

REAR PROJECTION SCREEN

TECHNICAL FIELD

5 The present invention relates to a screen for displaying optical images. In particular, it relates to a rear projection screen for receiving optical signals projected from a rear side and displaying optical images for viewing from a front side.

10 BACKGROUND

 Rear projection screens are used in image processing and displaying systems such as Liquid Crystal Display (LCD) or Digital Light Processing (DLP) projectors. In such an image projection system, lights or optical signals generated
15 by the projector is projected to a back side of the screen, and the optical images generated by the optical signals are displayed on the screen for viewing from a front side.

 To display clear images, one requirement is that the screen be capable of
20 distributing light evenly throughout the display area. One of the problems that exists in present projection systems is, however, that a bright light spot ("hot spot") generated by the light source of the projector and projected onto the screen, which is much brighter than the surrounding areas. This causes uneven distribution of lights on the screen, which reduces image quality.

25 Attempts have been made to solve the above-mentioned problem. In one approach, a rear projection screen is provided in which external electrical power is required to activate certain active elements formed in the screen so as to increase the light distribution quality and evenness. While such solutions may increase the
30 light distribution evenness, the cost of fabricating and maintaining such type of screen is higher because of the structural requirements and the requirement of

external power supply. Further, such type of screens may be used in indoor environment only.

What is needed is therefore a rear projection screen which can display light images with increased evenness throughout the screen area, which is simple in structural and relatively easy to fabricate.

SUMMARY OF THE INVENTION

Embodiments of the present invention provide rear projection screens in the form of screen structures and fabrication method. Rear projection screens according to embodiments of the present invention are capable of displaying optical images with an increased evenness throughout the screen area.

According to one aspect, there is provided a rear projection screen which has a first transparent layer and a second transparent layer. The first and second transparent layers are attached together by an adhesive. When cured, the adhesive forms an adhesive layer to bond the first and second transparent layers. The adhesive layer is translucent to light, i.e. it allows light to pass through in a diffused manner. One external surface of the first transparent layer is further treated such that the external surface becomes translucent to light. Alternatively, a translucent film may be laminated on the external surface. A rear projection screen can be formed accordingly. Light passing through the screen may be diffused by the first and second translucent layers, hence a screen with increased light evenness is obtained and the hot spot effect can be reduced.

According to another aspect, there is provided a rear projection screen which includes a first translucent layer, a second translucent layer and a transparent layer attached to and disposed between the first and second translucent layers. One or both translucent layers may be an external surface of the transparent layer which is treated to be translucent, or a translucent film laminated on the external surface.

According to a further embodiment, there is provided a method for fabricating a rear projection screen. According to one embodiment, first and second translucent layers are each formed on one side of a transparent layer. One or both translucent layers may be formed by either treating the external surface of the transparent layer to be translucent, by sand-blasting, grit-spraying or acid-etching, for example, or by laminating a translucent film on the external surface of the transparent layer.

BRIEF DESCRIPTION OF THE DRAWINGS

These and other aspects and advantages of the present invention will be described in detail with reference to the accompanying drawings, in which:

Fig. 1A is a cross sectional side view showing a rear protection screen according to a first embodiment of the present invention.

Figs. 1B and is a cross sectional side views showing a method of fabricating a rear projection screen shown in Fig. 1A.

Fig. 1C is a flow chart showing a method of fabricating a rear projection screen shown in Fig. 1A.

Fig. 2 is a cross sectional side view showing a rear protection screen according to a second embodiment of the present invention.

Fig. 3 is a cross sectional side view showing a rear protection screen according to a third embodiment of the present invention.

Fig. 4 is a cross sectional side view showing a rear protection screen according to a fourth embodiment of the present invention.

Fig. 5 is a cross sectional side view showing a rear protection screen according to a fifth embodiment of the present invention.

Fig. 6 is a cross sectional side view showing a rear protection screen according to a sixth further embodiment of the present invention.

Fig. 7A is a cross sectional side view showing a rear protection screen according to a seventh embodiment of the present invention.

Fig. 7B is a cross sectional side view showing a method of fabricating a rear projection screen shown in Fig. 7A.

Fig. 7C is a flow chart showing a method of fabricating a rear projection screen shown in Fig. 7A.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Fig. 1A shows a rear protection screen 110 according to one embodiment of the present invention. Rear protection screen 110 includes a first transparent layer 112 which is attached to a second transparent layer 116, via an adhesive layer 114. First and second transparent layers may be made of light-transparent material, for example glass. Adhesive layer 114 serves to bond first and second transparent layers 112 and 116 together. Further, adhesive layer is formed by an adhesive which, upon curing, is translucent to light. When first and second transparent layers are bonded and that the adhesive is cured, the adhesive forms a first translucent layer 114.

An external surface 132 of first transparent layer 112 is treated, by sand-blasting, grit-spraying or acid-etching, for example, such that the first transparent layer 112 becomes translucent at the external surface 122. Accordingly, after being treated, there is formed a second translucent layer 132.

When light 12 passes through the screen 110, second translucent layer 132 diffuses incoming light 12, which becomes a diffused light 14. After passing through first translucent layer 114, diffused light 14 becomes further diffused light 16. Due to the effect of diffusion provided by first and second translucent layers 114 and 132, light can be evenly distributed throughout the screen 110. When being used in a projection system, a screen 110 illustrated above is capable of displaying optical images in an evenly-distributed manner. The "hot spot" effect encountered in present projection system can be greatly reduced.

Figs. 1B and 1C show a method 150 of fabricating a rear projection screen shown in Fig. 1A. First and second transparent layers 112 and 116, made of glass for example, are provided. First and second transparent layers 112 and 116 are bonded together by an adhesive layer 114, as shown in Figs. 1B and 1C as step 152. Adhesive layer 114 is also translucent to light and upon curing, the adhesive layer 114 forms a first translucent layer. A second translucent layer is then formed, as shown in Figs. 1B and 1C as step 154. An external surface 122 of first transparent layer 112 is further treated, by sand-blasting, grit-spraying or acid-etching for example, such that the first layer becomes translucent at its external surface. In other words, after being treated, first transparent layer 112 can be understood to include a first segment 112a and a second segment 112b. First segment 112a is the part of the transparent layer 112 which is untreated, hence remains transparent. Second segment 112b is the part which is treated to become translucent to light.

It should be appreciated that the fabrication sequence may vary from that illustrated above. For example, external surface 122 of first transparent layer 112 may be treated to become translucent first. Thereafter, first and second transparent layers 112 and 116 may be bonded by adhesive layer 114. A rear projection screen so fabricated has a substantially same structure as that formed under the illustrations shown in Figs. 1B and 1C.

Fig. 2 shows a rear projection screen 210 according to another embodiment of the present invention. Rear projection screen 210 includes a first transparent layer 212 which is bonded to a second transparent layer 216 via an adhesive layer 214. Adhesive layer 214, upon curing, forms a first translucent layer between first and second transparent layers 212 and 216.

Rear projection screen 210 differs from that shown in Fig. 1A in that, instead of treating an external surface of the first transparent layer 212, a film 222 is formed or laminated on first transparent layer 212. Film 222 is translucent to light, and forms a second translucent layer. A rear projection screen 210 therefore possesses substantially the same light-diffusion properties as rear projection screen 110 shown in Fig. 1A.

Fig. 3 shows a rear projection screen 310 according to yet another embodiment of the present invention. Rear projection screen 310 includes first and second transparent layers 312 and 316, which are bonded by an adhesive layer 314. Adhesive layer 314 then forms a first translucent layer. A film 322 is laminated on external surface of first transparent layer 312, to form a second translucent layer. Rear projection screen 310 differs from that shown in Fig. 2 in that, the second transparent layer is formed of tint glass 316, for example a black-tint glass. One advantage of rear projection screen so configured is that, the black-tint glass can improve the contrast level of light images displayed on the screen.

Fig. 4 shows a rear projection screen 410 according to still another embodiment of the present invention. Rear projection screen 410 according to the present embodiment includes first and second transparent layers 412 and 416, which are bonded by adhesive layer 414. Rear projection screen 410 differs from those shown above in that, the adhesion layer is formed of an adhesive which is transparent upon curing. As such, external surface 422 of first transparent layer 412 and external surface 426 of second transparent layer 416 are both treated to become translucent by, for example sand-blasting, grit-spraying or acid-etching.

After the treatment, two translucent layers 432 and 436 are formed, as shown in Fig. 4. One advantage provided by the present embodiment is that, it enables a free selection of the adhesive material used for bonding the transparent layers and when one type of adhesive material is not available, or not satisfactory to certain applications, a rear projection screen may still be formed to provide the desired display quality and light evenness.

Fig. 5 shows a rear projection screen 510 according to still another embodiment of the present invention. Rear projection screen 510 includes first and second transparent layers 512 and 516, which are bonded by transparent adhesive layer 514. Rear projection screen 510 differs from that shown in Fig. 4 in that, both the external surfaces 522 and 526 are laminated with translucent film 532 and 536. Rear projection screen 510 therefore has two translucent layers 532 and 536, with transparent layers 512, 514 and 516 in between to provide the desired image displaying properties.

It should be appreciated that alternation and/or combination of features provided in the above-illustrated embodiments is also possible to provide a desired rear projection screen according to the present invention. As shown in Fig. 6, for example, a rear projection screen 610 may include first translucent layer 632 formed by treating an external surface 622 of a first transparent layer 612. A second translucent layer 636 may be formed by laminating a translucent film on the second external surface.

It should also be appreciated that the present invention is not limited to embodiments illustrated above. Variations or modifications of previously-provided embodiments may be made to meet different requirements for fabrication and applications. For example, as shown in Fig. 7, a rear projection screen 710 includes a first translucent layer 722 formed at one side of a transparent layer 712 and a second translucent layer 732 formed at an opposite side of transparent layer 712. First and second translucent layers 722 and 732 may be both a segment of transparent layer 712 which are treated to become translucent, or both

translucent films laminated on external surfaces of transparent layer 712.

Alternatively, one of the external surfaces of transparent layer 712 may be treated to become translucent, and the other external surface be laminated with a translucent film. In the present embodiment, a second transparent layer is not required.

Figs. 7B and 7C show a method 750 for fabricating a rear projection screen shown in Fig. 7A. Fig. 7B further shows alternatives of forming translucent layers on a transparent layer. According to the present embodiment, a transparent layer 712, made of glass for example, is provided. A first translucent layer is formed at a first side of the transparent layer 712, as shown in step 752 in Fig. 7C. A second translucent layer is formed at a second side of the transparent layer, as shown in step 754 in Fig. 7C. The first and second translucent layers may be both translucent films 732 laminated at respective side of the transparent layer 712, or both treated translucent surfaces 722 of the transparent layer 712. Alternatively, one translucent layer may be a translucent film, and the other one of the translucent layer is a treated translucent surface of transparent layer 712.

Fig 8 shows a rear projection screen 810 according to a further embodiment of the present invention. Rear projection screen 810 has first and second transparent layers 812 and 816, and a first translucent layer 814 sandwiched between first and second transparent layers 812 and 816. An external surface 822 of first transparent layer is treated to become a second translucent layer 832.

A protection film 842, such as one formed of PolyVinyl Butyral (PVB) material, is laminated onto the second translucent layer 832. A further protection layer 844, for example a glass panel, may be attached to and cover protection film. One advantage of providing a protection film and a protection layer over a treated translucent surface is that, the protection film and protection layer prevents moisture contents from contacting and being accumulated on the treated translucent surface, hence to keep the treated translucent clean. This feature is

particularly useful in situations where the rear projection screen is used in outdoor and / or high humidity environment.

5 Although embodiments of the present invention have been illustrated in conjunction with the accompanying drawings and described in the foregoing detailed description, it should be appreciated that the invention is not limited to the embodiments disclosed, and is capable of numerous rearrangements, modifications, alternatives and substitutions without departing from the spirit of the invention as set forth and recited by the following claims.

CLAIMS

1. A rear projection screen comprising:
a first translucent layer;
5 a second translucent layer; and
a transparent layer attached to and disposed between the first and the second translucent layers.
- 10 2. The rear projection screen of claim 1, wherein the transparent layer includes a first segment which is transparent and a second segment which is translucent, wherein the second segment forms one of the first and second translucent layers.
- 15 3. The rear projection screen of claim 2, further comprising a protection film laminated on said one of the first and second translucent layers.
4. The rear projection screen of claim 3, further comprising a protection layer attached to and covering the protection film.
- 20 5. The rear projection screen of claim 2, wherein the other one of the first and second translucent layers is a translucent film laminated onto the transparent layer.
- 25 6. The rear projection screen of claim 1, wherein the first and second translucent layers are each a translucent film laminated onto one side of the transparent layer.
- 30 7. The rear projection screen of claim 1, wherein the transparent layer includes a first surface segment, a second surface segment opposite to the first surface segment, and a center segment between the first and second surface segments, wherein the first surface segment is the first translucent

layer, the second surface segment is the second translucent layer, and the center segment is the transparent layer.

5 8. The rear projection screen of claim 1, wherein the transparent layer is a first transparent layer, the rear projection screen further comprises a second transparent layer attached to the first translucent layer.

9. The rear projection screen of claim 8, wherein the first translucent layer is an adhesive layer bonding the first and second transparent layers.

10 10. The rear projection screen of claim 8, wherein the second transparent layer is a tint glass.

11. A rear projection screen comprising:
15 a multilayer panel including:
 a first transparent layer;
 a second transparent layer, and
 a first translucent layer disposed between the first and second transparent layers; and
20 a second translucent layer formed at an external surface of the multilayer panel.

12. The rear projection screen of claim 11, wherein the second translucent layer is a surface segment of the first and the second transparent layers.

13. The rear projection screen of claim 12, further comprising a protection film laminated on the second translucent layer.

14. The rear projection screen of claim 13, further comprising a protection layer attached to and covering the protection film.

15. The rear projection screen of claim 11, wherein the second translucent layer is a translucent film laminated onto one of the first and the second transparent layers.
- 5 16. The rear projection screen of claim 11, wherein the first translucent layer is an adhesive layer bonding the first and second transparent layers.
17. The rear projection screen of claim 11, wherein the second transparent layer is a tint glass.
- 10 18. A method for fabricating a rear projection screen, comprising:
forming a first translucent layer at a first surface of a transparent layer;
forming a second translucent layer at a second surface of the transparent layer.
- 15 19. The method of claim 18, wherein forming the first translucent layer comprises laminating a translucent film onto the first surface of the transparent layer.
- 20 20. The method of claim 18, wherein forming the first translucent layer comprises treating the first surface of the transparent layer such that first surface becomes translucent.
- 25 21. The method of claim 20, wherein treating the transparent layer comprises sand-blasting the first surface of the transparent layer.
22. The method of claim 20, wherein treating the transparent layer comprises grit-spraying the first surface of the transparent layer.
- 30 23. The method of claim 20, wherein treating the transparent layer comprises acid-etching the first surface of the transparent layer.

24. The method of claim 20 further comprising, after treating the first surface, laminating a protection film on the first surface.
- 5 25. The method of claim 24 further comprising, after laminating the protection film, attaching a third transparent layer on the protection film.
26. The method of claim 18, wherein the transparent layer is a first transparent layer, the method further comprises attaching a second transparent layer to the second translucent layer.
- 10 27. The method of claim 26, wherein attaching the second transparent layer comprises applying an adhesive layer on the first transparent layer, wherein the adhesion layer forms the second translucent layer.
- 15 28. A method for fabricating a rear projection screen, comprising:
attaching a first transparent layer to a second transparent layer to form a multilayer panel having an adhesive layer formed between the first and second transparent layers, wherein the adhesion layer is a first translucent layer to diffuse light passing therethrough;
20 forming a second translucent layer at an external surface of the multi-layer panel.
29. The method of claim 28, wherein forming the second translucent layer comprises treating the external surface such that the external surface becomes translucent.
- 25 30. The method of claim 29, wherein treating the external surface comprises sand-blasting the external surface.
- 30 31. The method of claim 29, wherein treating the external surface comprises grit-spraying the external surface.

- 32. The method of claim 29, wherein treating the external surface comprises acid-etching the external surface.
- 5 33. The method of claim 27 further comprising, after treating the external surface, laminating a protection film on the external surface.
- 34. The method of claim 27 further comprising, after laminating the protection film, attaching a third transparent layer on the protection film.
- 10 35. The method of claim 28, wherein forming the second translucent layer comprises laminating a translucent film on the external surface.