od U113 .7 TM 1945

TM 11-2313

WAR DEPARTMENT TECHNICAL MANUAL

U.S. Dept. of Army

LIGHT METER

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Washington: 1945

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WAR DEPARTMENT

Washington 25, D. C., 9 March 1945

TM 11–2313, Light Meter, is published for the information and guidance of all concerned.

[AG 300.7 (17 Feb 45).]

BY ORDER OF THE SECRETARY OF WAR:

G. C. MARSHALL
Chief of Staff

OFFICIAL:

J. A. ULIO
Major General
The Adjutant General

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For explanation of symbols, see FM 21-6.

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DESTRUCTION NOTICE

WHY—To prevent the enemy from using or salvaging this equipment for his benefit.

WHEN—When ordered by your commander.

HOW—1. Smash—Use hand axes, hammers, heavy tools.

2. Cut—Use hand axes, machetes.

3. Burn—Use gasoline, kerosene, oil.

4. Explosives—Use firearms, grenades, TNT.

5. Disposal—Bury in slit trenches, fox holes, other holes. Throw in streams. Scatter.

USE ANYTHING IMMEDIATELY AVAILABLE FOR DESTRUCTION OF THIS EQUIPMENT

WHAT—1. Smash—Light meter completely.

2. Cut—Wires and springs.

3. Burn—Remains of light meter.

4. Bend—Multiplying plate.

5. Bury or scatter—Smashed parts.

DESTROY EVERYTHING

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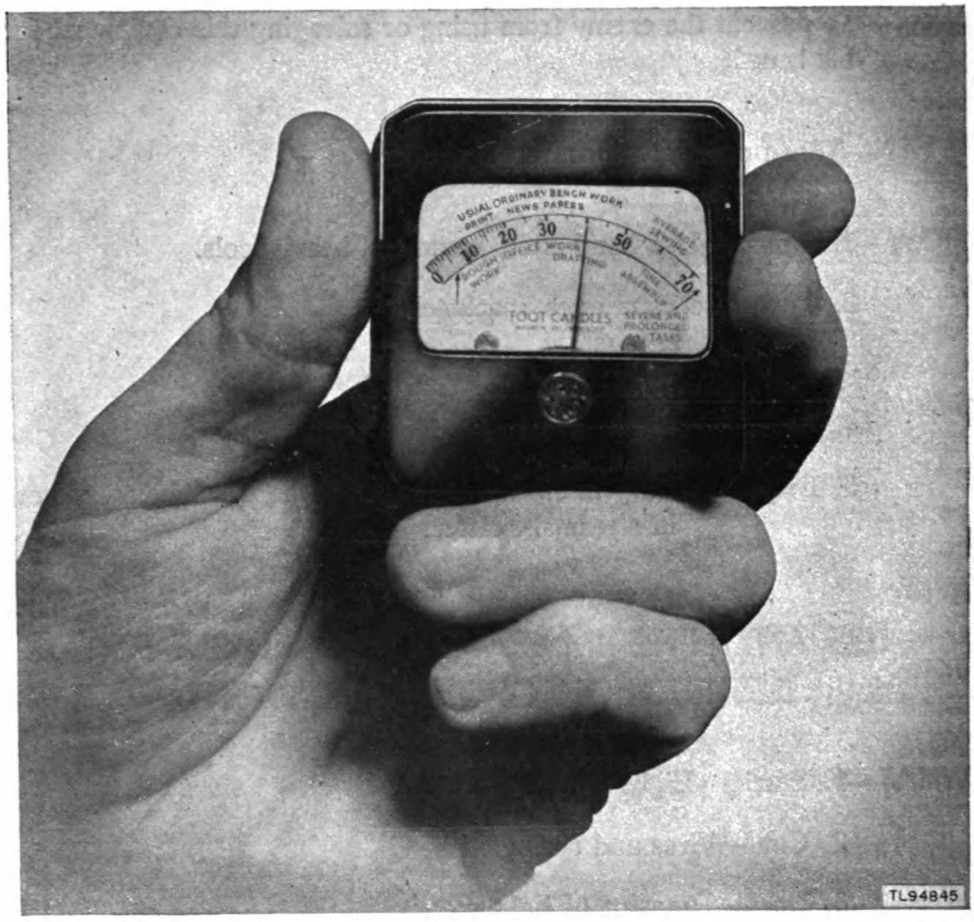


Figure 1. Light Meter (V-Mail).

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CHAPTER 1

GENERAL

Section 1. DESCRIPTION

1. General

The Light Meter (V-Mail) (fig. 1) is an instrument for measuring light in foot-candles by the use of a light-sensitive dry plate or barrier-layer cell. The cell, when struck by light rays, sets up a difference of potential and is connected directly to a microammeter. When light strikes the cell, it will actuate the microammeter needle and give readings on a scale graduated in foot-candles up to a full scale reading of 75. The meter is so designed that the face of the scale is at right angles to the recessed light-sensitive cell and, as a result, the meter may be used without the need for shading the cell. Issued with the meter is a 10-to-1 multiplying plate. When placed over the cell window, this plate permits readings up to 750 foot-candles. The light meter is a self-contained unit. The plastic housing measures 2¼ inches square by 1⅛ inches thick. The entire unit weighs 7 ounces. Light Meter (V-Mail) is the General Electric model 8DN4042.

2. Detailed Description

a. DIAL (fig. 1). The dial of the light meter is protected by glass against damage and dirt. The dial is marked at recommended light intensities for various everyday tasks such as office work, reading, drafting and similar activities. The foot-candle readings are calibrated from 0 to 75.

b. BACK (fig. 2). The back of the light meter is fitted with a zero adjusting slide lug for positioning the microammeter needle to zero. The backplate of the light meter lists the recommended light intensities for performing certain jobs and for work in various localities.

c. MULTIPLYING PLATE (fig. 3). The multiplying plate is used for readings above 75 foot-candles and is considered a part of the unit. This thin metal plate has four clamps designed to fit the beveled case of the meter. The rectangular slit through which light reaches the cell is recessed to form a light trap and to prevent extraneous light from interfering with the reading. The multiplying plate clips over the light-sensitive cell when

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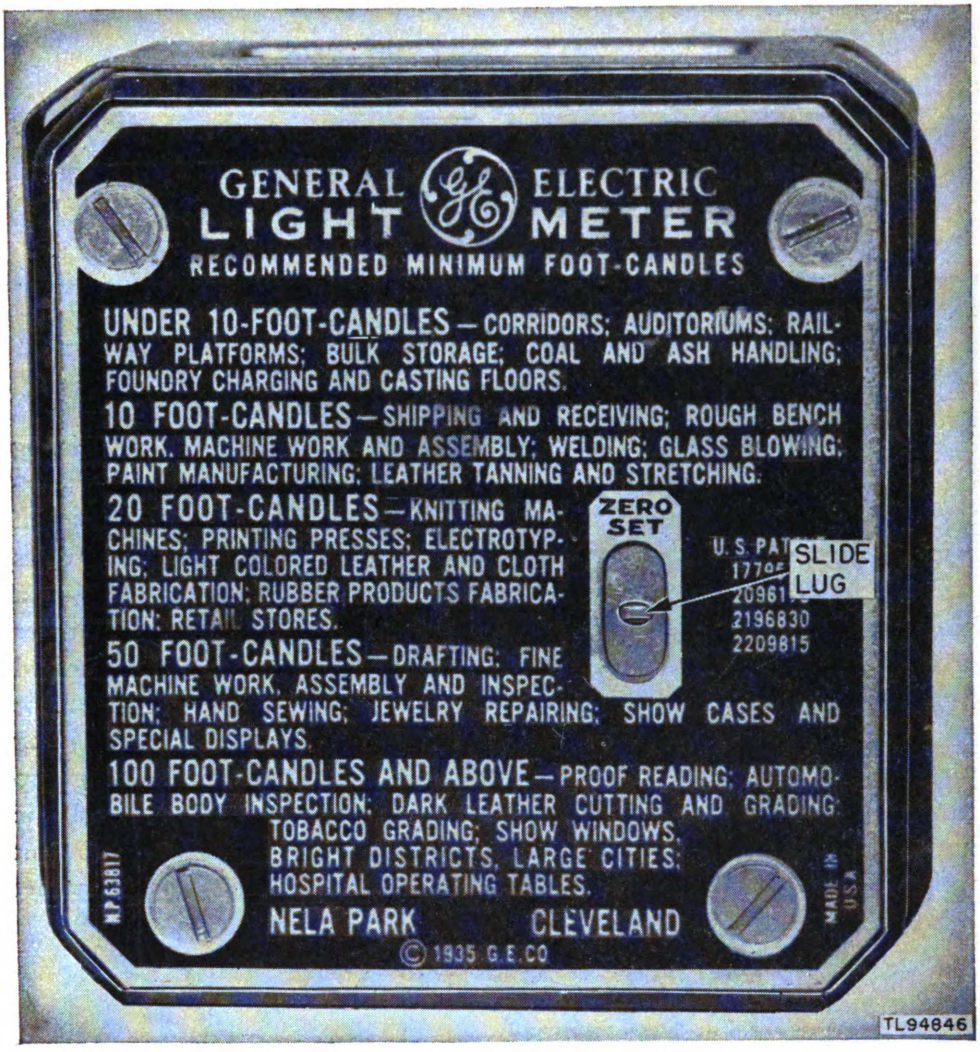


Figure 2. Backplate of light meter.

in use. By multiplying the resulting meter scale readings by 10, approximate readings up to 750 foot-candles may be taken. When not in use, the multiplying plate is clipped to the bottom of the meter.

Section II. APPLICATION

3. Varied Uses

The light meter has many uses as an illumination measuring instrument. Its use in determining the efficiency of lighting methods has resulted in more economical operation of various pieces of equipment under various operating conditions. In V-Mail operations at Photomail stations, the light meter is used in the following ways:

a. To determine the proper lamp voltage on Recorder PH-283.

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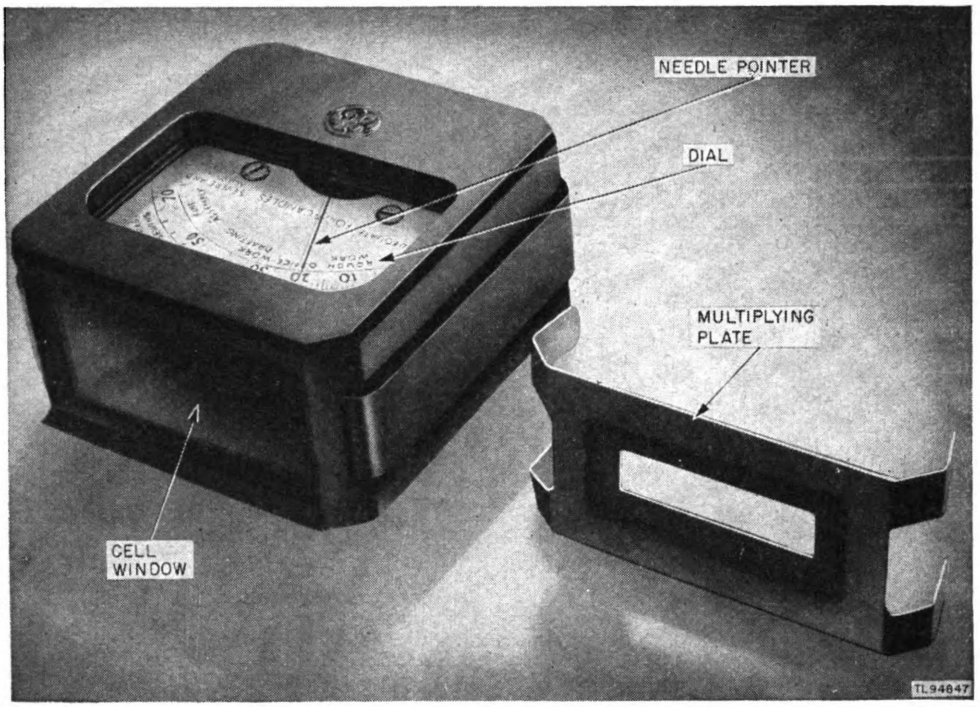


Figure 3. Light meter with multiplying plate.

b. To check the projection lamp efficiency with the voltmeter on Enlarger PH-285.

c. To match the illumination efficiency of individual lamps used in Recorder PH-283.

d. To estimate the densities of rolls of film to be printed on continuous Enlarger PH-285.

Section III. INSTALLATION AND ASSEMBLY

4. Unpacking and Checking

The light meter, when received, is packed in a small cardboard box, which should be retained at all times for storage of the meter when not in use. Check the meter for damage which may have resulted in shipping. To determine the accuracy of the readings, check the meter against another of definite known quality, or against a light source of uniform known intensity.

5 Installation

The installation of the light meter will vary, depending upon the uses to which it will be put. It may be hand-held to obtain illumination data of

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either direct or reflected light. For performing specific duties, it may be mounted in a special bracket, such as the bracket (Signal Corps stock No. 8A258) used with the Recorder PH-283 (par. 7).

Section IV. INITIAL ADJUSTMENTS

6. Preoperational Adjustments

a. ZEROING METER (fig. 2). The light meter must be checked occasionally to see that the needle is pointing to zero when no light is reaching the cell. An adjusting slide lug is built into the backplate of the case and labeled ZERO SET. To zero the meter, cover the cell window with a light-proof piece of cloth or other material to exclude all light from the cell, and move the lug either up or down until the needle points exactly to zero. To insure accurate readings, make this adjustment before each use of the instrument, with the meter in the position in which it is to be used; that is, vertical or horizontal.

b. USE OF MULTIPLYING PLATE. When the needle points to 60 foot-candles, or higher, it is advisable to install the multiplying plate over the cell window to prevent over-taxing the cell. The resulting dial readings, when the multiplying plate has been installed, must be multiplied by 10 to give the true foot-candle readings. Readings higher than 70 foot-candles will require the use of the multiplying plate.

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CHAPTER 2

OPERATING INSTRUCTIONS—STEP-BY-STEP PROCEDURE

Note. For information on destroying this equipment to prevent enemy use, see destruction notice at the front of this manual.

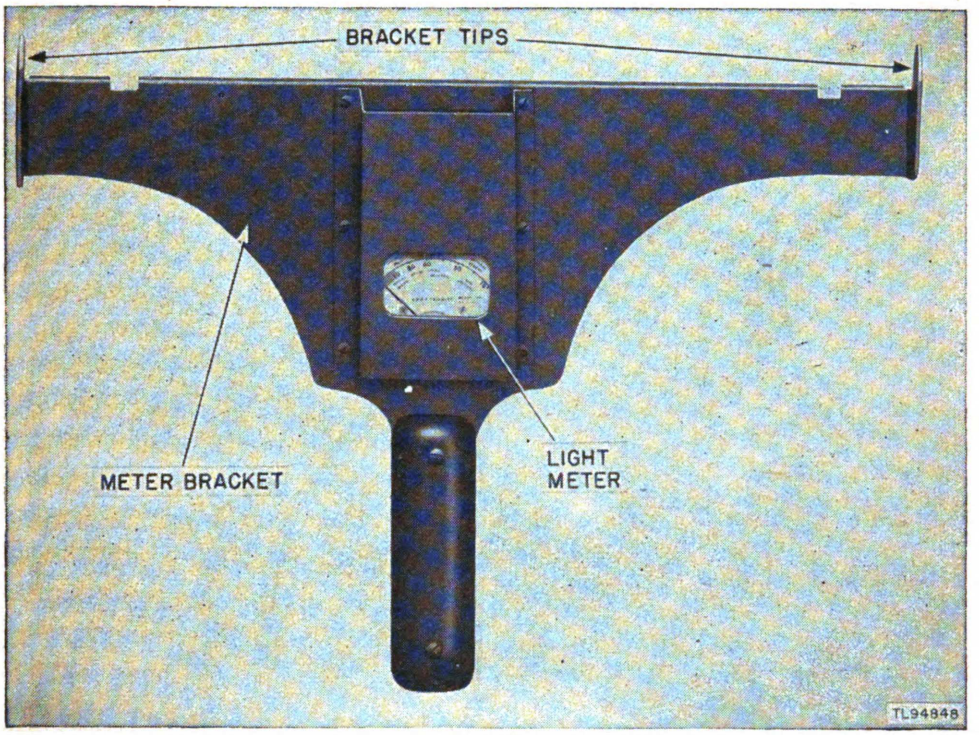


Figure 4. Light meter in recorder light testing bracket.

7. Regulating Voltage on Recorder PH-283

To adjust the lamp voltage on Recorder PH-283, follow the steps below:

a. Plug the recorder line cord into a suitable power source.

b. Press the noncrank button on the right side of the recorder, and open the rear cover.

c. While the rear cover is open, raise the front cover.

d. Turn the main switch to ON.

e. Turn the motor switch to OFF, or remove the motor line cord plug from its power receptacle.

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f. Select a clean sheet of white paper of the same tone value as the work to be photographed.

g. Feed the sheet of paper into the recorder by turning the drive wheel in a clockwise direction by hand, until the paper covers the drum area behind the glass guide.

h. Remove the multiplying plate from the light meter, and install the meter into the bracket (fig. 4).

i. Lower the meter and bracket into the front compartment of the recorder, and hook the tips of the bracket into the slots of the aperture assembly (fig. 5).

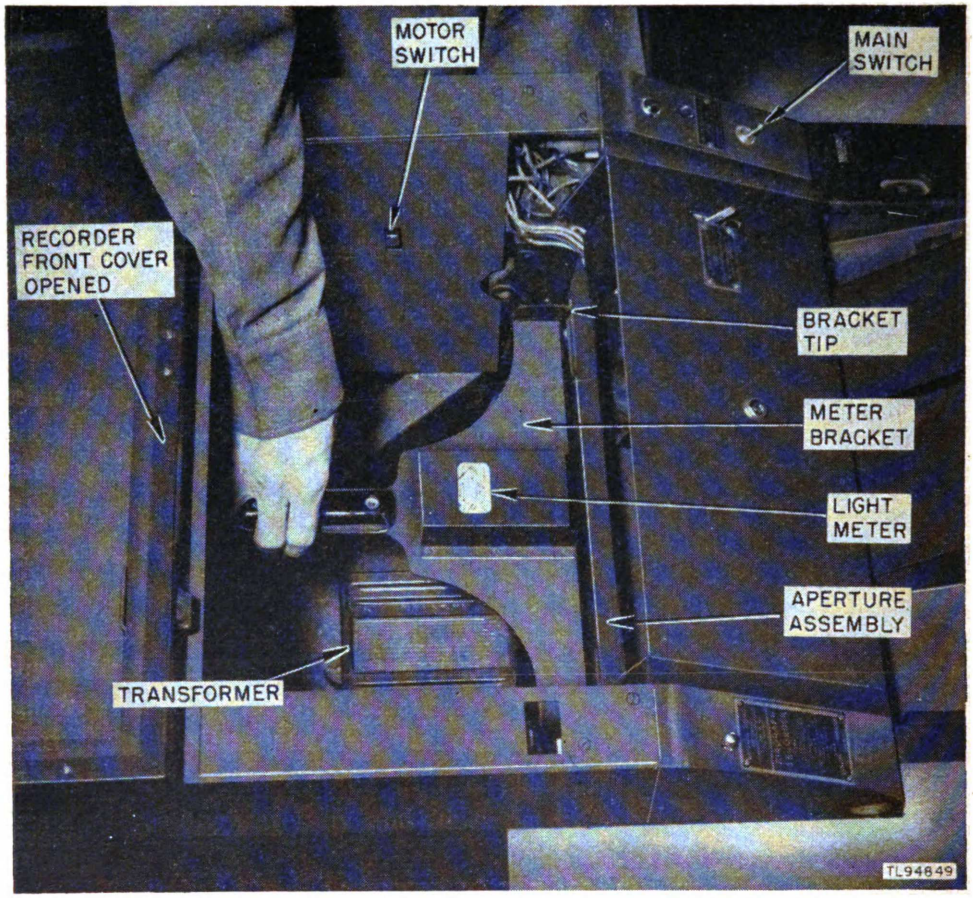


Figure 5. Meter bracket attached to Recorder PH-283.

j. With the meter bracket in place, move the bracket handle up and down until the highest meter reading is obtained.

k. With the bracket held in this position, adjust the rheostat in the back of the recorder (fig. 6) until the desired meter reading, which may vary with different recorders, is obtained.

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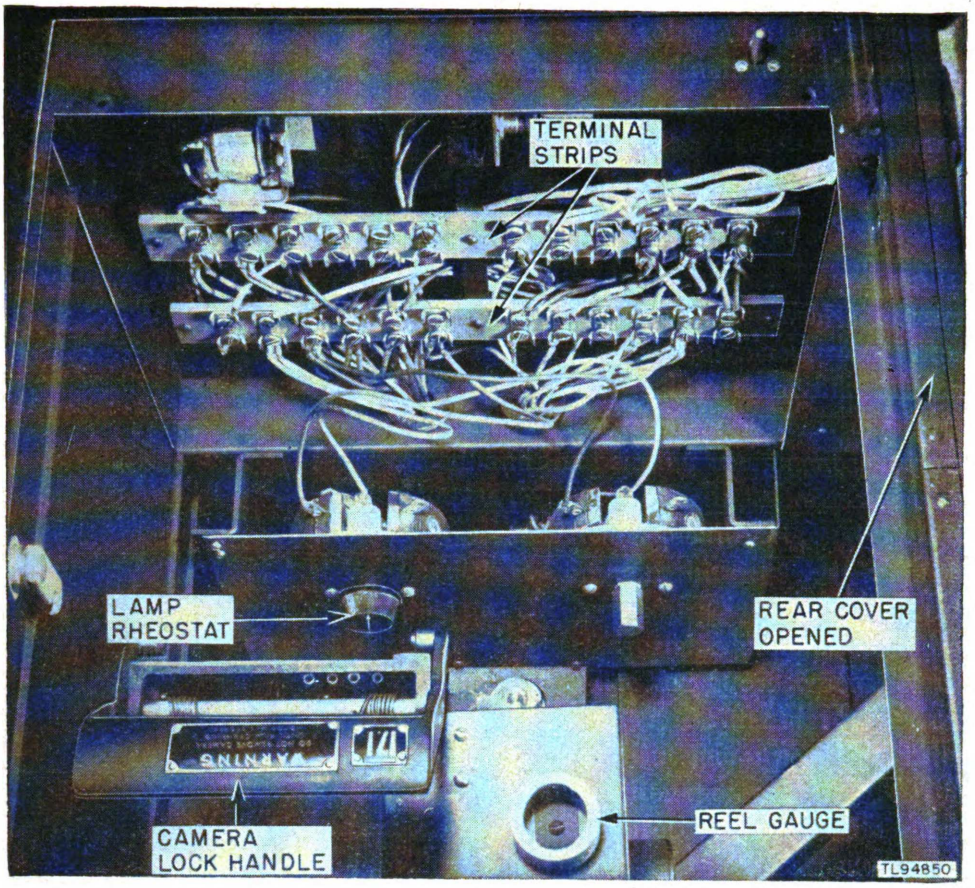


Figure 6. Location of rheostat on Recorder PH-283.

Note. The predetermined light meter reading usually is marked on a piece of adhesive tape and stuck to the recorder near the lamp failure reset switch.

l. When the rheostat is adjusted properly, remove the meter bracket from the recorder.

m. Remove the light meter from the bracket, replace the multiplying plate, and place the meter in its cardboard box.

n. Turn the recorder drive motor switch to ON, or plug the motor cord into its power receptacle, to move the sheet of paper around the drum and into the receiving hopper.

o. Turn the main switch to OFF.

p. Lower the front cover, and then the rear cover.

8. Regulating Voltage on Enlarger PH-285 (fig. 7)

The light intensity of the projection lamp of the continuous enlarger requires an occasional check to determine the proper voltage for the lamp. The voltmeter on Enlarger PH-285 is used to maintain constant illumination while the machine is in operation. If the lamp illumination efficiency

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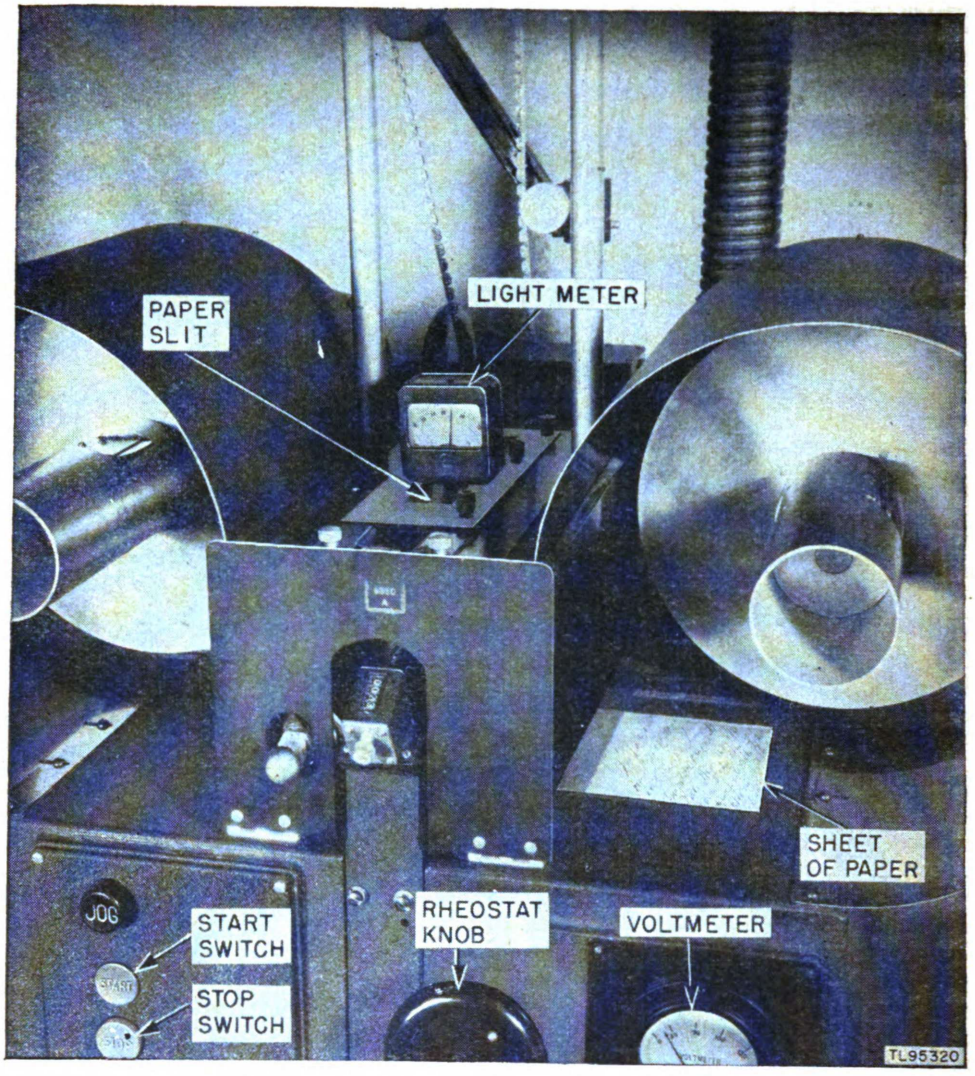


Figure 7. Adjusting running voltage on Enlarger PH-285.

becomes impaired by long usage, it then becomes necessary to establish a new running voltage to produce a beam of light of a definite intensity. To readjust the running voltage, proceed as follows:

a. Set the light meter on top of the paper slit as shown in figure 7.

b. Insert a sheet of paper between the paper idler roller and the paper signal switch actuating lever.

c. Adjust the lens aperture to the predetermined setting.

d. Push the START switch to turn on the enlarger light.

e. Turn off the room lights.

f. Adjust the rheostat until the light meter registers the desired foot-candle reading.

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g. Note the voltage setting from the voltmeter to obtain the new running voltage.

h. Push the STOP button, and remove the sheet of paper from between the paper idler roller and the paper signal switch.

i. Return the light meter to its cardboard box.

Note. Various other uses may be found for the light meter in connection with the operation of Enlarger PH-285. Meter readings may be taken of the light beam projected through the film, and average readings noted for several sections of the film. A chart may be made for the film, showing approximate light transmission, to aid in determining the voltage setting and lens setting for printing exposure. In using the light meter in this manner, it is advisable to place a sheet of transluscent glass about midway between the lens and the meter, to diffuse the light and prevent abrupt changes in the meter readings.

9. Matching Recorder Lamps

The eight exposure lamps of Recorder PH-283 must be matched carefully, to provide even illumination over the entire area of the document being recorded. When one lamp burns out on the recorder, it is necessary to replace the entire set of eight lamps to be certain the lamps are of equal brilliance. The remainder of the lamps may be used later by rigging a lampholder about 2 feet from a light meter, as shown in figure 8, and recording the light intensity from individual lamps, matching them in sets accordingly. The lampholder will require wiring to a power source. A 100- to 125-ohm, 10- to 15-watt resistor must be installed in the lamp circuit

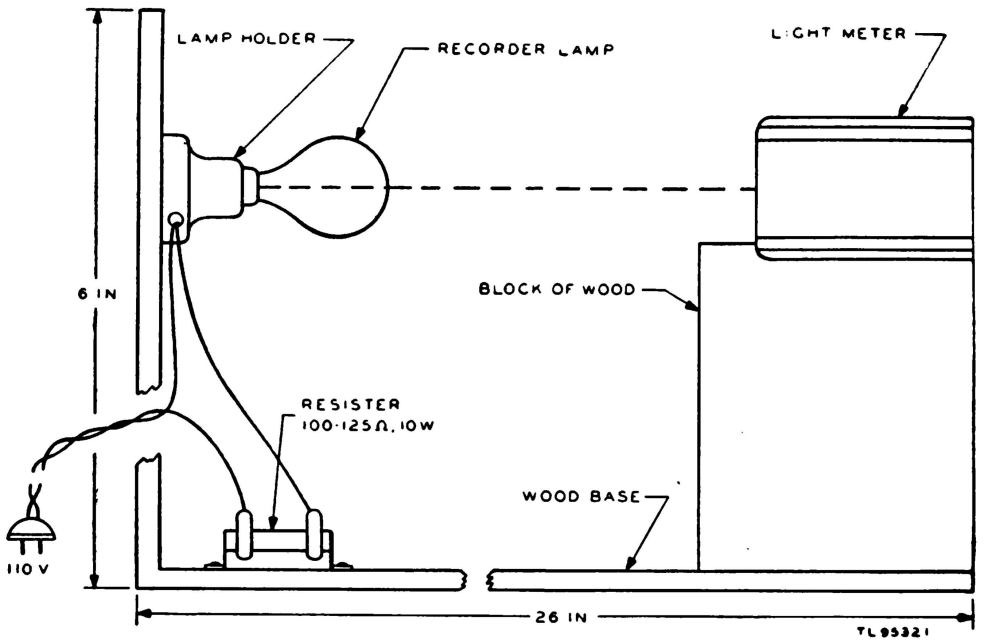


Figure 8. Diagram for testing lamps.

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since the lamps are rated at 100 volts only, and should be tested at approximately 90 volts, which is the ordinary voltage applied to the lamps in the recorder. The lamps so tested should be grouped according to their brilliancy, and sets of eight bundled together for use in the recorder.

10. Evaluating Film Densities (figs. 9 and 10)

a. GENERAL. Before successful printing can be accomplished from a roll of film, the density of the film must be known. A densitometer may be used to take density readings of several places along the roll of film to determine the light transmitting quality of the film. The information obtained from the densitometer is then applied to exposure charts which have been established, and the printing equipment is adjusted accordingly to produce satisfactory prints. A charting meter for estimating rapidly the approximate light transmitting qualities throughout a 100-foot roll of film has been designed and built in the field by personnel of Photomail units. This charting meter consists of a light-tight box which contains a lamp and rheostat to provide adjustable illumination, and a light meter over which the film is passed. The box is constructed of wood and placed between the reels of a film rewinder. As the film passes over the window of the light meter at the rate of about 1 foot per second, the beam of light passes through the film to the cell of the meter (fig. 9). The light meter reads the intensity of the light in direct proportion to the light transmitting qualities of the film. Thin negatives, having low density readings, will cause the meter to register greater light value, while dark negatives of higher density will result in lower meter readings. In this manner, a chart

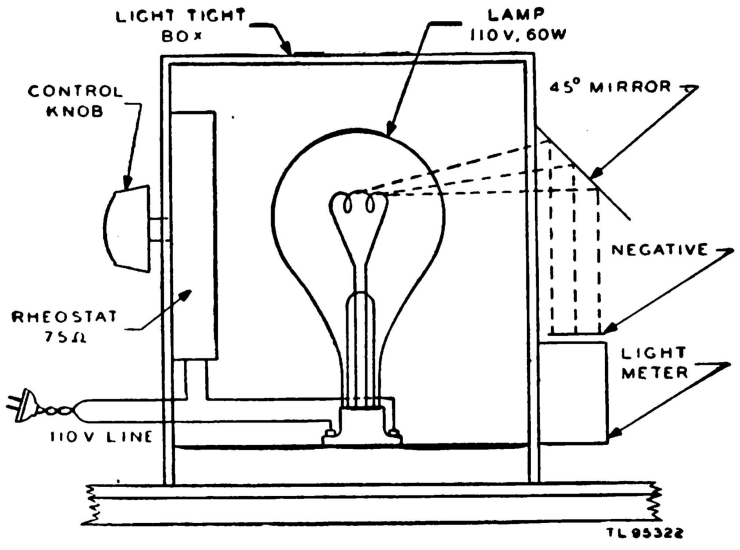


Figure 9. Charting meter lamphouse—cut-away view.

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may be made of the approximate light transmitting qualities of the negative throughout the entire roll.

Note. Two methods may be employed to adjust the light intensity of the lamp. Either a rheostat can be incorporated in the lamp circuit, or the lamp can be supported on an adjustable mount which can be moved closer to or further from the light meter.

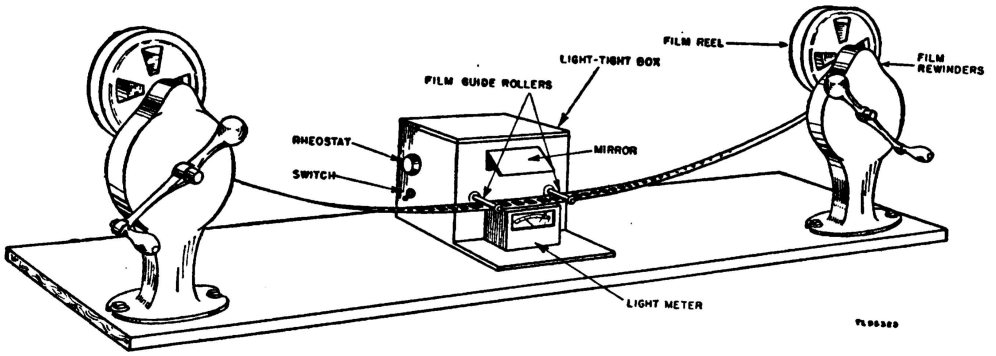


Figure 10. Film charting meter—lay-out diagram.

b. Standardizing Light Source. The light source in the charting meter must be of known intensity to provide a controlling constant in evaluating film density with the readings of the light meter. To provide a standard check on the lamp of the charting meter, the following procedure is advised:

(1) Select a short length of film with a density rating that will produce satisfactory prints. In the case of dyeback film used in V-Mail operations, a density rating of 1.15 will produce good results.

(2) Place this film on the charting meter and adjust the lamp until the light meter foot-candle readings are in the lower third of the scale, or approximately 20 foot-candles.

(3) With the lamp still on, replace the film with a selected strip, approximately 1 by 4 inches in size, of transluscent material such as empire cloth or plastic, or a piece of processed film having approximately the same optical density as the short length of film previously used.

(4) With the strip of transluscent material in place on the charting meter, note the meter reading carefully and label the transluscent strip with this reading.

Note. This transluscent strip will be the standard density strip to be used to standardize the lamp adjustment, and must be kept near the charting meter at all times.

(5) To standardize the charting meter lamp, place the transluscent strip over the cell window of the light meter and turn on the light. The lamp should be adjusted to produce a light meter reading to correspond to the value marked on the strip label.

Note. Standardizing the light source may be necessary when a new lamp is installed in the charting meter, or when adjustments have been made to the device.

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c. Operating Charting Meter. To chart a 100-foot roll of film, proceed as follows:

(1) Install the roll on one spindle of the film rewind, so that the film is pulled off the top of the reel.

(2) Standardize the lamp of the charting meter as described in paragraph 12*b*(5).

(3) Attach the end of the film to the take-up reel of the film rewind.

(4) Place the film over the light meter and between the two film guide rollers.

(5) Turn the film charting lamp on.

(6) Rewind the film from the supply to the take-up reel at a rate of approximately 1 foot per second and note the average of the light meter readings.

Note. Meter readings should be taken at several places as the film passes over the light meter. The minimum number of readings should be three, at each end and at the middle of the film. Readings at every 10 to 20 feet are desirable, however.

(7) Enter these readings on a film chart and attach the chart to the film to be sent to the printer, where the information can be used in making prints from the film.

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CHAPTER 3

PREVENTIVE MAINTENANCE

Section I. PREVENTIVE MAINTENANCE TECHNIQUES

11. Meaning of Preventive Maintenance

Preventive maintenance may be defined as a series of operations performed on equipment to minimize interruptions in service and to eliminate major break-downs. The function of trouble shooting and repair, on the other hand, is to locate and correct existing defects. This section of the manual contains specific instructions and serves as a guide for personnel assigned to perform the basic maintenance operations.

12. Preventive Maintenance for Light Meter

The most important factors in preventive maintenance for the light meter are care and cleanliness. Because it is a precision instrument, the light meter must be protected against jarring or being dropped, and extreme changes in temperature. Keep the meter in its original cardboard carton when not in use. If the light meter is left over night in the recorder meter bracket, hang the bracket carefully on its two wall hooks with the handle down, and cover the bracket with a cloth to prevent dust from settling on the meter. Observe the following precautions.

a. Use care in handling the meter at all times.

b. Protect the cell from direct sunlight and high temperatures.

c. Protect the meter from sudden, extreme changes in temperatures.

d. Check the dial needle frequently for correct zeroing.

e. Allow for cell fatigue under continued exposure.

f. Keep the multiplying plate attached to the meter case, at all times, clipped to the cell window when in use; clipped to the case bottom when not in use.

g. Store the meter in its cardboard carton when not in use.

h. Keep the meter case free from dust.

i. Do not allow the meter to come in contact with any oily substance.

Section II. LUBRICATION

13. Lubrication

No lubrication is required with the light meter, and the use of lubricants will definitely harm the meter.

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CHAPTER 4

AUXILIARY EQUIPMENT

(NOT USED)

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CHAPTER 5

REPAIR INSTRUCTIONS

Note. Failure or unsatisfactory performance of equipment used by Army Ground Forces and Army Service Forces will be reported on WD, AGO Form 468 (Unsatisfactory Equipment Report); by Army Air Forces, on Army Air Forces Form 54 (Unsatisfactory Report). If either form is not available, prepare the data according to the sample form reproduced in figure 12.

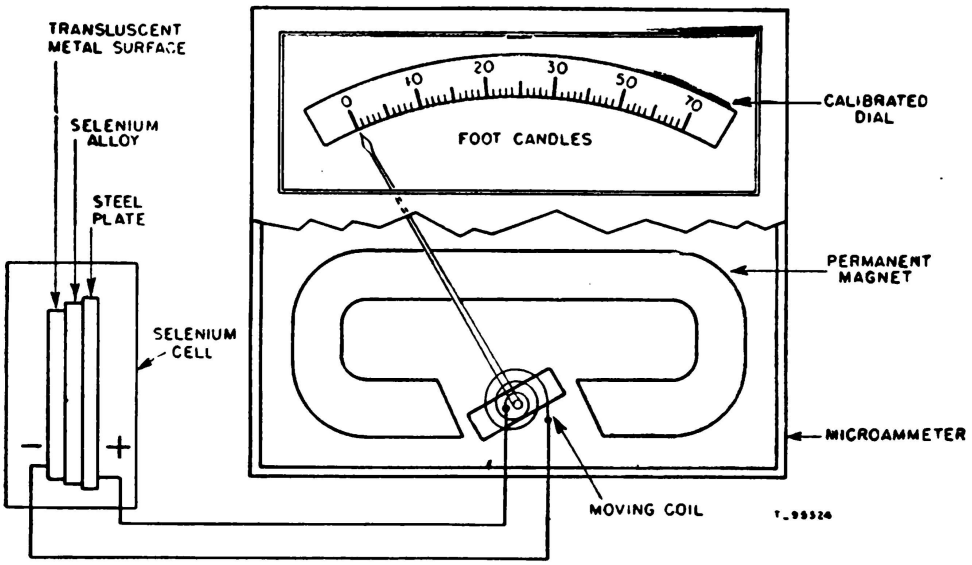


Figure 11. Light meter—wiring diagram.

14. Theory of Equipment—Electrical, Optical, and Mechanical Design (fig. 11)

a. General Design. The light meter contains two basic electrical units, the light-sensitive cell and the microammeter. The light-sensitive cell is connected in series with the microammeter.

(1) *Cell.* In general, the light-sensitive cell consists of a layer of selenium deposited on the surface of a steel plate; over this layer of selenium, transluscent layers of conducting metals are deposited. These metals make up the negative terminal of the cell, the active area of which measures 1.1 square inches. When light falls upon the cell, a photoelectric effect is produced which causes a current to flow through the microammeter connected directly to the cell.

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(2) *Microammeter.* The microammeter is so calibrated that the indication on the scale is proportional to the light flux falling on the light-sensitive cell.

b. SPECIAL CHARACTERISTICS. (1) *Cell Fatigue.* The cell in the light meter undergoes no permanent change as a result of fatigue. As in all other cells of this type, however, there is a slight change in current and in indication under continued exposure. At 60 foot-candles for 1 hour, this fatigue amounts to a decrease of about 5 percent, 3 or 4 percent of which occurs in the first 15 minutes. After a period of 1 hour, the reading is practically constant. At lower illumination levels, this effect is less pronounced. All light meters are calibrated at 20 and 60 foot-candles after exposure to 20 foot-candles of light at a color temperature of 2700° K for 15 minutes.

(2) *Calibration tolerance.* Manufacturing tolerances in cells and in instruments result in a variation in indication of ± 7.5 percent, but most meters fall within much closer limits.

(3) *Angle of incidence.* Light meters are affected by the angle at which the light strikes the cell window. As the surface of the glass is turned to a more oblique angle, more of the light is reflected from the surface and is not recorded by the instrument. It is necessary, therefore, to use the light meter whenever possible with the light beam striking the cell window at or near a perpendicular.

(4) *Temperature characteristics.* The characteristics of the cell depend largely upon temperature and the resistance in the external circuit. The resistance of the microammeter has been chosen to make as favorable a temperature characteristic as possible, which is approximately 300 ohms. With this resistance in the external circuit of the cell, the error due to temperature is very small. It will be within ± 4 percent, from 0 to 100° F. For ranges of temperature under which the light meter ordinarily will be used, the error is within 1 or 2 percent.

(5) *Spectral response.* The most important variable from a photometric standpoint is the degree of correspondence between the response of the cell and the response of the human eye to various colors. It is characteristic of all light-sensitive cells of this type that none of them follow exactly the spectral response curve of the eye. Filters may be used to correct this difference, but for ordinary purposes they are not required. The light meter responds favorably to the spectral response curve of the human eye under ordinary artificial lighting conditions.

15. Trouble Shooting

The trouble shooting required for the light meter is understandably minor. However, if the meter reading is high on the scale, this condition should

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be corrected by installing the multiplying plate. If, after prolonged usage, the meter readings tend to be low, allowance should be made for cell fatigue, as described in paragraph 14*b*(1).

16. Repair

Under no circumstances should the light meter be repaired in the field.

17. Unsatisfactory Equipment Report

a. When trouble in equipment used by Army Ground Forces or Army Service Forces occurs more often than repair personnel feel is normal,

WAR DEPARTMENT

UNSATISFACTORY EQUIPMENT REPORT

FOR (Technical service) SIGNAL CORPS — MATÉRIEL — DATE 15 JUN 1944

FROM (Organization) DETACHMENT 00, 00TH SIGNAL PHOTOMAIL CO. (Station) APO 000 NEW YORK, N.Y.

TO (Next superior headquarters) THEATRE SIGNAL OFFICER (THROUGH CHANNELS) (Station) (Technical service)

COMPLETE MAJOR ITEM

NOMENCLATURE: PRINTER PH-000 — TYPE:

MODEL: C-1 — MANUFACTURER: X Y Z CO

U. S. REG. NO: — SERIAL NO: B-219 — DATE RECEIVED: 1 JUN 1944

EQUIPMENT WITH WHICH USED (If applicable):

NOMENCLATURE OF DEFECTIVE COMPONENT

PART NO: SC STOCK NO 7A000/A0 — NAME: PLATEN SWITCH

MANUFACTURER: A B C. CORP — DATE INSTALLED: 1 JUN 1944

LENGTH OF SERVICE

DATE OF INITIAL TROUBLE: 14 JUN 1944

TOTAL TIME INSTALLED: YEARS —, MONTHS —, DAYS 15

TOTAL PERIOD OF OPERATION BEFORE FAILURE (Fill in where applicable):

YEARS	MONTHS	DAYS	HOURS	MILES	ROUNDS
—	—	—	7.5	—	—

DESCRIPTION OF TROUBLE AND PROBABLE CAUSE

GIVE TYPE OF FAILURE: MECHANICAL, ELECTRICAL, WORKMANSHIP, MATERIAL, DESIGN

ELECTRICAL CONTACTS BURNED AND PITTED, CAUSING POOR CONTACT AND ERRATIC EXPOSURE

UNUSUAL SERVICE CONDITIONS

GIVE BRIEF DESCRIPTION: PRINTER OPERATED APPROXIMATELY 4 HOURS EACH DAY AT 80 EXPOSURES PER HOUR. CONDITIONS NORMAL

TRAINING OR SKILL OF USING PERSONNEL (Check one): POOR — FAIR — GOOD ✓

DESCRIPTION OF ANY REMEDIAL ACTION TAKEN: BURNISHED THE CONTACTS AT 6-HOUR INTERVALS INSTALLED CAPACITOR ACROSS CONTACTS, 250,000 MMF.

RECOMMENDATIONS: NEW TYPE OF MATERIAL FOR CONTACTS, AND A CAPACITOR ACROSS CONTACTS

1ST IND

OFFICE — STATION — DATE

(Technical service) TO CHIEF SIGNAL OFFICER, WASHINGTON 25, D.C.

NAME — STATION — RANK

ORIGINATING OFFICER

SIGNATURE: John J. Smith

NAME: JOHN J. SMITH

RANK AND TITLE: 1ST LT SIGNAL CORPS

ORGANIZATION: DETACHMENT O. 000TH SIGNAL PHOTOMAIL CO.

INSTRUCTIONS

1 It is imperative that the Chief of Technical Service concerned be advised at the earliest practical moment of any constructional design or operational defect in material. This form is designed to facilitate such reports and to provide a uniform method of submitting the required data.

2 This form will be used for reporting manufacturing design or operational defects in material with a view to improving and correcting such defects and for use in recommending modifications of material.

3 This form will not be used for reporting failures related material defects or malfunctions of material resulting from fair wear and tear or accidental damage nor for the replacement reports or the issue of parts and equipment. It does not replace currently authorized operational or performance records.

4 Reports of malfunctions and accidents involving ammunition will continue to be submitted as directed in the manual described in AR 750-10 (Change No. 3).

5 It will not be practicable or desirable in all cases to fill all blank spaces of the report. However, the report should be as complete as possible in order to expedite necessary corrective action. Additional pertinent information not provided for in the blank spaces should be submitted as inclosures to the form. Photographs, sketches or other illustrative material are highly desirable.

6 When cases arise where it is necessary to communicate with a chief of service in order to assure safety to personnel more expeditious means of communication are authorized. This form should be used to confirm reports made by more expeditious means.

7 This form will be made out by using or service organizations and forwarded as duplicate through command channels to the chief of technical service. The office of the chief of technical service receiving the report will forward an acknowledgment copy to the Commanding General, Army Ground Forces or Army Air Forces, whichever is applicable, and to the Commanding General, Army Service Forces.

8 Necessity for using this form will be determined by the using or service troops.

W. D., A. G. O. Form No. 468, 1 December 1943

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Figure 12. Unsatisfactory Equipment Report. TL91061

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War Department Unsatisfactory Equipment Report, WD, AGO Form 468 should be filled out and forwarded through channels to the Chief Signal Officer, Washington 25, D. C.

b. When trouble in equipment used by Army Air Forces occurs more often than repair personnel feel is normal, Army Air Forces Form 54 should be filled out and forwarded through channels.

c. If either form is not available, WD, AGO Form 468 (fig. 12) may be reproduced, filled out, and forwarded through channels. When Army Air Forces Form 54 is required but unavailable, reproduce Form 468 and forward it through channels in accordance with directions on Form 468.

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APPENDIX

MAINTENANCE PARTS LIST AND REFERENCES

1. Maintenance Parts List

No maintenance parts list is applicable to this equipment.

2. References

The operator will find pertinent additional data in the publications listed below to aid in the efficient operation of this equipment.

a. TM 1-219, Basic Photography.

b. TM 11-2301, Densitometer PH-326.

c. TM 11-2351, Exposure Meters PH-77, PH-77-A, PH-77-C, and PH-252-A.

d. AR 380-5, Safeguarding Military Information.

U. S. Government Printing Office: 1945. 628023—TM26

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