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EVALUATION OF AN EXPERIMENTAL SIGNAL LIGHT GUN

FOR LIMITED DISTRIBUTION

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INTRODUCTION

Signal light guns presently used for controlling traffic at airports are somewhat bulky and unwieldy, being approximately 9 inches in diameter, 15 inches long, and weighing 7 or 8 pounds. An experimental model of a signal light gun which is smaller and lighter than the standard light guns was submitted to the Technical Development and Evaluation Center by the Office of Federal Airways for testing and evaluation.

DESCRIPTION OF THE MODEL SIGNAL LIGHT GUN

The model light gun is illustrated in Fig. 1. The body of the light is enclosed in an aluminum tube approximately 5 inches in diameter and 16 inches long. Levers for controlling the color screen position are immediately in front of the pistol-grip handle which houses the control switches. An aircraft-type machine gun sight is used. The color of the signal being exhibited is indicated to the operator by means of a lucite rod which extends out of the body. The weight of the model light gun is 4.3 pounds.

An interior view of the model is shown in Fig. 2. The light source is a 100-watt 120-volt projector-type lamp with a miniature bayonet base. The reflector behind the lamp is approximately 1 3/4 inches in diameter. The rear and front lenses are approximately 3/4 and 3 3/4 inches in diameter respectively.

Normally the rear lens is covered by the green color screen. When the trigger is pulled toward the handle the red color screen is moved in front of the rear lens. To obtain a white beam the thumb lever is depressed, moving both color screens clear of the rear lens.

The upper control switch is normally open, and the lower one is normally closed. In the absence of any operating instructions it was assumed that the upper switch is used to obtain a steady signal and the lower switch is used to flash the signal light.

Fig. 3 shows the operator's view of the sight. The reticle of the sight is shown illuminated with the sight properly aligned on the aircraft in the background.

CALCULATIONS AND TESTS

Calculations showed that the brightness of this light should be approximately 46,000 candle power. The National Bureau of Standards' test, received later from the Office of Federal Airways, showed 51,000 candle power maximum. Both the red and green beams will have a candle power of approximately 22 per cent of the white beam, or about 11,000 candles. All subsequent calculations in this report are based on the candle power available in the colored beam.

This signal light was clearly visible at two miles in the daytime when used against a relatively dim background. When used behind a pane of glass which was in direct sunlight it was not sufficiently bright to furnish a reliable signal.

In visibility calculations it is generally accepted that a light is barely visible at night when its intensity is 0.5 mile-candle. On dull days (when the background brightness is low) that threshold value often is taken to be 500 mile-candles. On days when the background brightness is high, that threshold value may be considered to be as high as 5,000 mile-candles.

Table I gives the light intensity available from the model projector under several conditions of distance and object visibility. In the table, "Ratio of Brightness" refers to the ratio of the light intensity available from the model projector to that required for the corresponding conditions. Where this ratio equals or exceeds unity the signal light can be considered adequate. The last four rows of the table give the minimum candle power necessary for reliable signaling.

Table I

Daylight Visibility Distance (miles)	3	6	35 (exceptionally clear weather)	Unlimited (condition never attained in practice)	3
Distance of observer from signal light (miles)	3	3	3	3	2
Light available in mile-candles from model projector	22.5	142.5	600	1,100	193
Available ratio of brightness to night threshold brightness	45	285	1,320	2,200	385
Available ratio of brightness to dull day threshold brightness	0.045	0.29	1.32	2.2	0.39
Available ratio of brightness to bright day threshold brightness	0.0045	0.029	0.132	0.22	0.039
Candle power required at lamp for use on dull day with color filter	244,000	38,500	8,350	5,000	28,600
Actual candle power required at lamp before adding color filter	1,220,000	192,500	41,750	25,000	143,000
Candle power required at lamp for use on bright day with color filter	2,440,000	385,000	83,500	50,000	286,000
Actual candle power required at lamp before adding color filter	12,200,000	1,925,000	417,500	250,000	1,430,000

DISCUSSION AND RECOMMENDATIONS

From Table I it may be seen that the signal light under consideration is more than adequate for night signaling. It is not sufficiently bright for daylight signaling, however, except in clear weather and with low background brightness.

It is believed essential that signal lights should be visible at least two miles, and it is desirable that they be visible at three miles with object visibility distance as low as three miles. This would indicate that the red and green beams should be of the order of 400,000 candle power. Such brightnesses are not practical, of course, in a self-contained portable unit. Brightnesses of the order of 400,000 candle power are possible, however, with a remotely controlled projector.

The beam is not sufficiently constricted. At a distance of three miles the beam is approximately 1,100 feet wide as compared to approximately 275 feet required in the standard specifications. Reduction of the beam spread will increase the candle power of the unit if the lumen output of the lamp remains constant. In any case the beam spread of the model is too great both for accurate signaling and for obtaining maximum candle power. The National Bureau of Standards' tests show that there are four distinct beams caused by the four filament coils in the lamp. The area to be covered by the signal light as specified in Section VI D of Specification No. CAA-508a is considered entirely satisfactory.

The model light under consideration could be improved materially by certain modifications. The beam spread could be reduced by use of a lamp with a much smaller low-voltage filament. Any increase in the diameter of the opening behind the color screen would increase the brightness approximately in proportion to the increase of that area.

The arrangement of triggers is satisfactory, although it could be improved by extending the thumb lever slightly farther back and slightly higher for the convenience of operators with small hands. Another, and possibly better, trigger arrangement could be obtained by placing the color screens so that white would be obtained by moving the trigger to the extreme rear. A stop similar to the safety on a rifle could be arranged to lock out the white position except when it was required for signaling. This arrangement would eliminate need for the thumb lever.

The sighting device on the model has some advantages over present sights. One particular advantage is that it does not require the operator's eye to be at an exactly fixed point. Another advantage is that the target is easier to find. There are, however, two objections to the sight in its present form. First, the illumination required on the reticle for daylight use is much too bright for night use. This light on the sight obscures the

navigation lights on aircraft when used at night. Also, the sight is useless except when the reticle is illuminated, and the signal light must be on before it can be aimed. Both of the objections could be overcome by adding a separate source of illumination for the reticle and providing a means of adjusting the brightness of that source. A convenient means of adjusting the sight to make the line of sight parallel with the light beam is needed also.

The telltale color screen indicator is inadequate because it does not project far enough into the tubular housing. If the lucite rod were extended approximately one-fourth inch into the tube, it should be adequate. It would be desirable to offset the lucite rod slightly out of the line of sight or to shorten that portion extending out of the tube about one inch. A color screen position indicator can be added by fastening a metal rod to the arm which holds the color screen and extending the rod through the housing. The rod would be painted in red, white, and green sections to indicate the physical position of the color screens.

The model incorporates three good features, viz.:

1. The sight, if modified as recommended, should be an improvement over existing sights.
2. The trigger arrangement requires the use of one hand only.
3. This model is lighter and more compact than existing signal lights. It should be pointed out, however, that even this light can be aimed and controlled properly, only if its weight is supported by something other than the hand which manipulates the controls.

While the optical system is inherently inefficient it must be of, or similar to, its present form if the color screen and trigger arrangement are retained. There is some possibility that the brightness could be improved to meet Specification No. CAA-508a. As a result of these tests, no change is recommended in this procurement specification. The possibility of developing a better light should be investigated further. There are two possible alternatives that could be explored. One is a remote control unit with larger lights located outside the control tower and controlled from within. This would allow use of a light having approximately 2,000,000 candle power in the white beam or about 300,000 to 400,000 candle power in the colored beams. The other alternative would be to improve the existing portable type of light by improving the light source itself.

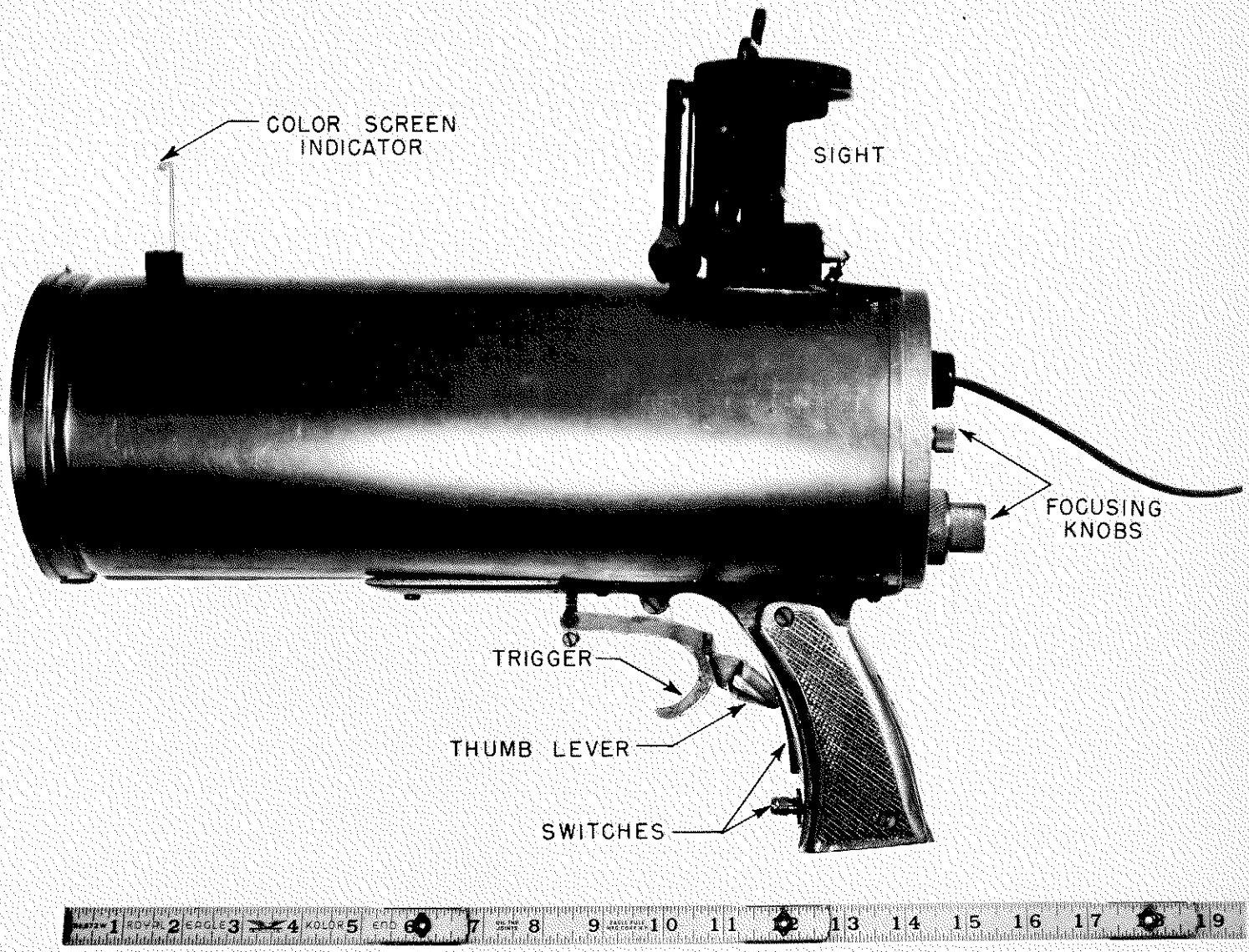

FIG. 1 MODEL SIGNAL LIGHT GUN

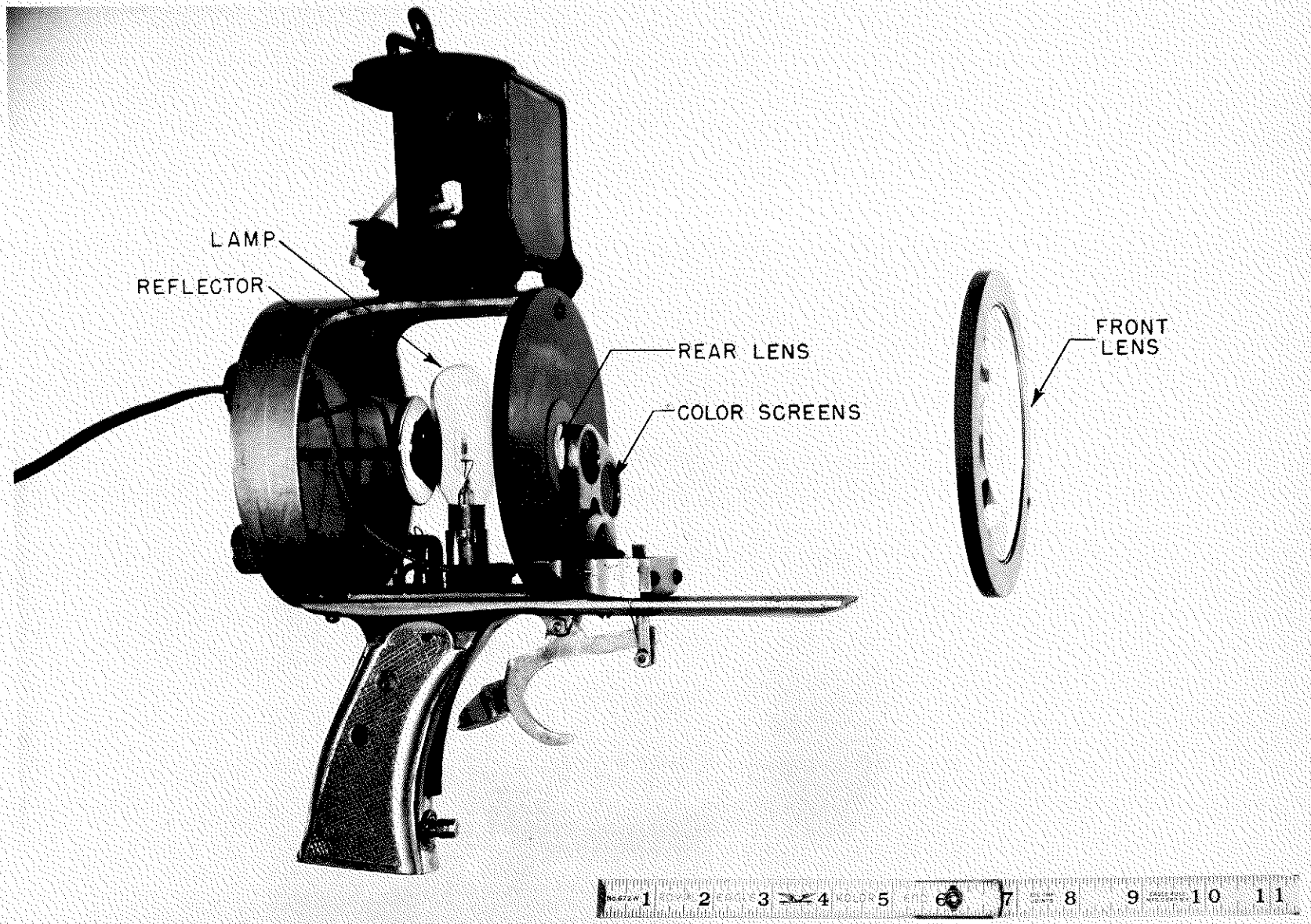

FIG. 2 MODEL SIGNAL LIGHT GUN WITH TUBE REMOVED

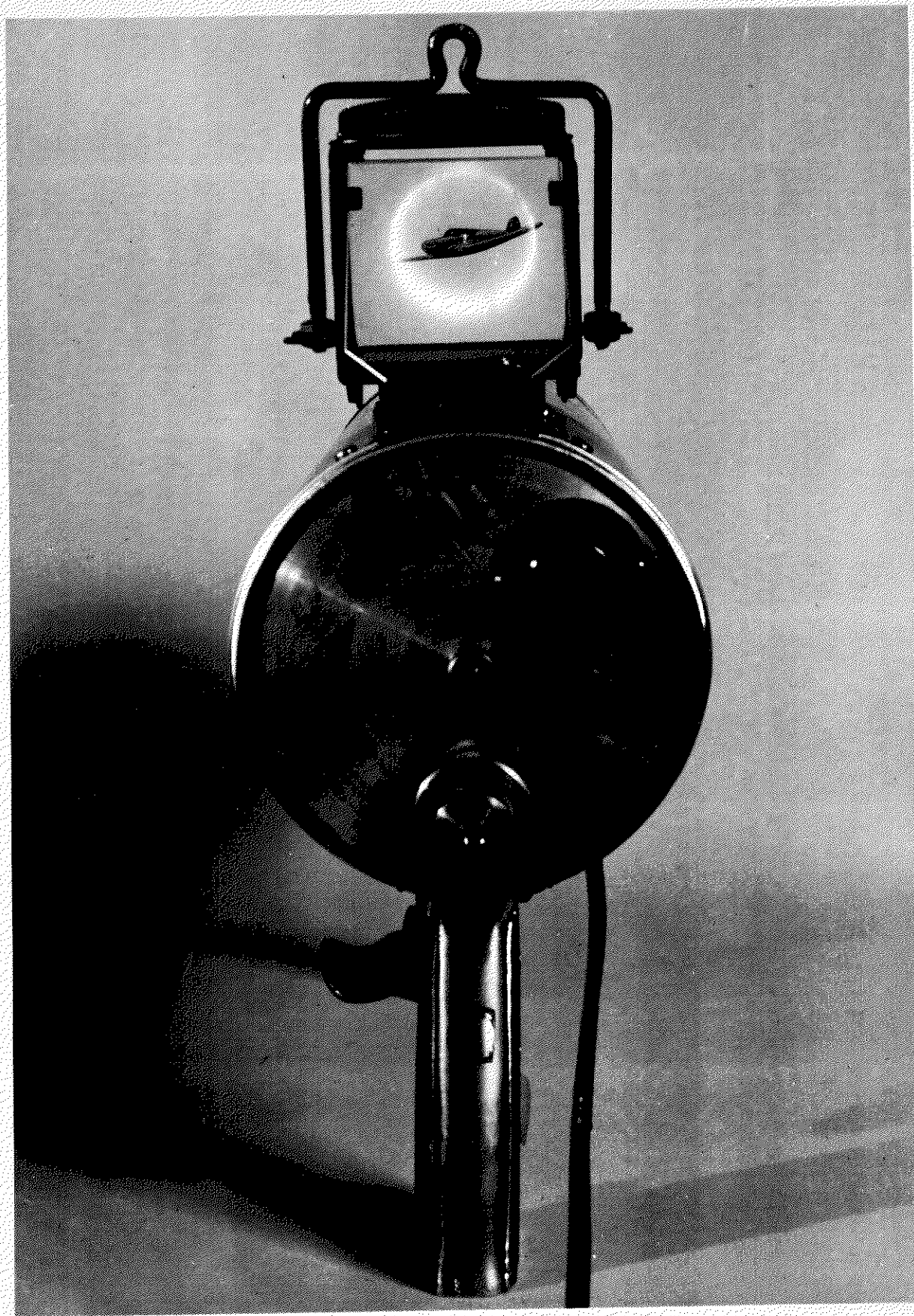

FIG. 3 OPERATORS VIEW OF SIGHT WITH RETICLE ILLUMINATED