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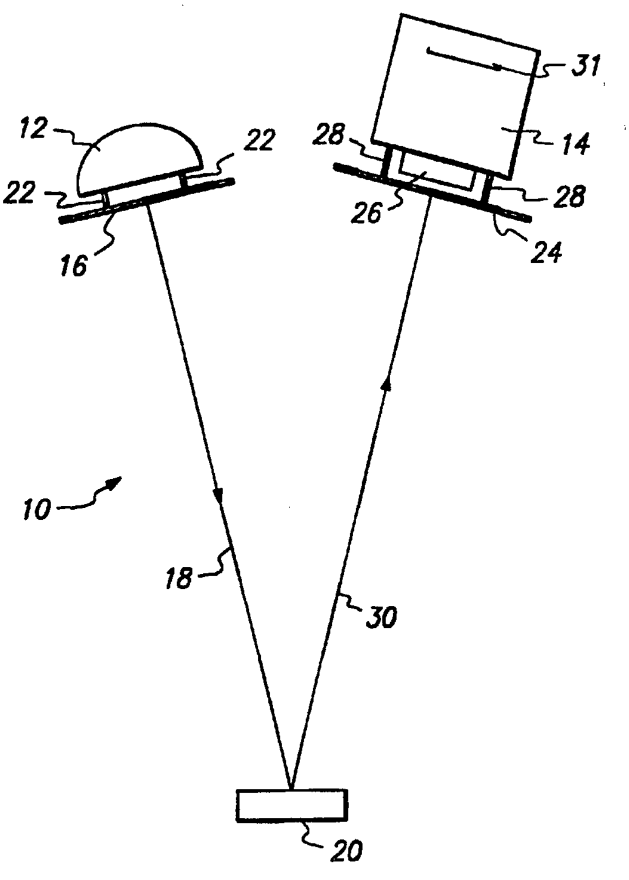
(54) Title: LIGHT POLARIZING AND REFLECTION FILTERING SYSTEM

(57) Abstract

An apparatus and a method for eliminating points of high intensity bright light and balancing the illumination of an image. The apparatus is comprised of a first polarizing filter (16) and a second polarizing filter (24) where the second polarizing filter is mounted such that its axis of polarization is oriented perpendicular to the axis of polarization of the first filter. The first polarizing filter is disposed between a single light source (12) and the object (20). The second polarizing filter is disposed in front of an imaging surface (31). The light source and camera's lens (26) are positioned adjacent to each other.



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LIGHT POLARIZING AND REFLECTION FILTERING SYSTEM

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates generally to the polarization of light for creating a uniform illumination of an object, subject or scene, and more particularly to a photo- or video-graphic system utilizing a single light source and a first polarizing filter to emit a polarized wave of light, where a second polarizing filter disposed at an angle to the first polarizing filter blocks the specular reflection of the polarized light to eliminate "hot spots" and create more uniform illumination.

2. Description of the Background Art

When a beam of incident light strikes an opaque surface, light is either reflected or absorbed. Reflected light may occur as specular or mirror-like reflection, or as a diffused reflection where light reflects among particles of the surface before being reflected off. Incident light usually travels in a straight line; however, as light passes across particles on a textured surface, light curving or diffraction occurs, further diffusing the incident beam prior to reflection from the surface. Specular reflection is reflection in which the reflected waves travel in a definite direction, and the directions of the incident and reflected waves make equal angles with a line normal to the reflecting surface and lie in the same plane with it. Rough surfaces reflect in a multitude of directions, and such reflection is said to be diffuse. Only a part of the emission of a light wave is reflected; the ratio of that part to the whole incident emission varies with the reflectivity of the surface.

A common problem that affects photographic or videographic works is the lack of uniform subject illumination. For example in a photographic setting where a single bulb illuminates a page of text, part of the cast light is diffused as it reflects in a multitude of directions about the page, and another part of the cast light is reflected directly back into the camera as specular reflection. This specular reflection causes a point of very bright illumination called a "hot spot". This non-uniform illumination poses a problem for the photographer attempting to accurately portray the page in a photograph.

To overcome the problem of non-uniform illumination, digital imaging compensation systems have been created. These systems adjust for non-uniform illumination by measuring the variation in brightness at different points in the scene, and then applying appropriate gain and offset compensation to even out the disparate illumination levels. This approach is limited, however, in that it is only effective for variations in brightness levels of approximately 10 to 1 across the image. Thus, electronic compensation is less effective for specular reflections because a specular reflection can be several hundred times brighter than the rest of the image. Electronic compensation is also less effective for specular reflection because specular reflections generally contain a constant brightness level, independent of the light and dark areas of the surface being illuminated. Diffuse reflections carry much of the information about the surface image being illuminated; specular reflections, with their more constant brightness levels, tend to wash out the diffuse reflections resulting in loss of image information.

To reduce the incidence of hot spots, common camera systems use two light sources - one cast upon the scene at an angle from one side of the camera, and the other light source disposed similarly on the other side of the camera. The combined illumination is very uniform as the lights are positioned away from the camera so that specular reflections are angled away from the camera's lens. The effectiveness of this system is dependent upon the amount of space available in which to set up the camera and lights. Thus, photos cannot be taken in small or compact spaces.

Other illumination flattening devices, such as that disclosed in U.S. Patent No. 3,544,196, provide a layer of transparent material having an engraved network of parallel lines. This filter causes the light rays passing through an automobile headlight to diffract, thus reducing the light intensity and eliminating headlight glare. The rays are also polarized to reduce the halo effect of the reflected light.

What is needed is a system for creating uniform illumination of an object, subject or scene that eliminates high intensity bright spots and can function effectively in compact spaces.

SUMMARY OF THE INVENTION

The present invention is a compact apparatus and a method for eliminating points of high intensity bright light, thereby balancing the illumination on the total image. The apparatus is comprised of first and second polarizing filters, where the first polarizing filter is disposed between a single light source and the object, subject or scene (object) to be photographed or videotaped. The second polarizing filter is disposed between an image plane and the object. The light source and camera's lens are positioned adjacent to each other and close together. The second polarizing filter is mounted such that its axis of polarization is oriented at a perpendicular angle to the axis of polarization of the first filter.

The method involves casting a light through the first polarizing filter onto an object. As the specular reflections from the object tend to preserve the initial axis of polarization, they will be blocked out or rejected by the second polarizing filter because the axis of polarization of the second filter is at right angles to that of the first polarizing filter. In diffuse reflections, the initial axis of polarization is lost upon reflection and such reflections return to the camera in random polarization. A portion of this light is polarized co-axially with the polarization of the second filter and thus passes therethrough providing an evenly illuminated image as seen by the camera.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a top view of a light polarizing system in accordance with the present invention, showing each element and its disposition relative to the other elements; and

FIG. 2 is a rear view of the system depicted in FIG. 1, illustrating the reflection of emitted light waves and their polarization orientation.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring now to FIG. 1, a top view of a light polarizing system in accordance with the present invention is shown. The system 10 includes a light source 12 disposed adjacent to a camera 14. Camera 14 is conventional and contains a lens 26 and an imaging surface 31. Imaging surface 31 may be film, a Charge-Coupled Device (CCD) element, or a similar image storage means. The light source 12 can be any means of illumination, including but not limited to a standard incandescent or fluorescent lamp. The camera 14 may be a photographic camera, a video camcorder, a CCD, or any other type of image recording device. In the preferred embodiment, light source 12 is mounted adjacent to camera 14 to form a compact unit. The system 10 shown in FIG. 1 exaggerates the separation of camera 14 and light source 12 in order to more clearly illustrate the operation of the system. Although specific types of illumination and image recording devices are described, it is anticipated that the use of other types of such devices will be obvious to those skilled in the art.

A first polarizing filter 16 having a first axis of polarization is disposed in front of light source 12 and positioned so that the light waves emanating from light source 12 (as indicated by line 18) that are directed toward the object 20 to be photographed are passed through the first polarizing filter 16.

The first polarizing filter 16 can be made from any material which causes the light waves passing therethrough to line up in one constant direction. The most widely used light polarizers consist of plastic sheets containing carefully aligned chains of iodine molecules, or sheets of plastic that are stressed in one direction to align the molecules. Other filters can be constructed of natural crystals, such as tourmaline or calcite (also called Iceland spar). The filter 16, which is disposed in front of light source 12, can be free standing, attached to a tripod or similar type stand, or it may engage the light bulb or lamp directly by one of many common means, such as being attached to the bulb or lamp by brackets 22, as is shown in this figure.

A second polarizing filter 24, having a second axis of polarization, is likewise disposed between the image surface 31 and object 20. In the preferred embodiment, the second polarizing filter 24 is disposed in front of camera 14, proximate camera lens 26. Like the first polarizing filter 16, the second polarizing filter 24 may be made of any light polarizing material and is disposed in front of lens 26. It too can be free standing or it can engage camera 14 directly, such as by brackets 28 shown. The second polarizing filter 24 is positioned such that its axis of polarization is perpendicular to the axis of polarization of first filter 16. The specularly reflected light waves (as indicated by line 30) that bounce off of object 20 and are reflectively directed toward lens 26, are blocked from entering camera lens 26 by the second polarizing filter 24.

The method for creating uniform illumination and eliminating hot spots by blocking the undesirable specular reflections is best illustrated in FIG. 2. FIG. 2 is a rear view of system 10 shown in FIG. 1, where light source 12 has the first polarizing filter 16 attached directly to its face and is positioned to emit light in the direction of the object 20.

The electromagnetic waves of light emitted by the light source 12 have no polarity and they lie in random planes. As the waves encounter the first polarizing filter 16, the filter transmits the component of the waves having an axis of polarization corresponding to the orientation of the first filter 16. Wave components which are not transmitted by first polarizing filter 16 are either reflected back into light source 12 or are absorbed by the filter, depending on the polarizing material used in the filter. In the illustration of FIG. 2, the axis of polarization of the first filter 16 is generally vertical, thus the polarization of the light 32 cast through the filter is vertical as well. Alternatively, a polarized light source 12 may be used, in which case first polarizing filter 16 is not required.

When the polarized light 32 reaches the object 20, some of the light waves will be diffused, that is they will reflect in a multitude of directions, and others will be directly reflected. The diffused light 34 loses power and loses its initial polarization. Thus, when the diffused light 34 is reflected from the object 20 back to the camera lens 26, the waves will have random polarizations;

i.e., some will be oriented vertically, some horizontally, and others at various angles as is shown in the figure by the reflected diffused light waves 34.

Specular reflections 36 occur from the polarized light waves 32 bouncing off of a shiny surface on the object 20. Specular reflections 36 are mirror-like reflections that tend to preserve their initial axis of polarization. In this illustration, the specular reflections 36 are the reflected waves that are oriented vertically. As this light is directly reflected without losing much power, it is high intensity light that would be seen through an unfiltered camera lens as a very bright point of light; i.e., a hot spot.

Where uniform illumination is desired, hot spots are undesirable. As the diffused light 34 and specular light 36 is reflected back to the camera lens 26, they encounter the second polarizing filter 24. The second filter 24 is positioned such that its axis of polarization is oriented at a 90 degree angle (shown as horizontal) to the original axis of polarization of the first filter 16. Since specular reflections 36 maintain their vertical angle of polarization, they are rejected by the second filter 24. Much of the diffusely reflected light 34 passes through the second filter 24 as the filter will usually allow a range of polarized light. For example, the second filter 24 may be designed to pass all light having an angle of polarization that is within 45 degrees of horizontal (45 to 135 degrees out of phase with the initial polarization orientation). Thus, there is still ample illumination in order to view the object through the camera 14 and hot spots are blocked out.

The invention has now been explained with reference to specific embodiments. Other embodiments will be apparent to those of ordinary skill in the art in light of this disclosure. For example, other equivalent means of supplying polarized light can be used, such as using light having a low angle of incidence. Therefore, it is not intended that this invention be limited, except as indicated by the appended claims.

What is claimed is:

1. A reflection filtering device comprising:

means for providing polarized light waves to be cast onto an object in order to illuminate the object; and

means for separating polarized light waves that are reflected from the illuminated object, the separating means operating to filter the reflected light waves allowing only the reflected light waves having a predetermined polarization orientation to pass therethrough.

2. The reflection filtering device according to claim 1 further comprising:

an image reproducing apparatus including a viewing lens disposed in cooperation with the separating means to receive the passed light waves.

3. The reflection filtering device according to claim 1, wherein the polarized light wave providing means comprises:

a light wave generating source; and

means for polarizing the generated light waves, the polarizing means disposed in cooperation with the light wave generating source.

4. The reflection filtering device according to claim 3, wherein the light wave generating source is an incandescent lamp.

5. The reflection filtering device according to claim 3, wherein the light wave generating source is a fluorescent lamp.

6. The reflection filtering device according to claim 3, wherein the polarizing means comprises a first polarizing filter having a first axis of polarization through which the light waves pass; the filter polarizing the light waves by passing only light waves polarized along the first axis of polarization.

7. The reflection filtering device according to claim 6, wherein the first polarizing filter is a plastic sheet polarizing filter.

8. The reflection filtering device according to claim 6, wherein the polarizing means is attached directly to the light wave generating means.

9. The reflection filtering device according to claim 1, wherein the separating means comprises a second filter having a second axis of polarization, the second filter allowing only light waves having an axis of polarization similar to that of the second filter to pass therethrough.

10. The reflection filtering device according to claim 9, wherein the second filter is a plastic sheet polarizing filter.

11. The reflection filtering device according to claim 1, wherein the separating means is attached directly to the lens of the image reproducing apparatus.

12. The reflection filtering device according to claim 6, wherein the separating means comprises a second filter having a second axis of polarization that is disposed perpendicular to the first axis of polarization of the first polarization filter.

13. A method for reducing specular reflections emanating from an illuminated object, the method comprising the steps:

polarizing light waves being cast upon an object; and

filtering the polarized light waves that reflect from the object.

14. A method for reducing specular reflections according to claim 13, wherein the step of polarizing involves transmitting only light waves aligned in a single plane.

15. A method for reducing specular reflections according to claim 13, wherein the step of filtering involves passing only the reflected light waves having a predetermined desirable orientation of polarization.

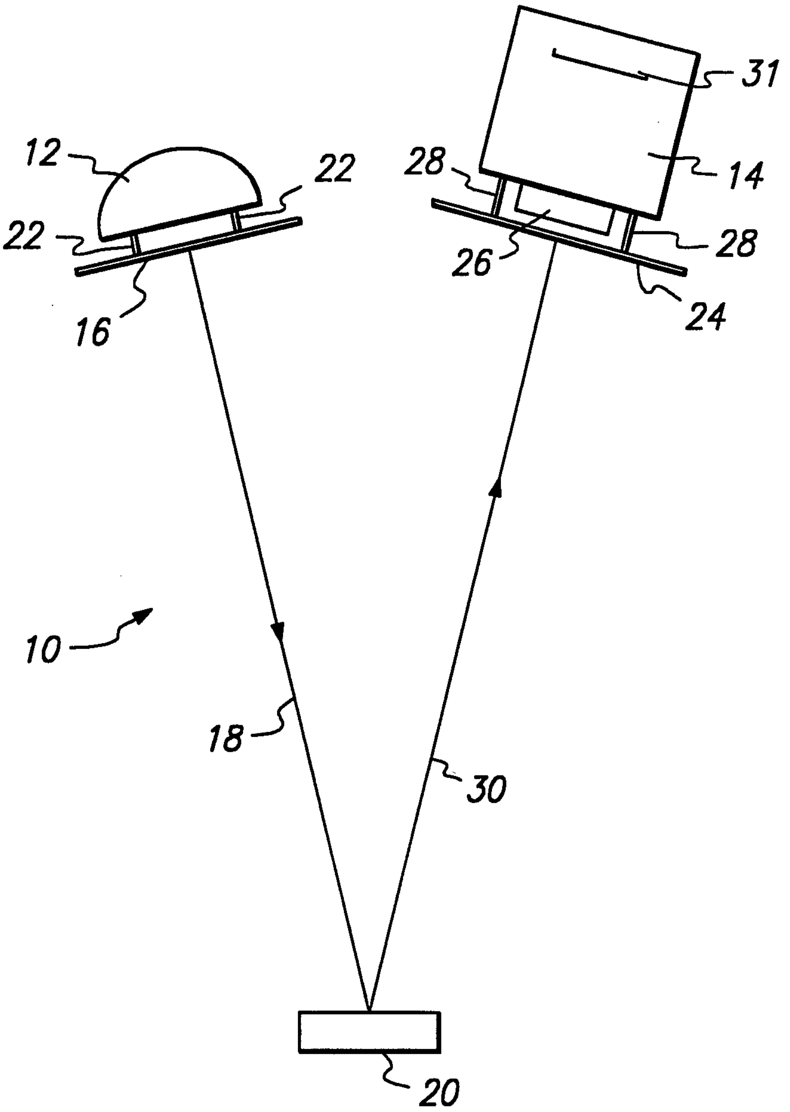

FIG. 1

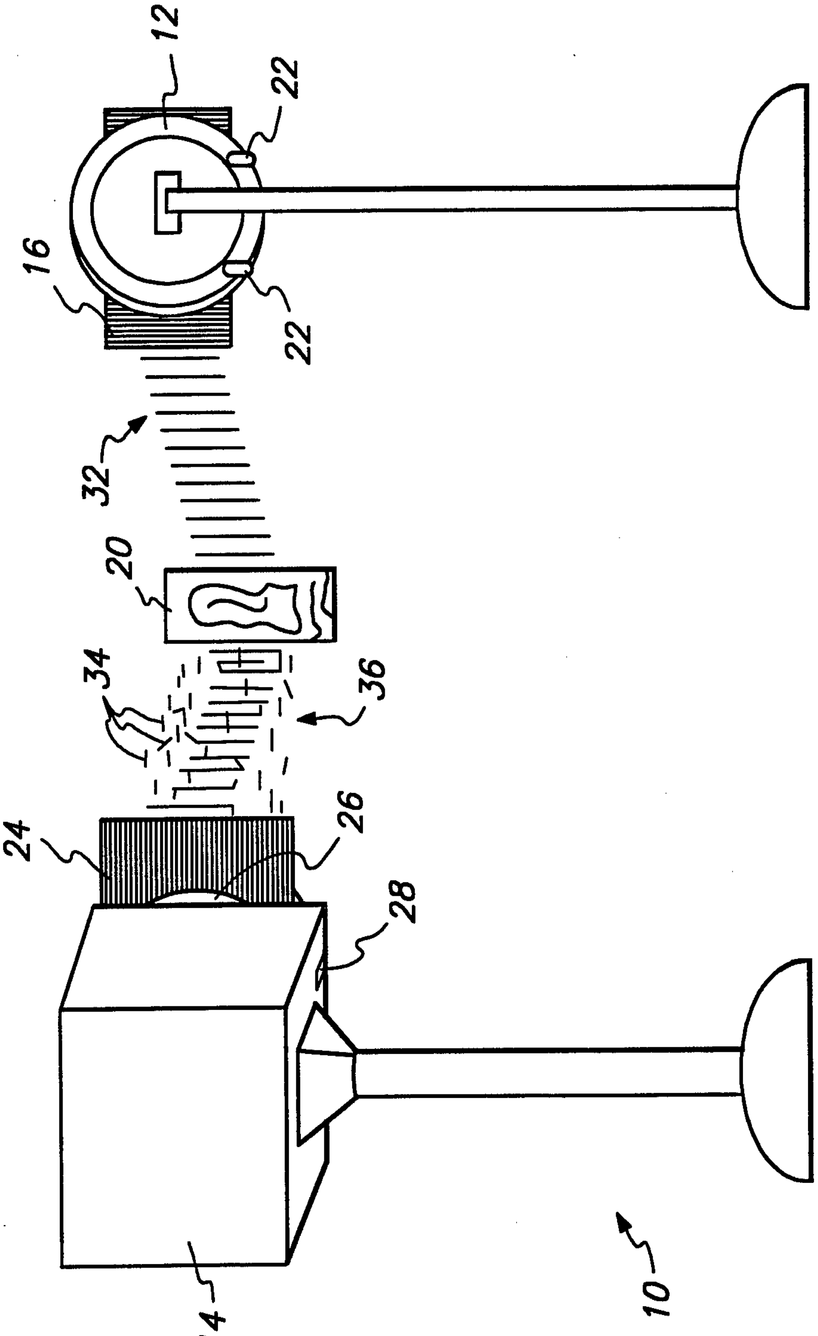

FIG. 2

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US94/03612

A. CLASSIFICATION OF SUBJECT MATTER

IPC(5) :G02B 5/30
US CL :359/501
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

U.S. : 359/485,487,489,490 359/501

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

none

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X/Y	US,A 2,393,968 (Burchell et al) 05 February 1946. See Entire Document	1-7,9,10,12-15/8,11
X/Y	US,A, 3,062,087 (Zandman et al) 06 November 1962. See Entire Document	1-3,6,9,12-15/4,5,7,8,10
X/Y	US,A, 3,368,652 (Klatchko) 13 February 1968. See Entire Document	1-4,6,9,12-15/5,7,8,10,11
Y	US,A, 2,432,867 (Dreyer) 16 December 1947. See entire document.	4,5,8,11

☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

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