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W. S. PAJES

1,954,947

ELECTROOPTICAL METHOD AND APPARATUS

Filed March 4, 1931

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Fig. 1.

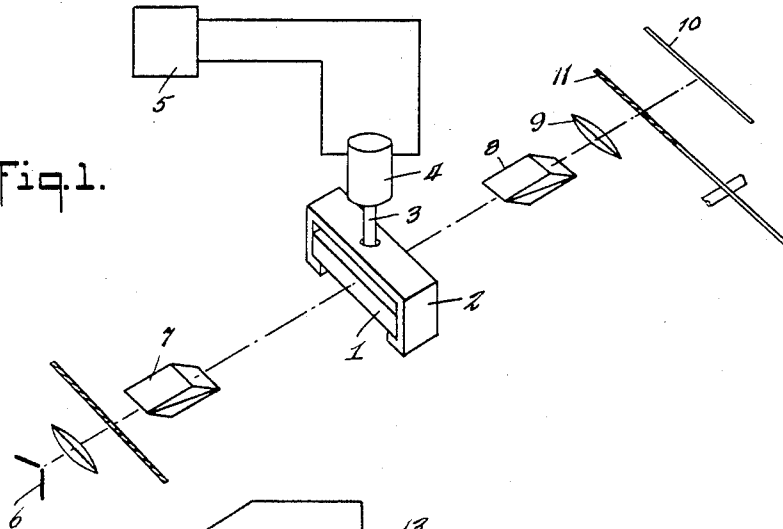
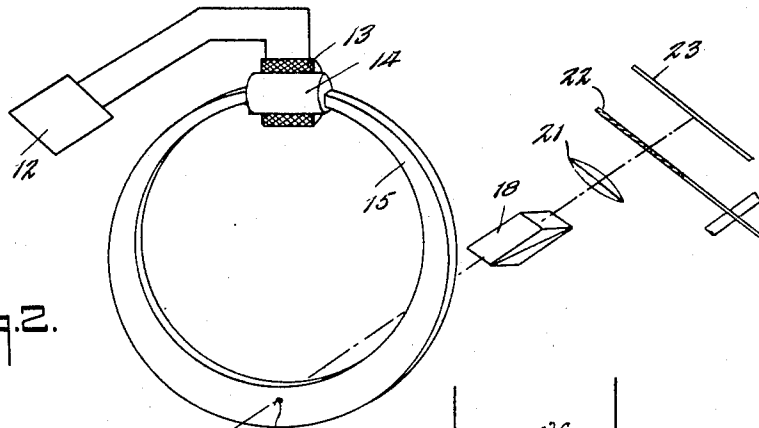
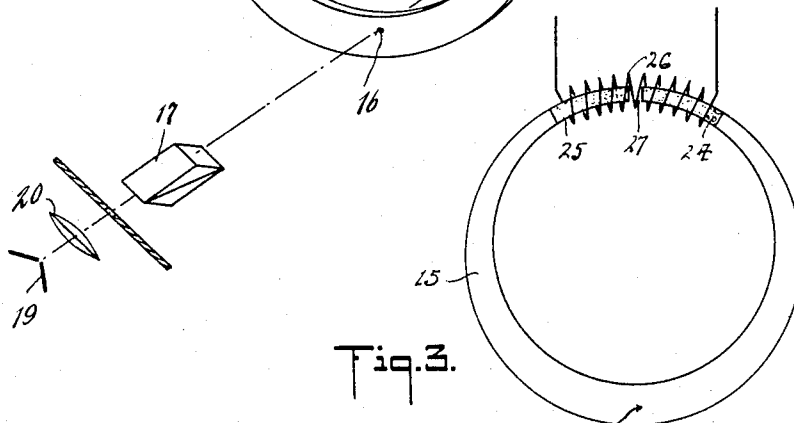


Fig.2.



Tiq.3.



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ELECTROOPTICAL METHOD AND APPARATUS

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Application March 4, 1931, Serial No. 520,064

6 Claims. (Cl. 88—61)

This invention relates to electro-optical systems and with particularity to methods and means for controlling light.

An object of the invention is to provide an improved method of changing a constant intensity light into a light of varying intensity.

Another object of the invention is to provide an improved method and means for translating signal variations into corresponding light variations.

A further object of the invention is to provide an improved form of light valve suitable for use generally in any system requiring the translation of energy variations of certain characters into corresponding light variations.

A feature of the invention relates to a method of translating mechanical stresses into light variations.

Another feature of the invention relates to the method and means for causing a normally transparent medium to act as a valving medium for light. In accordance with this latter feature it is proposed to employ a solid block of transparent material such as glass or the like which is subjected to mechanical strains to control the character of the light that emerges from said material.

A further feature relates to an electro-mechanical light valve wherein an electric field is used to stress a solid transparent member to control the character of the light that emerges from said member.

A still further feature of the invention relates to a method of using the magnetostriction effect to vary the light transmission characteristics of a solid transparent member.

Other features and advantages not specifically enumerated will be apparent after a consideration of the following detail descriptions and the appended claims.

Referring to the drawing:

Fig. 1 shows in schematic form a typical arrangement of apparatus embodying the light controlling features of the invention;

Fig. 2 is a schematic view of another embodiment of the invention; and

Fig. 3 shows a modified structure of light valve according to the invention.

It has been found possible to render isotropic bodies like glass, temporarily double refracting by subjecting them to mechanical stresses or the like. There is illustrated in Fig. 1 of the drawing a simple arrangement for subjecting a transparent member such as glass to varying mechanical stresses to correspondingly control the character of the light passing through and emerging from the transparent member.

As shown in Fig. 1, the member 1 is in the form of a bar of flint glass or other isotropic material. The bar 1 is mounted in such a manner that its longitudinal ends are rigidly fixed, for example in a frame 2. The bar 1 is adapted to be acted upon by a reciprocating member 3 which may be slidably or otherwise mounted in the frame 2, preferably at the middle of the member 1. The member 3 may be forced against the member 1 by any suitable mechanism, however for the purpose of illustration, the member 3 is shown in Fig. 1 as connected to an electro-magnetic solenoid 4 which in turn may be variably energized in accordance with signals received from the schematically represented signaling device 5. This latter signaling device may be a television transmitter, a facsimile transmitter, or even a source of sound currents. Due to the variable energization of the device 4 member 3 is forced with corresponding varying pressure against the center of the member 1, thus subjecting the latter member to a stress tending to deform it to an arcuate or U shape. It has been found that when the member 1 is mounted in optical array with the usual polarizing and analyzing device that the variations in stress exerted upon the member 1 correspondingly vary the character and amount of light that reaches the analyzer. Thus as shown more clearly in Fig. 1, the light from the constant intensity source 6 (which may be an arc lamp or any other suitable source) is projected through the polarizing or Nicol prisms 7 and thence through the member 1 to the analyzing prisms 8.

When the member 1 is placed between the prisms 7 and 8 with its length at an angle of approximately 45° to the principal planes of said prisms, there will be produced no effect upon the light transmitted so long as the member 1 is not strained. However, when the member 1 is strained, causing a slight bending thereof the light from the polarizer 7 passing through the upper and lower parts of the member 1, that is above and below the median line thereof, will be able to pass the analyzing prism 8, while the polarized light striking the median portion will be prevented from reaching the analyzer 8. The amount of light therefore passing through the analyzer 8 is proportional to the stress applied to the member 1. The angle of 45° is an optimum angle, all other angles causing smaller effects.

From the foregoing it will be seen that there is provided a novel method of changing the constant intensity beam from a source 6 into a varying beam corresponding to the signals from the

source 5. This varying beam may be collected by a suitable optical system 9, and projected upon a suitable receiving surface 10 in any well known manner. Thus, as shown in Fig. 1 the collected light is projected upon the surface 10 by means of a television scanning disc 11. In using the light control arrangement above described, the bar 1, in its normally unstressed position is placed as shown, and the prisms 7 and 8 are turned until the light from source 6 reaching screen 10 is extinguished. Consequently the application of signal impulses to member 1 causes corresponding quantities of light to reach screen 10, as above described.

Instead of applying direct mechanical stresses to the member 1 to control the light as above described, use may be made of the magneto and electro-striction effects to vary the deformation of the member 1. As it is well known para-magnetic bodies change their physical dimensions when subjected to the influence of a magnetic field, and these changes in dimension are proportional to the changes in the field intensity. It has been found that nickel exhibits the magneto-striction effect by increasing its length instead of shortening as in the case of iron or other similar materials. Any suitable arrangement therefore may be employed for translating this variation in length into a corresponding deformation of the member 1.

Referring to Fig. 2 there is shown one manner of producing the necessary strain in the isotropic medium using the magneto-striction effect. In this figure the numeral 12 represents a source of signal current such as a television transmitter, a facsimile transmitter, a source of sound current or the like. These currents are impressed upon a winding 13 which surrounds a core 14 of para-magnetic material such as nickel. The core 14 is mounted and closely fitted between the ends of a circularly shaped member 15 of flint glass or other transparent isotropic medium.

As shown in Fig. 2 the member 15 tapers towards its ends and is the widest at the region 16. Consequently as the winding 13 is variably energized by the received signal currents it causes a corresponding increase in length of the core 14, thus subjecting the member 15 to a double stress at opposite ends of the core. This stress has its greatest effect at the wide portion 16. In order to utilize this stress to control a light beam there is situated at opposite sides of the region 16 a polarizing prism 17 and an analyzing prism 18 respectively, a suitable source of high intensity and constant light 19 being provided. As hereinabove described, the light which passes from the polarizer 17, in passing through the region 16 of the member 15 is subjected to varying effects due to the strains existent in this portion of the member 15. It is preferred of course to confine the polarized light to a comparatively narrow strip, and for this purpose a suitable lens system 20 may be provided in front of the polarizer to focus the light in a small spot upon the member 15. By means of any suitable optical system 21, the light emerging from the analyzer 18 is collected and projected upon a suitable receiving surface. In the drawing the collected light is shown as projected upon the scanning field of a television scanning disc 22 whence it may be projected upon any suitable viewing surface 23, such as a ground glass screen or the like.

If the device shown in Fig. 2 is to be used for television reproduction it is preferable to so design the bar 14 that its resonant frequency is

outside of the frequency range of the signal currents. For example, if the signal currents have a range of 40 kilocycles, then the member 11 should have a higher natural period or resonant period. Thus in one particular design that has been found to provide extremely satisfactory results, the bar 14 was approximately 6 centimeters in length and had a diameter of 1.3 centimeters.

Instead of using a nickel magneto-striction member to stress the member 15, an iron or other similar member may be employed. In the case of an iron core, the ends of the core will be fastened to the ends of the member 15 since iron decreases in length under an electric field.

Furthermore, while a single magneto-strictive member is employed to deform member 15, a plurality of separate stressing members may be employed, for example in "push-pull" array with respect to said member. Other variations will be apparent to those familiar with the art. Furthermore, it is understood that the invention is not limited to any theory of operation but it is believed that the stressing of member 15 results in a corresponding rotation of the plane of polarization of the light together with other optical effects that result in a variation in the amount of light that passes the analyzer when member 1 (Fig. 1) or member 15 (Fig. 2) is stressed.

Fig. 3 shows another manner of stressing the curved glass member 15. In this embodiment the reduced ends of the member 15 have attached thereto in any convenient manner magnetic arms 24 and 25 which are surrounded by a suitable winding 26 leading to a source of signaling currents. As the winding 26 becomes variably energized the gap 27 between the magnetic members 24 and 25 opens and closes, thus subjecting the member 15 to a corresponding stress. The manner of using the device of Fig. 3 is identical with that disclosed in connection with Fig. 2, and further description thereof is not believed necessary. Instead of attaching the magnetic members 24 and 25 to the ends of the member 15 in Fig. 3, the magnetic member may completely surround the member 15 except for a small portion in the region 16 for permitting the passage of light, thus providing in effect a horse-shoe magnet with a magnetic gap 27. In this embodiment it will also be understood that preferably the member 15 with the magnetic members attached thereto has a natural frequency outside of the range of the signaling frequencies.

While specific manners of changing the electric signal currents into corresponding stresses or strains in a transparent isotropic medium have been disclosed, it will be understood that the invention is not limited thereto, and that other equivalent means may be employed without departing from the spirit and scope of the invention.

What is claimed is:

1. The method of controlling light which comprises producing a plane polarized light beam, positioning a bar of light transparent material with its longitudinal axis at an angle of 45° to the principal plane of said light, and bending said bar to control its light transmission characteristics under control of signal impulses applied thereto.

2. A light valve including a substantially U-shaped member of light transmitting material, a light polarizer situated on one side of the U-shaped member, a light analyzer situated on the other side of said U-shaped member, and signal controlled means for deforming the portion of

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the U-shaped member between said polarizer and analyzer.

3. A light valve including a looped body of light transmitting material, a magneto-strictive member positioned between the ends of the loop, means for projecting a polarized light beam through a portion of said looped member, and means for varying the degree of magneto-striction in said member in accordance with signal currents to correspondingly rotate the plane of polarization of the light passing through said looped member.

4. In combination a body of light transmitting material in the form of an incomplete loop, a magneto-strictive member positioned between the ends of the loop for subjecting said member to

varying bending moments, said member having a higher natural period than the maximum frequency of the said variations.

5. A light valve including a substantially annular body of light transmitting material, means for projecting a polarized light beam through said body, and signal controlled means for bending said annular body to control its light transmission characteristic.

6. In combination a body of light transmitting material in the form of an incomplete loop, the said body tapering in width from its central portion towards the loop ends, and means for subjecting said body to a bending moment in accordance with signal variations.

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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