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(54) [Title of the Invention] LIQUID CRYSTAL DISPLAY DEVICE
(57) [Abstract]
[Object] An object is to illuminate the entire display portion with uniform luminance and with high brightness.
[Construction] Plural insertion holes 32 are formed through longer sidewalls 24D and 24E of a reflector plate 24, which has the shape of a front-open rectangular shallow box. LEDs 2 are arranged and inserted through the insertion holes 32. A liquid crystal display board 10 and a wiring circuit board 22 are electrically connected to each other via a pair of electrically conductive members 21 provided along the respective two longer side edges of the reflector plate 24.
[Claim]
[Claim 1] A liquid crystal display device in which a reflector plate or a light-guiding plate is arranged on a rear face side of a liquid crystal display board, configured such that light emitted from light sources is guided to the liquid crystal display board via the reflector plate or light-guiding plate to backlight the liquid crystal display board, wherein the reflector plate or light-guiding plate is formed in a rectangular shape and disposed on a wiring circuit board, the liquid crystal display board and the wiring circuit board are electrically connected by electrically conductive members arranged along both longer side edges of the reflector plate or light-guiding plate, and a plurality of light sources are arranged next to one another along one or both of the longer sides of the reflector plate or light-guiding plate.
[Detailed Description of the Invention]
[0001]
[Field of Industrial Application] The present invention relates to a liquid crystal display device in which a liquid crystal display board is backlit using a reflector plate or a light-guiding plate.

[0002]
[Description of the Related Art] In general, in a liquid crystal display device used as a display unit in various kinds of devices/equipment, including but not limited to office automation (OA) equipment, a watch/clock, a blood pressure meter, and a hot water supply device, a display portion is backlit from the inside, thereby enhancing the visibility of displayed characters. In a typical battery-powered compact liquid crystal display device, reflective-type illumination is used

for the purpose of achieving low power consumption, and a light bulb (incandescent bulb) is turned on for illumination only when required by a user. This is because it is not possible to provide always-ON illumination by means of a light bulb due to the low power of 60 to 100 mW that can be used for such always-ON illumination, though it depends on the capacity of a battery built in an apparatus. In view of the above, recently, a backlight illumination method with the use of, as a light source, an LED (light emitting diode), which is one low-power-consumption light emission medium, has been employed. The power consumption of an LED (20 mW per piece) is far lower than that of a light bulb. In addition, an LED offers comparatively high brightness and comparatively long service life. Moreover, besides red LEDs, LEDs for various emission colors, such as green LEDs and yellow LEDs, are easily available on the market. For these reasons, an LED is suitable for use as an illuminating light source of a liquid crystal display device. However, light emitted from an LED has high directivity. Therefore, with the mere use of an LED, it is difficult to provide uniform illumination throughout an entire wide area. In order to overcome this difficulty, in prior art, as illustrated in Fig. 9, a flatpanel-type light emitter that is a combination of a lightguiding plate 1 and an LED 2 is used. In this flat-paneltype light emitter, the light-guiding plate 1, which is made of transparent resin that has excellent transparency to light, for example, acrylic resin, has the shape of a wedge in a side view. The back 3 of the light-guiding plate 1 is formed as a sloped surface. Light 4 emitted from the LED 2 enters the inside of the light-guiding plate 1 through a thicker side edge face 5, which is the incident light receiving portion of the light-guiding plate 1. The light that has gone into the light-guiding plate 1 is reflected by the light-guiding plate back 3. The reflected light goes out through a surface 6. By this means, uniform plane illumination throughout a light output area is obtained. As compared with other kinds of flat-panel light emitters using electroluminescence, optical fiber, etc. the illustrated flat-panel light emitter has advantages of a simpler structure and lower cost. In the LED 2, in order to overcome a small source emission area size, a diode chip 8 is molded by means of transparent resin 7 such as acrylic resin, and a convex lens 7a is provided on the tip of the transparent resin 7. The convex lens 7a magnifies the light emitted from the diode chip 8 for easier view. The inclined surface at the back 3 of the light-guiding plate 1 is formed

as the plane of reflection by aluminum vapor deposition, bonding of a reflective sheet 9 thereto, or the like. The reference numeral 10 denotes a liquid crystal display board.

[0003]

[Problems to be Solved by the Invention] In the liquid crystal display device described above, when the liquid crystal display board 10 has a rectangular shape, the following structure is typically adopted: electrodes for liquid-crystal-driving use are arranged next to one another along each of two longer side edges of said rectangular board; these electrodes are connected via lead wires, etc. to a liquid crystal driving circuit provided on a wiring circuit board. Therefore, the LEDs 2 are arranged along and next to a shorter thicker side edge of the light-guiding plate 1. In such a structure, because of optical attenuation, luminance decreases with distance from the light source in inverse proportion to the square of the distance. This makes it difficult to illuminate the entire display portion with uniform luminance. In this respect, there is a problem in the structure of prior art.

[0004]

The present invention has been made in view of the problem of prior art described above. An object of the invention is to provide a liquid crystal display device that can realize illumination with uniform luminance for the entire display portion and with high brightness.

[0005]

[Means for Solving Problem] In order to achieve the above object, the present invention is a liquid crystal display device in which a reflector plate or a light-guiding plate is arranged on a rear face side of a liquid crystal display board, configured such that light emitted from light sources is guided to the liquid crystal display board via the reflector plate or light-guiding plate to backlight the liquid crystal display board, where

the reflector plate or light-guiding plate is formed in a rectangular shape and disposed on a wiring circuit board, the liquid crystal display board and the wiring circuit board are electrically connected by electrically conductive members arranged along both longer side edges of the reflector plate or light-guiding plate, and a plurality of light sources are arranged next to one another along one or both of the longer sides of the reflector plate or light-guiding plate.

[0006]

[Operation] In the present invention, since the plurality of light source elements are arranged next to one another along one or both of the two longer side edges of the reflector plate or the light-guiding plate, as compared with a case where they are arranged next to one another along one or both of the two shorter side edges thereof, light is less susceptible to attenuation, and therefore, it is possible to

illuminate the liquid crystal display board with uniform greater luminance. Each of the electrically conductive members electrically connects the liquid crystal display board and the wiring circuit board to each other, and forms a gap space for accommodating the light source elements between itself and the reflector plate or between itself and the light-guiding plate.

[0007]

[Embodiments] On the basis of exemplary embodiments illustrated in the drawings, the present invention will now be explained in detail. Fig. 1 is a sectional view that illustrates a liquid crystal display device according to an exemplary embodiment of the present invention. Fig. 2 is a side sectional view of a flat-panel-type light emitter. Fig. 3 is an exploded perspective view of the flat-panel-type light emitter. In these drawings, the same reference numerals are assigned to components/portions that are the same as those of Fig. 9. In these drawings, a liquid crystal display device 11 includes a case 12, which has the shape of a shallow rectangular box with an opening 13 at the center of its top, a liquid crystal display board 10, which is housed inside the case 12 and can be seen from the outside through the opening 13, a transparent protection plate 14, which is fitted inside the opening 13 to protect the surface of the liquid crystal display board 10, a flatpanel-type light emitter 16, which is housed inside the case 12 and backlights the liquid crystal display board 10, a power supply 17 for the liquid crystal display board 10 and LEDs 2, plural operation switches 18, which are provided on the top face of the case 12, and the like.

[0008]

The liquid crystal display board 10 has a well-known panel structure, in which nematic liquid crystal, etc. is sealed between an upper glass plate 10a and a lower glass plate 10b. The width of the upper glass plate 10a is greater than that of the lower glass plate 10b. Plural electrodes 19 for liquid-crystal-driving use are arranged next to one another on the back of the upper glass plate 10a along each of two longer side edges. These electrodes 19 are connected to a liquid crystal driving circuit (not shown) provided on a wiring circuit board 22 via left and right electrically conductive members 21, which make up a pair.

[0009]

The flat-panel-type light emitter 16 includes a reflector plate 24, which is provided behind the rear of and

in parallel with the liquid crystal display board 10, the above-mentioned plural LEDs 2, which are arranged next to one another along each of two longer side edges of the reflector plate 24, the above-mentioned wiring circuit board 22, to which the reflector plate 24 is fixed, a light diffusing plate 25, which is provided between the liquid crystal display board 10 and reflector plate 24, the abovementioned pair of electrically conductive members 21, which supports the liquid crystal display board 10 and electrically connects the liquid crystal display board 10 to the wiring circuit board 22, and a cover 26, which encloses the liquid crystal display board 10 and the wiring circuit board 22, with the liquid crystal display board 10 therebetween, etc.

[0010]

The reflector plate 24 is made of resin and has the shape of a front-open rectangular shallow box. The reflector plate 24 is made up of a bottom plate 24A, a pair of shorter sidewalls 24B and 24C, and a pair of longer sidewalls 24D and 24E. The shorter sidewalls 24B and 24C are formed facing each other in the length direction of the reflector plate 24, and the longer sidewalls 24D and 24E are formed facing each other in the direction perpendicular to the length direction of the reflector plate 24. Due to reflection treatment applied to the inner surface of the reflector plate 24, said surface is formed as a reflection surface 27. To form the reflection surface 27, for example, a white paint is applied thereto, an aluminum foil is bonded thereto, or aluminum is vapor-deposited thereon. If necessary, ultra-small irregularities are formed therein for diffused reflection. A ridge 28, which extends through the center of the inner bottom surface of the reflector plate 24 throughout the entire length of the reflector plate 24 in its length direction, is formed as a part of said inner bottom surface. The ridge 28 has the shape of an inverted V in cross section. For supporting the edges of the light diffusing plate 25, a continuous fitting groove 29 is formed in such a way as to surround the opening 13. Each of the longer sidewalls 24D and 24E is formed at a relatively inner position as compared with the position of the corresponding one of two width-directional side edges 31 of the bottom plate 24A, with a predetermined distance therebetween. Each of the longer sidewalls 24D and 24E faces the corresponding one of the electrically conductive members 21, with a predetermined clearance therebetween. Plural insertion holes 32, through which the LEDs 2 are

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