350-377

Sept. 13, 1932. D. B. GARDNER 1,877,744

LIQUID PRISM

Filed Aug. 31, 1931

Fig. 1.

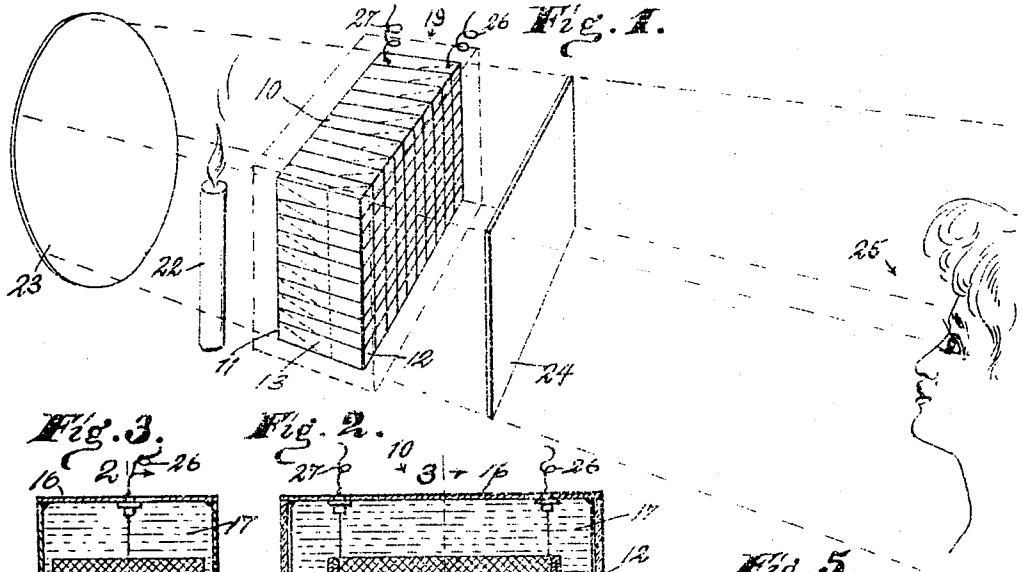


Fig. 3.

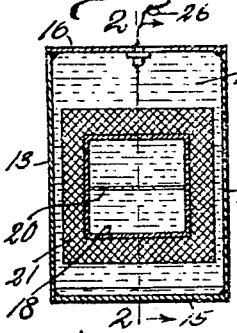


Fig. 2.

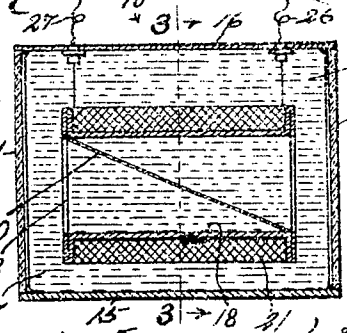


Fig. 5.

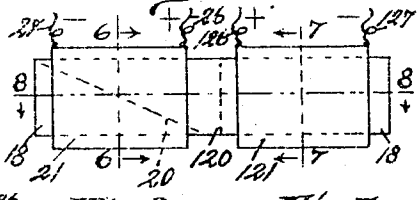


Fig. 4.

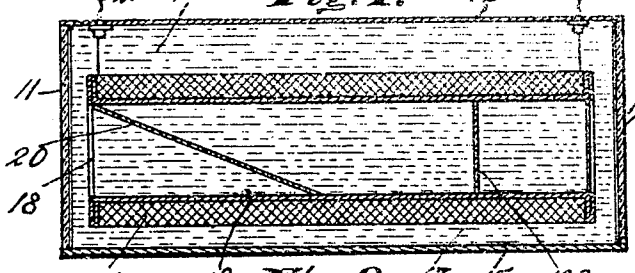


Fig. 6.

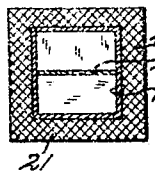


Fig. 7.

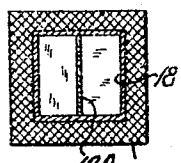


Fig. 9.

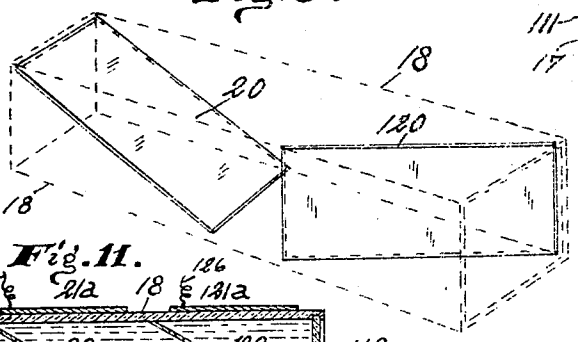


Fig. 8.

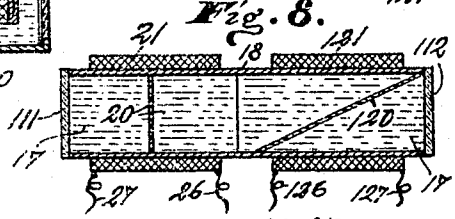


Fig. 10.

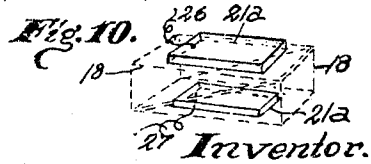
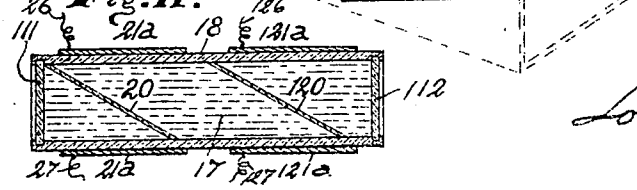


Fig. 11.



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UNITED STATES PATENT OFFICE

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LIQUID PRISM

Application filed August 31, 1931. Serial No. 560,458.

This invention relates to means for controlling light, and the principal object is to provide a prism that can be constructed cheaply and in varied sizes. To that end I provide a fluid prism including a transparent container in which I place a multi-refracting translucent solid such as mica, gypsum, cellophane, etc., to separate the fluid into parts or sections that in form are the shape of solid prisms and answer fully and effectively all of the purposes that the Nicol and Halle type prisms accomplish; and this liquid prism I provide can be made of sizes many times larger than the solid prisms now in use, and manufactured at less than one-tenth their cost. In other words, I provide a liquid prism that is relatively unlimited as to the extent of its dimensions, which is not true of solid prisms, for, as is well known, they are limited as to size; consequently this restriction as to size places a certain limitation on the art with which they are associated and, as previously inferred, an object of this invention is to remove this limitation by providing a liquid prism that can be made as large as the art may demand, and at a small fraction of the cost of the solid prism.

Another object is to provide a liquid prism that may be controlled electro-magnetically or electro-statically and thus control or fluctuate a steady beam of light that is directed therethrough. The liquid used is inherently responsive to magnetic flux and in direct proportion to the flux intensity, and when so influenced will alter the orderly or natural position of its component crystals, thus reflecting the light from their minute facets in an altered direction.

The unit is so constructed that the relationship of the crystals of the solution and of the solid partition or cleavage plane are balanced, but an unbalancing effect is produced by the change from normal position of the liquid crystals caused by the magnetic flux, this not being possible with solid crystals such as the Nicol and Halle type prisms.

Another object is to provide liquid prisms for use as a refracto-meter, polarizer and analyzer, and also in a multiple series (en banc) as scanning elements in a television screen; or as a light valve or interrupter, in series or multiple.

Other objects, advantages and features of invention may appear from the accompanying drawing, the subjoined detailed description and the appended claims.

The accompanying drawing illustrates the invention, in which:

Fig. 1 is a diagrammatic perspective view of a television scanning screen, showing a number of my liquid prisms assembled therein and in use.

Fig. 2 is a central longitudinal section through a liquid prism that is constructed in accordance with this invention, parts indicated diagrammatically and showing the partition sheet of multirefracting material exaggerated as to thickness.

Fig. 3 is a cross section on the line 3—3 of Fig. 2.

Fig. 4 is a slightly modified form of liquid prism which virtually is an assembly of two separate prisms in one container and adjusted permanently for the stoppage of light.

Fig. 5 is a diagrammatic view of the hollow core and windings removed from the container and illustrates a modified form of winding in two sections so the magnetic action may be produced independently of each other adjacent the end of the core for various purposes in controlling the light.

Fig. 6 is a cross section on lines 6—6, Fig. 5.

Fig. 7 is a cross section on line 7—7, Fig. 5.

Fig. 8 is a longitudinal section on line 8—8, Fig. 5, showing added transparent end plates to enclose the multirefracting transparent liquid in the core so the core can be used as a liquid prism independently of the container shown in Figs. 1 to 4 inclusive.

Fig. 9 is a diagrammatic perspective view of the core shown in Figs. 4 and 5 without its winding showing the core by dotted lines, and by full lines indicating the positions of the transparent multiple refracting solid sheet partitions.

Fig. 10 is a diagrammatic perspective view of a core analogous to the left hand portion shown in Fig. 9 showing metal plates substituted for the electric coil shown in Figs. 1,

2 and 3, the core being shown by dotted lines and the plates by full lines.

Fig. 11 is a central longitudinal section through a modified form of liquid prism, showing its ends closed by transparent plates, and metal plates attached to its top and bottom as substitutions for the coils shown in Fig. 5.

The liquid prism includes a container 10 having transparent ends 11 and 12, sides 13 and 14, and a bottom 15 that are made of any suitable material, and also a removable lid 16 formed of insulating material.

The container 10 is filled with a solution of transparent multiple refracting fluid 17 or crystals in a fluid condition such as CS2 or oil of merbane, etc. Then I provide a hollow core 18 in which I arrange a partition 20 of a solid transparent multiple refracting material, such as mica, gypsum, cellophane, quartz, etc., after which the core is fitted into an electric coil 21 and submerged in the liquid 17 so its open ends are adjacent to the transparent ends 11 and 12 of the container.

The partitions 20 and 120 are preferably fitted into the core loosely so as to avoid distortion and in a manner to divide the liquid into two sections that are wedge-shaped and of substantially the configuration of wedges in solid prisms.

When energized the coil 21 produces magnetic flux in the core 18 and affects the fluid 17 that is inherently responsive to the flux, thereby causing a change of position or a slight rotation of each individual ultra microscopical crystal of which the liquid is composed, thus alternating the direction of the light beams that have entered the fluid prism. Normally the light beams that enter the liquid prism on encountering the partition 20 are divided, part of them being diverted greatly so that they do not emerge from the prism, and the other part being only slightly diverted emerges from the prism as polarized light.

When the partitions 20 and 120 are used in a single unit or two units are used in series, each having a single partition, the light beams are polarized and entirely diverted and no light emerges from the prisms in series, but this condition can be altered by the application of the magnetic flux which causes an unbalanced condition of the fluid particles, permitting the light to pass through the second partition. The action of the magnetic flux on the liquid particles of the polarizing prism is to correct the slight deviation of that part of the light passing through the prism in a nearly straight or normal direction. The second prism then receives this corrected polarized light and the flux on the second prism repeats the action thereon, throwing all of the light it receives to a normal position for a proper light delivery.

In Fig. 1 I show a number of liquid prisms assembled in the scanning screen 19 for use in the art of television; and therein the flood light 22, reflector 23, ground glass screen 24 and visualizer 25 are indicated semi-diagrammatically and assembled to illustrate the adaptability of my liquid prism in that art, it being understood that it is equally useful for other purposes.

If desired a second transparent partition 120 may be inserted in the core 18 in advance of the first partition 20 and the positioning of these partitions may be regular or they may be placed at right angles to each other as shown in the drawing, depending upon the liquid surrounding them.

The partitions 20 and 120 function in my liquid prisms as the cleavage planes function in solid or the Nicol prisms, with the added features not possessed by the Nicol prisms, that they are multiple refracting solid and not just surfaces between wedges cemented together to form a reflecting surface through the body of the prism.

My prisms can be provided with a single electrical winding 21, as indicated in Fig. 4, or with divided windings 21 and 121 as shown in Figs. 5 and 8, so that these may be hooked up in series, multiple or reversed series. The reversed series connection produces opposing fluxes in the cores and liquid causing clockwise and counter-clockwise twisting of the crystals on each side of the partition, thus economizing the power applied and effecting a faster action through the unit.

The controls of the light through the liquid prism shown in Figs. 2 and 3 is the same as that in Fig. 4. An electric current is passed through coil 21 and the wires 26 and 27 from a source of supply not shown.

The container 10, under certain conditions, may be dispensed with by providing the core 18 with transparent ends 111 and 112 for retaining the multirefracting translucent liquid in the core as shown in Figs. 8 and 11, and when so constructed the apparatus can function as a liquid prism and be used independently of the container 10.

It is understood that when used without the container I can provide the core with the single partition 20 or with both of the partitions, and that when both partitions are used I can vary the angle at which they are arranged in the core; and that in some instances I may arrange them at the same angle and in parallel planes as shown in Fig. 11.

It is obvious that the plates 21*a* and 121*a* may be substituted for the coils 21 and 121 and when so employed permit the liquid prisms to be more closely assembled when a number of them are used in a television scanning screen as diagrammatically indicated in Fig. 1.

Preferably the core 18 is square in cross section and formed of insulating material so

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the plates 21*a* and 121*a* can be fitted closely to its top and bottom sides, as shown. It is understood, however, that the plates can be arranged in any suitable place on the core and that it may be of various forms in cross section.

The liquid prism is operated as described and in general use can function much better than prisms of solid type as previously stated; and also can be made as large as any of the arts demand and at a relatively low cost.

I claim as my invention:—

1. A liquid prism including a container having transparent ends, a solution of liquid crystals therein, a hollow core submerged in said solution, a thin sheet of transparent multirefracting material arranged in said core to form a cleavage plane through the liquid to separate it into wedge-shaped liquid parts, and an electric coil on said core for the purpose specified.

2. A liquid prism including a container having transparent ends, a solution of liquid crystals therein, a hollow core therein arranged so its ends are adjacent the ends of said container, a sheet of multirefracting solid arranged in said core to form a cleavage plane through the liquid to separate it into wedge-shaped liquid parts, and an electric oil on said core for the purpose specified.

3. A liquid prism including a container having ends through which light can be passed, a transparent multiple refracting liquid therein, a hollow core therein arranged with its ends adjacent the ends of said container, a sheet of transparent multi-refracting solid arranged diagonal to the longitudinal axis through said core, and an electric coil at each end of said core adapted to be energized independently of one another.

4. A liquid prism including a container having ends through which light can be passed, a transparent multi-refracting liquid therein, a hollow core therein arranged with its ends adjacent the ends of said container, a sheet of transparent multiple refracting solid arranged diagonal to the longitudinal axis through said core, another sheet of multiple refracting solid in advance of said first mentioned sheet of transparent multiple refracting solid that is arranged diagonal to the longitudinal axis of said core and at right angles to said first mentioned sheet of transparent refracting solid, and an electric coil at each end of said core adapted to be simultaneously energized in a reverse order.

5. A liquid prism including a hollow core having closed transparent ends, a multi-refracting transparent liquid therein, a sheet of multiple refracting solid extended therethrough to separate the liquid into equal wedge-shaped parts, oppositely arranged metal plates engaged with said core that, when electrically energized, produce an electrostatic field in said liquid.

6. A liquid prism including a hollow core that is square in cross section, transparent plates closing the ends of said core, a multi-refracting transparent liquid therein, sheets of multiple refracting solids spaced apart and arranged in parallel planes within said core so they are at an angle to the longitudinal axis of said core, and electrical means for creating an electrostatic field in said liquid.

In witness whereof, I have hereunto affixed my signature.

DELAMERE B. GARDNER.