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[54] **METHOD, MATERIAL AND APPARATUS FOR INCREASING AND DECREASING THE TRANSMISSION OF RADIATION**

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[52] **U.S. Cl.** **350/160,** 350/266

[51] **Int. Cl.** **G02f 1/28**

[58] **Field of Search** 350/160, 161, 267, 350/266

[56] **References Cited**

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[57] **ABSTRACT**

A light control valve is disclosed having certain fluid suspensions therein which when activated increase the transmission of radiation through the valve in one part of the electromagnetic spectrum and decrease the transmission in another part of the spectrum.

12 Claims, 4 Drawing Figures

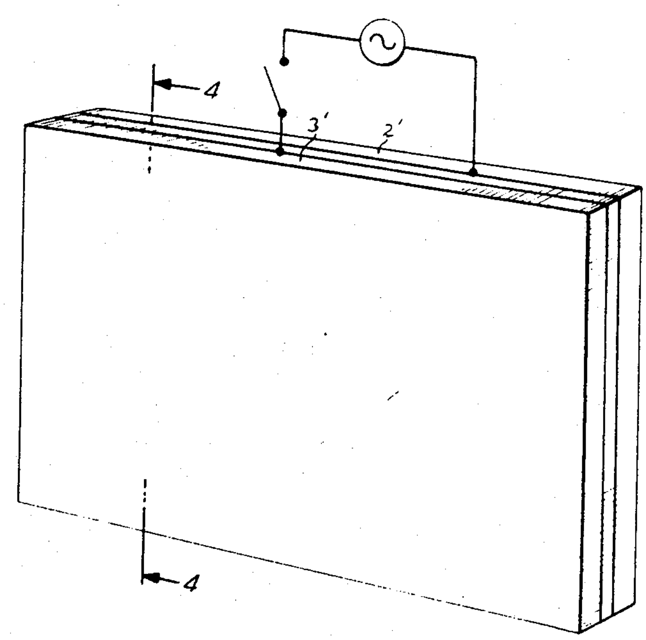

FIG. 4

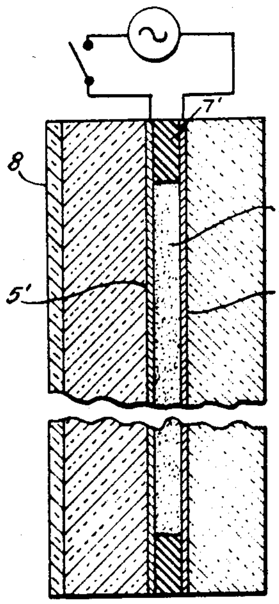

FIG. 3

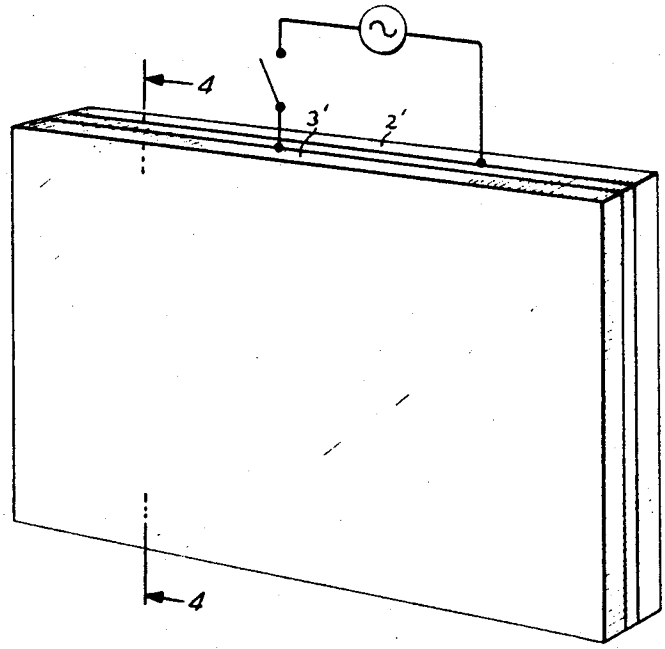

FIG. 1

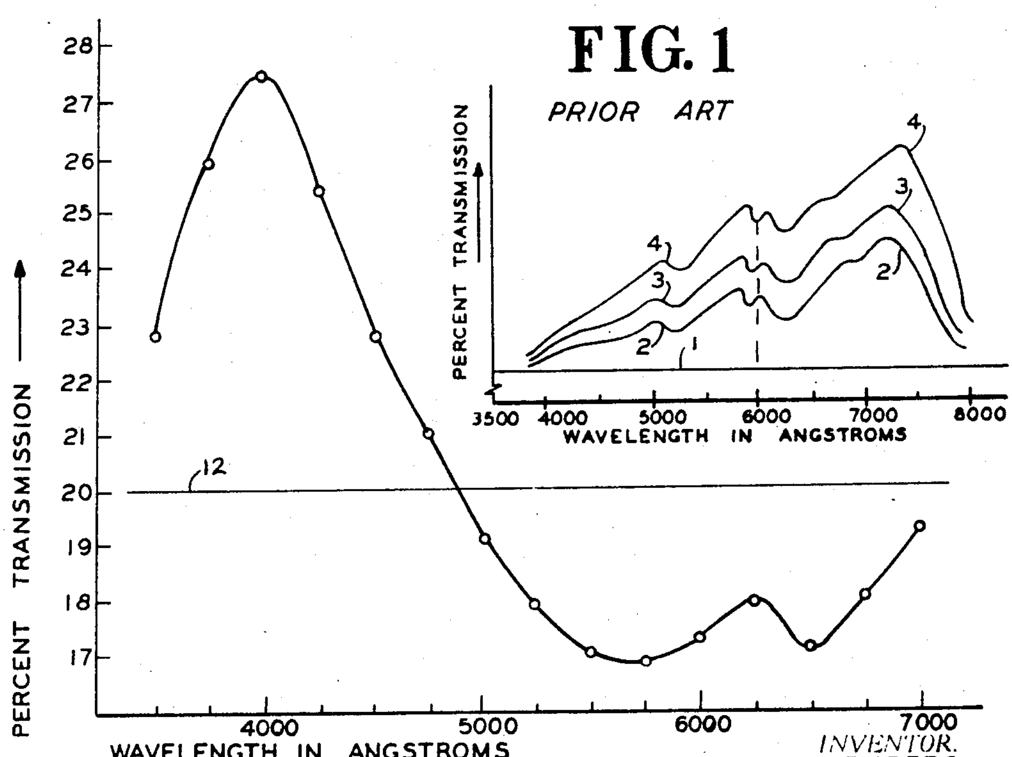

FIG. 2

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METHOD, MATERIAL AND APPARATUS FOR INCREASING AND DECREASING THE TRANSMISSION OF RADIATION

BACKGROUND OF THE INVENTION

Variable density light control devices, shutters, and filters of many kinds have been developed to control and vary the intensity of radiation, especially electromagnetic radiation in the region that includes ultraviolet, visible, and infrared radiation. These devices include mechanical shutters, iris diaphrams of variable opening, wedge shaped filters of variable thickness, liquid crystal light valves, Kerr cells and variable density light valves of the kind which use suspensions of particles in a fluid. When the last-mentioned control devices are opened or partially opened, or operated to increase the transmission of radiation, the transmission is increased simultaneously for all wavelengths, frequencies, and colors, even though the amount of the increase is different for different wavelengths, frequencies or colors. Likewise, when these control devices are closed or partially closed, or otherwise operated to decrease the transmission of radiation, the transmission is decreased simultaneously for all wavelengths, frequencies or colors, even though the amount of decrease is different for different wavelengths, frequencies or colors. Thus, these control devices have the effect of either increasing the transmission at all wavelengths or decreasing the transmission at all wavelengths. They cannot be used to decrease the transmission at some wavelengths and to increase the transmission at other wavelengths. These devices cannot substantially attenuate one color while letting another one pass through, but can only be used to substantially block out all colors (all wavelengths) or none at all.

Such a valve that can selectively filter certain wavelengths and transmit others would have substantial use in many industries. For example, in the photographic and related industries, a filtering valve such as this can be used in film printing and developing to surpress certain colors while enhancing others. Thus, there is a need for a light valve which acts as an inexpensive filter to filter out certain colors while increasing the transmission of others.

SUMMARY OF THE INVENTION

A light valve having a fluid suspension therein, which, when activated can reduce the light transmission in one part of the electromagnetic spectrum while simultaneously increasing the transmission in another part of the spectrum over the amounts of transmission in these same parts of the spectrum when the valve is not activated.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a graph plotting transmission vs. wavelength for a device of the PRIOR ART.

FIG. 2 is a graph plotting transmission vs. wavelengths for the device of this invention.

FIG. 3 is a perspective view of the light valve of FIG. 1.

FIG. 4 is a cross-sectional view of the valve of FIG. 1.

PREFERRED EMBODIMENT OF THE INVENTION

This invention is concerned with light control devices more commonly known as light valves of the type which consist of cells containing a substance therein which changes the transmission of radiation through the cell when a field is applied across the substance. A typical example of such a light valve is described in copending U.S. Application, Ser. No. 25,541, filed Apr. 1, 1970, *Light Valve With Flowing Fluid Suspension*, which is assigned to the assignee of the present Application. The aforesaid Application discloses light valves having thin, transparent walls constructed of flat glass or similar material and separated by a small gap which is filled with a fluid suspension containing small particles distributed therein. These particles will align themselves when a field is placed across the suspension. To place the field across the suspension, a thin layer of transparent, conductive material is coated on the inner side of each sheet of glass, either in contact with the substance, or spaced from the substance by a thin, transparent, non-conducting layer. The conductive layers are connected to an energy source by suitable wiring. Upon the application of a voltage across the suspension, the particles in the suspension are oriented so as to cause the suspension to be transparent; whereas, before the application of the voltage, the particles in the suspension were disoriented and therefore, the suspension was opaque. Light valves that operate such as these have been described in the above-identified Application and are well known in the prior art.

FIG. 1 is a graph showing wavelength vs. transmission for a valve of the prior art, a valve containing a suspension where increasing voltage causes increasing transmission, such as the valves discussed in the above Patent Application. In this graph, wavelength in Angstrom units is plotted along the X axis, and increasing transmission is plotted along the Y axis. The straight line **1** on the graph represents the transmission of radiation through the valve when no activating voltage is applied to the conductive surfaces. For ease in description, this line has been normalized to the same level of transmission for all wavelengths (20 percent transmission). It will be appreciated that the transmission through the valve in the off condition is not necessarily zero and that is the reason why straight line **1** is not shown at the position of zero transmission.

The curves **2, 3** and **4** represent transmission through the above prior art valves with applied voltages. Curve **2** in FIG. **1** represents the transmission of radiation through the valve at one activating voltage and frequency. Curve **3** represents the transmission of radiation at another voltage and frequency, and curve **4** represents the transmission and still another activating voltage and frequency. As the activating voltage and frequency are varied, the transmission varies from one to another of the family of curves **2, 3** and **4.** The curves are such that when the voltages are increased or decreased, the transmission of radiation at all wavelengths are either all increased simultaneously or decreased simultaneously. These curves uniformly increase and decrease; they never cross each other and they never go below the straight line (representing the inactivated condition of the valve). The transmission at any wavelength increases as the voltage increases. For example, if we take a wavelength of 6,000 Angstroms, which is in the orange color region, the transmission of light at that wavelength is greater with a greater applied voltage. The dotted line at 6,000 Angstroms intersects line **4** at a greater transmission value than where it intersects line **2.** Thus, the transmission is always greater as the applied voltage is increased and the transmission is always greater when a voltage is applied then when no voltage is applied at all (the straight line).

When these prior art valves are activated by any applied voltage, the valve becomes optically less dense (transmits more light through it) than when no voltage is applied and this occurs throughout all wavelengths. Still another way of starting this would be to say that density ratio of the prior art valves is always greater than unity. The density ratio is the ratio of the optical density of the light valve in the inactivated condition, to the optical density in the activated condition. Thus, with these prior art valves there is no possibility of increasing the transmission of one range of wavelengths while decreasing the transmission of another range of wavelengths. With these prior art valves the transmissions of all wavelengths are either all decreased or all increased. Thus, for example, with these valves, a filter could not be produced which would increase the transmission of blue light while decreasing the transmission of red light, or vice versa. However, with the valve of the present invention, this can be accomplished.

FIG. **2** is a graph showing the transmission of a typical light valve in accordance with the present invention; a light valve, which when it is activated, increases the transmission of radiation through it in one part of the spectrum and decreases the transmission through it in another part of the spectrum. In the graph percent transmission of radiation is plotted along the **Y** axis and the wavelength in Angstrom units is plotted along the X axis. This curve is for Example I, which is discussed hereinafter. The straight line **12** in the figure represents the transmission of the inactivated valve normalized to the same transmission for all wavelengths (20 percent). It is not actually the same for all wavelengths in the inactivated state, but for ease in illustration transmission for all wavelengths has been normalized to the same value and transmission in the activated state has been correspondingly changed. The curve represents light transmission of a light valve with an applied voltage of 1,000 volts at a frequency of 125 kilohertz as discussed in Example I. It will be seen from this graph that when voltage is applied, the transmission in one part of the spectrum (below 4,900 Angstroms) increases above the transmission for the inactivated valve and in another part of the spectrum (above 4,900 Angstroms) decreases below the transmission for the inactivated valve. There is also a point at about 4,900 Angstroms (for this example) where transmission is the same in both the activated and inactivated states. At this point, which is referred to as the crossing point, activating the valve will have no effect on transmission through the valve. From the graph, it will be seen with this particular valve (the valve of Example I) the transmission with the valve activated reaches a maximum at about 4,000 Angstroms and reaches two minimums, one about 5,750 and one about 6,500 Angstroms. It should be noted, however, that this is just one example of the valves of this invention. It will be appreciated that even though graphs of the valves of this invention have the general shape of the graph of FIG. **2**, the maximums, minimums and crossing points will vary substantially. The Examples mentioned hereinafter will point this out in more detail. One significant point to be noted is that because of the increase in transmission in one area and the decrease in another area, when a white light is seen through the valve, of the above example before the valve is activated, it would appear white, however, when the valve is activated, the intensities of the longer length wavelengths will be decreased, whereas, the intensities of the shorter ones will be increased; this will cause the color to change from white to a blue-white color. In other words, basically, the transmission curve for the activated light valve of this Example rises above the straight line **12** in the blue-purple part of the spectrum and falls below the level of transmission for the inactivated valve in the red-orange-yellow-green part of the spectrum. This can be expressed in still another way in accordance with the aforementioned density ratio, namely, the density ratio is greater than unity in one portion of the spectrum (e.g. the blue-violet region) and is less than unity in another portion of the spectrum, (e.g. the green-yellow-orange and red region). The valve then transmits more light in one region when it is activated than when it is inactivated, and transmits less light in another region when it is activated than when it is inactivated.

It also will be appreciated that by varying and changing the voltage and its frequency, a variety of filter and transmission effects can be produced to control the transmission of radiation in various wavelengths, including controlling color, color balance, color hue and color tone. As the transmission of one color of the spectrum is increased, another can be decreased and so on.

Now, describing the suspension itself: As aforementioned, this suspension is placed in the valve between its two transparent plates. On the inside of each of these plates is a conductive coating which may be in contact with the suspension (it can also be separated from the coating by a thin layer of insulating material). The cell is more clearly shown in FIGS. **3** and **4** where the plates are designated **2** and **3**, the conductive coatings **4** and **5**, and the suspension therebetween, **6.** A suitable sealant **7** is also provided to prevent the suspension from escaping from the valve.

The suspension may be a liquid or a gas, however, better results seem to be achieved with a liquid because its specific gravity makes it easier to keep the particles in suspension for longer periods of time. It also appears to be preferrable for the fluid and the suspended particles to have specific gravities that are as close to each other as practical. When the specific gravities are close to each other, there is less chance of the suspended particles coming out of suspension. For example, if the suspended particles and the fluid have the same specific gravity (i.e. density) then there are no net forces acting on the particles to cause them to settle out of the suspension. The particles may be of any shape. One preferred shape is an elongated rod with a ratio of length to cross-sectional diameter of about 25 to 1.

It is desirable that the ratio of the dielectic constant of the particle to dielectic constant of the suspending fluid be large in order that the electric forces on the particle be large. For example, ratios may vary from 3 or 4 to 1 to 50 to 100 or 200 to 1. Titanium dioxide which is used for the particles has a dielectic constant of approximately 170 and two commonly used suspending fluids for titanium dioxide, toluene and isopentyl acetate have dielectic constants of approximately 2 and 5, to result in ratios of about 85 to 1, or 34 to 1.

Also, suspending fluids of high viscosity cause the particles to remain suspended for a longer time. At the same time, suspensions in high viscosity fluids seem to be slower to react to an activating electric voltage, i.e. a high viscosity suspension is slower to act when an electric field is applied than a lower viscosity suspension. However, this is not a problem in most applications since light valves of the kind described in the invention can act in times less than 2 milliseconds. It is also desirable that the particles and fluid of the suspension be chemically stable and inert and that they do not react chemically with one another or with the walls, conductive layers or sealant of the cell in which they are contained or the effective life of the light valve will be substantially diminished.

Some materials that might be useful as the suspended particles include metal oxides, metal salts, alkali halides, and alkali oxides. Some of these materials that are particularly useful are: an oxide of titanium, TiO_2; an oxide of iron, $Fe_2O_3 \cdot H_2O$; and the salt of cobalt, $CoAl_2O_4$, cobalt aluminate.

The amounts of particles in suspension may vary on a part by weight basis within wide ranges depending on the size of the particles, the viscosity of the suspending medium (as aforementioned) and the amount of particles desired per volume of suspending fluid. For example, a suspension of 400–800 parts per weight of suspending medium to 1 part of suspending particles yields good results. However, if desired, these proportions can be increased to 1000 to one or greater or decreased below the 400 figure if desired. If a very dilute suspension is desired, one where it is only slightly tinted in the inactivated condition, the amount of particles to suspending medium will be substantially lessened. Conversely, if a very dark suspension were desired, then the ratio of suspending fluid to particles would be decreased from the 400 to 1 figure aforementioned. A figure of 200 or 100 to 1 might be desirable.

The following examples are illustrative of various embodiments of the practice of the present invention. However, it will be understood that they are not to be construed as limiting the invention in any way.

EXAMPLE I

Titanium dioxide (Titanox RA10) manufactured by Titanium Pigment Corporation, New York, New York (average particle size of approximately less than about 1 micron) was added to a mixture of isopentyl acetate and nitrocellulose with the latter added to minimize the tendencies of the particles to agglomerate or settle out. The mixture was ground with a mortar and pestle and then left to settle for one-half minute. More isopentyl acetate was added. An eye dropper was then used to draw out the top part of the suspension leaving the settled part of the mixture remaining. The part in the eye dropper had a composition of approximately 1 part of TiO_2 to 800 parts of isopentyl acetate to 3 parts of nitrocellulose by weight. This suspension was then placed in a cell. The cell was composed of two sheets of glass, each coated with a thin layer of conductive material, and spaced 33 millimeters apart and held together by a sealant in the same manner as previously described and as shown in FIG. 3. After the suspension was placed in the cell, 1000 volts at the frequency of 125 kilohertz was applied across the suspension and a tungston filament lamp was placed on one side of the cell. Readings were then taken with a spectrophotometer positioned on the opposite side of the cell from the light source. The results were tabulated as follows and are plotted as previously discussed in FIG. 2.

	3,500	3,750	4,000	4,250	4,500	4,750	5,000	5,250	5,500	5,750	6,000	6,250	6,500	6,750	7,000
Off	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20
On	22.8	25.9	27.5	25.3	22.7	21	19	17.9	17	16.8	17.2	17.9	17.6	18	19.4

From this data and the graph it will be seen that the transmission through the cell when it is activated (on) is less in one region (between 4900 and 7000 Angstroms) than when the cell is inactivated (off); and the transmission is greater when activated than when inactivated in another region (3500 to 4900 Angstroms.

EXAMPLE II

Yellow iron oxide $Fe_2O_3 \cdot H_2O$, sold under the tradename 2288 high oil, manufactured by Chas. Pfizer & Co., New York, New York, was added to a mixture of toluene and Ganex V220. Ganex V220, manufactured by GAF Corp., New York, N.Y. is a modified type polyvinyl pyrrolidone which tends to minimize the tendency of the particles of $Fe_2O_3 \cdot H_2O$ to settle out of suspension. The mixture was ground with a mortar and pestle. More toluene was then added. The suspension was then left to settle for about one-half minute. Also, as before, an eye dropper was used to remove the top part of the mixture. The suspension at this point consisted of about the same proportions as the previous example. The suspension was then placed in the same cell as in the previous example, comprising two conductive coated glass sheets separated by 33 mills. A tungsten filament was then placed on one side of the cell and the effect was observed from the opposite side of tthe cell by a spectrophotometer. A voltage of 500 volts at a frequency of 10 kilohertz was applied across the suspension in the first of the two groups of results stated below, and a voltage of 1000 volts still at a frequency of 10 kilohertz was used in the second group of results. The data is expressed in optical density instead of transmission. (As a substance becomes optically more dense, it transmits less radiation through it.)

	3,500	4,000	4,500	5,000	5,500	6,000	6,500	7,000	7,500
Off	4.2	4.78	4.1	3.5	2.57	2.12	1.82	1.62	2.0
On 500 V	4.3	4.8	4.0	3.55	2.72	2.38	2.08	1.72	2.15
On 1,000 V	4.4	4.75	4.0	3.6	2.75	2.4	2.05	1.73	2.15

In each of these cases the same results as with the previous example showed up, that is, the density increased (transmission decreased) with the application of voltage over one part of the visible spectrum, while the density decreased (transmission increased) with the application of voltage in another part of the spectrum.

EXAMPLE III

Cobalt aluminate was added to a mixture of nitrocellulose and isopentyl acetate in the same manner as with Examples I and II with cobalt aluminate being substituted for titanium dioxide and iron oxide in those examples. The entire procedure was the same as that of Examples I and II, with the same proportions and the same cell being used with the following results (with the readings in optical density).

	3,500	4,000	4,500	5,000	5,500	6,000	6,500	7,000	7,500
Off...	2.69	2.52	2.44	2.28	2.32	2.48	2.32	1.9	2.12
On...	2.68	2.52	2.45	2.30	2.33	2.49	2.33	1.94	2.15

Then the mixture was diluted by the addition of about 30 grams of isopentyl acetate, 500 volts at a frequency of 10 kilohertz was then applied with the following results (with the readings in transmission).

	3,500	4,000	4,500	5,000	5,500	6,000	6,500	7,000	7,500
Off...	9.5	13.5	18.5	24.5	26.5	26	27	33	19.5
On...	10	14	19.5	24.25	26.25	25.75	26.5	32	19.25

From both these results it will be seen that as before, the transmission decreased in one part of the spectrum (density increased) when voltage was applied instead of increasing as with the prior art cells.

Up until this point this invention has been discussed with regard to having a single type of particle in suspension. However, it will be appreciated that suspensions of two or more types of particles having different results can be used in the same suspending fluid. They can also be used in mixtures or solutions of two or more fluids. This will produce light valves that have combinations and modifications of the control effects of each individual suspension. An example of this is to mix TiO_2 with $Fe_2O_3 \cdot H_2O$ to form the suspension. This mixture is then suspended in isopentyl acetate with a protective colloid such as the aforementioned nitrocellulose. The effect of this is to produce a light valve which has a curve of transmission vs. wavelength such as to combine the separate effects of TiO_2 and $Fe_2O_3 \cdot H_2O$ and produce results which fall between the curves of each of the two individual ingrediants.

Moreover, one or more suspensions of the above substances can be combined, mixed, or dispersed into one or more of the suspensions of the conventional substances, such as herapathite, as described in the aforesaid application, Ser. No. 25,541, to make light valves that produce combinations of the effect of the light valve of this invention and the light valves using conventional suspensions. For example, titanium dioxide can be mixed with herapathite, or iron oxide can be combined with herapathite.

The valves of this invention can also be used in combination with conventional filters, as for example, the Wratten filters, manufactured by Eastman Kodak Company of Rochester, New York, to create other filtering effects.

By the use of a filter or filters, part of the spectrum can be attenuated while the remainder acts in its normal way in this invention. For example, in FIG. 4, a filter **8** can be inserted in front of the light valve to filter out all wavelengths shorter than those of the crossing point (namely, all wavelengths to the left of the wavelengths at which the curve crosses the horizontal straight line) as shown in FIG. 2. When this is done, only the wavelengths longer than 4900 will be able to pass through the valve. However, those wavelengths

are ones where the transmission decreases when a voltage is applied. The light valve then has an optical density ratio less than one since it is only operating in this decreasing region. The valve now operates in the reverse manner to conventional light valves of this type. The light valve will be darker when activated than when not activated. This is the reverse of the effect of the previously mentioned prior art valves which are lighter when activated than when not activated.

Also, a filter can also be used to attenuate the portion of the spectrum to the right of the crossing point in FIG. 2 (i.e. wavelengths longer than those of the crossing point). The part of the spectrum remaining will then act in a fashion similar to a conventional prior art light valve - increasing transmission with increasing voltage. This will have the advantage of a high optical density ratio which gives the advantage of a more complete valve operation.

Also, a filter can be used to attenuate only a portion or portions of either or both the decreasing or increasing parts of the spectrum aforementioned to create still different effects.

Further, two or more light valves with different suspensions, each with its own characteristic transmission curves, such as those shown in FIG. 2 can be combined in series with the light passing successively through each of them. This will result in a still further variety of color control and color effects. Also, one or more of these valves can be combined with one or more of the conventionally reacting valves such as mentioned in the aformentioned Patent Application to produce a still further variety of color control and color effects.

The voltage applied to activate the light valves can either be a DC voltage or an AC voltage, or a pulsed voltage. An alternating type voltage is preferred for most applications because this type of voltage is less likely to produce undesirable side effects such as coagulation, agglomeration, precipitation, or electrochemical destruction of the particles, or migration or plating of the particles on to the electrodes. Any of these will substantially impair the proper operation of the valves.

Magnetic fields can also be used either alone or in combination with electric fields to activate the light valve of this invention.

It is noted that if the transmission of a light valve of this invention is integrated over the full spectrum, the increased transmission in one portion of the spectrum is partially or fully compensated by the decreased transmission in another portion of the spectrum. By suitably selecting the frequency and voltage of the electric field applied to the suspension, and/or by using filters to attenuate portions of the spectrum, the aforesaid compensation can be made such that the integrated radiation energy transmitted by the valves over the entire spectrum remains practically constant as the valve is operated. For example, in the visible portion of the spectrum, the total transmitted light energy can be kept constant as the effective color and color balance are varied. In such a case, the optical density ratio of the valve for white light could be unity or close to unity while the density ratios for certain wavelengths and certain portions of the spectrum could be greater or less than unity.

The light valve of this invention can be used to control or modify color, color balance, color tones, color values, and color hues in the exposure, processing and printing of color photographic materials. For example, if a color photographic print is too redish, i.e. if red predominates at the expense of blue, the photograph can be printed through the light valve of this invention with the valve adjusted to transmit more of the blue portion of the visible spectrum and less of the red portion of the visible spectrum. Thus, tthe amounts of the blue and red transmissions can be controlled by the valve to modify the color balance of the print as desired.

The light valve of this invention can also be used to modify and control color and color balance in duplicating or printing motion picture films from the master or negative film on which the picture was originally made. In this duplicating or printing operation it is usually necessary or desirable to modify the color balance in a different way from scene to scene in order to achieve color realism or for dramatic or artistic effects. The light valve of this invention is highly suited to the Application because it operates rapidly so that a desired change in color balance can be made in the time between the individual frames of the motion picture film. The operation and construction of the valve, which is entirely electrical with no mechanical moving parts, is simple compared to the complicated sets of rotatable and adjustable mirrors, color filters, and lenses that are usual in this application; and further, it is easier to control or program the light valve of this invention than it is to program and control the usual system of mirrors, lenses and filters. The latter is true because the light valve of this invention is controlled and operated by a direct electrical input to the valve with no electromechanical or mechanical moving parts.

Light valves according to this invention can also be used to produce illuminated displays which change color. For example, a displayed word can be made to change the color of each of its letters independently as well as flash each letter on and off in any desired sequence of pattern. Likewise, a pattern or diagram or picture or illustration can have its displayed components or parts or individual symbols changed at will in color, color hue and color intensity. These effects are useful for purposes of advertising, amusement, artistic display, psychological testing and as aids in teaching instruction and education.

Thus, it will be appreciated that a highly efficient light valve is provided which selectively controls radiation transmission in different parts of the spectrum.

While specific embodiments of the invention have been described, it will be appreciated that the invention is not limited thereto since many modifications may be made by ones skilled in the art and fall within the true spirit and scope of this invention.

I claim:

1. A light valve for controlling the transmission of radiation in the electromagnetic spectrum comprising:
   a cell having front and rear wall sections spaced apart a distance which is small compared to the lateral dimensions of the sections
   a fluid suspension in said cell of minute particles dispersed therein capable of having their orientation changed by the application of an electric field to the suspension to change the transmission of radiation through the suspension
   means for applying an electric field to the suspension between said wall sections in a direction substantially parallel to the direction of transmission of radiation through the suspension and substantially perpendicular to said wall sections, and
   said suspension being characterized in that it is responsive to said field applied in said direction to decrease the level of transmission of radiation therethrough, in part of the electromagnetic spectrum, below the level of transmission of radiation in this part of the spectrum when said field is not applied to the suspension and to simultaneously increase the level of transmission of radiation therethrough, in another part of the electromagnetic spectrum, above the level of transmission of radiation in this other part of the spectrum when said field is not applied to the suspension.

2. The light valve of claim 1 wherein the minute particles comprise titanium dioxide.

3. The light valve of claim 1 wherein the minute particles comprise iron oxide.

4. The light valve of claim 1 wherein the minute particles comprise cobalt aluminate.

5. The light valve of claim 1 wherein the part of the electromagnetic spectrum where the level of transmission is decreased and the part of the electromagnetic spectrum where the level of transmission is increased are both in the visible section of the electromagnetic spectrum.

6. The light valve of claim 1 wherein filter means are provided to attenuate the light transmitted through the light valve in that portion of the visible spectrum where the level of transmission of radiation is increased in response to an applied electric field.

7. The light valve of claim 1 wherein filter means are provided to attenuate the light transmitted through the light valve in that portion of the visible spectrum where the level of transmission of radiation is decreased in response to an applied electric field.

8. A material for controlling the transmission of radiation in the electromagnetic spectrum comprising
   a fluid suspension including:
      a suspending medium and
      a plurality of minute particles dispersed therein capable of having their orientation changed by the application of an electric field to the suspension to change the transmission of radiation through the suspension,
   said suspension being characterized in that it is responsive to said field applied in a direction substantially parallel to the direction of transmission of radiation through the suspension to decrease the level of transmission of radiation therethrough, in part of the electromagnetic spectrum, below the level of transmission of radiation in this part of the spectrum, when said field is not applied to the suspension, and to simultaneously increase the level of transmission of radiation therethrough, in another part of the electromagnetic spectrum, above the level of transmission of radiation in this other part of the spectrum when the field is not applied to the suspension.

9. The material of claim 8 wherein the minute particles comprise titanium dioxide.

10. The material of claim 8 wherein the minute particles comprise iron oxide.

11. The material of claim 8 wherein the minute particles comprise cobalt aluminate.

12. The material of claim 8 wherein the part of the electromagnetic spectrum where the level of transmission is decreased and the part of the electromagnetic spectrum where the level of transmission is increased are both in the visible section of the electromagnetic spectrum.

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