BRIEF DESCRIPTION OF DRAWINGS

[0081] Further aspects of the present invention will become apparent from the following description which is given by way of example only and with reference to the accompanying drawings in which:

[0082] **FIG. 1** shows a diagrammatic representation of a multi-focal plane display in accordance with one embodiment of the present invention.

BEST MODES FOR CARRYING OUT THE INVENTION

[0083] A preferred embodiment of the present invention is shown in **FIG. 1** incorporated in a dual screen display (**1**) of known type. The display (**1**) includes two overlapping, parallel liquid crystal display screens (**2**, **3**) upon which information and/or images may be displayed by a variety of known means. In the preferred embodiment shown in simplified form in **FIG. 1, a** back light (**4**) is placed behind the rear LCD screen (**2**) to provide illumination for the images shown on one or both LCD screens (**2**, **3**).

[0084] To minimise costs, both LCD screens (**2**, **3**) are constructed in accordance with conventional manufacturing techniques, i.e. crossed polarising filters are located on the front and rear surface of each liquid crystal active element. A consequence of the characteristic operating mechanism of liquid crystal displays is that the plane polarisation of the light emerging from the front surface of the rear LCD screen (**2**) is crossed with respect to the polarisation plane of the rear surface of the front LCD screen (**3**).

[0085] To rotate the emergent light from the rear screen (**2**) by the required angle to align with the rear polarisation filter of the front LCD screen (**3**), an optical retarder (**5**) is placed between the LCD screens (**2**, **3**). Whilst in theory, the retarder (**5**) may be placed anywhere between the screens (**2**, **3**), the use of prior art retarders such as polyester necessitates a location adjacent the front of the rear LCD screen (**2**). This is primarily due to the need for a diffusive pattern to be applied to retarders to avoid interference effects degrading the resultant display (**1**) image. Interference patterns are generated by both the Moiré effect,—i.e., interference caused by slight period disparities between the structured surface on the LCD screens (**2**, **3**), and the effects of chromatic separation of white polarised light into ‘rainbow’ coloured fringes. Diffusing the light is therefore used to deregulate the interference patterns generated.

[0086] It has been found in practice that chemical etching of the diffusion pattern on polyester does not provide sufficient control of the colour interference patterns. The main alternative to chemical etching involves embossing a holographically recorded master with a randomised surface structure onto the polycarbonate retarder surface. This process is however significantly more expensive than chemical etching.

[0087] Prior art alternatives also include custom manufactured LCD screens constructed with the rear polarising filter of the front LCD screen (**3**) already aligned with the rear polariser of the front LCD screen (**3**). This re-alignment may also be undertaken after manufacture by a third party, albeit with a significant risk of damage to the LCD screens. Both means of re-alignment are prohibitively expensive.

[0088] The present invention addresses this need by use of a biaxial polypropylene film as a first order retarder (**5**) located between the LCD screens (**2**, **3**). Biaxial polypropylene available direct from commercial stationery outlets has been found to produce surprisingly good results in terms of optical performance in addition to the obvious cost and availability benefits. A brightness gain of 1.96 has been measured in comparison to existing polyester retarders. Furthermore, biaxial polypropylene of sufficient thickness to form a first order retarder eliminates the colour interference effects whilst also permitting the use of chemically etched diffusion pattern to eliminate the Moiré interference effect without loss of image quality.

[0089] As described earlier, the degree of retardance/retardation is generally expressed in terms of

[0090] d) linear displacement—the difference in the optical path length between the wave fronts of the two components, expressed in nanometers (nm);

[0091] e) fractional wavelength—the optical path length difference expressed as a fraction of a given wavelength, obtained by dividing linear displacement values by a particular phase angle value or wavelength by 2π; and

[0092] f) phase angle—the phase difference between the wave fronts of the two component beams;

[0093] It and thus, it can be thus seen that:

$$\delta=\Gamma/\lambda.2\pi$$

[0094] where δ=the phase angle

[0095] Γ=the linear displacement

[0096] λ=the wavelength

[0097] Γ/λ=is the fractional wavelength.

[0098] As biaxial polypropylene may readily be produced as thin flexible durable sheets, sufficiently thin to produce a linear displacement less than one wavelength of visible light, i.e, the retarder produces a phase angle of less than a, it is said to be of the first order. Prior art retarders used in this application produced resultant phase angles between 2π and 2π, or between 2π and 3π, i.e. second order, or third order retarders respectively.

[0099] The chemically etched diffusion pattern may be applied to a diffuser in the form of sheet of acrylic (**6**) or similar placed between the LCD screens (**2**, **3**). The biaxial polypropylene also provides sufficient chromatic uniformity that the retarder (**5**) can be placed at any point between the LCD screens (**2**, **3**).

[0100] According to further embodiments (not shown) the diffuser (**6**) may be either formed as a separate layer distinct from said retarder (**5**) or diffusive properties may be applied to the surface of the retarder (**5**) itself.

[0101] The said diffusive effects of the diffuser (**6**) may be formed by chemical etching; embossing; impressing: or calendering a random, non-periodic surface structure onto the diffuser surface.

[0102] The ideal separation of the said diffuser (**6**) from the surface of the display (**3**) surface is a trade off between image clarity (decrease with separation) and diffusion of the moiré effects (increasing with separation). This separation