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HILS

Officer-In-Charge
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Post Office Box 72 Naval Air Station
Moffett Field, California 94035

Subject: [redacted] 25X1

Gentlemen:

Pursuant to General Provision Article 26, your permission to present the attached report to a meeting of the Optical Society of America in September 1972 at Boulder, Colorado, is respectfully requested. The text of the report will appear in the conference summary publication and has been reviewed by your technical representative.

Should further information on this subject be required, kindly contact [redacted] member of technical staff, or the undersigned. 25X1

Very truly yours,

[redacted] 25X1

[redacted] 25X1

Supervisor, Contract Administration

WGB:eh

Attachment: as stated

Declassification Review by NGA/DoD

Application of Tungsten Halogen Lamps in a Wide Field Microscope Illuminator

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A six-inch long tungsten-halogen microscope illuminator produces a three-inch diameter, variable intensity, 25,000 ft. lambert, daylight spot.

Large photographic film formats used in aerial photography are assessed for detail over large illuminated viewing surfaces with the aid of a scanning zoom microscope. At low magnifications the microscope field covers only a small portion of the total illuminated surface. We therefore sought a more compatible means which could use the lamp input power more effectively where it is needed.

Typical viewing surfaces contain fluorescent lamps which supply 3000-3500 ft. lamberts of daylight quality. However it is desirable to visually penetrate into the deeper shadows or dense film regions. This can be accomplished by increasing the viewer luminance if extremes of heat or electric power input and loss of daylight quality can be avoided. In our search for a practical solution, we found that a highly concentrated spot of light covering only the instantaneous microscope field can be generated with a standard but efficient tungsten halogen lamp supported by appropriate optical components. Such a spot could be positioned beneath the microscope, beneath any portion of the format.

An illuminator generating the high intense spot can in most instances substitute for a large area source because it can fulfill several important requirements:

1. Illuminate the maximum field of the zoom microscope at its lowest magnification.
2. Fill the numerical aperture of the zoom microscope objective.
3. Have a daylight quality for color film application.
4. Have intensity control but maintain daylight quality.
5. Be adaptable for tracking the position of the microscope field over the viewing area.
6. Operate at a reasonable power input relative to the fluorescent lamps.
7. Be simple to maintain.
8. Be compact.

Two types of light sources are available for creating such a spot of light - one is the highly intense small arc source which can produce a well collimated beam, the other is a larger tungsten halogen source. We chose to try the new ELH tungsten halogen lamp because by comparison with an arc, it is easily available and replacable, requires no adjustment, and lends itself to a compact illuminator design requiring no special power supply.

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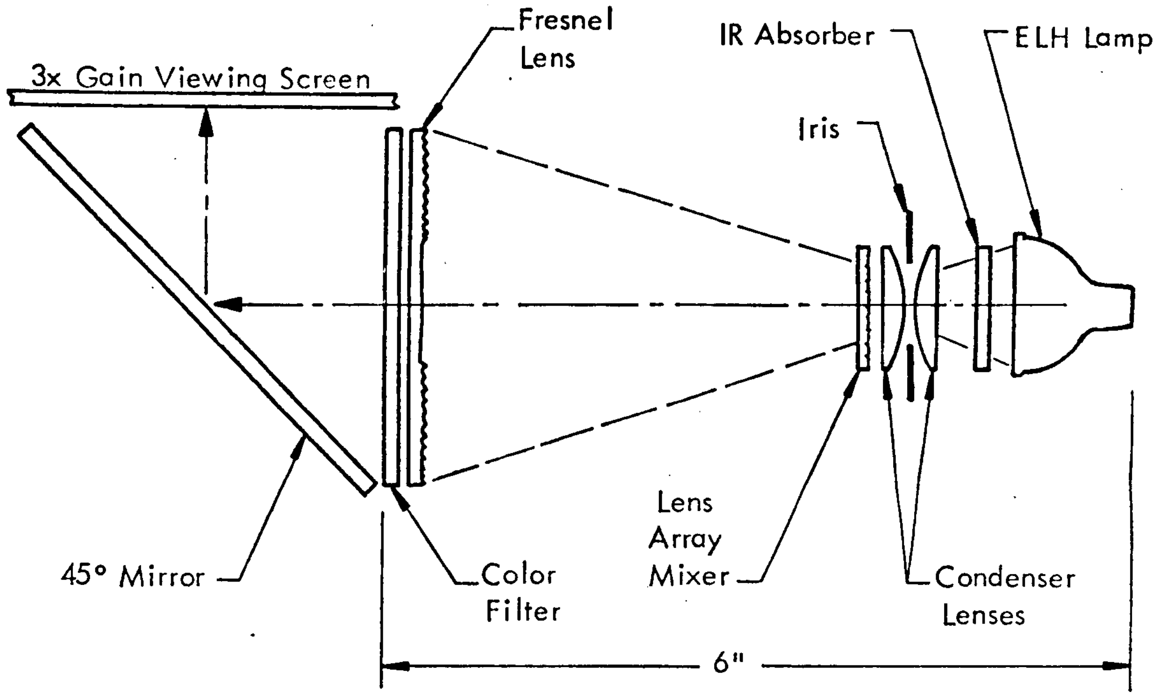

Figure I. Optical Layout of Illuminator

The experimental illuminator optics configuration is illustrated in Figure I. A 300 watt ELH lamp produces about a 3/4" diameter bundle of high intensity through the heat absorber. Two simple lenses located near the intense bundle project an image of the reflector aperture and lamp at the Fresnel lens. An iris for intensity control is mounted adjacent to the lenses. A mixer is inserted close to the principal focus of the Fresnel lens. The Fresnel lens projects the image of the mixer at about 5x. The projected Fresnel beam is intercepted by a 3x gain Polacoat rear projection viewing screen material, in this case about 3" from the Fresnel, to provide a highly intense spot of about 3" diameter. The 45° mirror directs the beam vertically and under the microscope viewing area. A sealed Wratten filter placed next to the Fresnel lens alters the tungsten color temperature to approximately 5000°K.

The two important components in this approach are the new ELH lamp and the mixer. An ELH lamp is excellent in this application. It has a deep dichroic reflector which collects a high percentage of the total visible filament radiation needed to compensate for light loss in the color filter. The collected light is condensed into an intense bundle near the iris diaphragm which introduces severe spot non-uniformity when the diameter is altered for intensity control. A 20x20/square inch lens array mixer redistributes the light into an acceptable uniformity.

The following table gives the characteristics of the illuminator.

Table of Characteristics

Lamp	ELH 300 watt dichroic reflector
IR Control	KG-1 filter + dichroic IR transmission
Spot Size	3" maximum, 2-3/4" effective
Uniformity	25% fall-off at 2-3/4" diameter
Color	5000° ± 500°K
Luminance	1,200 to 25,000 f.l. at 5000°K Maximum 140,000 f.l. without color correction

A high luminance viewing area should fill the numerical aperture of the microscope objectives. The selection of a 3x gain screen and the angular field subtended by the wide open iris at maximum luminance combine to produce the brightness polar diagram. We found the polar distribution adequately fills the numerical aperture and is shown in Figure II.

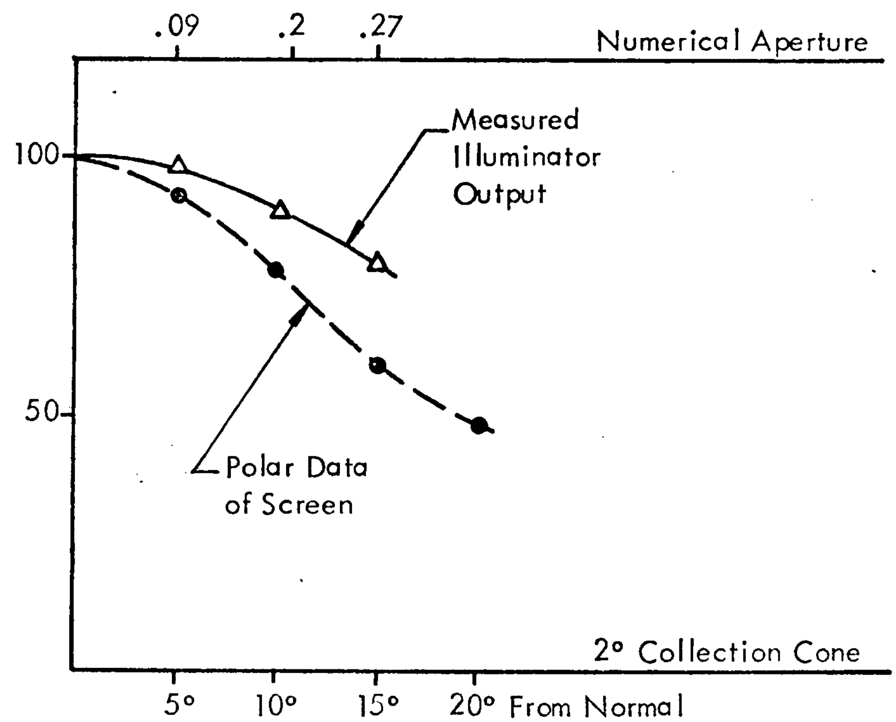

Figure II. Polar Output of Illuminator as Numerical Aperture Increases

The significance of increasing luminance from 3000 f.l. is apparent when dense film is viewed through high magnification stereo microscopes. The 8 to 9x increase reduces the visual contrast threshold* increasing the visual resolution cut-off of the system by 20 to 25%. In numerical values this corresponds to a change from 400 lp/mm to approximately 500 lp/mm cut-off.

* W.E.K. Middleton, "Vision Through the Atmosphere" (University of Toronto Press, 1952) p. 90.