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LIGHT CONTROLLING METHOD AND MEANS

Filed Oct. 25, 1928

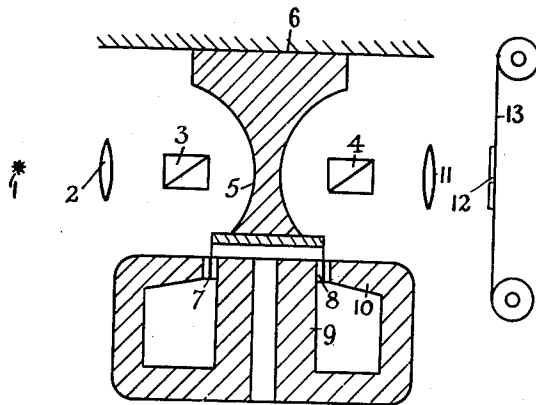


Fig. 1.



Fig. 2.

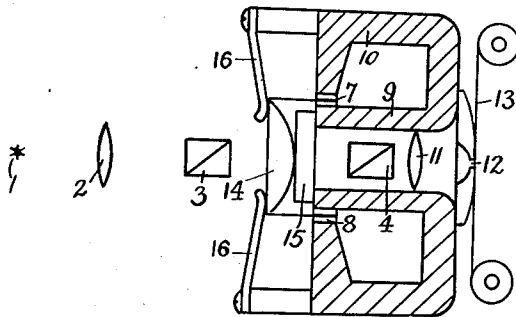


Fig. 3.

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UNITED STATES PATENT OFFICE

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LIGHT CONTROLLING METHOD AND MEANS

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11 Claims. (Cl. 179—100.3)

The present invention relates to means for controlling the intensity of a beam of light in accordance with variations in mechanical force produced by sounds or other mechanical oscillations.

It is known that certain transparent bodies which are isotropic when they are unstressed, nevertheless become birefringent when they are stressed. This effect is termed a photo-elastic effect.

According to the present invention, the intensity of a beam of polarized light is controlled in accordance with sound, or other mechanical oscillations, by applying corresponding oscillatory stresses to a body which in the unstressed condition is isotropic, the beam of light being passed through said body. The invention is to be understood to cover the use of bodies which are anisotropic provided that they are used in such combinations that the effects exhibited are equivalent to those shown by an isotropic body. An initial stress may, if desired, be applied to the body, in which case the body in its normal working condition will, of course, not be isotropic. The initial stress may be a steady or an oscillatory stress, and if the stress is oscillatory, it may have a frequency equal to the natural frequency of the body or to a harmonic thereof.

The invention will be described, as applied to the conversion of electrical oscillations corresponding to sounds into corresponding changes in the intensity of a beam of light, with reference to the accompanying drawing in which

Fig. 1 is a diagrammatic view in front sectional elevation of an arrangement in accordance with the invention.

Fig. 2 is a view in side elevation of a detail of Fig. 1.

Fig. 3 is a part sectional view of another arrangement according to the invention.

Referring to Fig. 1, a beam of light, which may, for example, be monochromatic, from the source 1 is formed by suitable optical means 2 into a parallel beam and is passed through two polarizing prisms 3 and 4, and in the path of the light between the prisms 3 and 4 is arranged a body 5 which in an unstressed condition is isotropic and which is at least partially transparent. Suitable bodies are, for example, glass, celluloid or the like material. These substances have the advantage of producing a relatively large effect per unit mechanical stress. They are also cheap and easily worked. The material selected should have a small lag in its

action and, although some kinds of celluloid have this small lag, other kinds have not. One end of this body 5 is fixed at 6 and the other end is attached to a coil 7 situated in an annular air gap 8 between two magnetic poles 9 and 10. The currents to be transformed into changes of light intensity are passed through this coil 7 and give rise to alternate tensions and compressions in the body 5. The body 5 may, as shown, be so shaped that the point of maximum stress lies in the path of the beam of light. A side view of the body 5 is given in Fig. 2. It will be clear that if, in the position of rest, the prisms are so arranged that no light passes, upon stressing the isotropic body between the prisms, the resulting birefringence will produce what is in many ways equivalent to a rotation of the plane of polarization produced by the first prism and consequently some light will pass through the second prism. It may, however, be advantageous to arrange the prisms in such a manner that complete extinction of the light only takes place at an extreme value of either compressive or tensile stress. The light between the two prisms may be allowed to remain in a parallel beam or it may be brought to a focus at the body and again converted into a parallel beam before passing through the second prism.

The light beam, after modulation, passes through an optical system indicated by 11 and 85 through a slit 12 on to a travelling film 13 where a record of the changes in stress applied to the body 5 is made upon the film in the form of transverse lines of varying degree of blackening.

In the form of the invention illustrated in Fig. 3, parts which correspond to those already described in Fig. 1 are given the same reference numbers.

In this arrangement, the light beam is passed through two transparent isotropic bodies 14 and 15 which may be of glass. The body 14 has a convex surface which contacts at a point, or along a line, with the flat surface of the body 15. The light beam is caused to pass through the point or line of contact, and the varying stresses produced at this point or line of contact when acoustic or the like currents are passed through the coil 7 produce, as before, effective rotation of the plane of polarization of the light beam.

An initial compressive stress is applied in any suitable manner to the bodies 14 and 15. Means for producing such a stress are indicated diagrammatically by the springs 16. The initial

stress must be such that the applied currents at no time reduce the stress quite to zero.

In one form of the arrangement illustrated in Fig. 3, the body 14 is of part cylindrical shape and therefore there is line contact between the bodies 14 and 15. By using a suitable optical system 11, this line of contact can be brought to a sharp focus upon the surface of the film 13 and the slit 12 may be dispensed with. When currents of varying magnitude and sign are applied to the coil 7, the fine line of light remains of substantially the same width but the intensity of its illumination varies.

One advantage of the present method of light modulation is that the parts which are set in mechanical vibration by the currents passed through the coil 7 may be made relatively heavy without impairing the performance at higher frequencies since the operation of the apparatus is dependent only upon changes of stress and the amplitude of vibration may be made exceedingly small.

In another form of the invention, which is not illustrated, the electrical oscillations may be applied either directly or, after their voltage had been stepped up, to a piezo-electric crystal, the stresses set up thereby being transmitted to the isotropic body. In this form of the invention, a battery of piezo-electric crystals is preferably used, a number of crystals being arranged one above the other with conducting material between them, conducting material being also placed at both ends of the pile, and alternate conducting layers being connected together. It will be clear that differences of potential applied to the two sets of conductors will cause changes in shape of the battery of crystals and if these are attached to the isotropic body they will produce changes in stress therein.

In a further modification, two crystals of an anisotropic material, such as quartz, may be used, one of the crystals producing a right handed rotation and the other producing a left handed rotation of the plane of polarization, the two rotations being equal and opposite. The combination is therefore in effect an isotropic body.

Although the invention has been described as applied to the conversion of electrical oscillations into changes of light intensity, it will be clear that it is not confined to this. For example, mechanical oscillations may be applied directly to the isotropic body.

In all cases, it will be understood that the isotropic body may be initially stressed and oscillatory stresses may be superimposed upon the unidirectional stress. The steady unidirectional stress may be either a tensile or a compressive stress.

It will be understood that the beam of light passed through the isotropic body may be wholly or partially plane polarized, or it may even be wholly or partially elliptically polarized.

The mechanical oscillations applied to the body may, in some cases, be in the form of high frequency oscillations modulated with acoustic or other relatively low frequency mechanical oscillations.

I claim:

1. A method of controlling the intensity of a beam of polarized light in accordance with sound vibrations which consists in applying an initial mechanical stress to a body that is isotropic in the unstressed condition and birefringent when stressed, passing a beam of polarized light

through said body, and applying to said body additional mechanical stresses corresponding to said sound vibrations.

2. A method of controlling the intensity of a beam of polarized light in accordance with sound vibrations which consists in applying an initial mechanical stress to a body that is isotropic in the unstressed condition and birefringent when stressed, passing a beam of polarized light through said body, applying to said body an additional high frequency mechanical stress, and modulating said high frequency stress in accordance with said sound vibrations.

3. A method of controlling the intensity of a beam of polarized light in accordance with sound vibrations which consists in applying an initial mechanical stress to a body that is isotropic in the unstressed condition and birefringent when stressed, passing a beam of polarized light through said body, generating an electric current corresponding to said sound vibrations, and employing said current to apply additional mechanical stresses to said body.

4. A method of controlling the intensity of a beam of polarized light in accordance with sound vibrations which consists in applying an initial mechanical stress to a body that is isotropic in the unstressed condition, and birefringent when stressed, passing a beam of polarized light through said body, generating a high frequency electrical current, employing said current to apply a high frequency mechanical stress to said body, and modulating said current in accordance with said sound vibrations.

5. A method of controlling the intensity of a beam of polarized light in accordance with sound vibrations which consists in initially stressing in a body that is isotropic when unstressed and birefringent when stressed, passing a beam of polarized light through the point of maximum stress in said body, and applying to said body mechanical stresses varying in accordance with said sound vibrations.

6. Apparatus of the class described comprising polarizing means, a body that is isotropic when unstressed but birefringent when stressed, analyzing means, means for directing a beam of light through said polarizing means, body and analyzing means, means for applying an initial stress to said body, a stress applying member operatively connected with said body, and electro-magnetic operating means for said member.

7. Apparatus of the class described comprising polarizing means, a plurality of bodies that are isotropic when unstressed but birefringent when stressed, said bodies having substantial line contact with one another, analyzing means, means for directing a beam of light through said polarizing means, through said bodies through the line of contact therebetween, and through said analyzing means, means for forcing said bodies together to apply stress thereto, and electro-magnetic operating means for said stress applying means.

8. Apparatus of the class described comprising polarizing means, a plurality of bodies that are isotropic when unstressed but birefringent when stressed, said bodies having substantial line contact, analyzing means, means for directing a beam of light through said polarizing means, bodies, and analyzing means, said light beam passing through said line of contact, means for forcing said bodies together to apply an initial stress thereto, and an additional stress applying

member operatively connected to one of said bodies.

9. Apparatus of the class described comprising polarizing means, a plurality of bodies that are isotropic when unstressed but birefringent when stressed, said bodies having substantial line contact, analyzing means, means for directing a beam of light through said polarizing means, bodies, and analyzing means, said light beam passing through said line of contact, means for forcing said bodies together to apply an initial stress thereto, an additional stress applying member operatively connected to one of said bodies, and electro-magnetic operating means for said stress applying member.

10. Apparatus of the class described comprising polarizing means, a plurality of bodies that are isotropic when unstressed but birefringent when stressed, analyzing means, means for di-

recting a beam of light through said polarizing means, at least one of said bodies, and said analyzing means, means for forcing said bodies together to apply an initial stress thereto, an additional stress applying member operatively connected to one of said bodies, and electro-magnetic operating means for said member.

11. Apparatus of the class described comprising polarizing means, analyzing means, a plurality of bodies that are isotropic when unstressed but birefringent when stressed, means for directing a beam of light through said polarizing means, at least one of said bodies, and analyzing means, means for forcing said bodies together to apply an initial stress thereto, and an additional stress applying member operatively connected to one of said bodies.

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20	95
25	100
30	105
35	110
40	115
45	120
50	125
55	130
60	135
65	140
70	145
75	150