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REDESIGN OF ARMORED ILLUMINATOR OPTICAL PROJECTION MODULE

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Under a previous contract, number DAAG53-76-C-0005, a compact, armored searchlight was developed for the U.S. Army Night Vision Laboratory. Field testing of that searchlight by the Army revealed some design problems in the optical projection module. Under this contract, the optical projection module was redesigned incorporating an improved infrared filter mechanism, blackout mechanism, and beamspreading mechanism. Heat transfer -

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SUMMARY

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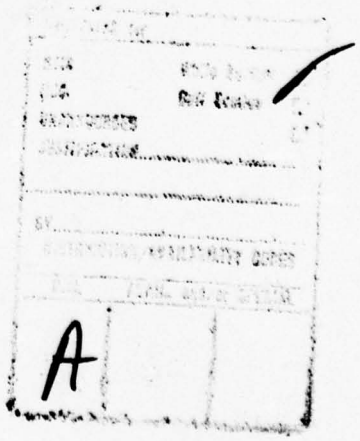
Under this contract, the optical projection module was redesign incorporating an improved infrared filter mechanism, blackout mechanism, and beamspreading mechanism. Heat transfer characteristics were also improved. Subsequent testing of this redesigned searchlight at Fort Knox, Kentucky confirmed that the design changes eliminated the previous operational deficiencies.



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REDESIGN OF ARMORED ILLUMINATOR

OPTICAL PROJECTION MODULE

I. INTRODUCTION

1. Background. The Armored Illuminator consists of three main units: an optical unit, a power conditioning unit and a remote control box. Interconnecting cables are also provided. A complete searchlight is shown in Figure 1 and a module block diagram of the system is shown in Figure 2. One xenon arc lamp is furnished with each modular searchlight.

One operational problem encountered with the originally delivered Optical Projection Module was peeling of the small (1-3/8" diameter) filter with intermittent sticking of the blackout mechanism. Also, the continuously variable zoom mechanism also stuck, on occassion, in an intermediate position somewhere between the 2 degree and 6 degree beam spread positions.

2. Objective. The purpose of this contract was to redesign and fabricate an improved Optical Projection Module for the Armored Illuminator. This module includes the blackout, spread lens and IR filter mechanisms as well as the beam projection lens. No testing of the redesigned unit was required.

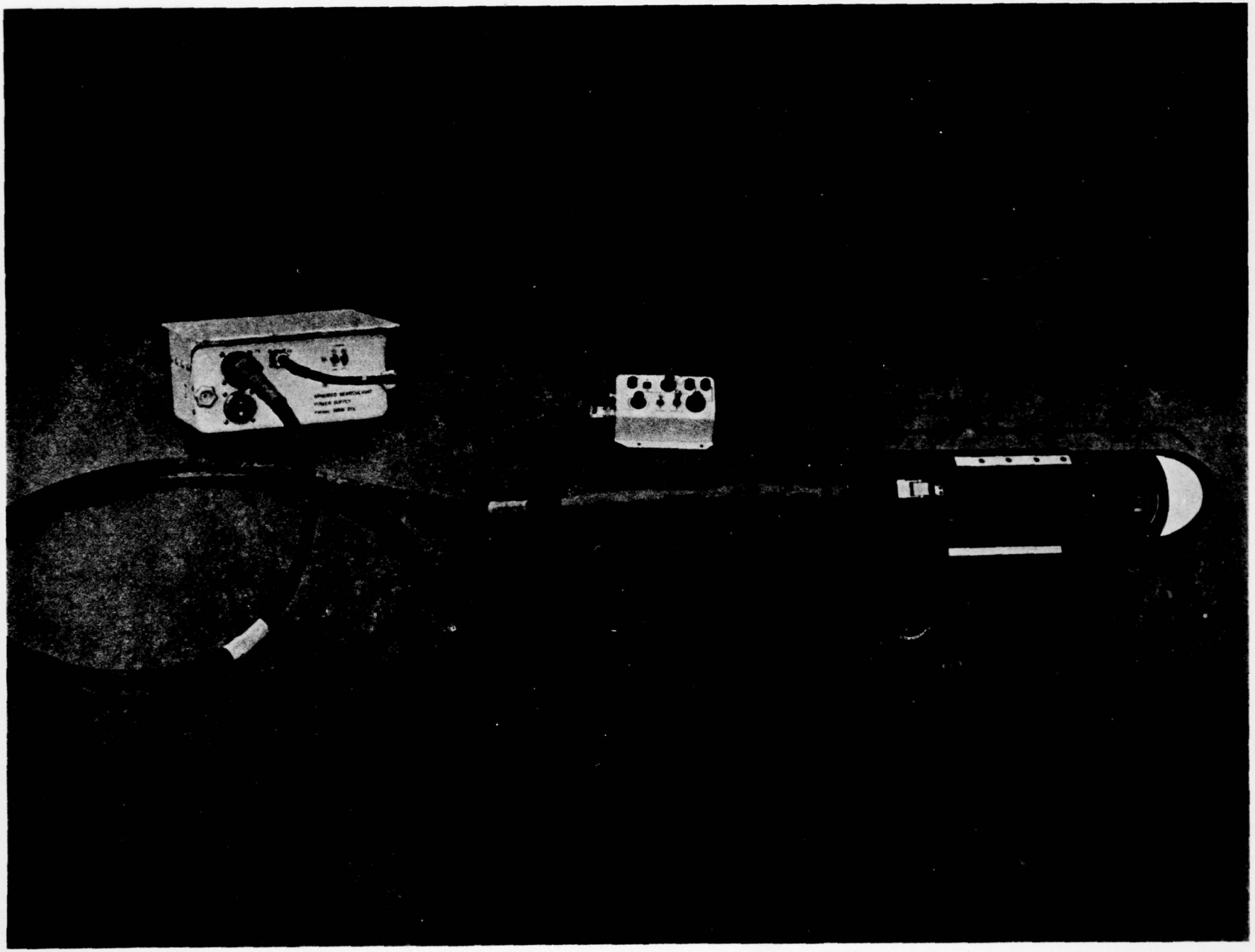
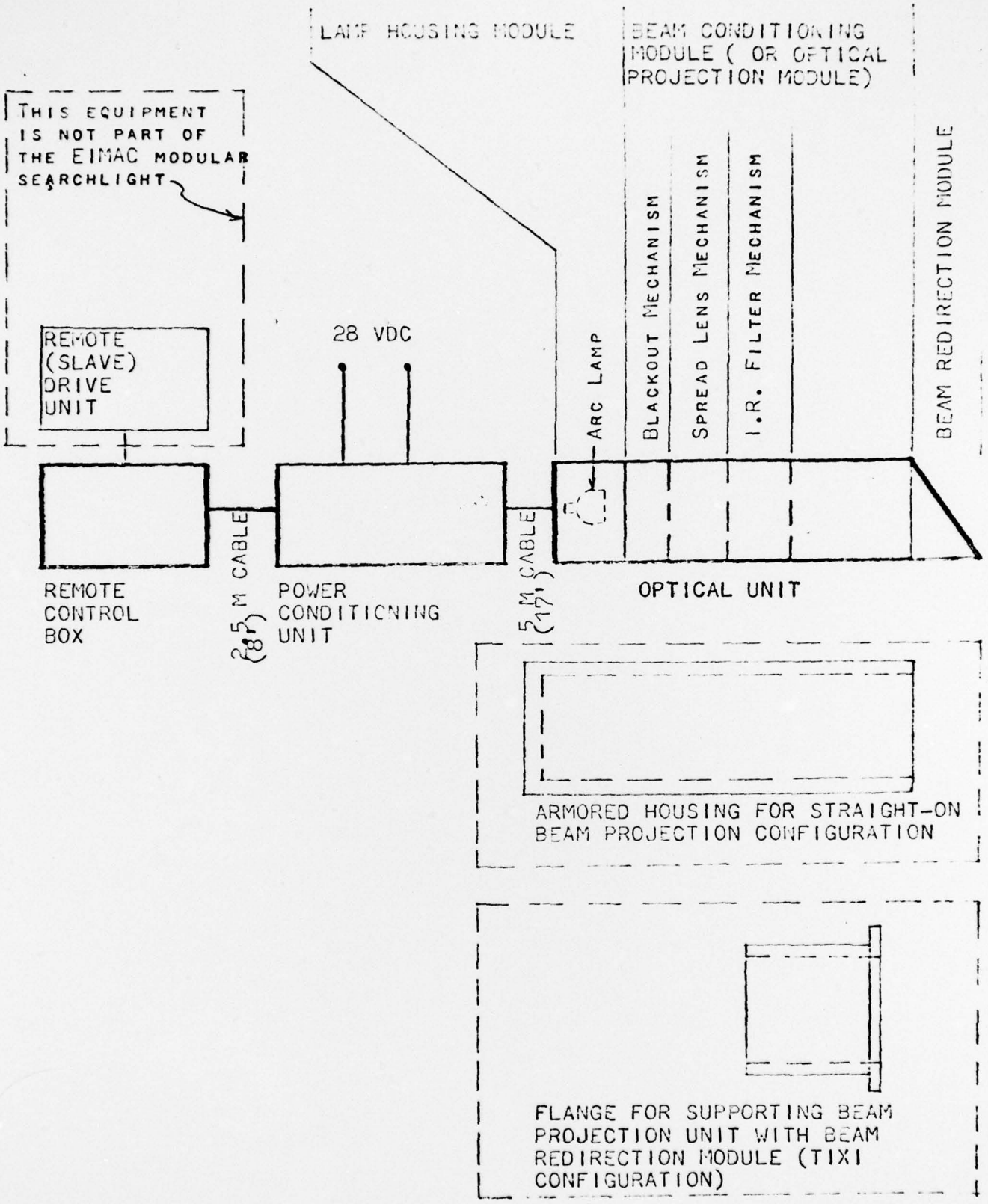


FIGURE 1: ARMORED XENON SEARCHLIGHT



BLOCK DIAGRAM OF SEARCHLIGHT

FIGURE 2

II. DESCRIPTION OF REDESIGN

3. General. The redesigned optical projection module was required to be the same as that assembled and tested for the original armored illuminator, except for three features. One was that the continuous zoom mechanism was to be replaced by a newly designed, quick acting, solenoid driven, two position drive. The second change involved installing a quick acting, infrared (I.R.) filter drive mechanism which activates a large (2-1/2") diameter filter. The increase in filter diameter allows it to be located further from the light source and, consequently, operates with less power density. The third feature was the inclusion of a stronger, more reliable blackout mechanism.

The general design for the new beam projection module also included improved heat paths for conductively cooling all operating mechanisms. All mechanisms now have solid heat paths to the air cooled blackout filter support plate, as well as to the outer shell of the optical projection module. Heat exchange fins were added to the air-cooled side of the blackout plate for increased cooling.

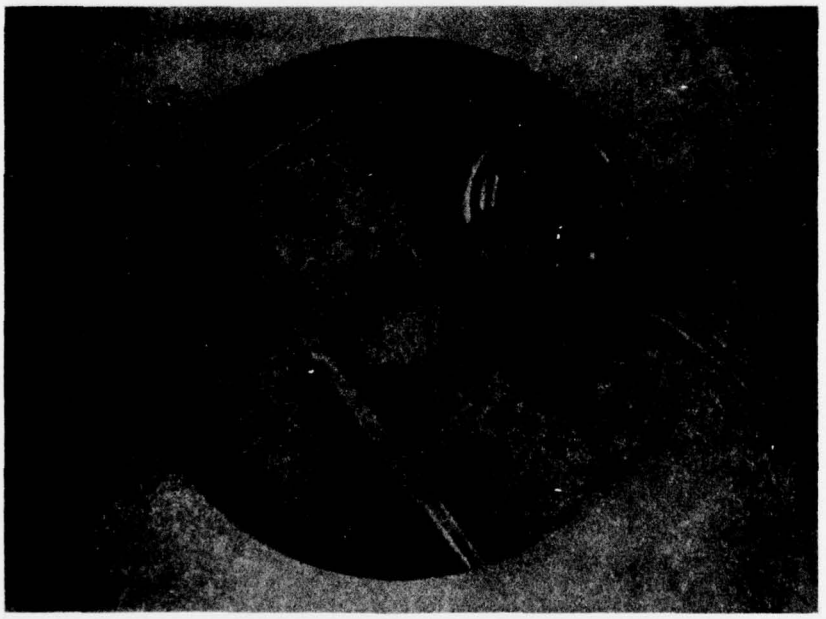
4. Blackout Mechanism. The blackout plate mechanism in the redesigned optical projection module was divorced from the I.R. filter. An evaluation model of this mechanism is shown in Figure 3. This model was used for vibration testing and does not have the heat exchange fins added for the final design.

This new blackout mechanism has only one large drive solenoid and a stiff drive arm whereas the original armored illuminator had a two solenoid drive (smaller solenoids) with a pivoted, double-acting drive linkage.

5. Beamspreading Mechanism. The armored illuminator delivered to the U.S. Army had a continuous zoom requirement wherein the searchlight's beam could be continuously spread from a 2° x 2° square to a 2° x 6° pattern. The beam spread could be held at any intermediate position. This feature required a reversible motor, limit switches and four wires. Maximum time for beam adjustment was specified at three seconds.

Army tank field personnel had expressed a desire for an instant beam spread feature. They prefer to operate in a spread beam mode for target acquisition and then immediately jump into a more intense narrow beam mode for target identification.

A) Blackout Plate In The Closed Position



B) Blackout Plate In The Open Position

BLACKOUT PLATE FOR THE EIMAC ARMORED SEARCHLIGHT

FIGURE 3

The lens designs furnished in the redesigned beam projection module are the same as those supplied in the original armored illuminator except that the spread lens material was changed from quartz to Pyrex. EIMAC replaced the continuous beam mechanism with a quick acting beam spread mechanism. It is a two position device which withdraws the spread lens from the light beam when a narrow beam is required, and inserts the lens into the light beam when a spread mode (6 degrees) is preferred (See Figure 4). The lens drive is solenoid activated. The solenoid is heat sink cooled with a continuous thermal path connected to the air cooled blackout filter support plate.

This operational mode of removing the spread lens for the 2 degree beam configuration offers the advantage of reducing the total optical transmission losses when the narrow beam is required.

A mockup of the quick acting spread lens mechanism was assembled and tested to the vibration requirements of the armored searchlight with positive results. This mockup is shown in Figure 5.

6. Infrared Filter Mechanism. The infrared light beam filter insertion requirement can now be met by EIMAC with a newly designed, quick acting assembly. A prototype of this design was assembled for vibration and high temperature testing and is shown in Figure 5.

The IR filter is supported in a filter support ring. The support ring has small ball bearings (not shown) which are mounted on steel shafts secured to the filter support ring. These ball bearings slide up the rails (Shown in Figure 5) whenever the rotary solenoid is activated.

The IR filter is shown in Figure 5 in an intermediate position; half in and half out of the light beam. In an operating searchlight, light will enter through a small aperture (not shown) on the left and exit to the right. When the solenoid is inactivated, the IR filter is retained in the covert, or IN position by a spring.

The new IR filter is approximately 2-1/2" in diameter. It has survived in the new optical projection module's internal operation environment.

Typical U.S. Army IR filter requirements are shown in Figure 6.

The contract for this program stated (Section 3.17, Infrared Filter) that:

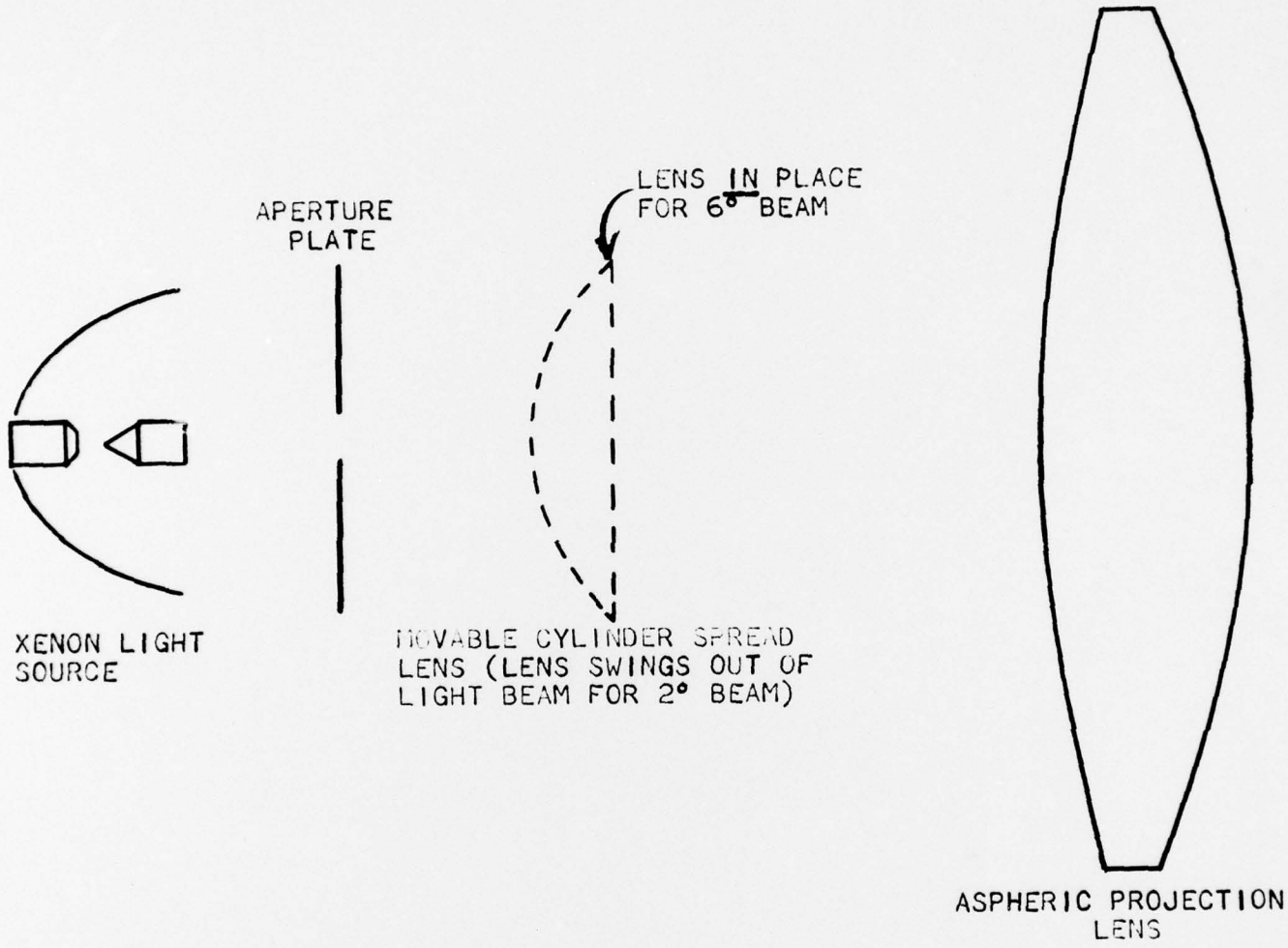
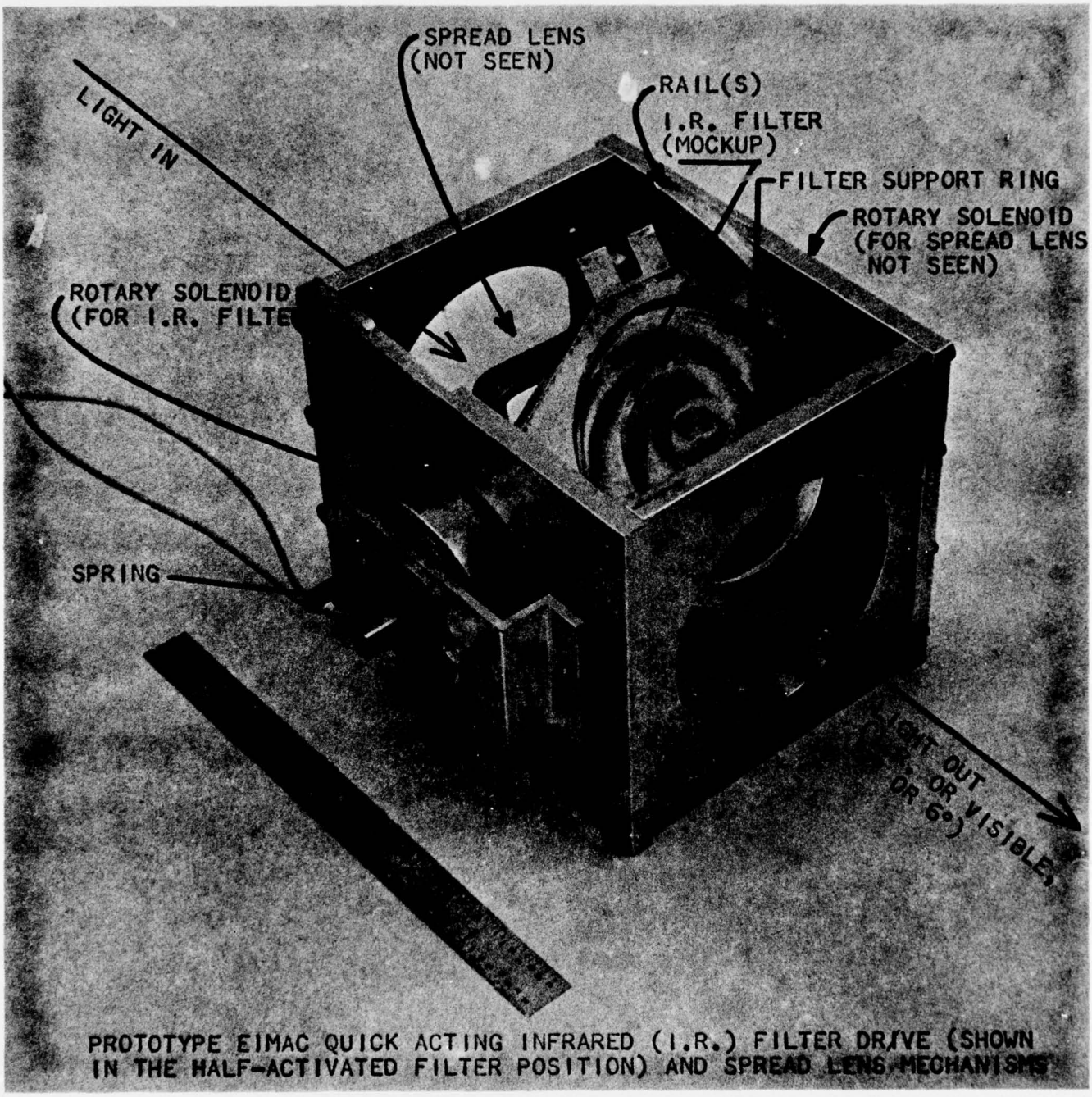


FIGURE 4: BEAMSPREADING LENS CONFIGURATION



PROTOTYPE EIMAC QUICK ACTING INFRARED (I.R.) FILTER DRIVE (SHOWN IN THE HALF-ACTIVATED FILTER POSITION) AND SPREAD LENS MECHANISMS

FIGURE 5

"The infrared filter shall have a spectral transmission characteristic equivalent to that of the AN/VSS-3A searchlight".

EIMAC obtained a sample filter from AN/VSS-3A IR filter supplier. The new beam projection module was shipped to NVL with this filter. It was apparent in the field evaluations at Fort Knox that this filter allowed too much of the visible red light to pass out of the searchlight. EIMAC then furnished NVL with two filters from other suppliers.

Figure 7 shows the new EIMAC optical (or beam) projection module partially disassembled.

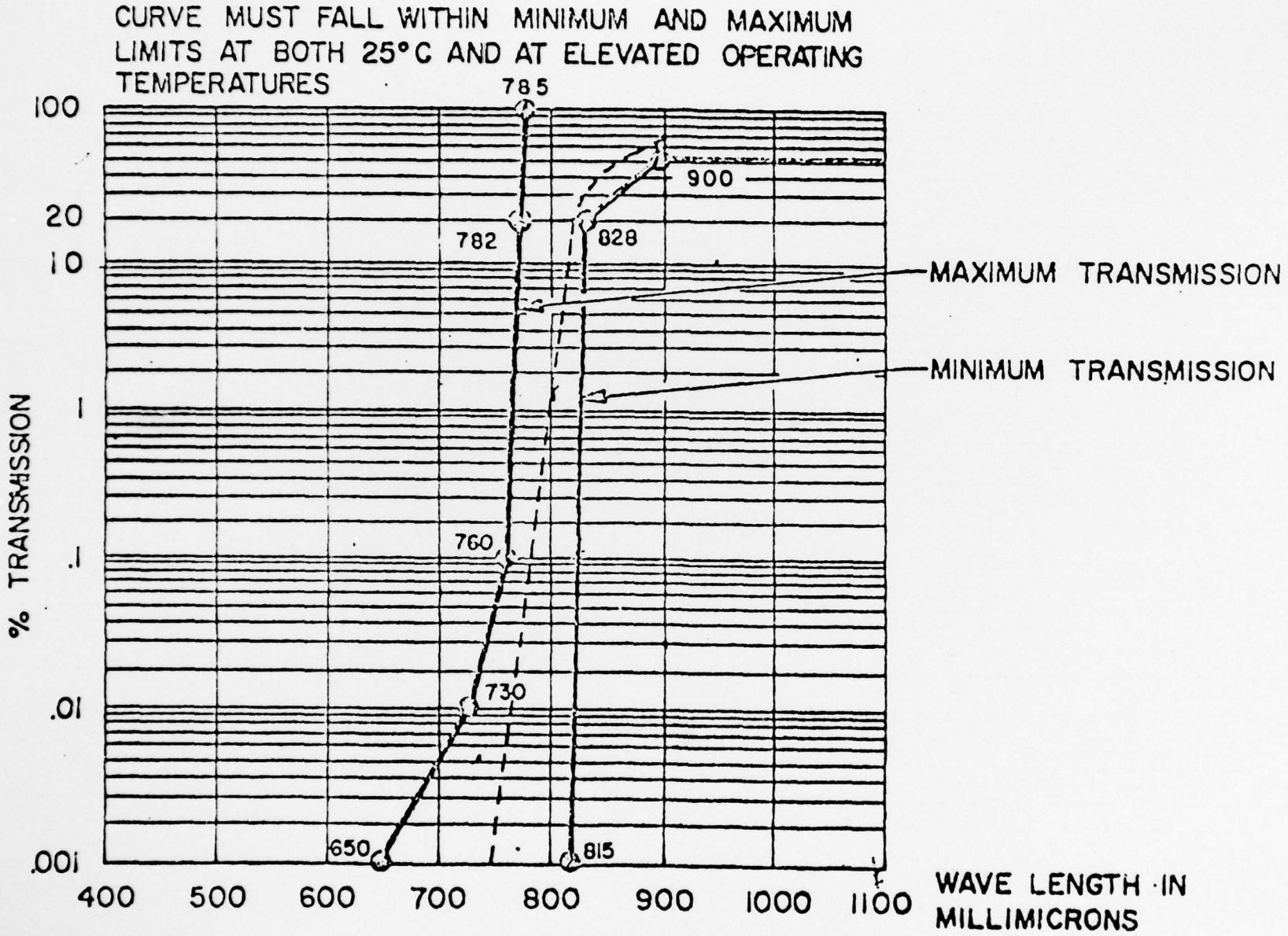


FIGURE 6 FILTER TRANSMISSION CURVE

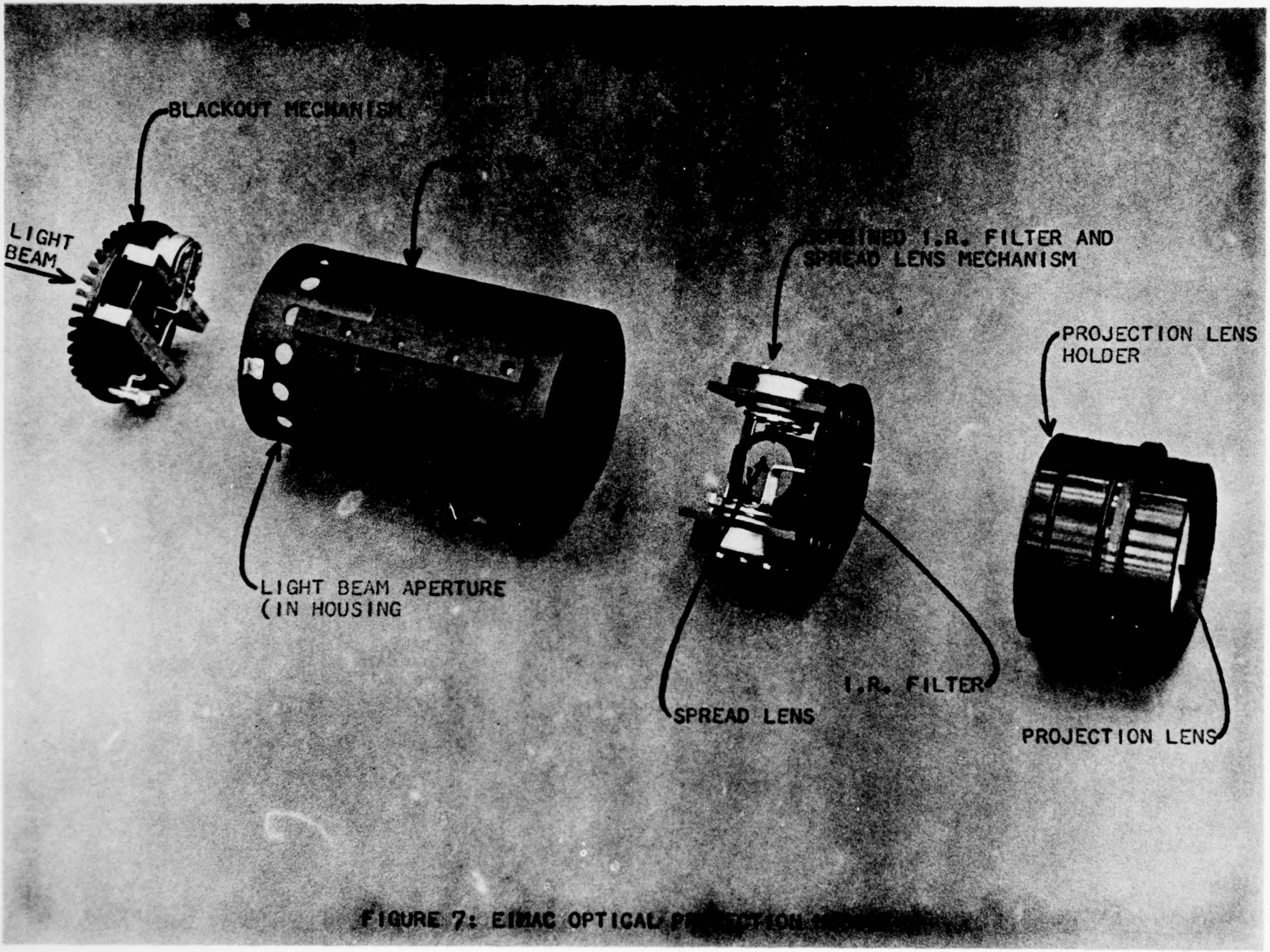


FIGURE 7: EIMAC OPTICAL PROJECTION

III. CONCLUSIONS

7. Conclusions. The EIMAC redesigned Optical Projection Module has been evaluated and found to meet all of the intended operational and performance requirements of the customer's specifications with one exception. This exception is that a slightly more covert infrared filter is needed.

The quality of this filter was not a contractual requirement. However, EIMAC intends to continue seeking sample filters for trial in the module.

IV. RECOMMENDATIONS

8. Recommendations. EIMAC recommends that no further redesign of the Optical Projection Module be made.

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