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(54) A PROJECTION VIEWER

(71) We, EASTMAN KODAK COMPANY, a Company organized under the Laws of the State of New Jersey, United States of America, of 343 State Street, Rochester, New York 14650, United States of America, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

The invention relates to projection viewers. In accordance with the present invention there is provided a projection viewer comprising a housing having a viewing opening, a front surface screen within the housing and aligned with the opening, the screen providing directional reflectance of any light incident on the front surface thereof, an optical system for projecting an image onto the screen for viewing through the opening, and light balancing filter means arranged within the housing between the opening and the screen for optimizing the luminance of the image reflected by the screen when viewed through the opening, the filter means being located to minimise back reflection of ambient light entering the viewer through the opening.

The filter preferably also effects a seal to prevent entry of dust into the viewer via the viewing opening. The filter preferably comprises a blue filter and a neutral density filter mounted in contacting relationship with a sheet of transparent plastics material, such as acetate, for mechanical strength. The blue filter provides for colour correction of the projected image, even though a tungsten source of illumination might be used and operated at a reduced voltage for obtaining a prolonged lamp life. The colour and density requirements of the filter may also be incorporated in a suitable plastics material to form an integral filter, if desired. A shroud may also be provided surrounding the viewing opening to reduce the amount of specular reflection from the filter means which reaches the eye of an observer who is viewing the image on the screen. Also by curving the filter away from or convex to

the screen, the size of any overhang or extension of the viewer housing which might be used as a shroud against ambient light can be reduced considerably in size, thereby reducing the size of the viewer housing.

In the accompanying drawings:—

Fig. 1 is a side elevation of a viewer constructed in accordance with one preferred embodiment of the invention showing the housing thereof in vertical section and in which a planar filter is arranged between the screen and the viewing opening in the housing;

Fig. 2 is a side elevation, similar to that shown in Fig. 1, of a second preferred embodiment of the invention in which the filter is partially curved in one dimension for reducing an effective overhang of the viewer housing relative to the filter;

Fig. 3 is a side elevation, similar to that shown in Fig. 1, of a third preferred embodiment of the invention in which the filter is partially curved in one direction and the housing is shortened;

Figs. 4a and 4b are partial, vertical sections of further embodiments of the invention showing differences in the construction of the viewer housing with a planar and a curved filter, respectively; and

Fig. 5 is a partial section showing an arrangement for mounting a filter in the viewer housing so as to effect a seal against ingress of dust.

With particular reference to Fig. 1, a viewer 20 comprises a housing 10 which is supported on a base member designated by the numeral 12. The housing 10 contains a front surface (reflecting type) screen 11 and a filter 13 that is arranged relative to a viewing opening 16 in a front wall 21 of the housing 10 and between the opening and the screen 11. A mirror 15 is also arranged within the housing 10 and relative to the screen 11 so that the optical axis 14 of a projection system 40 is incident on the mirror 15 at a point 22 and on the screen 11 at a point 19. The imaging rays falling on the screen 11 are spread to fill opening 16.

The base member 12 comprises an

illumination unit 23 and a film carrier and projection lens unit 24. The unit 23 includes a lamp and a suitable condenser-lens system. Also, the unit 24 carries the projection lens system 40 with respect to which an image carrier medium, such as a photographic paper or film, for example a microfiche 32, can be moved. A carrier 27 for the microfiche 32 is mounted for movement relative to the unit 24 by knobs 25 and 26 so that the microfiche 32 can be moved relative to the optical axis 14.

The filter means 13, as shown in Fig. 1, is planar and is mounted in the housing 10 between the opening 16 and the viewing screen 11. The walls 28 and 29 of the housing 10 together with the side walls 30, only one of which is shown in Fig. 1, form a generally rectangular shroud 41 surrounding the opening 16. The shroud 41 extends from the filter 13 in a direction toward the position in which an observer will view the image reflected by the screen 11. The lowest nominal viewing position is designated by the numeral 53. It will be noted that both of the walls 28 and 29 extend beyond the filter 13 with the portion 17 of wall 29 being considerably greater in length than the corresponding portion 18 of the wall 28. The interior surfaces of the housing 10 are preferably blackened to reduce light reflection within the housing. The inner surface of each portion of the walls forming the shroud are also blackened to absorb light and thereby reduce light reflection.

The filter means 13 preferably comprises a 80C blue light filter and a neutral density filter whose density factor will depend on the light source and the brightness gain of the screen. If the light output from a source that is used is low, a density filter may not be required. The filter elements may be mounted on a support sheet of transparent acetate for mechanical strength and rigidity or can be combined as integral parts of a suitably formulated plastics sheet. Such a light filter structure will correct for the colour temperature of the light source and greatly reduce ambient light reaching the observer, thereby enhancing the image contrast, as well as the luminance quality of the image. An 80B blue filter can also be used. 80B and 80C designate Wratten (Registered Trade Mark) filters of the light balancing type. Preferably, the density factor of the neutral density filter will range from about .4 to zero. In the latter case, no density filter will be required because of the low light output. For a particular light source, the light balancing filter and the density factor of the neutral density filter, if the latter is required, will be chosen so that the luminance of the image reflected by the screen 11 will be optimized when viewed through the opening 16 by an observer.

If the light source is an incandescent lamp, such as an automobile lamp rated at 12.8 volts, and is operated at its rated voltage, the life of the lamp will be about 100 hours. If this same lamp is operated at a reduced voltage of about 11.2 volts, the filament produces a colour temperature of about 2800 K. With an 80C filter, the colour temperature of the lamp will be effectively raised to that of a 4000 K light source on the basis of the black-body locus and its life will be increased to about 500 hours. The density factor of the neutral density filter will depend on the light output of the lamp, the efficiency of the condenser lens system, the speed of the projection lens system and the gain of the screen. The density factor should be such that approximately 120 ft. lamberts will be obtained as a measure of image brightness.

The portion of the housing 10 extending beyond the filter 13, namely the shroud 41 comprising portions 17 and 18 and side walls 30, reduces specular reflection from the filter, as designated by the bundle of rays 52, from reaching the observer's eyes at 53. Ambient light which might enter the housing 10 through the opening 16 will for the most part pass through the filter 13 and any reflection of the ambient light within the housing 10 which is not absorbed will again be returned through filter means 13. However, such ambient light will be attenuated by a factor of about 100 in passing twice through filter means 13, if the latter comprises an 80C filter and a neutral density filter having a density factor of .4. Ambient light which strikes the screen 11 after passing through the opening 16 and the filter 13 is generally directed toward the mirror 15 by reflection from the screen 11. For the most part, the light then falls on the black interior of the housing 10 and is absorbed, thereby reducing the ambient light which returns through the filter 13 and the opening 16. The combined effect of the screen configuration and the filter factor results in very high rejection of ambient light. For example, in one experiment the viewing device was placed in a 350 foot-candle ambient environment and no position could be found which would permit more than a fraction of one foot-lambert of luminance to be returned to the viewing position.

It has been found that the shroud 41 (particularly the portion 17 of wall 29) can be reduced considerably if the filter 13 is slightly curved (see Fig. 2). This is true even though the opening 16 might be of a larger size. The filter 13 can be curved in one plane with the convex side toward the screen 11, as shown in Fig. 2, or can be curved throughout its length in one plane as shown in Fig. 4b. In either case, the portion 17 of the wall 29 is materially reduced. With particular

reference to Fig. 3, the optical axis 14 has been shifted 14° relative to the normal at the screen centre and in this embodiment the base member 12, which comprises a single unit, has been designed with the filter 13 and the opening 16 shifted to the left, which results in an appropriately shorter housing with very little space required for filter means 13. In the embodiment shown in Fig. 2 and in Fig. 3, the curvature of the filter 13 is used to shorten the overall length of housing 10. In Figs. 1 to 3 the line 54 shows the extent to which the opening 16 can be increased in height with curvature of the filter 13.

The embodiment shown in Fig. 3 wherein a curved filter means is used permits the housing 10 to be shortened. This is made more clear by a comparison of Figs. 4a and 4b. In Fig. 4a, the filter 13 is flat and the portion 17 must be relatively long if effective control of specular reflections is required. On the other hand, with the filter 13 curved, as in Fig. 4b, the portion 17 is reduced considerably but the portion 18 must be extended to provide the same control of specular reflections. Neither of these extremes lend themselves to the most desirable design. However, an intermediate embodiment, as shown in Fig. 3, permits the housing 10 to assume a more balanced and pleasing form.

Also, the filter 13 forms a dust-tight seal for the housing 10 relative to the opening 16. Such a seal can be attained by providing a frame 35 that is fixed to or made integral with the walls 28 and 29 and the side walls 30 (see Fig. 5). The frame is faced with a sealing material 36, such as soft foam rubber, against which the filter 13 is positioned and maintained by a single retaining member 37 or by a plurality of suitable strips. Such a sealing structure can also be adapted to the curved type of filter disclosed in Figs. 2, 3 and 4b. As an alternative to the aforementioned structure, the filter 13 may be sealed in position by means of a suitable cement and means for properly locating said filter.

With reference to Fig. 1, the bottom wall 29 is provided with a sleeve portion 42 which extends in to the unit 24. The projection lens system 40 is slideably contained in a mount 43 on a plate 44 forming a part of the unit 24. A soft rubber washer 45 that is positioned between the sleeve portion 42 and the amount 43 is slightly compressed when the housing 10 is assembled with the units 23 and 24 so that a seal is effected between the housing 10 and the unit 24. Consequently, the seal effected by the filter 13 and the washer 45 provide means for

sealing the housing against dust and dirt from the environs. With such a seal, the screen 11, the mirror 15, the inner surface of filter 13 and the surface of the lens system 40 that faces into the housing 10 are protected against dust accumulation and physical damage. The interrelation of the housing 10 and the units 23 and 24 is set forth in more detail in copending application No. 12276/72 (Serial No. 1,384,561).

WHAT WE CLAIM IS:—

1. A projection viewer comprising a housing having a viewing opening, a front surface screen within the housing and aligned with the opening, the screen providing directional reflectance of any light incident on the front surface thereof, an optical system for projecting an image onto the screen for viewing through the opening, and light balancing filter means arranged within the housing between the opening and the screen for optimizing the luminance of the image reflected by the screen when viewed through the opening, the filter means being located to minimize back reflection of ambient light entering the viewer through the opening.
2. A viewer as claimed in Claim 1, wherein the filter means is mounted to seal the interior of the viewer against ingress of dust through the opening.
3. A viewer as claimed in Claim 1 or Claim 2, including a shroud for the opening, this shroud being arranged to reduce the amount of specular reflection from the filter means which reaches the eye of an observer who is viewing the image on the screen.
4. A viewer as claimed in any preceding claim, wherein the optical system includes a tungsten source of light for illuminating an image carrier medium to project the said image, and the light balancing filter means includes a blue coloured filter.
5. A viewer as claimed in any preceding claim, wherein the light balancing filter means comprises a light balancing filter and a neutral density filter arranged in generally contacting relationship.
6. A viewer as claimed in Claim 5 as dependent on Claim 4, wherein the maximum density factor of the neutral density filter is 0.4.
7. A viewer as claimed in any preceding claim, wherein the light balancing filter means is generally flat.
8. A viewer as claimed in Claim 3 and any of Claims 4, 5 and 6 dependent thereon, wherein at least part of the light balancing filter means is curved in one plane and in a direction convex to the screen, the curvature of the filter being such that ambient light

reference to Fig. 3, the optical axis 14 has been shifted 14° relative to the normal at the screen centre and in this embodiment the base member 12, which comprises a single unit, has been designed with the filter 13 and the opening 16 shifted to the left, which results in an appropriately shorter housing with very little space required for filter means 13. In the embodiment shown in Fig. 2 and in Fig. 3, the curvature of the filter 13 is used to shorten the overall length of housing 10. In Figs. 1 to 3 the line 54 shows the extent to which the opening 16 can be increased in height with curvature of the filter 13.

The embodiment shown in Fig. 3 wherein a curved filter means is used permits the housing 10 to be shortened. This is made more clear by a comparison of Figs. 4a and 4b. In Fig. 4a, the filter 13 is flat and the portion 17 must be relatively long if effective control of specular reflections is required. On the other hand, with the filter 13 curved, as in Fig. 4b, the portion 17 is reduced considerably but the portion 18 must be extended to provide the same control of specular reflections. Neither of these extremes lend themselves to the most desirable design. However, an intermediate embodiment, as shown in Fig. 3, permits the housing 10 to assume a more balanced and pleasing form.

Also, the filter 13 forms a dust-tight seal for the housing 10 relative to the opening 16. Such a seal can be attained by providing a frame 35 that is fixed to or made integral with the walls 28 and 29 and the side walls 30 (see Fig. 5). The frame is faced with a sealing material 36, such as soft foam rubber, against which the filter 13 is positioned and maintained by a single retaining member 37 or by a plurality of suitable strips. Such a sealing structure can also be adapted to the curved type of filter disclosed in Figs. 2, 3 and 4b. As an alternative to the aforementioned structure, the filter 13 may be sealed in position by means of a suitable cement and means for properly locating said filter.

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sealing the housing against dust and dirt from the environs. With such a seal, the screen 11, the mirror 15, the inner surface of filter 13 and the surface of the lens system 40 that faces into the housing 10 are protected against dust accumulation and physical damage. The interrelation of the housing 10 and the units 23 and 24 is set forth in more detail in copending application No. 12276/72 (Serial No. 1,384,561).

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2. A viewer as claimed in Claim 1, wherein the filter means is mounted to seal the interior of the viewer against ingress of dust through the opening.

3. A viewer as claimed in Claim 1 or Claim 2, including a shroud for the opening, this shroud being arranged to reduce the amount of specular reflection from the filter means which reaches the eye of an observer who is viewing the image on the screen.

4. A viewer as claimed in any preceding claim, wherein the optical system includes a tungsten source of light for illuminating an image carrier medium to project the said image, and the light balancing filter means includes a blue coloured filter.

5. A viewer as claimed in any preceding claim, wherein the light balancing filter means comprises a light balancing filter and a neutral density filter arranged in generally contacting relationship.

6. A viewer as claimed in Claim 5 as dependent on Claim 4, wherein the maximum density factor of the neutral density factor is 0.4.

7. A viewer as claimed in any preceding claim, wherein the light balancing filter means is generally flat.

8. A viewer as claimed in Claim 3 and any of Claims 4, 5 and 6 dependent thereon, wherein at least part of the light balancing filter means is curved in one plane and in a direction convex to the screen, the curvature of the filter being such that ambient light



passing through the viewing opening and incident on the filter means is reflected thereby onto interior surfaces of the shroud.

- 5 9. A viewer substantially as described herein with reference to and as shown in

Figures 1 and 5 or Figures 2, 3, 4a or 4b of the accompanying drawings.

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