

PATENT SPECIFICATION

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 (72) Inventor STEPHEN PATTERSON HINES



(54) IMAGE VIEWING APPARATUS

(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:—

This invention relates generally to image viewing apparatus.

Along with the growing need to condense large volumes of information, e.g., on microfilm, there has been a commercial need for compact and lightweight viewing apparatus to make this condensed information readily available to the user. This growing commercial need has resulted in several designs of compact viewing apparatus which have attempted to produce highly illuminated images with a minimum amount of image distortions. Such apparatus has generally been plagued with one or more of the following problems: (1) "hot spots" i.e., formation of areas of excessive light intensity at the centre of the viewing surface; (2) overheating of the apparatus housing; (3) the general bulkiness of the reader; and (4) the overall high cost of the apparatus.

In order to achieve the maximum compactness in the usual prior art viewing apparatus which employs a narrow-angle projection lens, i.e., a lens which projects a beam over a full angle of about 30° or less, several mirrors or other reflective surfaces are required. For example, U.S. Patent Specification 3,319,517 shows a prior art viewing apparatus making use of a narrow-angle projection lens. It requires a telescopically arranged two-part housing structure to contain the reader. The reader consisted of a main housing portion which contained a light source, a microform receiving station, a narrow-angle optical projection system, and a viewing screen. A second housing portion has a mirror coupled thereto, swingably mounted with respect to both housing portions. While such prior art apparatus can be made to appear compact when not in

use, it requires substantial space during operation.

In the viewing apparatus art it is desirable that the image be projected onto a light-distributive screen in such a manner that the image will appear to be rectangular and appears evenly illuminated to the viewer. However, compactness obtained by use of a light-distributive screen positioned at an acute angle to the projection lens rather than perpendicular to the lens along its optical path results in keystoneing of the projected image i.e., that portion of the image projected onto the edge of the screen closest to the projection lens will appear smaller to the viewer than the image projected onto the farthestmost edge of the screen.

It is an object of the present invention to provide an improved compact reader.

In accordance with the invention there is provided an image viewing apparatus having a lens which projects an image upon a screen, the said image being projected upon said screen at an acute angle, and a magnifying lens being positioned at an angle to said screen so as to differentially magnify the image viewed on said screen through the magnifying lens.

Viewing apparatus in accordance with the invention will now be described by way of example with reference to the accompanying drawings wherein:

Fig. 1 is a front perspective view of one embodiment of the viewing apparatus, the apparatus being shown in its open position with some of its parts shown in phantom and some parts broken away for illustration;

Fig. 2 illustrates a top plan view of the apparatus in its open position; and

Fig. 3 is a top perspective view of the apparatus in the closed position.

Referring now to the drawings, the compact microimage reader 1 shown in Fig. 1 has a wide-angle condenser system 3 which comprises lenses 5, 6 and 7 which operate to converge light from a source 4 towards mirror 8. The light is reflected from mirror 8 towards lens 10, which converges the light such that

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it passes through the centre of lens 14. A spherical reflector 9 is located in close proximity to source 4 and along the centre axis of lenses 5, 6 and 7. The apparatus further comprises a condenser housing 15, a film slit 13, an adjustable film guide 17 and a focusing knob 12 used to focus a projected image onto light-distributive screen 16 which is positioned along the optical path of lens 14 at an acute angle relative to lens 14. Screen 16 is also positioned at an angle α relative to lens 20 (see Fig. 2). In Fig. 1, lens 20 has been partly cut away to illustrate screen edges 22 and 24 and a bellows arrangement 25.

When reader 1 is in its open position, screen 16 is separated from magnifying lens 20 (here a Fresnel lens) by a predetermined acute angle α . A bellows arrangement 25 together with an internal bi-stable latch 30 (seen in Fig. 1) locks and supports the screen of the reader in its open position (see Fig. 2). The bellows arrangement further prevents any light from escaping the optical path along which an image is projected and also rejects any ambient light from a source other than source 4. Microdocument 32 is inserted into film slit 13 and is illuminated by light from source 4. Once source 4 is energized, lenses 5, 6, 7 and 10 converge light inwards at an angle towards the centre of lens 14 and onto the reflective projection screen 16. Spherical reflector 9 also reflects light from source 4 along the path described.

Projection lens 14 is capable of projecting an image of document 32 diagonally onto the screen 16 over a wide angle, e.g., having an angle of field coverage from about 30° to 80°, and as used in this specification the term "wide-angle" lens is used to denote a lens having an angle of field coverage in that range. Condenser system 3 is desirably capable of gathering substantially all of the light which diverges from source 4 over an angle at least equal to the angle of field coverage of projection lens 14 and concentrating the light through lens 14. By making use of a wide-angle projection lens the distance from the projection lens 14 to screen 16 (i.e., the optical path length for lens 14) can be minimized. To effectively utilize the compactness capability evolving from use of the wide-angle lens, the projected image is reflected only by a single light deflecting surface, (screen 16) located at an acute angle to the axis of projection lens 14. However, when an image is projected by lens 14 onto screen 16 along a non-perpendicular axis, the projected image, in the absence of some correcting means, appears to the viewer to be keystoneed, i.e., the image projected onto screen edge 22 which is closest to lens 14 appears to be smaller in size than does the image which is projected onto the farthest screen edge 24.

A magnifying lens 20 (here a Fresnel lens) is positioned at an angle relative to screen 16

such that the vertex of such angle is located at screen edge 24 which is farthestmost from lens 14. This is done to effect a gradually increasing magnification of the image from the farthestmost edge 24 of screen 16 to the edge 22 of the screen which is closest to lens 14. That is, the image appearing on the screen between edges 24 and 22 will be magnified, with the image portions proximate edge 24 being magnified much less than the image portions proximate edge 22. The angle between the screen 16 and lens 20 is chosen such that the image is magnified to a point that the entire image when viewed, will appear to be rectangular on screen 16, i.e., the image on and proximate screen edge 22 will appear to be equal in size to the image on and proximate edge 24.

Fig. 2 illustrates a top plan view of the viewing apparatus in its open and operative viewing position. The figure further illustrates the bellows arrangement 25 which together with an internal bi-stable latch 30 (not shown in Fig. 2) locks the reader in its open position. Magnifying lens 20 is shown positioned at an angle α relative to screen 16.

Fig. 3 illustrates the microimage reader 1 in its most compact state, i.e., the closed inoperative position. In this closed position the magnifying lens 20 is located near screen 16 at a very small angle β relative to screen 16. Magnifying lens 20 has been cut away to illustrate both the bellows arrangement 25, which is collapsed when reader 1 is in the closed position, and the edge of screen 16 which is located closest to the projection lens (not shown).

A specific embodiment of the invention was constructed using a flat aluminium Ektalite screen (Ektalite is a trademark of Eastman Kodak Company), a 10 watt light source, a blue coloured plastic Fresnel lens with a 140 mm focal length, and a 12.5 mm projection lens having a full diagonal angle of field coverage of 59°. The projection lens axis was positioned at a 20° angle to the plane of the Fresnel lens and oriented so that the maximum field of coverage extended diagonally across the screen. The screen was located, in its operative orientation, so that the projection axis of the lens formed a 44.95° angle relative to a line normal to the screen surface. Thus, a 25.05° angle α was provided between the screen and the Fresnel lens to substantially correct the keystone distortion in the image.

In the above specific example, the 10 watt light source was supplied with a voltage lower than its rating to provide for a long life. This resulted in the light emitted by the source being of slightly yellowish colour. However, when the yellow-coloured image light passed through the blue-coloured Fresnel lens the yellow colour was reduced thereby to restore the white colour to the image.

The angle α between screen 16 and lens 20

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may vary from the 25.05 found suitable for the above specific example. For instance, if a concave screen is used in the apparatus instead of a flat screen, a Fresnel lens having a longer focal length (greater than 140 mm) would be appropriate. That is, a concave screen will converge some of the light towards the viewer's eyes, a function which must be performed totally by the Fresnel lens where a flat screen is used. When both the Fresnel lens and the concave screen operate to converge the light towards the viewer's eyes, less convergence is effected by the Fresnel lens. With a weaker Fresnel lens, i.e., a lens having a focal length greater than 140 mm, the Fresnel lens must be positioned farther away from the smaller edge of the projected image, edge 22 for adequate magnification; thus the angle α will be larger than the 25.05° angle in the above example.

Angle α will also vary if the angle between screen 16 and the axis of projection of lens 14 varies. That is, if lens 14 projects light onto screen 16 at an angle such that the angle between the projected beam and a line normal to the screen is less than the 44.95° angle in the above example, the angle α will decrease, since the image projected onto screen edge 22 will need less magnification to appear equal in size to the image projected onto edge 24. Conversely, if light is projected onto screen 16 such that the angle between the projected beam and the line normal to screen 16 is greater than 44.95°, the angle α will be larger than the 25.05° angle in the above example, since the image projected onto screen edge 22 will need more magnification to appear equal in size to the image projected onto edge 24.

Maximum compactness of the reader is attained when the angle between the projected beam and a line normal to the screen is such that the rays forming on the screen that edge of the image which is farthest from the projection lens 14, i.e., the image edge adjacent to screen edge 24, passes parallel and adjacent to lens 20.

The use of a Fresnel lens as the correcting lens 20 also operates to eliminate "hot spots"

i.e., localized areas of excessive light intensity, at the viewing surface since the Fresnel lens converges the illumination from across the entire screen surface to the viewer's eye.

Also, the Fresnel lens is preferred over a solid continuous surface lens because of its light weight and its uniform thickness, which allows for easy moulding and will permit the addition of a filter dye directly into the lens material itself instead of applying the filter as a separate layer.

The invention has been described in detail with particular reference to a preferred embodiment thereof, but it will be understood that variations and modifications can be effected within the scope of the appended claims.

WHAT WE CLAIM IS:—

1. An image viewing apparatus comprising a lens which projects an image upon a screen at an acute angle, and a magnifying lens positioned at an angle to said screen so as to differentially magnify the image viewed on said screen through the magnifying lens.
2. An image viewing apparatus as claimed in Claim 1, wherein the said screen is a reflective screen.
3. An image viewing apparatus as claimed in Claim 1, wherein the said magnifying lens is a Fresnel lens.
4. An image viewing apparatus as claimed in Claim 3, wherein the said magnifying lens incorporates a dye providing colour correction for light from the source of light for the image.
5. An image viewing apparatus as claimed in Claim 3, wherein the rays forming on the screen that edge of the image which is farthest from the projection lens pass to the screen parallel to and adjacent to the magnifying lens.
6. An image viewing apparatus substantially as hereinbefore described with reference to the accompanying drawings.

L. A. TRANGMAR, B.Sc., C.P.A.
Agent for the Applicants.



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Maximum compactness of the reader is attained when the angle between the projected beam and a line normal to the screen is such that the rays forming on the screen that edge of the image which is farthestmost from the projection lens 14, i.e., the image edge adjacent to screen edge 24, passes parallel and adjacent to lens 20.

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3. An image viewing apparatus as claimed in Claim 1, wherein the said magnifying lens is a Fresnel lens.

4. An image viewing apparatus as claimed in Claim 3, wherein the said magnifying lens incorporates a dye providing colour correction for light from the source of light for the image.

5. An image viewing apparatus as claimed in Claim 3, wherein the rays forming on the screen that edge of the image which is farthestmost from the projection lens pass to the screen parallel to and adjacent to the magnifying lens.

6. An image viewing apparatus substantially as hereinbefore described with reference to the accompanying drawings.

L. A. TRANGMAR, B.Sc., C.P.A.
Agent for the Applicants.