WALTER R. AMBROSE*
Bausch & Lomb, Inc.
Rochester, N. Y. 14602

A Radar Image Correlation Viewer

Scale, rotation, and distortion correction help one to see a photo and a map simultaneously.

(*Abstract on page 213*)

INTRODUCTION

SIDE-LOOKING RADAR is a means of rapidly obtaining a small-scale photographic record of large areas of the earth. It may be used at night and under adverse weather conditions. Information on the photograph may be used to advantage if it has been transferred to topographic map sheets. An instrument that would allow an operator to view simultaneously side-looking-radar photography and a topographic map sheet has recently been developed by Bausch & Lomb for the United States Army Electronics Command. The instrument was required to provide a means for matching the scale of the photography with the map, compensate for the distortion in the radar photograph, and allow the operator to annotate on the map or an overlay sheet. The instrument is capable of being mounted in a van.

GENERAL CONFIGURATION

The instrument developed is named the Still Picture Viewer AR-73 (Figure 1). The concept of the instrument is that the radar photograph is projected onto a rear projection screen with the scale-matching and distortion-correction performed optically. The rear projection screen and the map are viewed simultaneously through a beam splitting prism. The operator sits on a stool with the map on the easel, much as a draftsman sits at a drawing board. The optical system consists of a condenser system, an anamorphic relay system and a projection system.

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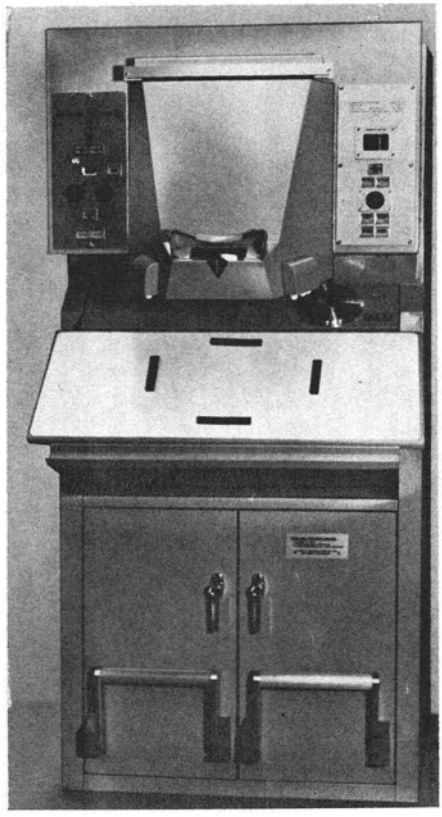

FIG. 1. Still picture viewer AR-73.

VIEWING SYSTEM

The viewing system is based on the "camera lucida" principle, which is familiar to users of the Sketchmaster, although there are several major differences between the Sketchmaster and the AR-73. In the Sketchmaster the scales of the photograph and map are matched by placing them at different distances. A lens accommodates the eye to the difference in focus. The photograph may be tilted to compensate for the tilt of the camera at the time of exposure. It is necessary that the operators eye be restricted in motion by a "peep hole" so that there will be no parallax. However, in the AR-73 the operator views through a beam splitting prism, looking straight through at the map while seeing the rear projection screen by reflection. The screen and easel are rigidly fixed at right angles and are equidistant from the beam splitting prism. This allows the operator to view without any lenses to accommodate for different distances, and without any restriction of head movement because there is no parallax. There is no peep hole so the operator

WALTER R. AMBROSE

can use both eyes; he can hold his head as close or as far away as he pleases depending only on how large a field he wishes to see. The map is illuminated by six small incandescent lamps which have a dimming control on the upper left control panel.

PROJECTION SYSTEM

The specifications required that the instrument match certain combinations of photo scale and map scale. This is shown in Table 1. Allowing for about ±10 per cent scale error of the photography, the magnifications can be covered with two ranges: 2× to 3×, and 6.5× to 10×.

TABLE 1

Photo Scale	*Map Scale*	*Magnification*	*Magnification Range*
1:560,000	1:250,000	2.24×	2×–3×
1:280,000	1:100,000	2.8×	
1:1,800,000	1:250,000	7.2×	6.5×–10×
1:900,000	1:100,000	9×	

Two projection lenses are used; one has a 150 mm. focal length, and the other 64.5 mm. (See Figure 2.) The magnification is varied by moving the entire substructure containing the film drive, the anamorphic system, and the projection system, thereby varying the object-to-image distance. Focus is maintained throughout the range by an autofocus system: a cam follower moves along the autofocus cam varying the position of the projection lens with respect to the intermediate image plane, thereby maintaining the correct object and image conjugates of the lens. There are two cams, one for each lens. When changing magnification ranges, either lens will be in focus when it moves into position.

Each lens has an associated field lens which images the exit pupil of the relay lens into the entrance pupil of the projection lens. The 64.5 mm. projection lens requires a strong field lens, which unavoidably introduces field curvature; this is compensated for by a nega-

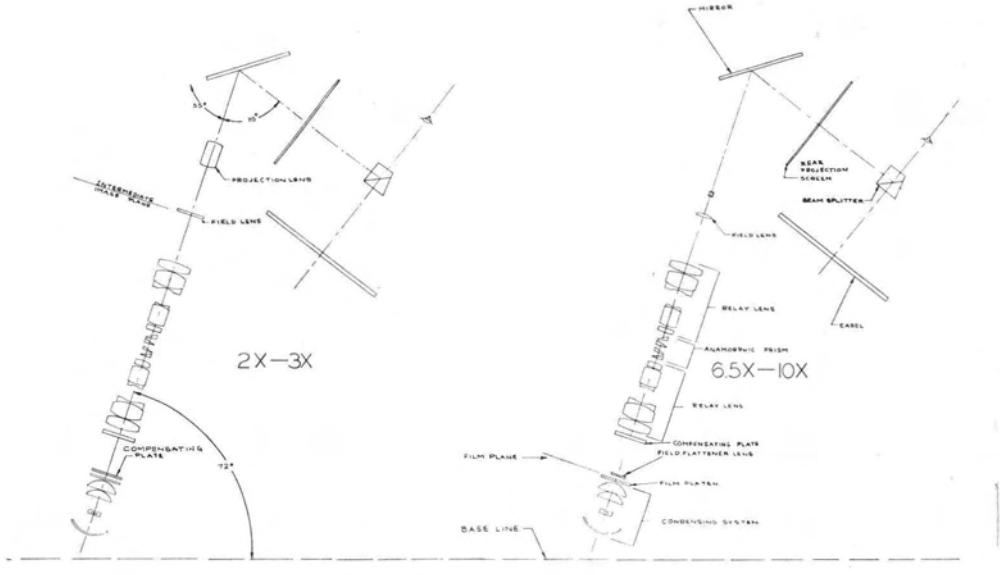

FIG. 2. AR-73 optical system.

tive field flattener lens near the film plane. When the 150-mm. lens is in place the field flattener is moved out and is replaced with a compensating plano plate. The position of the lamp with respect to the condenser lenses depends on whether the field flattener or the plano plate is in position. The change in magnification range is accomplished by a single push button (located on the control panel) which actuates motors that move the projection lens, field lens, and field flattener into place, and varies the lamp distance to the condenser.

ABSTRACT: *After the imagery on photographic film from Side-Looking Radar has been retrieved, it is necessary to expedite the extraction of data. An instrument recently developed to correlate the radar imagery with topographic map sheets is the Still Picture Viewer AR-73. This instrument utilizes the camera lucida principle to enable the operator to view the map and the radar imagery simultaneously. The radar imagery is projected onto a rear-projection screen, and a means of scale matching and image rotation is provided. Distortion in the imagery is compensated by a variable anamorphic system.*

ANAMORPHIC SYSTEM

The radar photography may be distorted ± 10 per cent in any direction. The nature of the distortion is such that a square will appear to be a rectangle. The anamorphic system used in the AR-73 consists of four tilting wedge prisms. Two prisms could have been used rather than four, but the optical axis would shift when changing distortion. The prism system must function in collimated light; for this reason it is located in the center of a $1\times$ relay system consisting of two lenses with a collimated path between them. The anamorphic system is motor driven, one motor to tilt the prisms, and another to rotate the assembly so that the distortion direction can be oriented.

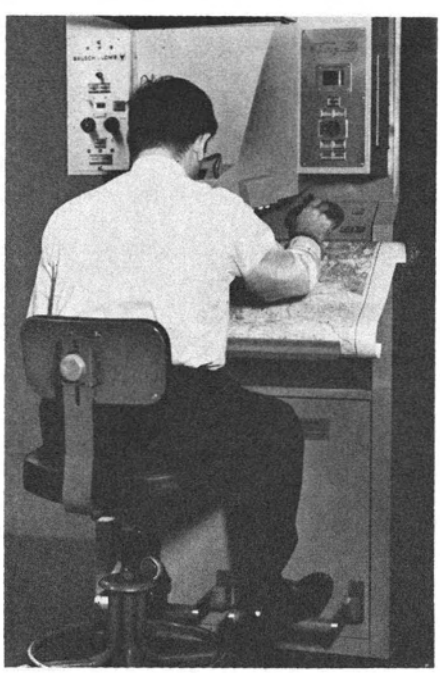

FIG. 3. AR-73 in use.

FILM DRIVE

The AR-73 will accept either two 70 mm. films, two 5-inch films, or one $9\frac{1}{2}$-inch film, in 100 foot rolls. The radar photography is of two types which are recorded simultaneously side-by-side. The film may be scanned at a variable speed or moved rapidly at slew speed. The film drive translates at a variable speed for scanning across the film. The film scan and table translation are controlled by a joystick. The image of the film seen in the viewing prism moves in the same direction as the joystick.

The film drive can be rotated $\pm 180°$ to orient of the photograph with the map. The control for this rotation is the joystick housing. When the joystick is rotated, the film rotates to align itself with the joystick. Therefore, the image seen in the viewing prism will always move in the direction the joystick is deflected.

OPERATION AND CONTROLS

The operator sits at the instrument much as a draftsman sits at a drawing board (Figure 3). A pencil trough holds his drawing tools. Excess portions of the map at the top and bottoms are rolled into split tubes. The map is held flat with four magnets.

At the top of the easel is the joystick. The operator uses this control when he searches

for the imagery to be studied and for aligning imagery with the map. There is also a push button for rapidly moving from one roll of film to the other.

The controls on the upper right control panel, from top to bottom are as follows: the magnification indicator, the magnification range switch, and the magnification change switches which are used to match the scale of the photograph to the maps; the distortion direction indicator, the distortion direction switches, and the switches for varying the distortion are used to remove the distortion in the photograph.

The upper left control panel has, from top to bottom: the main circuit breaker, a footage counter for metering distances along the film, projection lamp dimming switch and map lamp dimming switch for balancing the illumination of the map and the photography, a switch that allows the operator to synchronize the two rolls of film, and the lens fine focus switches.

Beneath the easel are doors for access to the film compartment. The film drive slides out of the cabinet for ease in loading. On the doors are folding foot rests.

SUMMARY

The Still Picture Viewer AR-73 can be used for rapidly analyzing the photographic returns from side-looking radar. Information on the photography may be transferred to the map by annotating with a pencil. The purpose may be for revision or updating maps, of for locating objects not normally recorded on a topographic map. The process is simplified for the operator so that he can perform this task as comfortably as a draftsman. The scale and distortion of the photograph are optically matched to the map. Frame photography, strip photography, etc., can be viewed in this instrument, as well as radar photography. The instrument could be used for approximate rectification of small areas of oblique photographs.