DIRECT IMAGE VIEWER,

SPECIFICATION FOR

10 July 1964

STATINTL

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for

1.0 SCOPE

1.1 This specification describes the performance and technical characteristics of an Experimental Direct Image (High Resolution) Viewer. The Direct Image Viewer employs a unique optical approach, involving diffraction gratings, to provide an observer with an enlarged aerial image which can be viewed simultaneously with both eyes.

1.2 Major features of this viewer include the elimination of performance limitations imposed by the use of rear projection diffusion screens, and the achievement of high magnification viewing qualities comparable to advanced microscope viewing objectives.

2.0 APPLICABLE DOCUMENTS

2.1 The following drawings form a part of this specification:

STATINTL [ ] Dwg. No. 7506L1 Layout Dual Magnification, Direct Image Viewer

STATINTL [ ] Dwg. No. 7506L2 Assembly, XY Translator, Direct Image Viewer

3.0 REQUIREMENTS

3.1 Design - The overall configuration of the Experimental Direct Image Viewer specified herein shall be in general conformance with [redacted] Drawing No. 7506L1. STATINTL The viewer shall employ materials of highest commercial quality consistent with its intended performance and specified operating environments.

3.2 Performance Characteristics - The performance characteristics of the Experimental Direct Image Viewer shall consist of the following general values:

3.2.1 Magnification - Dual individual magnifications of 5X and 50X.

3.2.2 Observable Film Area - The observable film area shall consist of a nominal two (2) inch by two (2) inch square area in the film plane at 5X magnification, and two-tenths inch by two-tenths inch square area in the film plane at 50X magnification.

3.2.3 Film Size - The viewer shall possess a capability for viewing single frames of either 70mm or 5 inch film chips. 4x5" —

3.2.4 Exit Pupil Size - The nominal size of the composite exit pupil shall be 3.5 inches square.

3.2.5 System Resolution - At 5X magnification, the Experimental Direct Image Viewer shall be

capable of providing a system AWAR resolution of 60 lines per millimeter over the used field when referred to a high contrast target in the object plane. At 50X magnification, the viewer shall be capable of providing an resolution of 200 lines per millimeter on axis at the film plane with a high contrast target while employing commercially available lens. The resolution goal of the system when operating at 50X shall be 200 lines per millimeter as viewed in the object plane for a low contrast (1.6:1) target.

3.2.6 Light Intensity - The lamp intensity shall be variable and of sufficient brightness to allow the measurement of a 0.05 density difference over a required density range of 0 to 1.8. As a design goal, the viewer will provide a capability of measuring a desirable density difference of 0.02 over a density range of 0 to 2.5.

3.2.7 Illumination Spectrum - The illumination of the viewer system shall be contained in a narrow band within the 450-550 millimicron portion of the spectrum. 508 mμ Cd line - centered about this λ

3.2.8 Film Positioning - The viewer shall incorporate a provision for remote film positioning through X and Y translations to permit full coverage viewing areas for either 70mm and 5-inch film chips.

3.2.9 Focusing - A manual fine focus controll shall be provided for each viewer lens magnification.

3.2.10 Film Temperature - The temperature of the film when mounted in the film plane of the viewer during operation shall not exceed ambient (75°F.) by more than 20°F.

Fogged Silver 0.8 density in Balm Gate.

3.2.11 Viewer Controls - The Experimental Direct Image Viewer shall contain a set of viewer controls, front panel mounted, consisting of the following:

3.2.11.1 Power - ON/OFF

3.2.11.2 ~~Lamp~~ Illumination Intensity

3.2.11.3 Magnification Selector, 5X and 50X

3.2.11.4 Lens Focus, 5X and 50X

3.2.11.5 Film Translation
± one inch X
± one inch Y

3.2.12 Power Consumption - The power consumption of the viewer shall be approximately 800 watts of 110 volts, 60 cycle, electrical power.

Not Critical →

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3.2.13 Physical Size - (Reference [redacted] Dwg. No. 7506L1). The viewer shall consist of the following general dimensions: Length - 66 inches, height - 26 inches, width - 29 inches.

Not Critical →

3.2.14 Weight - The weight of the viewer shall be approximately 150 pounds.

3.3 Theory of Operation - In direct viewing optical instruments, such as a microscope, the exit pupil is small, requiring that the operator place his eye close to the eye piece for satisfactory viewing. The present Experimental Direct Image Viewer, with its larger optical elements and diffraction grating, enlarges the exit pupil in a manner that the operator may view with both eyes the image and still have adequate head movement. In the absence of employing diffraction gratings in the present viewer, a single small exit pupil would exist, which would restrict the operator to the use of a single eye and no head movement when viewing at high magnifications. Through the insertion of the

gratings in the optical path, and the use of a narrow portion of the spectrum, many exit pupils are created, which when arranged side by side and placed both above and below one another, form a matrix of exit pupils in space providing an effective viewing area of 3.5 inches square, where the operator may place his eyes for viewing. This unique approach results from the use of a special field lens, and specially designed and built set of diffraction gratings. Near monochromatic light must be used in the viewer, or the diffraction characteristics of the gratings will produce a rainbow of images between matrix units (exit pupil images).

3.4 Technical Details

3.4.1 Viewer body, optical supports, and controls -

3.4.1.1 Chassis - The viewer frame will be constructed from aluminum jig plate, and rigid mounts will be supplied for all optical elements. The large field lens will be of a split design, and flange mounted to one-inch thick plates. The diffraction gratings will be mounted between the field lens elements and their one-inch separated flanges.

3.4.1.2 Film support and X-Y translation - The film support system, as shown in STATINTL [redacted] Dwg. No. 7506L2, accomodates both 70mm and 5-inch film chips. The film will be held by a vacuum to a flat glass plate free of striations. The glass platen will be mounted on a mechanical mechanism which will provide controlled X and Y movement of 2 inches and translate the film 9 inches in X to change magnification.

3.4.1.3 Objective lens mounting - The two lenses will be flange mounted with the position of the flange being manually adjustable for fine focus.

3.4.1.4 Auxiliary equipment - Two pieces of equipment will be placed within the viewer:
(1) The light source power supply will be repackaged and mounted along one side of the viewer enclosure;
(2) A small vacuum pump will be mounted so as not to induce any vibration to the optical path.

3.4.1.5 Viewer Housing - The viewer housing and enclosure will have a hinged section at the rear for access to the mechanism and for inserting film and lamp replacement. The front panel will contain the controls and provide the proper mask around the field lens and gratings.

3.4.2 Viewer Optics

3.4.2.1 Field Lens - A symmetrical design multi-element, 15-inch diameter, field lens will be used. The lens will image the exit pupil of the objective lens 20 inches from its rear nodal point. The lens shall be of a sufficiently high quality as not to degrade the high resolution image requirements of the viewer.

3.4.2.2 50X Magnification Components - A large aperture photographic lens will be used

with a modified exit pupil producing a square opening. The resolution of the viewer is dependent upon this lens, and the best commercially available lens with an f number approaching unity will be used.

A multi-element condensed system will be used to concentrate the light to the small 0.2 x 0.2 inch square film area while filling the objective lens.

Field flatteners shall be employed to provide field curvature for optimum field lens operation.

3.4.2.3 5X Magnification Components - A commercially available 8.5 inch focal length lens will be modified to contain a square exit pupil equal in size to the 50X lens case.

The condenser system to be employed with this lens will concentrate and illuminate a 2 x 2 inch square area evenly.

Separate field flatteners will be used for the same purpose employed with the 50X system.

Two additonal small mirrors will be inserted in the path, one before and one after the lens to provide the dual 5X magnification. The mirror in front of the lens is movable to permit inserting it or removing it from the optical path. With film translation, the two magnifications are obtained.

3.4.2.4 Light Source - Two lamps and reflectors shall be employed, one for each lens. In addition, special interference filters will be employed to provide the narrow spectrum required.

3.4.3 Diffraction Grating - In order to obtain the unique optical multiplication of exit pupils required, special diffraction gratings are required. Two gratings are employed to diffract the light into a multiplicity of exit pupils dispersed in two directions 90^{o} apart, thus providing a matrix of exit pupil images.

3.4.3.1 For the prescribed magnification levels and the size of the multiple exit pupil required, a minimum of nine (9) orders of diffraction are required, a central order and four (4) on each side. The difficulty of the grating design is that all orders should receive the same amount of energy so that each exit pupil appears of the same brightness to the observer.

3.4.3.2 The gratings shall be of a 10 x 10 inch ruled surface, which influences the field of view of the system and the observable film size. Special ruling techniques are required and will be used to produce these gratings.

3.4.3.3 The light is diffracted by one grating in one direction, and then each diffracted exit pupil is spread out in the other direction by a second grating. The

cascaded diffraction gratings produce a decrease in light intensity, which is then enhanced by the use of a narrow band light source. Compensation is provided in the condensers, high intensity lamps and the small f/number projection lens at the high magnification.

3.4.3.4 The nominal angular deviation of the various orders shall be:

First order	1^{o} 9'
Second order	2^{o} 18'
Third order	3^{o} 27'
Fourth order	4^{o} 35'

The tolerance for each of the above deviations shall be $\pm$ 10% of the above angles.

3.4.3.5 Intensity variations throughout the nine orders shall be no greater than 40% between adjacent orders and no greater than a 2:1 ratio between the lowest and highest order in the nine central orders.

3.4.3.6 The transmission of the order which transmits the minimum amount of light shall be at least 40% of the light intensity falling on an individual grating.

3.4.3.7 The glass quality to be used in the manufacture of the diffraction gratings shall be greater than striae free through the faces.

3.4.3.8 A maximum of 10 arc minutes of slope error shall be a permissible planeness (figure) of the glass.

4.0 QUALITY ASSURANCE PROVISIONS

4.1 The optical components will be inspected and tested to demonstrate compliance to the performance requirements stated in Section 3.2.

4.2 The diffraction gratings will be inspected and tested to show compliance to the performance requirements stated in Section 3.2

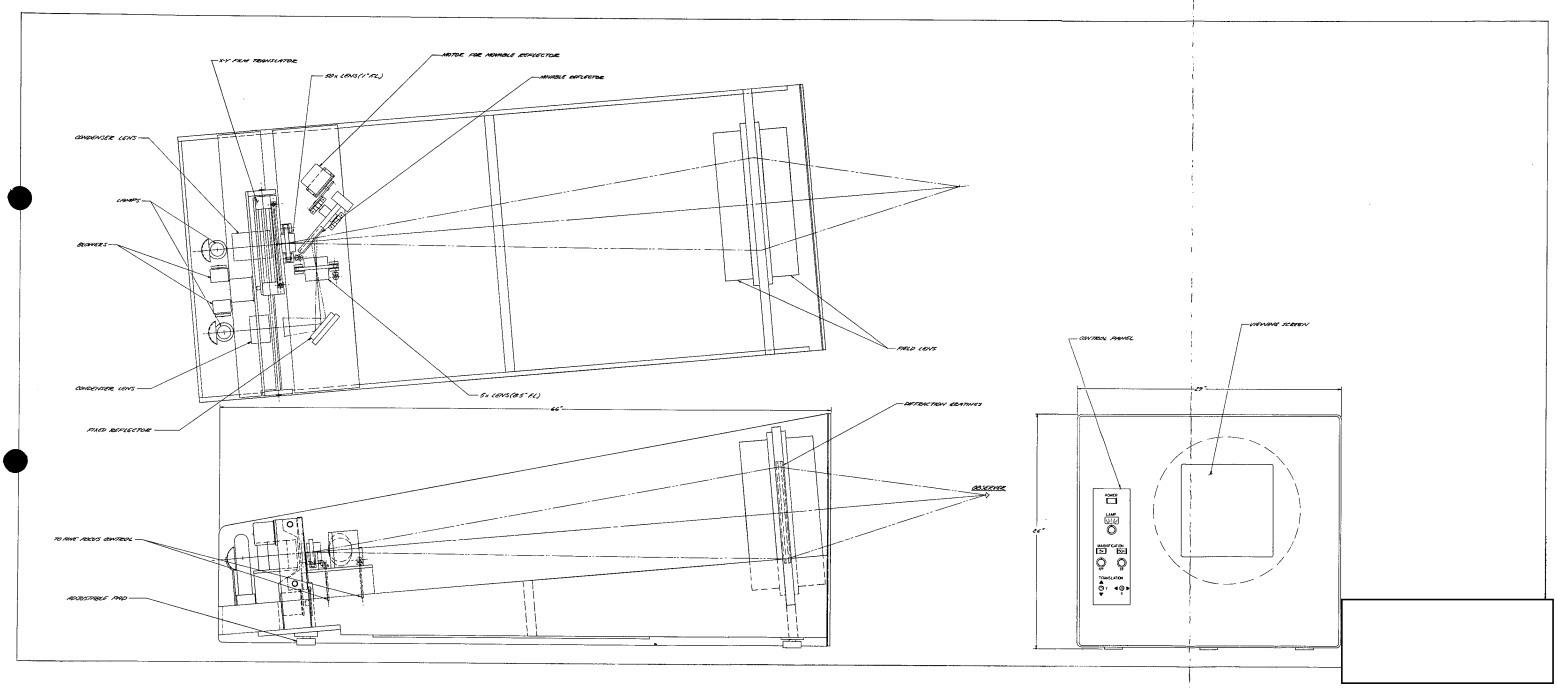
4.3 A set of complete viewer acceptance tests will be conducted to demonstrate satisfactory operation of all the functions and specifications stated in Section 3.0.

5.0 PREPARATION FOR DELIVERY

This viewer will be packaged and prepared for shipment and delivered in accordance with accepted commercial practices.

6.0 NOTES

None


X-Y-TILT TRANSLATOR
50 x LENS (1" FL)
MOTOR FOR MOVABLE REFLECTOR
MOVABLE REFLECTOR
CONDENSER LENS
LAMPS
REFLECTORS
FIELD LENS
CONDENSER LENS
5 x LENS (0.5" FL)
FIXED REFLECTOR
66"
DEFLECTION BEARINGS
OBJECTIVE
TO RAVE MODES CONTROL
ADJUSTABLE PAD
CONTROL PANNEL
VIEWING SCREEN
29"
24"
POWER
LAMP
INTENSITY
FOCUS
TRANSLATION

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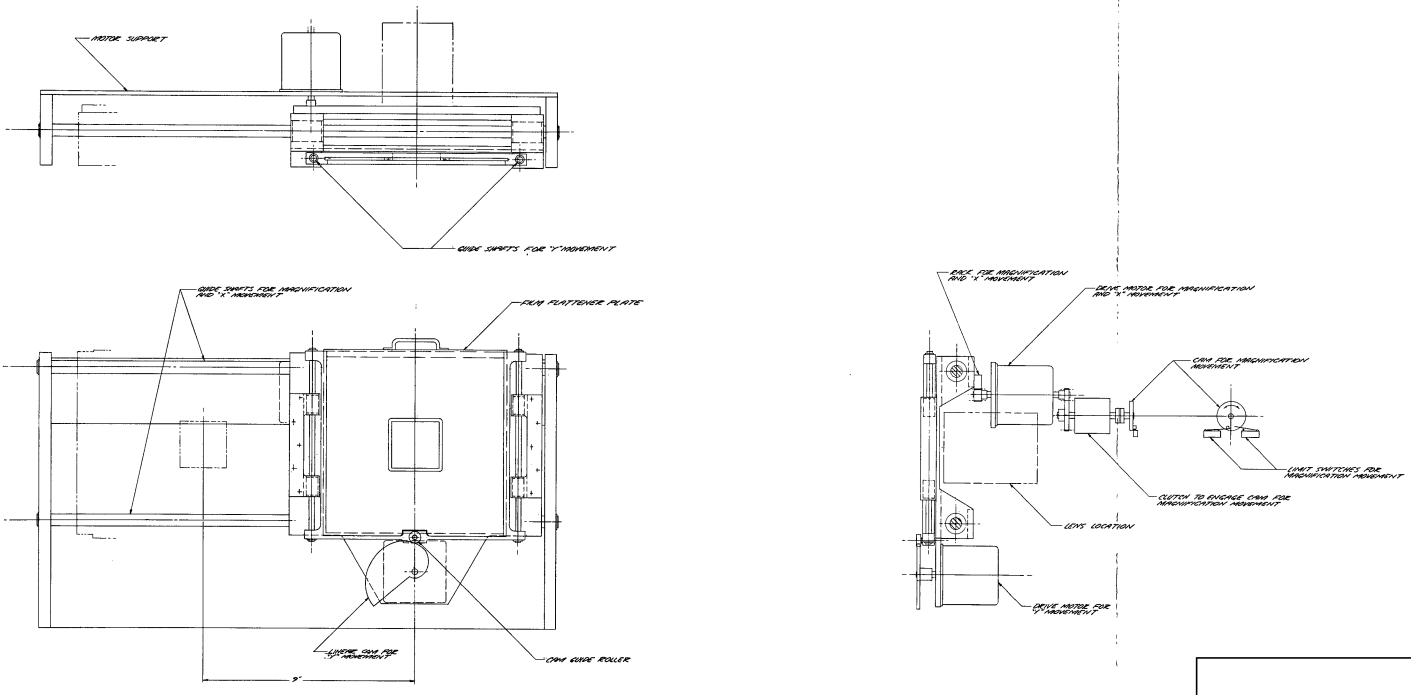
MOTOR SUPPORT
GUIDE SHAFTS FOR "Y" MOVEMENT
GUIDE SHAFTS FOR MAGNIFICATION AND "X" MOVEMENT
FILM FLATTENER PLATE
LIMIT SWITCHES FOR "Y" MOVEMENT
CAM GUIDE ROLLER
9"
RACK FOR MAGNIFICATION AND "X" MOVEMENT
DRIVE MOTOR FOR MAGNIFICATION AND "X" MOVEMENT
CAM FOR MAGNIFICATION MOVEMENT
LIMIT SWITCHES FOR MAGNIFICATION MOVEMENT
CLUTCH TO ENGAGE CAM FOR MAGNIFICATION MOVEMENT
LOW'S LOCATION
DRIVE MOTOR FOR "Y" MOVEMENT

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