

Description

This invention relates to projection-type liquid crystal display devices.

Conventional projection-type display devices using light crystal light valves as shown in JP-A-179723/85, JP-A-35481/86 and JP-A-150487/86. In the conventional projection-type display devices, red, green and blue light, controlled by liquid crystal light valves, is combined by additive colour mixing, using a dichroic mirror, a dichroic mirror prism or the like, and the combined image is projected onto a screen through a projection lens. Liquid crystal light valves employing the twisted nematic mode (hereinafter referred to as TN mode) and driven by an active switching array are used because of their high resolution, high contrast ratio and drivability with low voltage. These conventional projection-type display devices have the advantages of compactness and lightweight over projection-type display devices using cathode ray tubes (CRT).

However, these conventional projection-type display devices suffer from a number of drawbacks. Since the photoelectric transfer characteristics of the TN mode is dependent on the wavelength of incident light, a projection-type display device using liquid crystal light valves shows undesirable colouration in the gray scale and also erroneously shows a different colour from the designated one.

The present invention seeks to provide a projection-type display device which is excellent in terms of gray scale and colour reproducibility.

According to the present invention there is provided a projection-type display device with the features of claim 1.

In one embodiment the thickness of the layer of liquid crystal material in each light valve is substantially the same.

In another embodiment the birefringence of the liquid crystal material in each light valve is substantially the same.

The invention is illustrated, merely by way of example, in the accompanying drawings, in which:-

Figure 1 is an exploded perspective view of a TN liquid crystal light valve for a projection-type display device according to the present invention;

Figure 2 shows schematically a projection-type display device according to the present invention;

Figure 3 is a graph showing photoelectric transfer characteristics of TN liquid crystal materials with various values of $\Delta n d / \lambda$;

Figure 4 shows graphically the photoelectric transfer characteristics of red, green and blue light obtained with the projection-type display device of Figure 2; and

Figure 5 is a sectional view of another embodiment of a TN liquid crystal light valve projection-type display device according to the present in-

vention.

The most important factor directly determining photoelectric transfer characteristic in the TN mode is $\Delta n d / \lambda$ where Δn is the birefringence of a TN liquid crystal material, d is the thickness of a layer of the liquid crystal material and λ is the wavelength of incident light. Namely, the photoelectric transfer curve is shifted as a function of $\Delta n d / \lambda$.

Therefore, the photoelectric transfer characteristic can be kept uniform between individual incident beams by approximately equalising $\Delta n d / \lambda$ for three TN liquid crystal light valves in a projection-type display device according to the present invention for controlling individual colours of light. In the case of a projection-type display device using three TN liquid crystal light valves in which $\Delta n d$ for red light is the greatest of the three colours of light, $\Delta n d$ of blue light is the least of the three colours of light and $\Delta n d$ of green light is intermediate, depending on the individual wavelengths, the combined image presents a neutral gray scale as well as excellent colour reproducibility.

Further, $\Delta n d$ can easily be controlled at low cost by using TN liquid crystal materials with different Δn and a constant thickness. Thus the TN liquid crystal light valves may be assembled in the same process and thereafter liquid crystal cells of the TN liquid crystal light valves are filled with liquid crystal material having different values of Δn . Thus, the present invention may be accomplished without increasing the number of manufacturing steps.

Further, the photoelectric transfer characteristics of TN liquid crystal light valves having a twist angle of 90° or less have been investigated and it has been shown by the applicants that the optimum value of $\Delta n d / \lambda$ is greater than 2.2 and less than 2.6, i.e. $2.2 < \Delta n d / \lambda < 2.6$. As is clear from Figure 3 which shows graphically a photoelectric transfer curve in which transmittance T is plotted against voltage E for various values of $\Delta n d / \lambda$ of TN liquid crystal materials, the photoelectric transfer curve shows the longest linearity in the range $2.2 < \Delta n d / \lambda < 2.6$ and light leakage at a black level is the lowest. When $\Delta n d / \lambda$ is 2.2 or less, the linearity is relatively short and the transmittance voltage curve has an inverted portion. When $\Delta n d / \lambda$ is 2.6 or more, the dynamic range of the contrast ratio is reduced. Therefore, for a video image, the optimum photoelectric transfer characteristics for colour reproducibility, colour purity, and contrast ratio are realised with the above range of $\Delta n d / \lambda$.

Generally, the dominant wavelength of red light is $0.62 \mu\text{m}$, the dominant wavelength of green light is $0.54 \mu\text{m}$, and the dominant wavelength of blue light is $0.46 \mu\text{m}$. Therefore, for an optimum value of $\Delta n d$ of individual colours of light, $\Delta n d$ of red light is greater than $1.4 \mu\text{m}$ and less than $1.6 \mu\text{m}$, i.e. $1.4 \mu\text{m} < \Delta n d < 1.6 \mu\text{m}$, $\Delta n d$ of green light is greater than $1.2 \mu\text{m}$ and less than $1.4 \mu\text{m}$, i.e. $1.2 \mu\text{m} < \Delta n d < 1.4 \mu\text{m}$ and $\Delta n d$ of blue

light is greater than $1.0\ \mu\text{m}$ and less than $1.2\ \mu\text{m}$, i.e. $1.0\ \mu\text{m} < \Delta n d < 1.2\ \mu\text{m}$. Namely, TN liquid crystal materials having different values Δn are held in the liquid crystal cells so that $\Delta n d$ of red light is the greatest of the three, that of blue light is the smallest and that of green light is intermediate therebetween, and $\Delta n d$ of each TN liquid crystal light valve is set in the above predetermined range. As a result, a projection-type display device which has very excellent gray scale, colour reproducibility, colour purity, contrast ratio, etc. is achieved and a projected image without inversion of the gray scale can be provided inexpensively without involving complicated manufacturing processes.

Figure 1 is an exploded perspective view of a TN liquid crystal light valve for a projection-type display device according to the present invention. As a means for driving the TN liquid crystal light valve, a plurality of matrix-arranged polysilicon thin film transistors (TFTs) 102 are formed on a transparent substrate 101. A light shielding layer 104 is provided on an opposed substrate 103 in order to shield at least the TFTs. In this example, polysilicon TFTs are used as the driving means but amorphous silicon TFTs, compound semiconductor TFTs, elements with two terminals utilising diode characteristics such as ring-diodes, MIMs or simple matrix driving may be employed. An organic polymer film (not shown) as an aligning layer is formed on the substrates 101, 103 and aligning treatment is performed so that liquid crystal molecules align along the directions of an axis 105 or an axis 106. The twist angle between the axes 105, 106 is 80° . Three similar liquid crystal cells having thicknesses of $5\ \mu\text{m}$, $6\ \mu\text{m}$ and $7\ \mu\text{m}$ respectively are formed by the combination of the substrates 101, 103 and by the use of a spherical spacer (not shown) to maintain a predetermined separation therebetween. Each liquid crystal cell is filled with a TN liquid crystal material having Δn of 0.22, thus providing a TN liquid crystal light valve for controlling red light whose $\Delta n d$ is 0.154, a TN liquid crystal light valve for controlling green light whose $\Delta n d$ is 0.132, and a TN liquid crystal light valve for controlling blue light whose $\Delta n d$ is 0.11. The above cell thickness d and the birefringence Δn are not limited to the specific values $\Delta n d$ given. However, the value $\Delta n d$ of the three colours should be determined so that $\Delta n d$ of red light is the greatest of the three, $\Delta n d$ of blue light is the least of the three and $\Delta n d$ of green light is intermediate therebetween. Compared with a conventional projected image, halftone colour is improved by optimising at least two light colours.

For example, $\Delta n d$ of red light should be greater than that of green light. Furthermore, if $\Delta n d$ of red light is greater than $1.4\ \mu\text{m}$ and less than $1.6\ \mu\text{m}$, i.e. $1.4\ \mu\text{m} < \Delta n d < 1.6\ \mu\text{m}$, $\Delta n d$ of green light is greater than $1.2\ \mu\text{m}$ and less than $1.4\ \mu\text{m}$, i.e. $1.2\ \mu\text{m} < \Delta n d < 1.4\ \mu\text{m}$ and $\Delta n d$ of blue light is greater than $1.0\ \mu\text{m}$ and less

than $1.2\ \mu\text{m}$, i.e. $1.0\ \mu\text{m} < \Delta n d < 1.2\ \mu\text{m}$, then higher quality images can be obtained. Each of the three liquid crystal light valves have polarisers 109, 107 between which the respective liquid crystal cell is sandwiched. The polariser 109 is provided on the incident light side of the TN liquid crystal light valve so that its transmission axis 110 is parallel to the axis 105 of the substrate 103 on which light is incident. The polariser 110 is provided on the side from which light passes out of the TN liquid crystal light valve so that its transmission axis 108 is perpendicular to the axis 106 of the substrate 101. The position of the polarisers may be twisted by 90° relative to each other if desired.

A projection-type display device according to the present invention is shown in Figure 2 using three TN liquid crystal light valves. White light from a light source 201 is divided into three colours by a dichroic mirror 202 for reflecting blue light, a dichroic mirror 203 for reflecting green light and a dichroic mirror 204 for reflecting red light and, as mentioned above, each reflected colour of light is introduced into a corresponding TN liquid crystal light valve whose $\Delta n d$ is different from the others, i.e. a TN liquid crystal light valve 207 for controlling red light, a TN liquid crystal light valve 206 for controlling green light, and a TN liquid crystal light valve 205 for controlling blue light, thereby forming three images. The three images are combined by a dichroic mirror prism 208 comprising four right-angled prisms each of which has a dichroic mirror surface embracing the right-angle, and then the combined image is projected by a lens 209. In place of the dichroic mirror 208 three dichroic mirrors can be used.

Figure 4 shows the photoelectric transfer characteristics of red, green and blue light obtained with the projection-type display device of Figure 2. In this example, the photoelectric transfer characteristic of each colour is approximately the same since $\Delta n d$ of the three colours of light are determined so that $\Delta n d$ of red light is the greatest of the three and greater than $1.4\ \mu\text{m}$ and less than $1.6\ \mu\text{m}$, i.e. $1.4\ \mu\text{m} < \Delta n d < 1.6\ \mu\text{m}$, $\Delta n d$ of blue light is the least of the three and greater than $1.0\ \mu\text{m}$ and less than $1.2\ \mu\text{m}$, i.e. $1.0\ \mu\text{m} < \Delta n d < 1.2\ \mu\text{m}$, and $\Delta n d$ of green light is intermediate and greater than $1.2\ \mu\text{m}$ and less than $1.4\ \mu\text{m}$, i.e. $1.2\ \mu\text{m} < \Delta n d < 1.4\ \mu\text{m}$. Further, the photoelectric transfer characteristic of each colour is substantially linear. Furthermore, the black level can be set lower and there is no inversion of the gray scale. Therefore, the projection-type display device of Figure 2 using three TN liquid crystal light valves allows the presentation of neutral halftone display with high contrast. Accordingly, a projected image which is excellent in colour reproducibility is obtained. Moreover, the reproducibility is greatly improved in the vicinity of the black level which has lower transmittance.

In a modification of the projection-type display device of Figure 2, under vacuum, each liquid crystal

cell is filled with a nematic liquid crystal material which has different Δn from that of the other liquid crystal cells. In this modification the thickness of each liquid crystal cell is the same, i.e. 7 microns. Thus, the TN liquid crystal light valve for red light employs liquid crystal material having Δn of 0.215, the TN liquid crystal light valve for green light employs liquid crystal material having Δn of 0.19, and the TN liquid crystal light valve for blue light employs liquid crystal material having Δn of 0.165. The values of Δn are not limited to those given above. With the thickness of the liquid crystal cells constant, Δn of the TN liquid crystal light valve for red light is the greatest, Δn of the TN liquid crystal light valve for blue light is the least and Δn of the TN liquid crystal light valve for green light is intermediate.

When Δn is controlled with respect to at least two colours, halftones can be improved. Further, if Δn of each light valve is determined so that Δn of the TN liquid crystal light valve for red light is greater than $1.4 \mu\text{m}$ and less than $1.6 \mu\text{m}$, i.e. $1.4 \mu\text{m} < \Delta n < 1.6 \mu\text{m}$, Δn of the TN liquid crystal light valve for green light is greater than $1.2 \mu\text{m}$ and less than $1.4 \mu\text{m}$, i.e. $1.2 \mu\text{m} < \Delta n < 1.4 \mu\text{m}$, and Δn of the TN liquid crystal light valve for blue light is greater than $1.0 \mu\text{m}$ and less than $1.2 \mu\text{m}$, i.e. $1.0 \mu\text{m} < \Delta n < 1.2 \mu\text{m}$, more excellent image quality is obtained.

In this modification halftone colours hardly change in respect to all the halftones, and neutral colour is kept. Further, colour reproducibility is obtained to the same degree as with a CRT. Colour reproducibility is excellent in the vicinity of reflectance near to black level which is hard to obtain with the conventional projection-type display devices. In this example, all the TN liquid crystal light valves are manufactured by the same process and consequently cost can be reduced. Further, if the thickness of the liquid crystal cell does not meet with the predetermined value, the difference between the obtained cell thickness and the predetermined value can be corrected by adjusting the value of Δn (e.g. a liquid crystal cell having a thickness of $8 \mu\text{m}$ is filled with liquid crystal material having Δn of 0.187, thereby obtaining a TN liquid crystal light valve for red light). Therefore, a liquid crystal cell which could be regarded as defective in view of the fact that its thickness differs from the predetermined value, can still be used to improve manufacturing yield. Further, viscosity and threshold voltage of each liquid crystal material can be determined in advance and have substantially the same values. Thus it is not necessary to vary the driving voltage to match each twisted liquid crystal light valve and response speed for each colour is substantially the same. As to the liquid crystal material, a liquid crystal mixture which has triple bonds in its molecular structure is preferable since such a nematic liquid crystal materials allows the response speed to be increased more than with other types of liquid crystal

materials.

Figure 5 shows a sectional view of another embodiment of a TN liquid crystal light valve for a projection-type display device. The TN liquid crystal light valve of Figure 5 has a simple matrix liquid crystal cell in which strip-type transparent electrodes 502 are formed on upper and lower transparent substrates 501. An aligning layer composed of an organic molecular film is formed on each of the upper and lower substrates. In this example, the twist angle of nematic liquid crystal material between the substrates is 210° and the thickness of the liquid crystal cell is 6 microns. The TN liquid crystal light valve for red light, the TN liquid crystal light valve for green light and the TN liquid crystal light valve for blue light are filled with TN liquid crystal material having Δn of 0.165, 0.15, and 0.12, respectively. A projection-type display device as shown in Figure 2 is then formed using the three TN liquid crystal light valves.

The combined image obtained by such a projection-type display device presents neutral halftones and colours as expected. Naturally, a TN display characteristic having a twist angle of 90° or more presents special dependence on $\Delta n/\lambda$. However, Δn is controlled according to the wavelength of the incident light, thereby enabling the required photoelectric characteristics to be met. Accordingly, excellent images can be obtained.

As mentioned above, since a projection-type display device according to the present invention has three TN liquid crystal light valves, each of which has approximately the same photoelectric transfer characteristics, the display of halftones and colour reproducibility are excellent.

Further, the black level is reduced and the gray scale is hardly reversed by optimising Δn for each colour of light. Therefore, the projection-type display device of Figure 2 displays a gray scale without reversal, has a high contrast ratio and high colour purity.

Further, the three TN liquid crystal light valves may be manufactured by the same process.

Furthermore, variation of cell thickness does not affect the characteristics of the projection-type display device if Δn is corrected to give the desired value of Δn . Therefore, manufacturing yield is improved. Accordingly, a projection-type display device according to the present invention may be produced at relatively low cost.

Claims

1. A projection-type display device comprising:
 - a first transmissive type liquid crystal light valve (207) for controlling red light of wavelength λ_r , said first light valve (207) comprising a layer of thickness d_1 of twisted nematic liquid crystal material with a birefringence Δn_1 ;

cell is filled with a nematic liquid crystal material which has different Δn from that of the other liquid crystal cells. In this modification the thickness of each liquid crystal cell is the same, i.e. 7 microns. Thus, the TN liquid crystal light valve for red light employs liquid crystal material having Δn of 0.215, the TN liquid crystal light valve for green light employs liquid crystal material having Δn of 0.19, and the TN liquid crystal light valve for blue light employs liquid crystal material having Δn of 0.165. The values of Δn are not limited to those given above. With the thickness of the liquid crystal cells constant, Δn of the TN liquid crystal light valve for red light is the greatest, Δn of the TN liquid crystal light valve for blue light is the least and Δn of the TN liquid crystal light valve for green light is intermediate.

When Δn is controlled with respect to at least two colours, halftones can be improved. Further, if Δn of each light valve is determined so that Δn of the TN liquid crystal light valve for red light is greater than $1.4 \mu\text{m}$ and less than $1.6 \mu\text{m}$, i.e. $1.4 \mu\text{m} < \Delta n < 1.6 \mu\text{m}$; Δn of the TN liquid crystal light valve for green light is greater than $1.2 \mu\text{m}$ and less than $1.4 \mu\text{m}$, i.e. $1.2 \mu\text{m} < \Delta n < 1.4 \mu\text{m}$, and Δn of the TN liquid crystal light valve for blue light is greater than $1.0 \mu\text{m}$ and less than $1.2 \mu\text{m}$, i.e. $1.0 \mu\text{m} < \Delta n < 1.2 \mu\text{m}$, more excellent image quality is obtained.

In this modification halftone colours hardly change in respect to all the halftones, and neutral colour is kept. Further, colour reproducibility is obtained to the same degree as with a CRT. Colour reproducibility is excellent in the vicinity of reflectance near to black level which is hard to obtain with the conventional projection-type display devices. In this example, all the TN liquid crystal light valves are manufactured by the same process and consequently cost can be reduced. Further, if the thickness of the liquid crystal cell does not meet with the predetermined value, the difference between the obtained cell thickness and the predetermined value can be corrected by adjusting the value of Δn (e.g. a liquid crystal cell having a thickness of $8 \mu\text{m}$ is filled with liquid crystal material having Δn of 0.187, thereby obtaining a TN liquid crystal light valve for red light). Therefore, a liquid crystal cell which could be regarded as defective in view of the fact that its thickness differs from the predetermined value, can still be used to improve manufacturing yield. Further, viscosity and threshold voltage of each liquid crystal material can be determined in advance and have substantially the same values. Thus it is not necessary to vary the driving voltage to match each twisted liquid crystal light valve and response speed for each colour is substantially the same. As to the liquid crystal material, a liquid crystal mixture which has triple bonds in its molecular structure is preferable since such a nematic liquid crystal materials allows the response speed to be increased more than with other types of liquid crystal

materials.

Figure 5 shows a sectional view of another embodiment of a TN liquid crystal light valve for a projection-type display device. The TN liquid crystal light valve of Figure 5 has a simple matrix liquid crystal cell in which strip-type transparent electrodes 502 are formed on upper and lower transparent substrates 501. An aligning layer composed of an organic molecular film is formed on each of the upper and lower substrates. In this example, the twist angle of nematic liquid crystal material between the substrates is 210° and the thickness of the liquid crystal cell is 6 microns. The TN liquid crystal light valve for red light, the TN liquid crystal light valve for green light and the TN liquid crystal light valve for blue light are filled with TN liquid crystal material having Δn of 0.165, 0.15, and 0.12, respectively. A projection-type display device as shown in Figure 2 is then formed using the three TN liquid crystal light valves.

The combined image obtained by such a projection-type display device presents neutral halftones and colours as expected. Naturally, a TN display characteristic having a twist angle of 90° or more presents special dependence on $\Delta n/\lambda$. However, Δn is controlled according to the wavelength of the incident light, thereby enabling the required photoelectric characteristics to be met. Accordingly, excellent images can be obtained.

As mentioned above, since a projection-type display device according to the present invention has three TN liquid crystal light valves, each of which has approximately the same photoelectric transfer characteristics, the display of halftones and colour reproducibility are excellent.

Further, the black level is reduced and the gray scale is hardly reversed by optimising Δn for each colour of light. Therefore, the projection-type display device of Figure 2 displays a gray scale without reversal, has a high contrast ratio and high colour purity.

Further, the three TN liquid crystal light valves may be manufactured by the same process.

Furthermore, variation of cell thickness does not affect the characteristics of the projection-type display device if Δn is corrected to give the desired value of Δn . Therefore, manufacturing yield is improved. Accordingly, a projection-type display device according to the present invention may be produced at relatively low cost.

Claims

1. A projection-type display device comprising:
a first transmissive type liquid crystal light valve (207) for controlling red light of wavelength λ_r , said first light valve (207) comprising a layer of thickness d_1 of twisted nematic liquid crystal material with a birefringence Δn_1 ;



a second transmissive type liquid crystal light valve (206) for controlling green light of wavelength λ_g , said second light valve (206) comprising a layer of thickness d_2 of twisted nematic liquid crystal material with a birefringence Δn_2 ;

a third transmissive type liquid crystal light valve (205) for controlling blue light of wavelength λ_b , said third light valve (205) comprising a layer of thickness d_3 of twisted nematic liquid crystal material with a birefringence Δn_3 ;

characterised in that:

$$\Delta n_1 \cdot d_1 / \lambda_r \approx \Delta n_2 \cdot d_2 / \lambda_g \approx \Delta n_3 \cdot d_3 / \lambda_b$$

2. A projection-type display device as claimed in claim 1 in which the thickness d_1 , d_2 , d_3 of the layer of liquid-crystal material in each light valve (207-205) is substantially the same.
3. A projection-type display device as claimed in claim 1 in which the birefringence Δn_1 , Δn_2 , Δn_3 of the liquid crystal material in each light valve is substantially the same.
4. A projection-type display device as claimed in any one of the preceding claims in which $\Delta n d / \lambda$ of the first, second and third light valves falls within the following range: $2.2 < \Delta n d / \lambda < 2.6$.
5. A projection-type display device as claimed in any one of the preceding claims, in which the first, second and third light valves are driven by one or more thin film transistors (102) formed on a substrate (101).
6. A projection-type display device as claimed in any preceding claim in which $\Delta n_1 d_1$ of the first light valve (207) is between 1.4 and 1.6, $\Delta n_2 d_2$ of the second light valve (206) is between 1.2 and 1.4 and $\Delta n_3 d_3$ of the third light valve (205) is between 1.0 and 1.2.

Patentansprüche

1. Anzeigevorrichtung vom Projektionstyp umfassend:

ein erstes Durchlaßtyp-Flüssigkristall-Lichtventil (207) zum Steuern von rotem Licht der Wellenlänge λ_r , wobei das erste Flüssigkristalllichtventil (207) eine Schicht der Dicke d_1 aus verdrehtem, nematischem Flüssigkristallmaterial mit einer Doppelbrechung Δn_1 aufweist;

ein zweites Durchlaßtyp-Flüssigkristall-Lichtventil (206) zum Steuern von grünem Licht der Wellenlänge λ_g , wobei das zweite Flüssigkristalllichtventil (206) eine Schicht der Dicke d_2 aus verdrehtem, nematischem Flüssigkristallmaterial mit einer Doppelbrechung Δn_2 aufweist;

ein drittes Durchlaßtyp-Flüssigkristall-Lichtventil (205) zum Steuern von blauem Licht der Wellenlänge λ_b , wobei das dritte Flüssigkristalllichtventil (205) eine Schicht der Dicke d_3 aus verdrehtem, nematischem Flüssigkristallmaterial mit einer Doppelbrechung Δn_3 aufweist; dadurch gekennzeichnet, daß:

$$\Delta n_1 \cdot d_1 / \lambda_r \approx \Delta n_2 \cdot d_2 / \lambda_g \approx \Delta n_3 \cdot d_3 / \lambda_b$$

2. Anzeigevorrichtung vom Projektionstyp nach Anspruch 1, bei welcher die Dicke d_1 , d_2 , d_3 der Flüssigkristallmaterialschicht in jedem Lichtventil (207-205) im wesentlichen gleich ist.
3. Anzeigevorrichtung vom Projektionstyp nach Anspruch 1, bei welcher die Doppelbrechung Δn_1 , Δn_2 , Δn_3 Flüssigkristallmaterials in jedem Lichtventil im wesentlichen gleich ist.
4. Anzeigevorrichtung vom Projektionstyp nach einem der vorhergehenden Ansprüche, bei welcher $\Delta n d / \lambda$ in folgenden Bereich fällt: $2.2 < \Delta n d / \lambda < 2.6$.
5. Anzeigevorrichtung vom Projektionstyp nach einem der vorhergehenden Ansprüche, bei welcher das erste, zweite und dritte Lichtventil von einem oder mehreren, auf einem Substrat (101) gebildeten Dünnschichttransistoren (102) angesteuert werden.
6. Anzeigevorrichtung vom Projektionstyp nach einem der vorhergehenden Ansprüche, bei welcher $\Delta n_1 d_1$ des ersten Lichtventils (207) zwischen 1,4 und 1,6 liegt $\Delta n_2 d_2$ des zweiten Lichtventils (206) zwischen 1,2 und 1,4 liegt und $\Delta n_3 d_3$ des dritten Lichtventils (205) zwischen 1,0 und 1,2 liegt.

Revendications

1. Dispositif d'affichage du type à projection comprenant :

une première diode lumineuse de transmission à cristaux liquides (207) pour commander la lumière rouge de longueur d'onde λ_r , ladite première diode lumineuse (207) comportant une couche d'épaisseur d_1 de matériau à cristaux liquides nématiques torsadés ayant une biréfringence Δn_1 ;

une seconde diode lumineuse de transmission à cristaux liquides (206) pour commander la lumière verte de longueur d'onde λ_g , ladite seconde diode lumineuse (206) comportant une couche d'épaisseur d_2 de matériau à cristaux liquides nématiques torsadés ayant une biréfringence Δn_2 ;

une troisième diode lumineuse de trans-



mission à cristaux liquides (205) pour commander la lumière bleue de longueur d'onde λ_b , ladite troisième diode lumineuse (205) comportant une couche d'épaisseur d_3 de matériau à cristaux liquides nématiques torsadés ayant une biréfringence Δn_3 ;

caractérisé en ce que :

$$\Delta n_1 \cdot d_1 / \lambda_r \approx \Delta n_2 \cdot d_2 / \lambda_g \approx \Delta n_3 \cdot d_3 / \lambda_b$$

2. Dispositif d'affichage du type à projection selon la revendication 1, dans lequel l'épaisseur d_1 , d_2 , d_3 de la couche de matériau à cristaux liquides de chaque diode lumineuse (207-205) est sensiblement la même. 10
3. Dispositif d'affichage du type à projection selon la revendication 1, dans lequel la biréfringence Δn_1 , Δn_2 , Δn_3 du matériau à cristaux liquides de chaque diode lumineuse est sensiblement la même. 15 20
4. Dispositif d'affichage du type à projection selon l'une quelconque des revendications précédentes, dans lequel le produit $\Delta n d$ de la première, de la seconde et de la troisième diodes lumineuses se situe dans la plage suivante : $2,2 < \Delta n d / \lambda < 2,6$. 25
5. Dispositif d'affichage selon l'une quelconque des revendications précédentes, dans lequel la première, la seconde et la troisième diodes lumineuses sont commandées par un ou plusieurs transistors (102) à films minces formés sur un substrat (101). 30 35
6. Dispositif d'affichage du type à projection selon l'une quelconque des revendications précédentes, dans lequel $\Delta n_1 d_1$ pour la première diode lumineuse (207) est compris entre 1,4 et 1,6, $\Delta n_2 d_2$ pour la seconde diode lumineuse (206) est compris entre 1,2 et 1,4 et $\Delta n_3 d_3$ pour la troisième diode lumineuse (205) est compris entre 1,0 et 1,2. 40 45 50 55

