United States Patent

Jeffers

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[54] HIGH CONTRAST DISPLAY DEVICE

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[52] **U.S. Cl.** **350/156,** 350/153, 350/157

[51] **Int. Cl.**.....**G02b 27/28**

[58] **Field of Search**.....350/147, 150, 153, 156, 157, 350/160; 313/91

[56] **References Cited**

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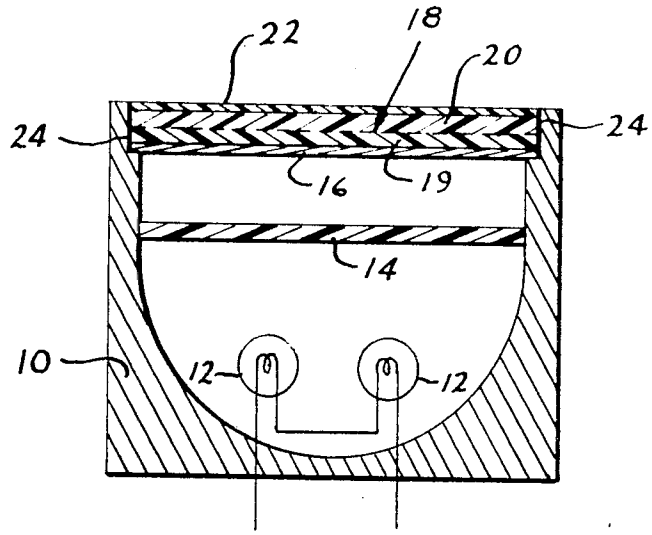
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Primary Examiner—David Schonberg
Assistant Examiner—Paul R. Miller
Attorney—Dybvig & Dybvig

[57] **ABSTRACT**

A high contrast display lens comprises a circular polarizer and a specular reflector confronting limited areas of the circular polarizer. In one embodiment, the specular reflector outlines or encloses relatively transparent character areas which are capable of conveying information. The display device is operated by a source of light which passes through the information character areas and then the circular polarizer for observation by an observer. In another embodiment the specular reflector is in the form of a foraminous screen or mesh having specularly reflective wires or mullions. The screen permits continuously varying messages such as those received from a cathode ray tube to be displayed through the foramina thereof. The specular surface in conjunction with the circular polarizer radically increases the contrast between the message and the background.

19 Claims, 6 Drawing Figures



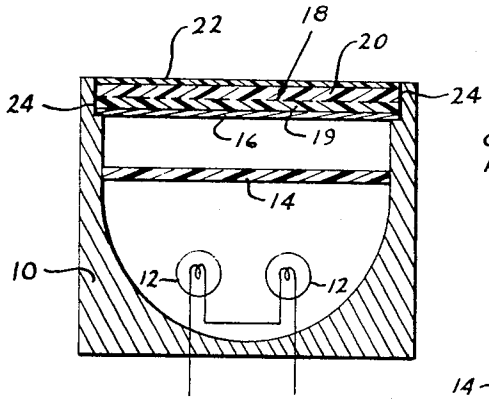


FIG. 1

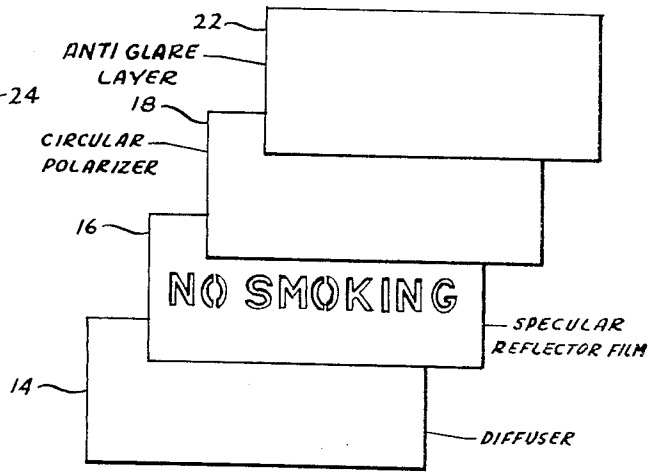


FIG. 2

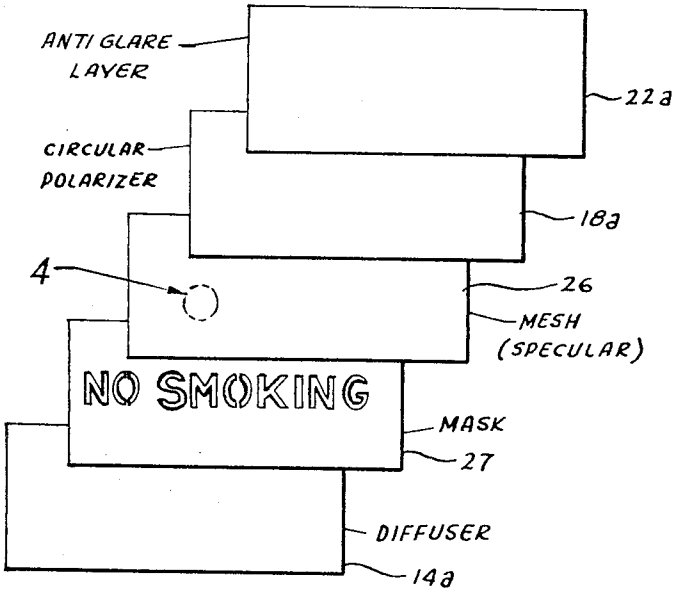


FIG. 3

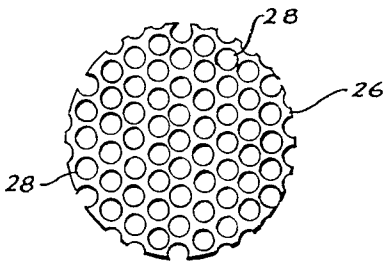


FIG. 4

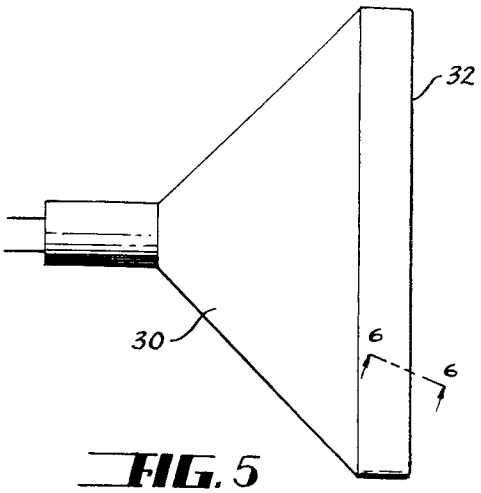


FIG. 5

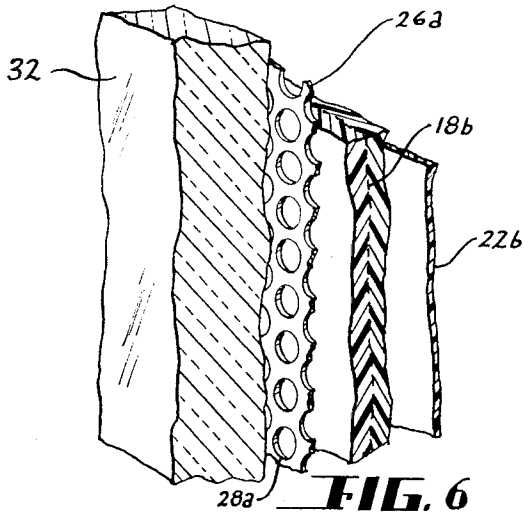


FIG. 6

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HIGH CONTRAST DISPLAY DEVICE

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates to the display of information by the projection of light toward a display area and the creation of information in the display area by interrupting the light projected to selected parts of the display area. The display may be static or dynamic. An example of a static display is the projection of light and the masking of light from selected areas of the display screen by means of a stationary opaque mask which outlines the information to be displayed. An example of a dynamic display is the projection of the beam of a cathode ray tube toward a phosphor screen, the movement of the cathode ray beam through a pattern and the periodic interruption or modification of the power generating the cathode ray beam to produce areas of high and low brightness in the phosphor screen which convey intelligible information. The areas of intelligible information may periodically change as in a television or radar display.

2. Description of the Prior Art

A common and well known form of static information display is a luminous sign such as the "No Smoking" sign commonly employed in aircraft passenger compartments. In a typical embodiment the sign comprises a frosted panel which may be a glass or a transparent or translucent plastic. The glass or plastic is frosted so that light passing through the panel will be scattered at the frosted surface, creating the visual impression that the light emanates from the frosted surface. The information to be conveyed by such a sign is created by a mask which encloses or outlines relatively transparent information characters that may be letters of the alphabet. The sign is illuminated by means of a light source disposed behind the mask which projects light toward the frosted display panel. A well known limitation to this type of display device is that a high ambient light level projected toward the frosted panel from the side of the viewer will produce a level of background illumination at the frosted surface of the frosted panel which competes with the light intended to convey information. Thus, if the display is a "No Smoking" sign in an aircraft passenger compartment, sunlight entering the windows of the passenger compartment and reflected toward the "No SMoking" sign can render the sign unintelligible. In this event, even though a passenger knows that a "No Smoking" sign is provided in a given area of the passenger compartment, the passenger is unable to determine whether or not the "No Smoking" sign has been illuminated. Thus, the sign is there and the sign is "ON," but no intelligible information is conveyed. Various devices such as baffles and color selective filters have been employed to enhance the visibility of the described message displays with only limited success.

A dynamic form of message display known in the prior art utilizes a cathode ray tube such as a television tube for the display of information which can be periodically changing. Here again, baffles, shields and various types of filters have been employed in an effort to enhance the contrast which provides the information to be displayed. One notable technique that has been devised for enhancing the contrast available from such devices is the insertion of a circular polarizer between

the viewer and the cathode ray tube. The explanation for the benefit obtained is that some of the ambient light entering the circular polarizer will be specularly reflected by the phosphor and the glass surface of the cathode ray tube so that the reflected light returns to the circular polarizer and is trapped. While the benefits of this technique are visually discernable, the contrast enhancement is generally not sufficient.

It has been proposed to further enhance the contrast available when a circular polarizer has been inserted in front of a cathode ray tube display by applying to the cathode ray tube window a layer which functions as a partial mirror. Such a partial mirror yields a considerable contrast enhancement since a good percentage of the light entering a message area that should be background is trapped. It is to be noted however that a partial mirror layer not only reduces the level of undesired background illumination, but it also uniformly reduces the message light emanated from the cathode ray tube's phosphor. In other words, the contrast enhancement is obtained at the expense of a general reduction in the amount of light available for presentation of the message.

A further technique that has been used to enhance the contrast available from cathode ray tube displays is to place an essentially opaque specular layer between the phosphor at the viewing window and the cathode ray source. While this layer will attenuate the cathode ray beam, it will cause all light produced by the phosphor to be reflected toward the viewing window. By also inserting a circular polarizer between the viewer and the viewing window, a large portion of the ambient light incident to the viewing window will be absorbed by reason of specular reflection from phosphor and the specular layer behind the phosphor.

SUMMARY OF THE INVENTION

The present invention employs a mask which has some areas optically transparent and other areas specularly reflective and preferably opaque. In a static display embodiment the transparent areas of the mask may comprise character display areas enclosed by or bordered by the specularly reflective mask areas. The mask is placed adjacent a circular polarizer with the result that ambient light entering the circular polarizer and reflected by the specularly reflective portions of the mask is absorbed or trapped with a very high efficiency. On the other hand, light from a suitable source entering the transparent areas of the mask passes through the circular polarizer with only a modest attenuation and the result is an exceedingly high contrast between the information characters being displayed and the background in which the display takes place.

A dynamic display embodiment particularly suitable for display devices such as cathode ray tubes utilizes a foraminous mask or screen in which the transparent areas of the mask as well as the specularly reflective areas of the mask are regularly arranged and are sufficiently small under the viewing conditions so as to be nonresolvable to the unaided eye. In other words, the transparent areas of the mask as well as the specularly reflective areas of the mask are individually so small under the viewing conditions that the mask will appear to the unskilled observer to be a neutral density filter or may even appear to be a partially silvered surface.

However, there is an important difference between the mask of the present invention and the partial mirror surface described with reference to the prior art. As mentioned previously, the partial mirror surface uniformly absorbs or attenuates the light available from the light source which will create the message display. On the other hand, the foraminous mesh or mask of the present invention will transmit all light from the source of message light which enters its foramina. Thus, with respect to the source of message light, the message displayed in the message area will be made up of discrete areas of no light and adjacent areas of highly transmitted light, all areas being individually nonresolvable by the observer. One advantage of the described foraminous mask over a partially mirrored layer is that the foramina in the mask function somewhat as jewels and produce a brighter light in the bright areas of the message to be projected than is obtainable with a partially mirrored surface. This is true even though the partially mirrored surface as well as the foraminous mesh of the present invention may have equal light transmission values taken over large areas.

The combination circular polarizer and foraminous specularly reflective mesh of the present invention, while particularly useful in association with dynamic displays, also offers improvements in the design of static message displays since it allows a simple opaque mask such as may be cut from black paper to define the message which is intended to be displayed and since the mesh reduces the visibility of the message when the display is in an off state.

One object of the present invention is to provide a new and improved message display device.

Another object of the present invention is to provide a message display device utilizing a circular polarizer and a specular reflective surface adapted to produce a static message display.

A further object of the present invention is to provide a message display device which utilizes the combination of a circular polarizer with a specularly reflective screen for either static or dynamic displays.

Other objects and advantages reside in the construction of parts, the combination thereof, the methods of manufacture and the mode of operation, as will become more apparent from the following description.

BRIEF DESCRIPTION OF THE DRAWING

In the drawing,

FIG. 1 is a section view of a static display device in accordance with the present invention.

FIG. 2 is a partially exploded illustration showing the filter elements of the FIG. 1 invention in overlapping relation.

FIG. 3 is a partially exploded illustration of the filter elements of a modification, the filter elements being displayed in overlapping relation.

FIG. 4 is a greatly enlarged illustration of mesh material bounded by the circle 4 in FIG. 3.

FIG. 5 is a schematic illustration of a cathode ray tube modified in accordance with the present invention.

FIG. 6 is an enlarged fragmentary sectional view taken along the line 6—6 of FIG. 5 and having portions broken away to reveal a layered structure.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Static Display Device

FIGS. 1 and 2 illustrate a conventional type of static display device which has been constructed in accordance with the present invention. The display device includes a hollow rectangular housing 10 having opaque walls on all but one side thereof. Located within the interior of the housing 10 are lights 12 adapted to be connected to any suitable source of operating voltage. Disposed above the lights 12 and confronting the one side of the housing 10 which is not opaque is a light diffusing panel 14 which may comprise a transparent or translucent sheet of plastic or glass material which may be frosted on at least one face thereof.

The light diffusing panel 14 cooperates with the lights 12, when energized, to produce a layer of uniform luminosity at a surface of the panel 14. To maximize the amount of light reaching the uniformly illuminated surface of the panel 14, the interior wall of the housing 10, which is generally parabolic, may be coated with a layer of white paint, or other reflective and preferably diffusive material, not shown, so as to reduce the absorption of light at the inner surface of the housing.

Disposed above the diffusing panel 14 and preferably spaced therefrom is a circular polarizer 18 having a specularly reflective layer 16 applied to the surface thereof which confronts the diffusing panel 14.

The circular polarizer 18 comprises two separately identifiable layers labeled 19 and 20. The layer 19, which is the layer closest to the lights 12, is commonly referred to as a quarter-wave retarder. The layer 20, which is the layer most remote from the lights 12, is commonly referred to as a linear polarizer. The circular polarizer is commercially available in laminated form and, as a matter of convenience, FIG. 1 illustrates the circular polarizer in the commercially available laminated form. However, it is to be understood that the layers 19 and 20 may be physically separate layers and may even be spaced apart.

The specularly reflective layer 16 is a highly reflective film which may be metalized and which may be applied directly to that surface of the layer 19 which confronts the lights 12. As one example, the layer 16 may be a layer of metal such as silver, gold, aluminum or the like vacuum deposited onto the lower surfaces of the circular polarizer, as it appears in FIG. 1. It may also be a "wet bond" of black paint. A suitable mask, not shown, may be positioned over the lower surface of the circular polarizer 18 during application of the layer 16 to produce whatever message information is desired for the static display. FIG. 2, for example, illustrates the message "No Smoking" produced in the layer 16. The letters of the "No Smoking" message represent openings or windows of low optical density extending through the specularly reflective layer 16.

While vacuum deposition of a metalized layer or painting have been described with reference to the layer 16, the layer 16 may also be produced with any suitably glossy material which is applied to produce the desired message. Another method for producing the desired message is to uniformly coat the lower surface of the circular polarizer 18 with a specularly reflective

material and then selectively remove portions of the uniform layer by any suitable process such as chemical etching.

A further method for producing the specularly reflective layer **16** is to take a glossy foil such as tin foil, punch out or otherwise remove the desired message areas, and then position the tin foil below the surface of the circular polarizer **18**.

In cases where an adhesive is employed to directly affix the layer **16** to the circular polarizer, it is important that the adhesive be transparent and not capable of any appreciable light diffusion or retardation. Thus, the specularly reflective character of the layer **16** is of prime importance on that side of the layer which confronts the circular polarizer and relatively unimportant as to that side of the layer **16** which confronts the lights **12**. The importance of the layer **16** apart from the message windows therethrough is two-fold. As to light emitted by the lights **12**, it is desired that the layer **16** have a high optical density or opacity, except at the message windows therethrough. This is to produce a maximum of contrast between the luminous message areas that will be defined by the windows through the layer **16** and the viewing background that will be defined by the portions of the layer **16** which surround the message windows.

Another function of the layer **16** is to act in cooperation with the circular polarizer to absorb or trap ambient light which may enter the circular polarizer from regions outside the housing **10**. In order to perform this function, it is important that the layer **16** specularly reflect light incident upon that layer from the circular polarizer **18**. It is a well understood phenomenon that light which has been polarized by a linear polarizer, then retarded by a quarter-wave by the retarder, then specularly reflected back through the retarder to the linear polarizer will be trapped or absorbed by the linear polarizer with very high efficiency. Obviously, the efficiency of this light trapping action depends to a great extent on the specular character or glossiness of the surface of the layer **16** which confronts the layer **19** and also upon the absence of any diffusive or further retarding means interposed between the layer **16** and the circular polarizer **18**.

In the preferred form of the present invention, the circular polarizer **18** is laid under a second panel or layer **22** which is preferably a transparent plastic or glass material treated so as to provide an anti-glare or anti-reflective surface on at least the front surface thereof. The purpose of this layer is to cause as much ambient light as possible to enter the filter and to be trapped therein rather than being reflected to the viewer as undesirable background illumination. While the present invention does not specifically require the panel **22**, the display visibility is enhanced and the efficiency of the filter is rendered more apparent by its presence.

In commercially available polarizer devices made of plastic, a portion of the light entering the polarizer will be piped or scattered laterally to the side margins of the polarizer. To minimize the contribution of such scattered light to the background which will surround the message characters to be displayed, the side margins of the assembled polarizer **18** and panel **22** are coated with any suitable light-absorptive layer **24**. As one example, this layer may be a black, low-reflective paint.

A noteworthy feature of the FIG. **1** embodiment is that substantially all ambient light which enters the circular polarizer **18** is either trapped by specular reflection from the layer **16** or passed to the interior of the housing **10** through the message windows thereof. The ambient light which thus reaches the interior of the housing **10** tends to become additive to that supplied by the lights **12** and enhances the message brightness. Thus, except for reflections from the anti-glare panel **22**, all ambient light entering the circular polarizer **18** is either absorbed or used beneficially to augment the available message light.

For some static display applications, it is important not to be able to distinguish the message when the display lights are off. The assembly of filter elements illustrated in FIG. **3** is useful in producing a modified static display device which efficiently conceals the message when the display is "off" and which involves only a minimal sacrifice in the display contrast obtainable with the device of FIG. **1**. For convenience, FIG. **3** illustrates only the filter elements employed in the modification and it is to be understood that these filter elements are intended to be assembled in any suitable housing with accompanying light source. Where the filter elements employed in the FIG. **1** embodiment are used without change in the FIG. **3** embodiment, these filter elements are given the same Arabic reference numerals and distinguished by the suffix *a*. It can thus be noted that the FIG. **3** embodiment includes an anti-glare or anti-reflective layer **22***a* comparable to the layer **22** of the FIG. **1** embodiment; a circular polarizer **18***a* comparable to the circular polarizer **18** of the FIG. **1** embodiment; and a diffusing panel **14***a* comparable to the diffusing panel **14** of the FIG. **1** embodiment. In addition to these elements, the FIG. **3** embodiment includes a message bearing mask **27** which is desirably opaque and light-absorbing, but not required to have a specularly reflective surface, and a foraminous screen or mesh **26**.

The foraminous character of the screen **26** is illustrated in greatly enlarged detail in FIG. **4**. The screen **26** is a thin sheet of specularly reflective metal such as aluminum, gold, silver or the like which has been etched, punched or otherwise formed to produce foramina **28** therein. The specularly reflective sheet from which the screen **26** is produced may be of varying thickness depending upon the application. The thickness of the sheet in conjunction with the size of the foramina will determine the angles from which the display may be viewed. Sheets varying in thickness from 0.0001 inch (for displays requiring a wide viewing angle) to 0.125 or greater (for limited viewing angle) have been used. In the thicker sheets the axis of the foramina may be other than normal to the surface to provide selective viewing angles. Screens of the character described are commercially available in various thickness and foramina sizes.

Typically, screens of the type described are specified in terms of "lines per inch." The term "lines per inch" has reference to the wires or mullions which separate adjacent foramina. Typically, the lines per inch are equal in both horizontal and vertical directions. Thus, a screen characterized as a 100 line per inch screen would have $100 \times 100 = 10^4$ foramina per square inch. For the purposes of the present invention but not as a limitation thereto, the screens preferred for the present

invention range from 100–750 lines per inch for displays to be viewed at close range.

The specification of the screen in terms of lines per inch is obviously not a complete specification of the screen. A further important screen character is its light transmission. A screen having a 50 percent transmission and having 100 lines per inch would be a screen having 10^4 foramina per square inch and the aggregate area of the 10^4 foramina in each square inch would be one-half of a square inch. Thus, one-half of the light incident upon the screen would strike the wires or mullions between the foramina and would be specularly reflected. The other half of the light incident upon the screen, if incident normal to the screen, would pass through the foramina and would be transmitted. The preferred range of light transmission values for use in the present invention is the range 30–70 percent; however, the practice of the present invention is not limited to this range.

As previously indicated, screens having an appreciable thickness in relation to their foramina may be used in the practice of the present invention. As the thickness of the screen increases in relation to the diameter of the foramina therethrough, the viewing angle through which intelligible information can be received is diminished. In effect, then, there is a relationship between the light transmission and the viewing angle, the effect becoming more pronounced as the thickness of the screen increases in relation to the diameter of the foramina therethrough. It was also suggested that for specialized viewing conditions the axes of the foramina through relatively thick screens may be inclined at selected angles to the plane of the screen so as to favor selected viewing angles. In such cases the light transmission of the screen when viewed on an axis vertical to the plane of the screen may actually be less than the light transmission when viewed at a different angle. Due to the possibility of specialized conditions such as described, the above indicated preferred transmission range of 30–70 percent is to be recognized as limited to screens which are thin in relation to the dimensions of the foramina therethrough.

It can be noted in FIG. 4 that the foramina 28 in the screen 26 are circular. It is to be understood however that the particular shape of the screen foramina will depend upon the manufacturing process and irregular shapes as well as rectangular shapes or triangular shapes are equally suitable for use in the practice of the present invention.

Assume a screen fabricated with a specularly reflective material such as silver having 100 lines per inch and having a 50 percent transmission assembled into a housing such as the housing 10. Assume also a circular polarizer 18*a* having a 40 percent transmission to unpolarized light, a mask 27 formed with low reflective black paper, a diffuser panel as shown at 14*a* and an anti-glare or anti-reflective surface as shown at 22*a*. The device will operate as follows. Light emanated from lights such as the lights 12 illustrated in FIG. 1 will permit the mask 27 to outline an appropriate message visible through windows in the mask 27, through the screen 26, through the circular polarizer and through the anti-glare or anti-reflective panel 22*a*. Since the screen 26 is assumed to have a 50 percent transmission and the polarizer 18*a* a 40 percent transmission, approximately 20 percent of the light available from the lights 12 will be available for observation by a viewer.

Directing attention to ambient light which may reach the circular polarizer from the viewer's side of the display device, 60 percent will be absorbed by the circular polarizer, then 50 percent of the remaining ambient light reaching the screen 26 will be specularly reflected back through the circular polarizer 18*a* and will be trapped therein. The other 50 percent of the remaining ambient light will pass through the screen 26 where it will be absorbed by the black paper of the mask 27. Ambient light which passes through the message windows of the mask 27 becomes diffuse and additive to the message light available from the lights 12.

What has been achieved with the FIG. 3 embodiment is utilization of a relatively simple to prepare and inexpensive mask 27 which has been substituted for the reflective layer 16 required in the FIG. 1 embodiment. A more important achievement with the FIG. 3 embodiment is a more effective shielding of the information bearing mask 27 from visual examination by means of ambient light. The combination of the screen 26 with the circular polarizer so effectively conceals the mask 27 that ambient light is incapable of exposing the message cut into the mask 27 under all but the most extreme viewing conditions. The importance of this feature is that when the message lights are off a false simulation of an "on" condition is virtually impossible. Thus, from the viewer's point of view, he either sees a message and therefore the message light is on, or he sees no message whatever and therefore the message light is off.

It has been previously expressed that the preferred range of foramina sizes expressed in lines per inch is between 100–750 lines per inch. In those cases where the message will be closely viewed, a 100 line per inch screen will create a perceptible graininess in the message characters. On the other hand a much finer screen such as a 750 line per inch screen will produce no perceptible graininess. The graininess associated with the message display will of course depend substantially upon the viewing conditions. Accordingly, a message viewed from a distance or optically reduced will lose its graininess even with a 100 line per inch screen and likewise a message viewed under expanded or optically enlarged conditions may acquire graininess with screens finer than a 100 line per inch screen. In general, however, for direct viewing by an observer, a 100 line per inch screen assembled in a display device such as illustrated in FIG. 1 and in accompaniment with the other filter elements illustrated in FIG. 3 will provide an acceptable message display under direct viewing conditions for all but the most sensitive requirements.

Dynamic Display Device

A dynamic display device which utilizes the screen 26 discussed with reference to the FIG. 3 embodiment is disclosed in FIGS. 5 and 6.

FIG. 5 schematically illustrates a conventional cathode ray tube 30 having proximal to its viewing window 32 a specularly reflective screen or mesh 26*a* over which is placed a circular polarizer 18*b* and over which is applied an anti-glare or anti-reflective layer 22*b*. The specularly reflective mesh 26*a* is similar to that described under reference numeral 26 in connection

with the FIG. 3 embodiment. The circular polarizer **18***b* is similar to those described under the reference numerals **18** and **18***a* in the FIGS. **1** and **3** embodiments and the anti-glare/anti-reflective surface **22***b* will be recognized as similar to those described under the reference numerals **22** and **22***a* of the FIG. **1** and FIG. **3** embodiments, respectively.

As well understood in the art, a cathode ray tube is a device in which a cathode ray beam is advanced through a pattern and at discrete positions in the pattern is turned off or reduced so as to create bright and dark areas in a phosphor, not shown, which underlies the viewing window **32**.

Due to the location of the screen **26***a* proximal to the viewing face of the cathode ray tube, the image as viewed by an observer will be adjusted as follows. Assume for example a 50 percent transmission through a screen **26***a* characterized as a 333 ⅓percent line per inch screen. In those areas where the cathode ray tube phosphor is being energized by the cathode ray beam, one-half of the light emanated by the phosphor toward the viewing window **32** will be reflected back toward the phosphor by the screen **26***a*. The other one-half will pass the screen **26***a* without attenuation except by the circular polarizer **18***b*. The result is that approximately 50 percent of the light sought to be developed by the cathode ray beam will be unable to pass the screen **26***a*. Approximately 60 percent of the other 50 percent will be absorbed in the circular polarizer **18***a*. Of course, in those areas where the cathode ray tube is seeking to provide information by interrupting the cathode ray beam, the screen **26***a* acting in cooperation with the circular polarizer **18***b* will have the beneficial effect of further darkening the dark message areas. The net result of placing the screen **26***a* and the circular polarizer between the cathode ray tube **30** and the viewer will be a loss of approximately 80 percent of the light which would otherwise be available from the phosphor in the cathode ray tube. While the message forming light available to the viewer is thus reduced for the reasons described, an enhancement in the message contrast is found to more than offset the reduction in the available light. Thus, approximately 60 percent of the ambient light entering the circular polarizer is absorbed in the circular polarizer. Half of the approximately 40 percent of ambient light passing the circular polarizer is absorbed by the light trapping action effected by the specular screen **26***a* acting in combination with the circular polarizer. The remaining approximately 20 percent of the ambient light will pass through the foramina in the screen **26***a* where it will be scattered and diffused by the phosphor of the cathode ray tube such that only a fraction thereof will return through the screen **26***a*. Assuming a worst case condition in which all ambient light reaching the phosphor is returned to the foraminous mesh and thence to the circular polarizer, only 20 percent of 20 percent = 4 percent of the initial ambient light entering the circular polarizer can be returned to the viewer. Those skilled in the art will immediately recognize of course that the benefit obtained by a reduction in the ambient light illumination that can appear in the background in which a message is displayed is a more important contribution to the message legibility than is a mere increase in the amount of available message light. It is thus possible to improve message legibility by reducing the relative brightness of the background in which the message will be displayed even though there is also a reduction in the amount of light available to form the message.

It has been mentioned previously that a similar enhancement in the legibility of cathode ray tube displays can be achieved by replacing the screen **26***a* by a partially silvered surface having an equivalent light transmission (e.g., 50 percent). However, a difference arises in the fact that screens such as the screen **26***a* will transmit all available message light through the foramina thereof, whereas the partially silvered layer, being uniformly silvered throughout its area, will effect a uniform reduction in the message light available from all areas of the cathode ray tube. In both cases the same total amount of light will reach the observer's eyes, but in the case of a screen such as the screen **26***a*, the light will reach the observer as relatively intense spots of light each occupying a small area in the display. In contrast, the message produced by the cathode ray tube when used in association with a partially silvered surface will comprise a markedly less intense source of light uniformly distributed over what are to be the lighted portions of the message area. The more intense spots of light produced with the present invention are obviously better equipped to compete with ambient background radiation than would be the more uniformly distributed areas of light produced with a partially silvered surface. It is found also that the screen of the present invention causes a sharpening of the display image. The sharpening results from a reduction in edge fuzziness caused by light spillage from the edge of a static display or by the halo effect produced by the excited phosphor of a cathode ray tube. The reduction in edge fuzziness is due to the ability of the opaque areas of the screen to interrupt the visual continuity of light "spilling" over the edges of the message areas.

Another benefit available from the present invention when the foraminous mesh is a conductive material is that an electrical connection, not shown, can be made between the mesh and ground or a suitable source of high potential to facilitate removal of accumulated electrical charges at the surface of a cathode ray tube.

Having thus described my invention, I claim:

1. A high contrast display device comprising circular polarizing means having a front and a rear face, said polarizing means circularly polarizing first light when said first light enters said front face and exits from said rear face, means to direct second light toward said rear face, a mask member having a first area of high optical density and a second area of low optical density, said mask member interposed between said light directing means and said rear face, said mask member having a surface of specular reflectivity substantially coextensive with said first area and confronting said rear face whereby first light entering said front face and reflected from said surface toward said rear face is absorbed by said polarizing means.

2. The display device of claim **1** wherein said second area is bounded by a margin shaped to convey information.

3. The display device of claim **2** wherein said second area is contiguous with said first area.

4. The display device of claim **3** wherein one of said first and second areas surrounds the other of said areas.

5. The display device of claim 1 wherein said second area is one of a plurality of spaced apart windows each contiguous to a portion of said first area.

6. The display device of claim 5 wherein said mask member comprises a foraminous screen, said first area comprising the body of said screen and said second area comprising openings through the body of said screen.

7. The display device of claim 6 in which said body of said screen is electrically conductive.

8. The display device of claim 6 wherein the body of said screen is a film the thickness of which is small in relation to the dimensions of the openings therethrough.

9. The display device of claim 6 in which said body of said screen is a sheet the thickness of which is at least comparable in magnitude to the dimensions of the openings therethrough.

10. The display device of claim 9 in which said openings each surround a preselected axis favoring a preselected viewing angle.

11. The display device of claim 1 wherein said means directing second light comprises a cathode ray tube.

12. The display device of claim 1 wherein said circular polarizer is a plate element having side edges, said polarizer means having anti-reflective absorbing means confronting the side edges of said plate elements.

13. The display device of claim 1 including means of low optical density providing an anti-reflective surface overlying said front face.

14. The display device of claim 1 including light diffusing means interposed between said mask member and said second light directing means.

15. The display device of claim 14 wherein said diffusing means is spaced from said mask member.

16. A contrast enhancing filter assembly comprising a linear polarizing element, a mask member, an optical quarter-wave retarding element interposed between said linear polarizing element and said mask member, said mask member having first and second areas, said first area being an area of high optical density and said second area being an area of low optical density, said first area having a surface confronting said retarder element, said surface confronting said retarder element having specular reflectivity.

17. The filter of claim 16 wherein said second area is contiguous to said first area and has a margin adjacent said first area adapted to convey information by reason of its shape.

18. The assembly of claim 16 in which said first area comprises the body of a screen and said second area comprises an opening through said screen.

19. The assembly of claim 18 wherein said body of said screen is electrically conductive.

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