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Son et al.

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(54) **BACKLIGHT DEVICE FOR LIQUID CRYSTAL DISPLAY**

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(22) Filed: **Sep. 8, 2000**

(30) **Foreign Application Priority Data**

Sep. 8, 1999 (KR) 1999-38155

(51) **Int. Cl.**[7] **G02F 1/1335**

(52) **U.S. Cl.** **349/115**

(58) **Field of Search** 349/115, 175, 349/185, 117, 96, 97, 98

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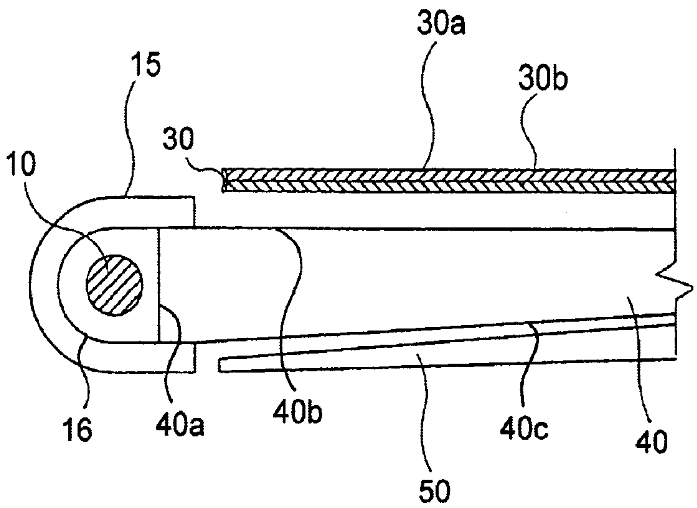
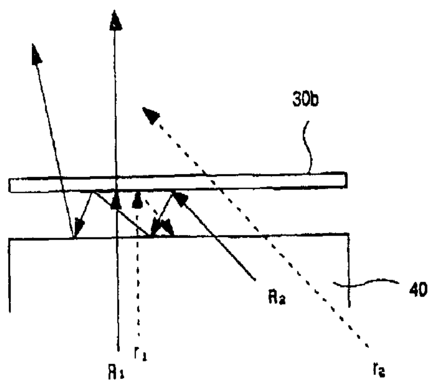
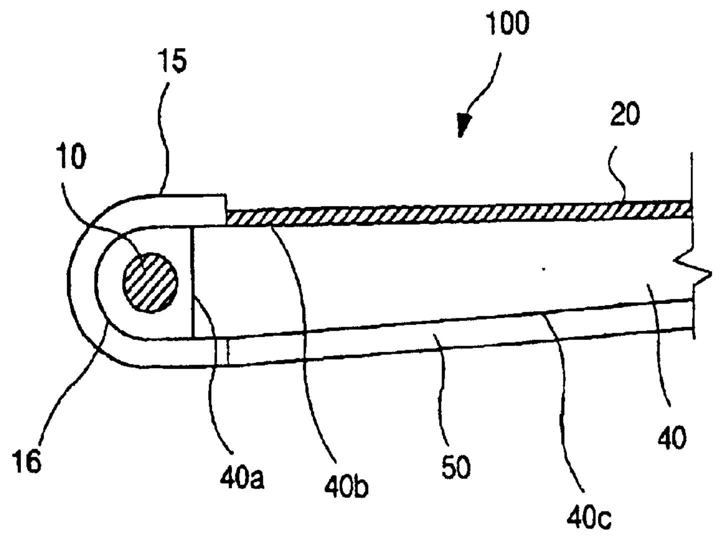
(57) **ABSTRACT**

A backlight device for a liquid crystal display device includes a light source providing light; a light waveguide plate **40** guiding light from the light source, having an emitting surface, a front surface and a bottom surface, the emitting surface adjacent to the light source; a reflector arranged under the bottom surface of the light wave guide plate, reflecting light; and at least one cholesteric liquid crystal (CLC) film arranged over the front surface of the light wave guide plate, collimating light.

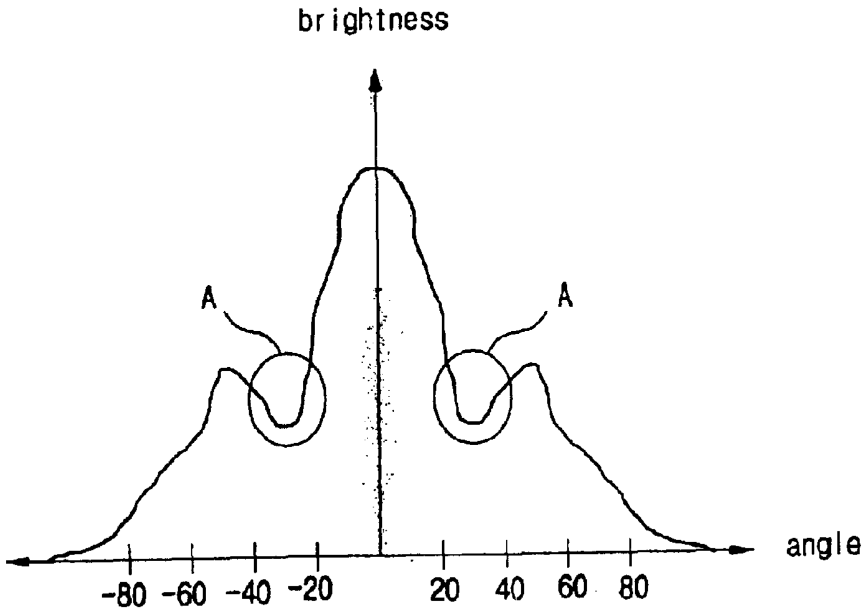
16 Claims, 6 Drawing Sheets







(Related Art)
Fig 1



(Related Art)
Fig 2

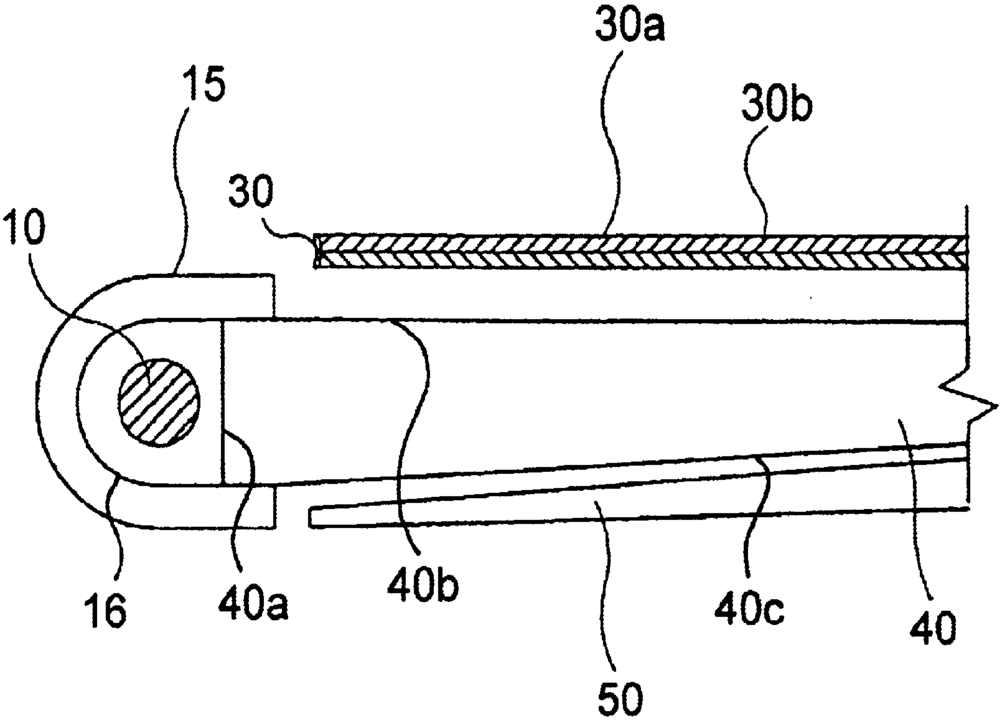


Fig 3

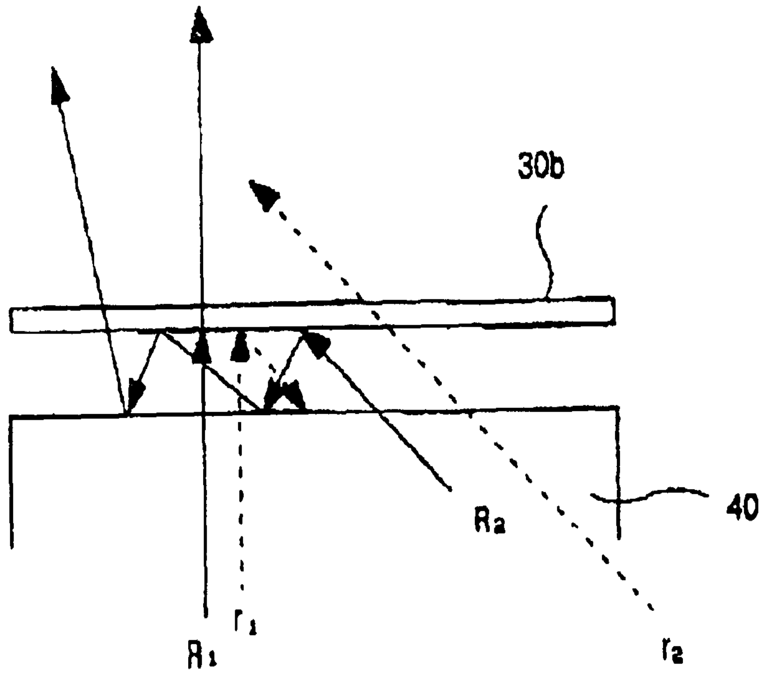


Fig 4

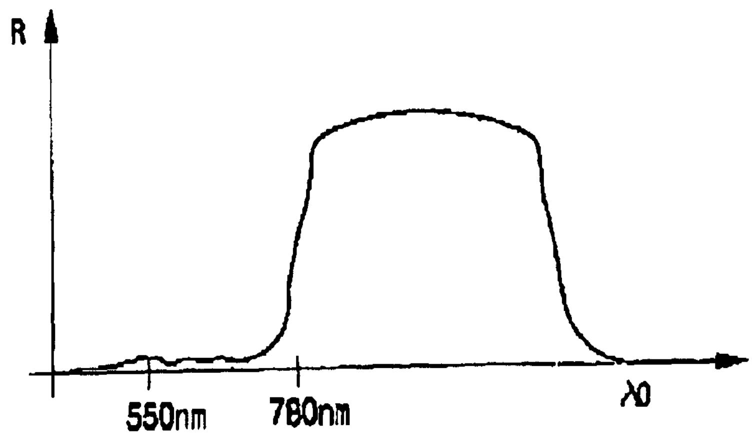


Fig 5A

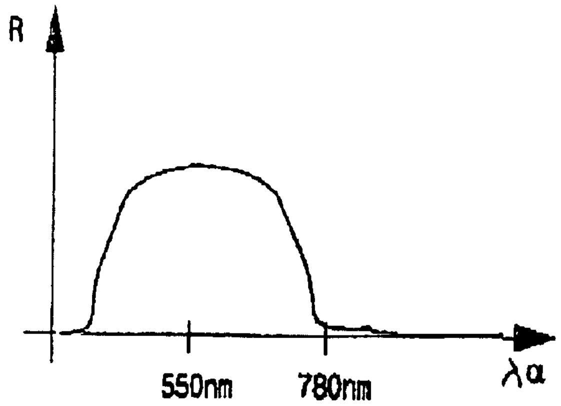


Fig 5B

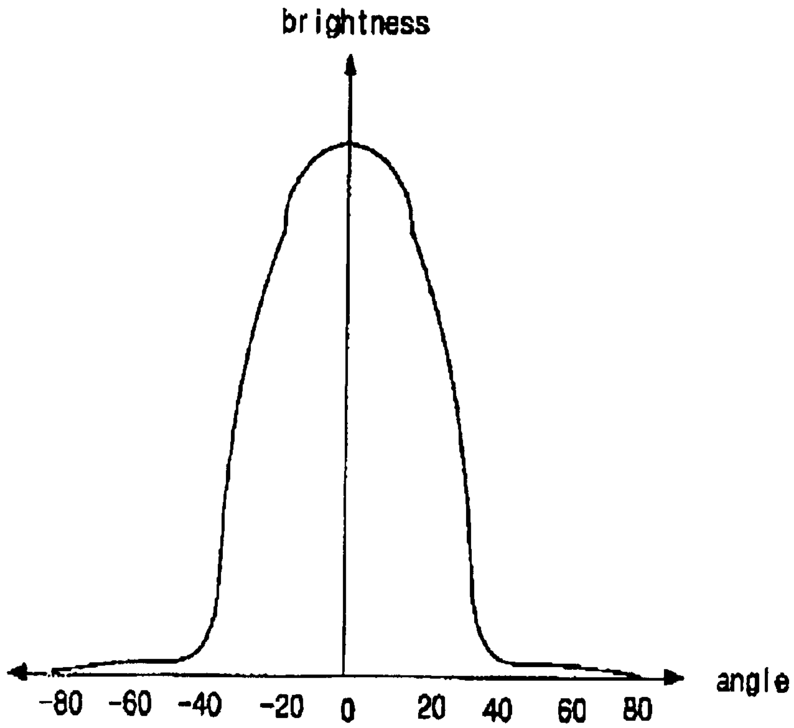


Fig 6

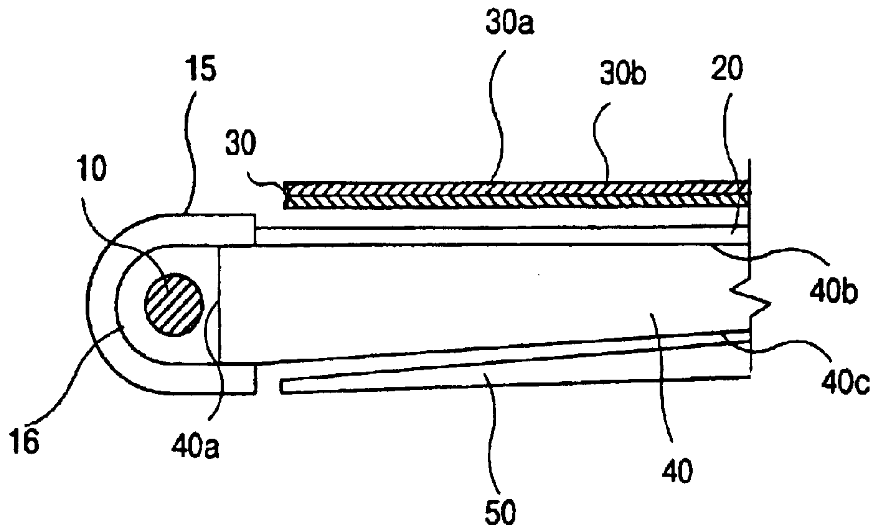

30a
15
30b
20
30
10
40b
40c
16
40a
40
50

Fig 7

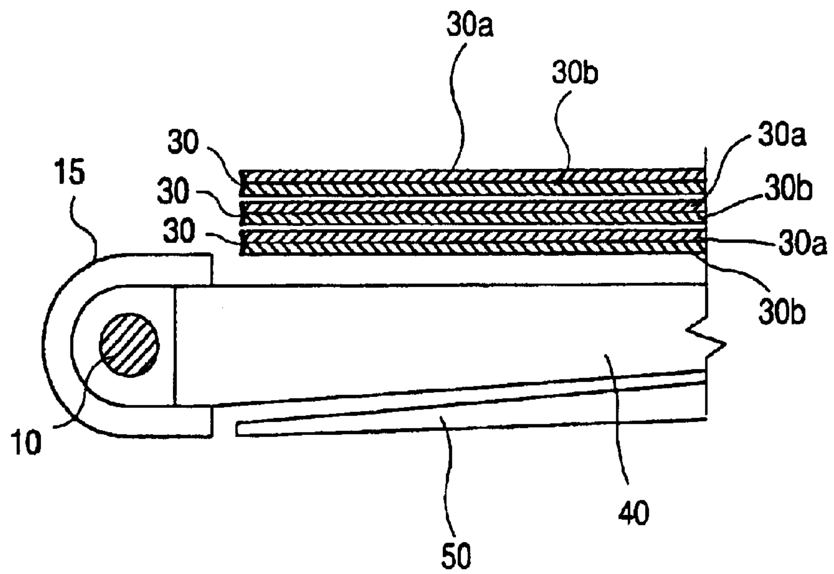

30a
30b
30
30a
15
30
30b
30
30a
30b
10
40
50

Fig 8

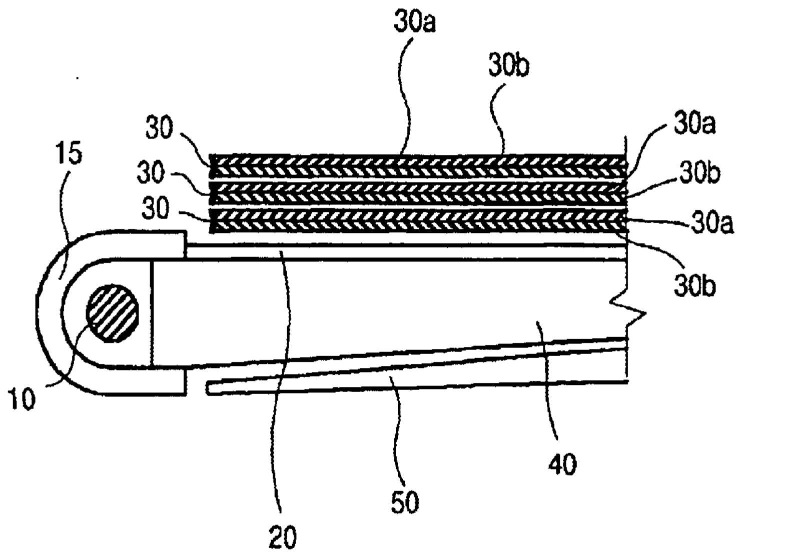


Fig 9

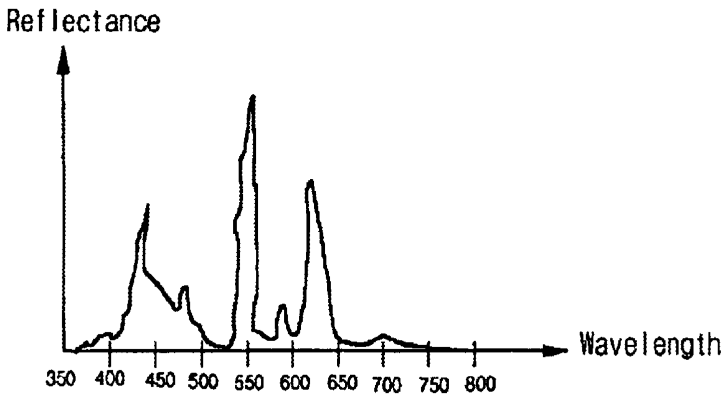


Fig 10

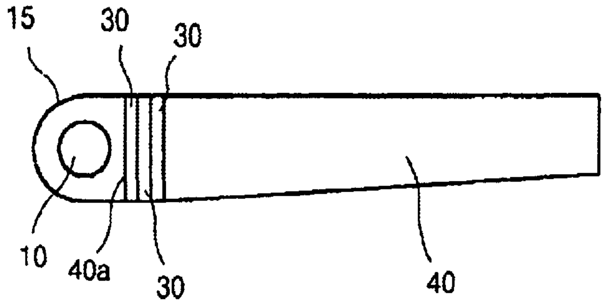


Fig 11

BACKLIGHT DEVICE FOR LIQUID CRYSTAL DISPLAY

CROSS REFERENCE

This application claims the benefit of Korean Patent Application No. 1999-38155, filed on Sep. 8, 1999, under 35 U.S.C. § 119, the entirety of which is hereby incorporated by reference.

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to a backlight device, and more particularly, to a backlight device for use in a liquid crystal display (LCD) device.

2. Description of Related Art

FIG. **1** shows a conventional backlight device for use in an LCD device. As shown in FIG. **1**, the conventional backlight device **100** includes a light source **10**, a U-shaped lamp holder **15** having a lamp reflector **16**, a light waveguide plate **40**, a reflector **50**, and a prism sheet **20**. The light source **10** is located adjacent to an end **40***a* of the light waveguide plate **40**, and most of the light source **10** is surrounded by the lamp holder **15**. The end **40***a* constitutes a surface through which the incident light from the light source **10** is emitted. The prism sheet **20** is arranged on a front surface **40***b* of the light wave guide plate **40**, and the reflector **50** is located under a bottom surface **40***c* of the light wave guide plate **40**.

The emitted light from the light source **10** is directed toward the surface **40***a* of the light waveguide plate **40** by the lamp reflector **16** and is then directed either toward a prism sheet **20** or a reflector **50**. The light reflected by the reflector **50** is emitted toward the observer through a prism sheet **20**, and a liquid crystal panel (not shown) in the form of an information.

FIG. **2** is a graph illustrating brightness with respect to an angle of light passing through the prism sheet. As shown in FIG. **2**, brightness distribution is discursive. In other words, light passing through the prism sheet **20** is not well collimated. As a result, light collimating efficiency is bad, and collimating loss takes place at portions "A". In addition, in the conventional backlight device of such a structure, it is not easy to narrow an angle of light passing through the prism sheet to a desirable angle range (for example, from −40 degrees to +40 degrees).

For the foregoing reasons, there is a need for a backlight device having a high light collimating efficiency.

SUMMARY OF THE INVENTION

To overcome the problem described above, preferred embodiments of the present invention provide a backlight device having a high light collimating efficiency.

In order to achieve the above object, a preferred embodiment of the present invention provides a backlight device for a liquid crystal display device, including: a light source providing light; a light waveguide plate guiding light from the light source, having an emitting surface, a front surface and a bottom surface, the emitting surface being adjacent to the light source; a reflector arranged under the bottom surface of the light wave guide plate, reflecting light; and at least one cholesteric liquid crystal (CLC) film arranged over the front surface of the light wave guide plate, collimating light.

The CLC film has a one-layered structure of one of either a right- or a left handed CLC layer, wherein the right- and left handed CLC layer selectively reflect right- and left-handed circularly polarized light, respectively. The CLC film may also have a dual-layered structure of a right- and a left handed CLC layer, wherein the right- and left handed CLC layer selectively reflect right- and left-handed circularly polarized light, respectively. The backlight device further includes a prism sheet arranged between the CLC film and the front surface of the light wave guide plate.

By using the backlight device according to preferred embodiments of the present invention, light collimating efficiency and brightness can be improved.

BRIEF DESCRIPTION OF THE DRAWINGS

For a more complete understanding of the present invention and the advantages thereof, reference is now made to the following descriptions taken in conjunction with the accompanying drawings, in which like reference numerals denote like parts, and in which:

FIG. **1** shows a conventional backlight device for use in a LCD device;

FIG. **2** is a graph illustrating brightness with respect to an angle of light passing through a prism sheet;

FIG. **3** is a cross-sectional view illustrating a backlight device according to a preferred embodiment of the present invention;

FIG. **4** shows a principle that the CLC film **30** collimates light according to a preferred embodiment of the present invention;

FIG. **5**A is a graph illustrating a reflectance with respect to a wavelength of light vertically incident on a cholesteric liquid crystal (CLC) film according to a preferred embodiment of the present invention;

FIG. **5**B is a graph illustrating a reflectance with respect to a wavelength of light non-vertically incident on the CLC film;

FIG. **6** is a graph illustrating brightness with respect to an angle of light passing through the CLC film;

FIGS. **7**, **8** and **9** are cross-sectional views illustrating modifications of the backlight device according to a preferred embodiment of the present invention;

FIG. **10** is a graph illustrating brightness with respect to a wavelength of spectrum; and

FIG. **11** is a cross sectional view illustrating another modification of the backlight device according to a preferred embodiment of the present invention.

DETAILED DESCRIPTION OF PREFFERED EMBODIMENTS

Reference will now be made in detail to preferred embodiments of the present invention, examples of which are illustrated in the accompanying drawings.

FIG. **3** is a cross-sectional view illustrating a backlight device according to a preferred embodiment of the present invention. As shown in FIG. **3**, the backlight device includes a light source **10**, a U-shaped lamp holder **15** having a lamp reflector **16**, a light waveguide plate **40**, a reflector **50**, and a cholesteric liquid crystal (CLC) film **30**. The light source **10** is located adjacent to an end **40***a* of the light waveguide plate **40**, and most parts of the light source **10** are surrounded by the lamp holder **15**. The end **40***a* constitutes a surface through which the incident light from the light source **10** is emitted. The CLC film **30** is arranged on a front surface **40***b* of the light wave guide plate **40**, and the reflector **50** is located under a bottom surface **40***c* of the light wave guide plate **40**.

The CLC film **30** serves to collimate light emitting from the light source **10** and preferably has a dual-layered structure of right-handed and left-handed CLC layers **30***a* and **30***b*. Since direction vector of the liquid crystal is helical in cholesteric state, the CLC film **30** reflects only light that is the same in helical director and satisfies Bragg reflection condition. In other words, the right-handed CLC layer **30***a* reflects only a right-handed circularly polarized light, and the left-handed CLC layer **30***b* reflects only a left-handed circularly polarized light. Using this principle, lost light can be restored, thereby improving the light collimating efficiency and brightness. The CLC film **30** may have a one-layered structure of either the right- or the left-handed CLC layer. However, since light has a right-handed circularly polarized light and a left-handed circularly polarized light, it is preferable that the CLC film **30** has a dual-layered structure of the right- and the left-handed CLC layers **30***a* and **30***b*.

FIG. **4** shows a principle by which the CLC film **30** collimates light. As shown in FIG. **3**, a left-handed circularly polarized light **R1** incident within a certain angle, which has a wavelength less than 780 nm, passes through the left-handed CLC layer **30***b*, and a left-handed polarized light **R2** incident out of a certain angle, which has a wavelength less than 780 nm, is reflected. The left-handed polarized light **R2** incident out of a certain angle is reflected again by the light wave guide plate **40** or a reflector (not shown) and directs toward the left-handed CLC layer **30***b*. it is repeated until the left-handed polarized light **R2** incident out of a certain angle becomes light incident within a certain angle to pass through the CLC layer **30***b*.

FIG. **5**A is a graph illustrating a reflectance with respect to a wavelength of light vertically incident on the CLC film. "R" denotes a reflectance, and "λ_1" denotes a wavelength of vertically incident light. The CLC film **30** also serves to transmit only light of a certain wavelength by controlling a helical pitch. The wavelength of light vertically incident on the CLC film **30** can be obtained by the following formula: $\lambda_0=P(n_o+n_e)/2$. In the formula, "λ_0" is a wave length of vertically incident light, "P" is a helical pitch, "n_o" is an ordinary refractive index, and "n_e" is an extraordinary refractive index. Therefore, by controlling a helical pitch of the CLC film **30**, an ideal visible ray having a wavelength of from 380 nm to 780 nm can be transmitted, as shown in FIG. **4**. By controlling a helical pitch of the CLC film **30**, it is also possible for the CLC film **30** to transmit a wavelength of vertically incident light less than 780 nm in light of a prism sheet.

FIG. **5**B is a graph illustrating a reflectance with respect to a wavelength of light obliquely incident on the CLC film. "R" is a reflectance, and "λ_α" is a wavelength of obliquely incident light with a certain angle "α". A wavelength of obliquely incident light with a certain angle "α" can be obtained by the following formula: "λ_α"$=\lambda_0\cos[\sin^{-1}\{2\sin\alpha/(n_o+n_e)\}]$. In order to reflect a visible ray of from 380 nm to 780 nm and transmit a wavelength of light greater than 780 nm, it is preferable that an average refractive index "$(n_o+n_e)/2$" of the CLC film **30** is as small as possible.

As described above, the CLC film **30** according to the preferred embodiment of the present invention selectively reflects light with a wavelength of more than 780 nm. However, it is also possible to selectively reflect light with a wavelength of more than 600 nm by controlling a helical pitch of the CLC film **30** so that only a wavelength of an ideal visible ray generated from the backlight device may be transmitted

FIG. **6** is a graph illustrating brightness with respect to an angle of light passing through the CLC film **30**. As shown in FIG. **6**, by arranging the CLC film **30** having the right- and left-handed CLC layers **30***a* and **30***b*, brightness distribution can be concentrated within a range between −40 degree and +40 degree.

The backlight device according to the preferred embodiment of the present invention may further include a prism sheet **20** as shown in FIG. **7**.

The backlight device according to the preferred embodiment of the present invention may further include a plurality of the CLC films **30** without or with the prism sheet **20** as shown in FIGS. **8** and **9**, respectively.

Further, one of the right- and left-handed CLC layers **30***a* and **30***b* may be constructed to selectively reflect all the wavelength range of from 400 nm to 1000 nm, and the other may be constructed to selectively reflect vertically incident light with a wavelength of more than 600 nm. As a result, since only one of the right- and the left-handed circularly polarized lights is transmitted, a light collimating efficiency and brightness can be improved. Further, it is possible to include the CLC layer which selectively reflects vertically incident light with a wavelength of from 480 nm to 530 nm and selectively reflects vertically incident light with a wavelength of from 560 nm to 610 nm in the light of spectrum of the backlight device shown in FIG. **10**. Therefore, a color spot, which may occur when the plurality of CLC films are arranged so that vertically incident light with a wavelength of more than 600 nm is transmitted, can be prevented, and the light collimating efficiency can be improved to as narrow a range as between −30 degrees and +30 degrees.

FIG. **11** shows a modified backlight device according to another preferred embodiment of the present invention. As shown in FIG. **11**, at least one CLC film **30** may be arranged on the end **40***a* of the light wave guide plate **40** adjacent to the light source **15**. By doing this, light emitting from the light source **10** can be collimated. Therefore, when incident light within a certain angle (a range between about −30 degree and about +30 degree) is directed into the light wave guide plate **40**, it is easy to design the light wave guide plate **40** to guide light in a desirable distribution.

As described above, by using the backlight device according to preferred embodiments of the present invention, light collimating efficiency and brightness can be improved.

While the invention has been particularly shown and described with reference to preferred embodiments thereof, it will be understood by those skilled in the art that the foregoing and other changes in form and details may be made therein without departing from the spirit and scope of the invention.

What is claimed is:

1. A backlight device for a liquid crystal display device, comprising:

a light source providing light;

a light waveguide plate guiding light from the light source, said light waveguide plate having an emitting surface, a front surface and a bottom surface, the emitting surface being adjacent to the light source;

a reflector arranged under the bottom surface of the light waveguide plate, reflecting light; and

at least one single layer cholesteric liquid crystal (CLC) film arranged on the front surface of the light waveguide plate, selectively collimating light by controlling a helical pitch P of said CLC film according to the equation:

$$\lambda_0=P(n_o+n_e)/2,$$

where λ_0 is a wavelength of incident light, P is a helical pitch, n_o is an ordinary refractive index, and n_e is an extraordinary refractive index.

2. The backlight device of claim **1**, wherein the single layer CLC film is one of either a right-handed or a left-handed CLC layer, the right-handed CLC layer selectively reflecting right-handed circularly polarized light and the left-handed CLC layer reflecting left-handed circularly polarized light.

3. The backlight device of claim **1**, wherein the at least one single layer CLC film has a dual-layered structure having both a right-handed and a left-handed CLC layer, the right-handed and left-handed CLC layer selectively reflecting right-handed and left-handed circularly polarized light, respectively.

4. The backlight device of claim **1**, further comprising a prism sheet arranged between the at least one single layer CLC film and the front surface of the light waveguide plate.

5. A backlight device for a liquid crystal display device, comprising:

a light source providing light;

a light waveguide plate guiding light from the light source, said light waveguide plate having an emitting surface, a front surface and a bottom surface, the emitting surface being adjacent to the light source;

a reflector arranged under the bottom surface of the light waveguide plate, reflecting light; and

at least one single layer cholesteric liquid crystal (CLC) films arranged over the front surface of the light waveguide plate, collimating light, wherein the at least one CLC film selectively reflects incident light with a wavelength of more than 600 nm by controlling a helical pitch P of said CLC film according to the equation:

$$\lambda_0=P(n_o+n_e)/2,$$

where λ_0 is a wavelength of vertically incident light, P is a helical pitch, n_o is an ordinary refractive index, and n_e is an extraordinary refractive index.

6. The backlight device of claim **5**, wherein each single layer CLC film is one of either a right-handed or a left-handed CLC layer, each right-handed CLC layer selectively reflecting right-handed circularly polarized light and each left-handed CLC layer reflecting left-handed circularly polarized light.

7. The backlight device of claim **5**, wherein each single layer CLC film is formed by a dual-layered structure, each structure having both a right-handed and a left-handed CLC layer, the right-handed and left-handed CLC layers selectively reflecting right-handed and left-handed circularly polarized light, respectively.

8. The backlight device of claim **5**, further comprising a prism sheet arranged between the at least one single layer CLC film and the front surface of the light waveguide plate.

9. A backlight device for a liquid crystal display device, comprising:

a light source providing light;

a light waveguide plate guiding light from the light source, said light waveguide plate having an emitting surface, a front surface and a bottom surface, the emitting surface being adjacent to the light source, the length of said emitting surface being substantially shorter than a length of the front surface; and

at least one cholesteric liquid crystal (CLC) film arranged on the emitting surface of the light waveguide plate, collimating light by reflecting light outside the band of incedent light.

10. The backlight device of claim **9**, wherein the at least one CLC film is one of either a right-handed or a left-handed CLC layer, the right-handed CLC layer selectively reflecting right-handed circularly polarized light and the left-handed CLC layer reflecting left-handed circularly polarized light.

11. The backlight device of claim **9**, wherein each of the at least one CLC films is formed by a dual-layered structure, each structure having both a right-handed and a left-handed CLC layer, the right-handed and left-handed CLC layers selectively reflecting right-handed and left-handed circularly polarized light, respectively.

12. The backlight device of claim **9**, further comprising a prism sheet arranged between the at least one CLC film and the front surface of the waveguide plate.

13. A backlight device for a liquid crystal display device, comprising:

a light source providing light;

a light waveguide plate guiding light from the light source, said light waveguide plate having an emitting surface, a front surface and a bottom surface, the emitting surface being adjacent to the light source, the length of said emitting surface being substantially shorter than a length of the front surface;

a reflector arranged under the bottom surface of the light waveguide plate, reflecting light; and

at least one cholesteric liquid crystal (CLC) film arranged on the emitting surface of the light waveguide plate adjacent to the light source reflecting light outside of the band of incedent light.

14. The backlight device of claim **13**, wherein the single layer CLC film is one of either a right-handed or a left-handed CLC layer, the right-handed CLC layer selectively reflecting right-handed circularly polarized light and the left-handed CLC layer reflecting left-handed circularly polarized light.

15. The backlight device of claim **13**, wherein the at least one single layer CLC film has a dual-layered structure having both a right-handed and a left-handed CLC layer, the right-handed and left-handed CLC layer selectively reflecting right and left-handed circularly polarized light, respectively.

16. The backlight device of claim **13**, further comprising a prism sheet arranged between the at least one single layer CLC film and the front surface of the light waveguide.

* * * * *

专利名称(译)	用于液晶显示器的背光装置

公开(公告)号	US6822710	公开(公告)日	2004-11-23
申请号	US09/657506	申请日	2000-09-08

[标]申请(专利权)人(译)	乐金显示有限公司
申请(专利权)人(译)	LG.飞利浦液晶CO.，LTD.
当前申请(专利权)人(译)	LG DISPLAY CO.，LTD.
[标]发明人	SON HYEON HO MOON JONG WEON
发明人	SON, HYEON-HO MOON, JONG-WEON
IPC分类号	G02F1/1335 G02F1/13 G02F1/13357 G02F1/133
CPC分类号	G02F1/133615 G02F1/13362 G02F2001/133607 G02F2001/133543
审查员(译)	PARKER，KENNETH
优先权	1019990038155 1999-09-08 KR
外部链接	Espacenet USPTO

摘要(译)

一种用于液晶显示装置的背光装置，包括提供光的光源;光波导板40引导来自光源的光，具有发射表面，前表面和底表面，发射表面与光源相邻;反射器，设置在光波导板的底面下方，反射光;至少一个胆甾型液晶（CLC）薄膜设置在光波导板的前表面上，准直光。