber is now required to dissipate, thermal conductivity becomes a very critical parameter. The bond affixing the absorber to the acoustic losses in the bonding material. To obtain a reliable and thin bond it is necessary that differential thermal expansion be small. It is also necessary, in minimizing acoustic reflections at the bonding interface, to match the mechanical impedances of the acoustic and absorbing media very closely.

It is evident that for a given acoustic medium, in this case lead molybdate, these several criteria place very stringent demands on the absorbing material.

According to this invention, an acoustic-optic device employing lead molybdate as the acoustic medium and beryllium oxide as the absorbing medium largely satisfies the foregoing prerequisites.

These and other aspects of the invention may become more apparent from a consideration of the following detailed description.

IN THE DRAWING:

The FIGURE is a perspective and partly schematic representation of an acousto-optic deflector representing a broader category of devices to which the invention is directed.

The FIGURE shows an acoustic medium **10**, which in this case is composed of lead molybdate, with transducer **11** attached as shown. The transducer is typically a thickness mode $LiNbO_3$ plate which has high electromechanical coupling. Other high efficiency transducers can be used as well. A signal generator **12** drives the transducer **11** which launches the acoustic wave into the acoustic medium **10**. The source of the optical beam, shown here as laser **13**, directs the beam into the acoustic medium where the beam interacts with the elastic

wave according to principles well established in the art. The deflected beam exits from the acoustic medium and is sensed by photodetector **14**. The photodetector might be found at a remote station where the acousto-optic device is used for digital modulation. Where the device is used for beam scanning the element being scanned, e.g., a holographic recording medium, appears as a sensing element in lieu of photodetector **14**. The acoustic absorber **15** is bonded to the acoustic medium with an adhesive layer **16**. The adhesive layer is typically epoxy, although other appropriate bonding materials such as indium or solder can be used. As indicated above, the absorbing material is beryllium oxide. A conductive mount **17**, conveniently of copper, serves as a heat sink.

The properties of the beryllium oxide absorber, and, where significant, those of lead molybdate, are summarized in the following table as follows:

	BeO	$PbMoO_4$
Temperature coefficient of expansion	8	9
Mechanical impedance	35.6	27.7
Thermal conductivity	.58	
Absorbing characteristic	Good	

In an acousto-optic beam deflector absorbing at 100 MHz. this absorber is capable of absorbing over 97 percent of the acoustic power at an operating power level of several watts, while at the same time dissipating the heat generated by conduction to the associated heat sink **17**. The high conductivity associated with this absorber maintains the acoustic medium at a constant temperature. Effective bonds can be made between the medium and the absorber with no evidence of adverse strains and with acoustic losses comparable with prior art bonds.

It has also been found that the addition of a layer of lead 2–10 mils, on the end (acoustic) of the absorber further enhances the performance of the device by absorbing the small residual signal.

Various additional modifications and extensions of this invention will become apparent to those skilled in the art. All such variations and deviations which basically rely on the teachings through which this invention has advanced the art are properly considered within the spirit and scope of this invention.

What is claimed is:

1. An acousto-optic device comprising:

an ultrasonic traveling wave medium of lead molybdate,

an ultrasonic transducer attached to said traveling wave medium for propagating an ultrasonic wave through the medium, and

an absorbing medium attached to said traveling wave medium for dissipating ultrasonic energy after it has passed through that medium, said absorbing medium comprising beryllium oxide.

2. The device of claim **1** further including a laser device disposed with its radiation output incident on the said traveling wave medium and means for sensing the radiation deflected from said medium.

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UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,653,746 Dated April 4, 1972

Inventor(s) Arthur W. Warner

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Column 1, line 29, after "acoustic" insert --medium must be exceptionally thin to avoid undue acoustic losses--.

Column 2, line 25, cancel "absorbing" and insert --operating--, after "MHz" delete the period.

Signed and sealed this 1st day of August 1972.

(SEAL)
Attest:

EDWARD M.FLETCHER,JR.
Attesting Officer

ROBERT GOTTSCHALK
Commissioner of Patents

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