TM 11-2351

WAR DEPARTMENT TECHNICAL MANUAL

EXPOSURE METERS PH-77, PH-77-A, PH-77-C, AND PH-252-A

WAR DEPARTMENT *8 JULY 1944*

WAR DEPARTMENT TECHNICAL MANUAL

TM 11-2351

EXPOSURE METERS PH-77, PH-77-A, PH-77-C, AND PH-252-A

WAR DEPARTMENT *8 JULY 1944*

WAR DEPARTMENT,
WASHINGTON 25, D. C., 8 JULY 1944.

TM 11-2351, Exposure Meters PH-77, PH-77-A, PH-77-C, and PH-252-A, is published for the information and guidance of all concerned.

[A.G. 300.7 (24 Mar '44).]

BY ORDER OF THE SECRETARY OF WAR:

G. C. MARSHALL,
Chief of Staff.

OFFICIAL:
J. A. ULIO,
Major General,
The Adjutant General.

DISTRIBUTION:

Armies (5); Corps (5); Sv C (5); Dept (5); Def Comd (2); IC 4, 8, 11, 44, (2); Tech Sv (2); Arm & Sv Boards (2); Sig C Dep (2); Sig C Rep Shop (2); Sig C Photo Labs (3); Port Photo Labs (3); Post Photo Labs (3).

IC 4 : T/O and E 4-260-1.
IC 8 : T/O and E 8-697.
IC 11: T/O and E 11-37.
IC 44: T/O and E 44-312.

For explanation of symbols, see FM 21-6.

★ ★

TECHNICAL MANUAL

EXPOSURE METERS PH–77, PH–77–A, PH–77–C, PH–77–D, PH–77–E, AND PH–252–A

CHANGES No. 1

WAR DEPARTMENT,
WASHINGTON 25, D. C., 5 December 1944.

TM 11–2351, 8 July 1944 (manual reprinted 30 September 1944), is changed as follows:

The title of this manual is changed to read: "Exposure Meters PH–77, PH–77–A, PH–77–C, **PH–77–D, PH–77–E,** and PH–252–A."

1. PURPOSE AND SCOPE

* * * * *

c. In this manual * * * PH–32–C or PH–32–F. Exposure Meter PH–252–B is Exposure Meter **PH–77–E,** with a special dial for *ciné* work. This meter is * * * discussed in TM 11–434–C.

51. GENERAL

The list of * * * meter is 8A1057C. If this meter becomes unserviceable, it may be replaced by Exposure Meter **PH–77–D,** which is discussed in chapter 5.

CHAPTER 5

EXPOSURE METER PH–77–D

SECTION I

GENERAL INFORMATION

52. PURPOSE

Exposure Meter **PH–77–D** is used primarily for determining exposure data for still photography, but may be used also for *ciné* work.

The cell component * * * as reflected light.

Figure 14—Exposure Meter **PH–77–D,** with Carrying Case PH–137.

54. GENERAL

Exposure Meter **PH–77–D** may be used in a manner similar to the methods described in chapter 1. A thorough reading * * * using any meter.

Figure 15—Exposure Meter **PH–77–D,** cover open.

58. GENERAL

a. Exposure Meter **PH–77–D** must not be subjected to any of the abuses listed in paragraphs 15 and 25. Any repair or * * * proper precision equipment.

b. Unlike the other meters described in this manual, Exposure Meter **PH–77–D** may *in an emergency,* be repaired in the field. Repairs should be * * * in paragraph 60.

Figure 16—Exposure Meter **PH–77–D,** ZERO SET on back.

Figure 17—Method of separating Exposure Meter **PH–77–D.**

Figure 18—Removal of retaining ring from Exposure Meter **PH–77–D.**

Figure 19—Removing four screws from Exposure Meter **PH–77–D.**

Figure 20—Removing ZERO SET and copper spring from Exposure Meter **PH–77–D.**

Figure 21—Removing front of Exposure Meter **PH–77–D.**

Figure 22—Photoelectric cell of Exposure Meter **PH–77–D.**

Figure 23—Replacing hairspring in Exposure Meter **PH–77–D.**

Figure 24—Removing brace plate of Exposure Meter **PH–77–D.**

Figure 25—Exposure Meter **PH–77–D,** completely disassembled.

61. PACKING INSTRUCTIONS

Exposure Meter **PH–77–D** is almost completely dustproof, moisture-proof, and noncorrosive. It can be * * * all exposure meters.

* * * * *

62. MAINTENANCE PARTS LIST FOR EXPOSURE METER PH–77–D

* * * * *

Delete item 1, column 3, paragraph 62, "METER, Exposure, PH–77–C (General Electric DW48)" and substitute the following therefor: EXPOSURE METER PH–77–D.

CHAPTER 6

EXPOSURE METER PH–77–E

SECTION I

GENERAL INFORMATION

63. PURPOSE

Exposure Meter **PH–77–E** (fig. 26) is used primarily for determining exposure data for still pictures, although it may be used for motion picture photography if the shutter speed of the motion picture camera is known.

Figure 26—Exposure Meter **PH–77–E.**

Figure 27—Calculator dial of Exposure Meter **PH–77–E.**

65. GENERAL

The method of using Exposure Meter **PH–77–E** is similar to the method described in chapter 1. A thorough reading * * * any exposure meter.

66. CAMERA-POSITION METHOD

This method, more than any other, is used with Exposure Meter **PH–77–E** because this meter has only one method of selecting the combination of shutter speeds and *f* stops to be used. Although the light * * * on the meter.

* * * * *

68. USE IN DARKROOM

Exposure Meter **PH–77–E** may be used to calculate the printing times in either contact or projection printing, if a table of times and brightness values is set up as described in paragraph 11.

69. GENERAL

Exposure Meter **PH–77–E** must not be subjected to any of the abuses described in paragraphs 15 and 25. Treat it with * * * precision instrument requires.

Figure 28—Exposure Meter **PH–77–E,** disassembled.

73. (Superseded.) MAINTENANCE PARTS LIST FOR EXPOSURE METER PH–77–E

Ref symbo	Signal Corps stock No.	Name of part and description	Quan per unit	Running spares	Orgn stock	3d ech	4th ech	5th ech	Depot stock
Fig. 28...	8A1057E/B1.....	BEZEL ASSEMBLY, dial: exp meter; glass and brass chromium pl; used as moveable seal; 2¼'' OD x 2⅛'' ID x 7/32'' d; DeJur Amsco #Z20.91; (consists of Bezel glass window and brass seals; full circumference of Bezel serrated, scale calibrated in time, 1 side 1/2000 to 60 sec and other side in film speed 0.3 to 800; p/o Sig C Exposure Meter PH–77–E).	1	..	*	..	**	..	*
Fig. 28... (1)	8A1057E/C1.....	CASE, meter: brown cowhide leather; empty; for photo cell light meter; 3⅝'' lg x 2¾'' wd x 1⅜'' thk; single compartment; DeJur Amsco #2–10.129; (snap lock; leather belt strap at back; p/o Sig C Exposure Meter PH–77–E, DeJur Amsco Model #40).	1	..	*	..	**	..	*

*Indicates stock available.
**Indicates parts may be requisitioned as needed from depot stocks.

Ref symbol	Signal Corps stock No.	Name of part and description	Quan per unit	Running spares	Orgn stock	3d ech	4th ech	5th ech	Depot stock
Fig. 28... (12)	8A1057E/C2.....	CELL, photo-electric: selenium; copper coated w/ selenium; converts light to electrical cur; 1 9/16" lg x 1 1/16" wd 1/4" thk overall; DeJur Amsco #Z20146; (p/o Sig C Exposure Meter PH-77-E DeJur Amsco Model #40).	1	..	*	..	**	..	*
Fig. 28... (5)	8A1057E/D1.....	DIAL, calibrated disk: brass; no finish indicates light values; 2 3/8" diam x 0.023" thk; DeJur Amsco #Z-6.77; (3 screw holes 1/8" diam csk, centered 7/64" from edge and 120 deg apart; p/o Sig C Exposure Meter PH-77-E, DeJur Amsco Model #40).	1	..	..	..	**	..	*
Fig. 28... (12)	8A1057EP1.....	PIN, straight: brass; to hole cell assem in place; 13/16" lg x 0.064" diam; DeJur Amsco #Z-7.49; (p/o Sig C Exposure Meter PH-77-E, DeJur Amsco Model #40).	1	..	..	..	**	..	*
Fig. 28... (3)	8A1057E/R1.....	RING, friction: phosphor bronze; used for friction against bezel; 2 3/32" OD x 1 3/4" ID x 0.0045" thk overall; DeJur Amsco #Z-6.83; (p/o Sig C Exposure Meter PH-77-E; DeJur Amsco Model #40).	1	..	*	..	**	..	*
Fig. 28... (4)	6L6348-3S.....	SCREW, machine: FH; steel, #3-48 thd, 3/16" lg.	3	..	..	..	**	..	*
Fig. 28... (7)	6L6640-3.3-1.....	SCREW, machine, Fil H; brass; 0.133" 40 thd, 3/16" lg; DeJur Amsco #Z-1.31; (u/w Sig C Exposure Meter PH-77-E, DeJur Amsco Model #40).	2	..	..	..	**	..	*
Fig. 28 .. (15)	8A1057E/S1.....	STRAP, carrying: rayon, black; 5 ft lg x 3/16" wd x 1/32" thk; DeJur Amsco #Z-10.56; (ends tipped w/ metal shoe lace tips; p/o Sig C Exposure Meter PH-77-E, DeJur Amsco Model #40).	1	..	*	..	**	..	*
Fig. 28...	6L50111-9.....	WASHER, flat: brass; 7/64" ID, 15/64" OD, 0.036" thk; DeJur Amsco #Z-5.25; (p/o Sig C Exposure Meter PH-77-E, DeJur Amsco Model #40).	2	..	..	..	**	..	*
Fig. 28... (6)	8A1057E/W1.....	WINDOW, dial: celluloid; 2 1/8" diam x 0.015" thk; DeJur Amsco #Z-10.118; (3 sq notches cut in edge 120 deg apart; p/o Sig C Exposure Meter PH-77-E, DeJur Amsco Model #40).	1	..	..	..	**	..	*

*Indicates stock available.
**Indicates parts may be requisitioned as needed from depot stocks.

83. GENERAL DESCRIPTION

a. General. Exposure Meter PH–252–A General Electric DW48 (fig. 30) is of a design similar to Exposure Meter **PH–77–D,** but the calculator dial is designed for the specific purpose of calculating exposures for motion picture cameras.

* * * * *

c. Photoelectric cell assembly. The photoelectric cell assembly is exactly the same as that in Exposure Meter **PH–77–D,** described in **paragraph 53c.**

* * * * *

84. GENERAL

The use of this meter is similar to that of Exposure Meter **PH–77–D,** except for the setting of the calculator dial.

87. TESTS

The same tests will be made as those described for Exposure Meter **PH–77–D** in paragraph 59.

88. DISASSEMBLY

The disassembly is done in exactly the same manner as the disassembly of Exposure Meter **PH–77–D** described in paragraph 60. The same restriction * * * proper precision equipment.

89. LIST OF PARTS

Rescinded.

[AG 300.7 (21 Nov 44)]

BY ORDER OF THE SECRETARY OF WAR:

G. C. MARSHALL
Chief of Staff

OFFICIAL:
J. A. ULIO
Major General
The Adjutant General

DISTRIBUTION:

AAF (5); AGF (5); ASF (5); T of Opn (5); Base C (5); Dept (5); Def C (2); AAF C (2); Arm & Sv Bd (2) except QM Bd (7); Tech Sv (2); Sv C (5); Area ASvC (2); WDGS Lib (5); PC&S (2); PE (2); Dep, 11 (2) except Holabird Dep (15); Gen Oversea SOS Dep (Sig Sec) (2); GH (2); M Conc C (2); Air Base H (2); Gen Sv Sch (5); SP Sv Sch (10) except ORD Sch (15) and QM Sch (15); USMA (2); ROTC (5); Lab, 11 (2); Sig Photo Labs, 11 (3); Port Photo Labs (3); Post Photo Labs (3); Sig AS (2); Rep Sh 11 (2); A (5); D (2); AF (2); T/O & E 4–260–1 (2); 8–697 (2); 11–37 (2); 44–312 (2)

For explanation of symbols, see FM 21–6.

U. S. GOVERNMENT PRINTING OFFICE: 1944

TECHNICAL MANUAL

EXPOSURE METERS PH–77–C, PH–77–D, PH–77–E, PH–252–A, AND PH–260

CHANGES No. 2

WAR DEPARTMENT
WASHINGTON 25, D. C., 17 July 1947

TM 11–2351, 8 July 1944, is changed as follows:

The title of the manual is changed to read: "EXPOSURE METERS PH–77–C, PH–77–D, PH–77–E, PH–252–A, **AND PH–260.**"

1. Purpose and Scope

* * * * * * *

b. The symbol (&), * * * which it appears. The nomenclature Exposure Meter PH–77–(&) **and Exposure Meter PH–260** is used solely for the *still*-type meters; the nomenclature Exposure Meter PH–252–(&) is used only for the *ciné*-type meters. Since Exposure Meter PH–77–B * * * in this manual. **Exposure Meters PH–77 and PH–77–A, which are discussed in chapters 2 and 3 of this manual, now are obsolete and chapters 2 and 3 are rescinded.**

* * * * * * *

Paragraphs 2 through 16 contain general information and instructions which apply also to Exposure Meter PH–260. To make these paragraphs applicable to Exposure Meter PH–260, make the following changes:

In the first sentence of paragraphs 2, 3*c*, 6*a*, 14 and 16, change the statement "Exposure Meter PH–77–(&) and PH–252–(&)" to read "Exposure Meters PH–77–(&), PH–252–(&), **and PH–260.**"

In the first sentence of paragraphs 7*a* and 11*a*, change the statement "Exposure Meter PH–77–(&) or PH–252–(&)" to read "Exposure Meter PH–77–(&), PH–252–(&), or **PH–260.**"

Section III. MAINTENANCE

Note. Rescinded.

15.1. Unsatisfactory Equipment Report (Added.)

a. WD AGO FORM 468 (UNSATISFACTORY EQUIPMENT REPORT) FOR EQUIPMENT USED BY ARMY GROUND FORCES AND TECHNICAL SERVICES. WD AGO Form 468 will be filled out and forwarded through channels

to the Office of the Chief Signal Officer, Washington 25, D. C., when trouble occurs more often than is normal, as determined by qualified repair personnel.

b. AAF FORM 54 (UNSATISFACTORY REPORT) FOR EQUIPMENT USED BY ARMY AIR FORCES. AAF Form 54 will be filled out and forwarded to Commanding General, Air Matériel Command, Wright Field, Dayton, Ohio, in accordance with AAF Regulation 15–54, when trouble occurs more often than is normal, as determined by qualified repair personnel.

CHAPTER 2
EXPOSURE METER PH–77

Rescinded.

CHAPTER 3
EXPOSURE METER PH–77–A

Rescinded.

CHAPTER 9 (Added)
EXPOSURE METER PH–260

Section I. GENERAL INFORMATION

90. Purpose

Exposure Meter PH–260 (fig. 31) is designed primarily for determining the correct exposure data to be used with still cameras. However, this meter may be used for motion picture photography if the shutter speeds of the motion picture camera to be used are known (see app. V).

Figure 31. (Added.) *Exposure Meter PH–260.*

91. General Description

a. GENERAL. Exposure Meter PH–260 consists of a photoelectric cell and a moving element asembly contained in a bakelite case which is 3½ inches long, 2½ inches wide, and 1¼ inches high. The photoelectric cell converts light into an electric current which energizes the moving element assembly. This assembly has a pointer which visibly indicates light-values on one of the two dials mounted on the case.

b. CALCULATOR DIALS. Two calculator dials are mounted concentrically above the mechanism assembly.

(1) The bottom calculator is fixed. On one-half of its surface there is a scale of *f*/stops, from *f*/1 to *f*/45, printed in black. The other half is provided with a light-value scale over which the pointer moves. This scale is laid out in red blocks indicating the light values. These values are not marked in figures on the dial, but range from 0 to approximately 1,250 candles per square foot.

(2) The top calculator can be rotated by means of the knurled surface of the bezel. Around approximately one-half of its surface there is printed in black figures a scale (labeled TIME) from 1/800 to 120 seconds. A scale of American Standard Association film speed numbers (labeled A. S. A. FILM SPEED) from 0.8 to 800 is printed in red figures around the remaining portion. Only the primary numbers are marked on the dial, the intermediate numbers being represented by index marks. The exact values of intermediate film speed numbers are given in appendix II.

Section II. DETAILED USE

92. General

The method of using Exposure Meter PH–260 is similar to the method described in chapter 1, which should be thoroughly read before using any exposure meter.

93. Camera-Position Method

a. Hold the meter near the camera with the photoelectric cell pointing toward the scene being photographed. The pointer will indicate the amount of light entering the meter by pointing to one of the red blocks or intermediate spaces.

b. Set the A. S. A. FILM SPEED number (of the film being used) opposite the calibration indicated by the pointer. The correct combinations of shutter speeds and *f*/stops now are lined up on the calculators.

c. Select the combination which best suits the nature of the scene being photographed. If Exposure Meter PH–260 is being used with a motion-picture camera, the shutter speed is fixed by the number of frames per second at which the camera is operated and the angle of opening of the shutter in the camera (see app. V).

94. Use in Darkroom

Exposure Meter PH–260 may be used in a darkroom to calculate printing times in either contact or projection printing if a table of times and brightness values is set up (par. 11).

Section III. MAINTENANCE

95. General

Exposure Meter PH–260 must not be subjected to any of the abuses described in paragraph 15. Never lubricate the meter. Repairs involving disassembly should be performed only by trained personnel with specialized equipment.

96. Tests and Adjustments

Note. **The following tests ascertain only the reason for the meter's failure to function properly. Do not use them as a basis for making repairs.**

a. Testing Zero Position of Indicator. (1) Hold the meter in a horizontal position with the bezel assembly facing up.

(2) Cover the glass window over the photoelectric cell with one hand. The pointer should be in the zero position. The zero position is the first red line at the left end of the light-value scale.

(3) If the pointer does not indicate the zero position, turn the zero regulating stop (located at the back of the meter) until the pointer rests at the first red line (zero position).

b. Testing for Balance. (1) Hold the meter so that the calculators are in a vertical position.

(2) Cover the glass window over the photoelectric cell with one hand.

(3) Slowly rotate the meter clockwise, and then counterclockwise. Watch the action of the pointer carefully; *the pointer should not move appreciably from the zero position.*

(4) If the pointer does move from the zero position (first red line), the readings obtained are not reliable. This condition should be corrected only by an experienced instrument mechanic since it involves disassembly of the meter so that the complete mechanism is available, as follows:

(*a*) Disassemble the meter as instructed in paragraph 97*a* through *g*.

(*b*) Readjust the tail and side (balance) weights until the pointer remains on the zero calibration (with no light striking the cell) when the meter is held in any position.

c. Testing for Irregular or Jerky Movement. (1) Point the photoelectric cell toward a source of light which is brilliant enough to cause the pointer to indicate as nearly full scale as possible. *Do not point the meter directly at the sun.*

(2) With some opaque material, gradually cover the window surface of the photoelectric cell. Observe the movement of the light-value indicator. Then reverse the procedure. The pointer should move evenly with no sticking or jerking.

(3) If the pointer moves irregularly or jerkily, the meter should be disassembled and the condition corrected by an experienced instrument mechanic, as follows:

(*a*) Disassemble the meter as instructed in paragraph 97*a* through *g*.

(*b*) Examine the mechanism assembly under a strong light. If particles of foreign matter are obstructing proper operation, remove them by blowing with a rubber syringe. *Do not breathe into the meter.* If blowing with the syringe does not remove the disturbing particle, use a small camel's-hair brush. If this does not work, carefully use a small, sharp, nonmagnetic rod.

(*c*) If no particles of foreign matter are found, the irregular movement may be caused by the pointer's being bent and rubbing on the transparent window located below the bottom calculator. Straighten the pointer and test the meter ((1) and (2) above).

(*d*) If the pointer still moves irregularly, loosen the locknut and adjust the jewel screw with a small screw driver until the proper tension is obtained; then tighten the locknut.

97. Disassembly (fig. 32)

Note. All disassembly and reassembly must be performed in a room as nearly dust-free as possible.

a. Remove the meter from the carrying case and place the meter on a flat surface with the calculators facing up.

b. Remove the bezel assembly by inserting a screw driver between the bottom edge of the bezel and the bakelite case. Carefully twist the screw driver, being particularly careful not to bend or distort the bezel. (It may be necessary to pry on both sides of the bezel to remove it.)

c. Lift the bezel assembly from the case. Do not disassemble the bezel assembly any further.

Figure 32. (Added.) *Exposure Meter PH–260, disassembled.*

d. Remove the friction ring which prevents the bezel assembly from turning too easily.

e. Remove the three flathead screws and lift off the bottom calculator plate.

f. Remove the transparent window which is just beneath the bottom calculator.

g. If further disassembly is necessary, loosen the two screws and lockwashers holding the blank scale plate, and carefully slip it from beneath the pointer. The complete mechanism assembly now is visible and may be inspected and cleaned without removal from the case.

h. If it is necessary to remove the mechanism assembly from the case, remove the magnet mounting plate screws and lockwashers. Be careful of the soldered terminal that is located under the right screw. The entire mechanism assembly now may be lifted out of the case *but cannot be completely removed since it still has a wire connected to it.* Do not disconnect the wire unless it is necessary completely to remove the mechanism assembly from the case (*k* below).

i. When the mechanism assembly is lifted from the case, the crank and zero-regulating stud and tension spring remain within the case as fixed components. This crank, by controlling the tension of the hairspring, controls the zero setting of the pointer. In addition to the crank, stud, and spring, a brass holding pin remains within the case. This pin holds the cell assembly in place. It must not be removed unless the cell assembly is to be removed (*l* below).

j. Examine for corrosion or oxidation. Examine the instrument for general cleanliness.

k. To remove the mechanism assembly from the bakelite case, unsolder the connection of the blue coded wire to the moving element assembly.

l. To remove only the cell assembly, unsolder the blue coded contact at the moving element assembly, and also the bare wire from the lug which normally is underneath the right-hand magnet-mounting plate screw. After unsoldering these two contacts, the holding pin must be removed. Force the cell assembly out of the case by pressing on the cell assembly band.

98. Reassembly

Complete reassembly of the meter is done by reversing the procedure for disassembly (par. 97). Use rosin-core solder for resoldering the electrical connections. *Do not use acid-core solder under any circumstances.*

Section IV. LIST OF PARTS

99. Maintenance Parts for Exposure Meter PH–260

The following information was compiled on 10 October 1946. The appropriate pamphlet of the War Department Supply Catalog for Exposure Meter PH–260 is:

Organizational and Higher Echelon Spare Parts
SIG 7 & 8–PH–260 (when published)

For an index of available catalog pamphlets, see the latest issue of War Department Supply Catalog SIG 1 & 2.

[AG 300.7 (21 Oct 46)]

BY ORDER OF THE SECRETARY OF WAR:

OFFICIAL:
EDWARD F. WITSELL
Major General
The Adjutant General

DWIGHT D. EISENHOWER
Chief of Staff

DISTRIBUTION:

AAF (10); AGF (5); T (5); Dept (2); Base Comd (2); AAF Maj Comd (15); Arm & Sv Bd (2); Tech Sv (2); Class III Instls (3); Stg A (1); Dep 11 (2); GH (1); Sch (1) except 11 (10); Lab 11 (2); Two (2) copies to the following T/O–E, 3–500, (FB), (FC); 8–500, (KA); 9–500, (EE); 11–37; 11–107; 11–127; 11–500, (FA), (FC), (FF), (FH), (FL), (FM); 11–587; 11–597.

For explanation of distribution formula, see TM 38–405.

U. S. GOVERNMENT PRINTING OFFICE: 1947

TABLE OF CONTENTS

LIST OF ILLUSTRATIONS

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 sledges, axes, handaxes, hammers, crowbars, or heel of heavy shoe.
2. Burn—Use gasoline, kerosene, oil, flame throwers, incendiary grenades, etc.
3. Explosives—Use firearms, grenades, etc.
4. Disposal—Bury in slit trenches, foxholes, other holes. Throw in streams. Scatter.

USE ANYTHING IMMEDIATELY AVAILABLE FOR DESTRUCTION OF THIS EQUIPMENT

WHAT—1. Smash—The entire meter, particularly all glass, and the photoelectric cell mechanism.
2. Burn—All parts that are inflammable.
3. Bury—Any or all of the above pieces after breaking.

DESTROY EVERYTHING

CHAPTER 1

GENERAL INFORMATION AND INSTRUCTIONS

Section I. CHARACTERISTICS AND DESCRIPTION

1. PURPOSE AND SCOPE.—a. The purpose of this manual is to present a complete description of the characteristics, use, maintenance, and parts of the exposure meters described herein. Chapter 1 contains general information and instructions concerning all types of meters discussed; each succeeding chapter deals with one particular type of meter.

b. The symbol (&), when used in this manual, refers to all models of items of equipment with which it appears. The nomenclature Exposure Meter PH-77-(&) is used solely for the *still*-type meters; the nomenclature Exposure Meter PH-252-(&) is used only for the *ciné*-type meters. Since Exposure Meter PH-77-B (the original designation assigned to a *ciné* meter) is no longer issued and is now superseded by Exposure Meter PH-252, it is not discussed in this manual.

c. In this manual, the single designation Exposure Meter PH-252-A is used in referring to each *ciné*-type meter, since letter designations of Exposure Meter PH-252-(&) are usually governed by the letter designation of the particular Spotting Set PH-32-(&) with which the meter is issued. Thus, the same meter will be given different letter designations because of its use with different models of the spotting set. For example, Spotting Set PH-32-A will include two Exposure Meters PH-252-A, and Spotting Set PH-32-B will include two Exposure Meters PH-252-B. There are some exceptions to this; for example, Exposure Meter PH-252-B is issued with Spotting Set PH-32-C or PH-32-F. Exposure Meter PH-252-B is Exposure Meter PH-77-C DeJur Amsco Critic, with a special dial for *ciné* work. This meter is issued only as a part of the spotting set. Exposure Meter PH-252-B is discussed in TM 11-434-C.

2. GENERAL—Exposure Meters PH-77-(&) and PH-252-(&) are designed to indicate accurately the light value or brightness value of any scene or object. These meters also provide a means for converting the light-value information into proper combinations of lens aperture and shutter speed, or, in the case of motion picture cameras, into lens aperture for a prescribed number of frames per second. A photographer, or his assistant, operates the meter, which can be attached to the user's belt by means of a strap in the carrying case, or can be carried around the neck by means of a neck cord.

3. DETERMINING LIGHT VALUE.—a. A glass-covered photoelectric cell is built into the meter. This cell is commonly called an *electric eye* and is used to convert the light striking it into an electrical current. This current operates the light-value indicator (fig. 1). An arbitrary system of

calibration for light value is used on some meters, while a calibration in foot-candles is used on others.

b. The light value indicated on the meter may be the measurement of the light reflected either from the object being photographed, or from a substitute object.

c. Exposure Meters PH-77-(&) and PH-252-(&) may be used to measure the actual light intensity when desired; for example, the measurement of the light passing through a negative, when such information is to be used in computing data for the operation of the contact or projection printer.

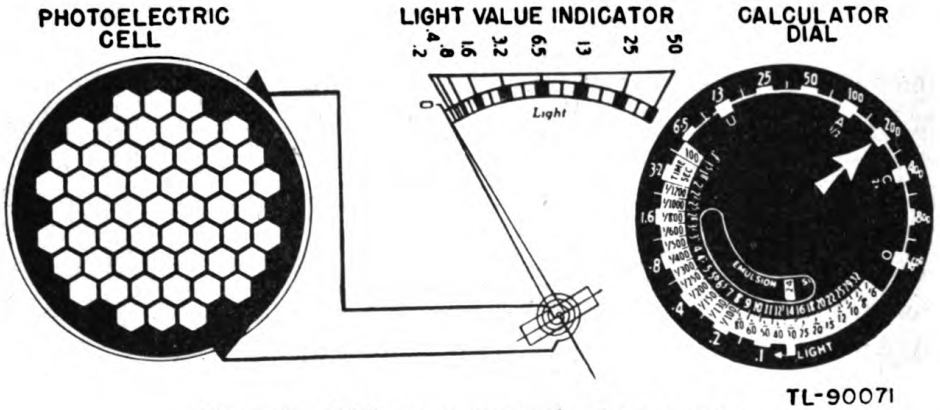


Figure 1.—Main components of exposure meter.

4. CALCULATING APERTURE AND SHUTTER DATA.—a. A circular dial with a smaller dial set concentrically is used to compute the correct lens aperture and shutter speed for a given set of conditions. These dials act as a slide rule for rapid computations (fig. 1).

b. Before measuring the light reflected from the subject, set, on the calculator dial, the emulsion-speed rating of the film being used; to obtain the proper rating, consult the emulsion-speed tables in appendix I. This setting, which is made differently on each of the meters, is discussed in detail in later chapters.

c. Measure the reflected light and set the value on the calculator dial. This setting also differs with the individual meters.

d. The various correct combinations of lens apertures and shutter speeds can now be read directly, and the proper one chosen according to the effect desired.

5. THEORY OF EXPOSURE.—The following brief explanation or the theory of exposure will help in understanding the functioning of the exposure meter.

a. Principles of exposure.—The brightness of an object of the light reflected *from* it, not the intensity of light falling *upon* it, determines exposure. The amount of light and the length of time the film is exposed

to it are the factors which, when properly controlled, bring about the desired effect upon the photographic emulsion.

b. Plotting exposure.—When light falls upon an emulsion, the light-sensitive silver salts are acted upon and will be reduced, when developed, to metallic silver. The amount of reduction, or the density of the film, is a product of the exposure and the time and temperature of development. Plotting the value of density of the film for a given development against the logarithms of the exposure produces a characteristic curve known as the H&D curve (fig. 2). Such a curve is produced by plotting the results of standard films. The lower end of the curve below the point D is the region of underexposure. The center portion from D to B is the region of correct exposure. The upper portion which extends beyond the point B is the region of overexposure. These regions of overexposure and underexposure are frequently used since the shadows or highlights of a scene may well extend into these areas.

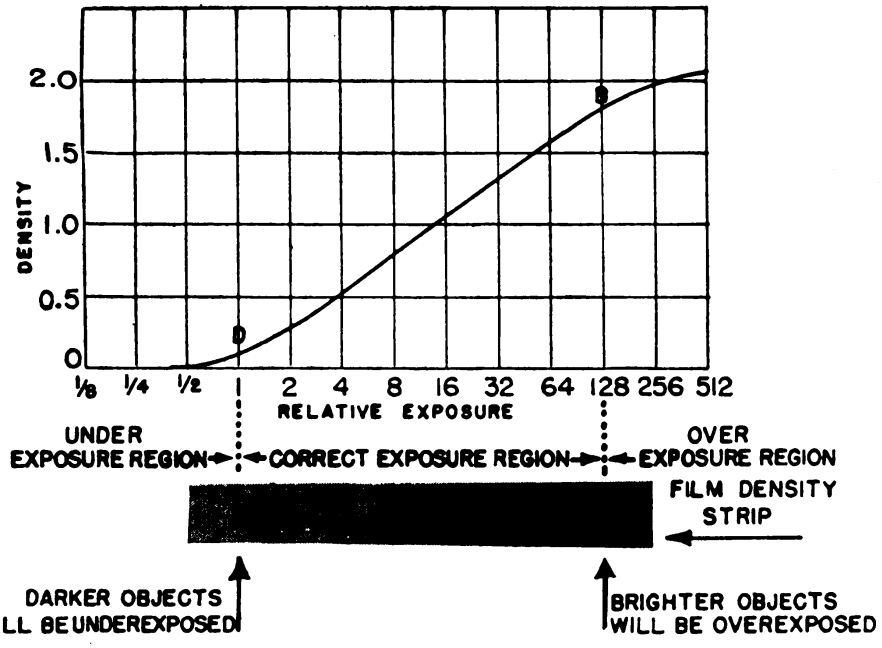


Figure 2.—H&D characteristic curve showing relative exposures (logarithms) plotted against density of film.

c. Light control.—(1) Referring to the characteristic curve, note that the range of correct exposure represents a ratio of 128 to 1. This ratio varies slightly for different types of film, but, for the purposes of studying exposure meters, this average for the film range may be used. Any object or scene to be photographed consists of areas of varying brightness. The problem in exposure is to fit the range of light values as nearly as possible into the straight line portion of the H&D curve. This is accomplished by controlling the amount of light reaching the film by varying the lens aperture and the shutter speed.

(2) If, in a given scene, the ratio of the brightest object to the darkest object in which detail is desired is 32 to 1, then the brightness range will be only one-fourth the film range, and the scene will be correctly exposed if it is placed anywhere in the 128 to 1 film range. However, if the brightness range of the scene is 128 to 1, then there is only one correct exposure.

(3) If the relatively narrow brightness range of 32 to 1 is placed at the low end of the film range, then any exposure less than the one which places this brightness range at the low end produces underexposure, but the exposure may be increased four times and still give a good negative. If this range (32 to 1) is placed in the center of the film range, the exposure may be increased or decreased two times and still produce an equally good negative. Further, if the brightness range is placed near the top of the film range, the exposure cannot be further increased, but may be decreased four times and still produce a good negative.

(4) If the brightness range of the scene is 256 to 1, there is no completely correct exposure, and a certain portion of the scene, either the highlights or the shadows, must be incorrectly exposed. A compromise takes care of this; the deciding factor is the effect desired and the relative importance of the bright areas and the dark areas. Hence, some means of correlating brightness range and film range is necessary for consistent results; the exposure meter is used for this purpose.

Section II. METHODS OF USE

6. GENERAL.—a. Exposure Meters PH-77-(&) and PH-252-(&) are used for obtaining the best possible negative under the existing light conditions. The best possible negative is that one which produces a good photographic print showing detail in both the highlights and the shadows. Negatives made for special effects are not considered in this discussion.

b. The meter must be held in the proper position, so that it records only that portion of the scene which is to be included in the photograph. Extraneous reflections must be prevented from entering the photoelectric cell and giving a false reading. There are several correct methods of holding the meter; each method is discussed in one of the following paragraphs.

7. AVERAGE-BRIGHTNESS METHOD.—This method, also known as the *camera-position method* records the average brightness of the scene being photographed, when the meter is used as prescribed in the following subparagraphs.

a. Position.—Holding Exposure Meter PH-77-(&) or PH-252-(&) near the camera, direct the opening over the photoelectric cell toward the scene. If the angle of view of the meter includes excessive sky, the meter should be pointed downward so that, when the user sights along

the top, his line of sight will hit the ground at a point halfway between himself and the center portion of the scene to be photographed. It is important that the user know the angle of acceptance of the meter he is using so that he may get a reading on the object desired without including extraneous light.

b. Dial settings.—Set the emulsion speed on the calculator dial of the meter. Read the brightness value on the scale directly under the indicator needle, and set this value to register with the index mark provided on the meter. These indices will vary with the individual meter.

c. Shutter speed and f stop.—(1) Any combination of shutter speed and *f* stop which appears on the calculator dial after the above settings have been made will give an identical exposure. If the *f* stop is of primary importance, use the shutter speed appearing alongside. Conversely, when the shutter speed is predetermined, use the *f* stop appearing alongside.

(2) The *f* stop is of primary importance when depth of field is necessary in the final photograph, as in the case of an over-all scene with important objects in both the foreground and background.

(3) The shutter speed is predetermined when there is a great deal of action in the scene, and a fast shutter speed is necessary to stop the action. The shutter speed may be fixed in the case of some motion picture work, and the *f* stop must be made to fit the conditions.

8. DARKEST-OBJECT METHOD.—a. When full detail is desired in the darkest shadows, and highlights can be sacrificed, hold the meter close to the darkest object in the scene to make a light reading. This method is useful when there are extraneous reflections surrounding the important object in a scene, because using the darkest object avoids reading the brightness value of the extraneous reflections. As a general rule, the distance of the meter from the object should be not less than the widest dimension of the object. For example, when the brightness of a face is being measured, hold the meter about 6 inches from the face, and be careful not to cast shadows on the object from either the meter or user.

b. On Exposure Meter PH-77-(&), three or more indicators are provided to set the brightness value. In the *darkest-object method,* choose the lowest indicator, which is marked in a manner to be described later. The shutter speeds and *f* stops then correlated will be correct, if the brightest object in the scene does not lie outside the normal film range—128 to 1.

9. BRIGHTEST-OBJECT METHOD.—a. This method is used when it is especially desired to have complete detail in the highlights of the photograph. This method is also used in scenes which have values too low to be recorded by the brightness-value indicator, allowing the use of the meter in lower ranges of brightness.

b. Measure the value of the brightest object in which complete detail is desired; then set the upper indicator alongside the brightness just measured. This method will be discussed in detail in the chapters following, which deal with the individual meters.

10. SUBSTITUTION METHOD.—a. This method may be employed when there is some important object in the scene which is below the brightness range of the meter.

b. As an example, the brightness of a tree trunk is to be measured, and it lies outside the brightness range of the meter. Measure the brighter side of the trunk, or the brighter side of some other object in the scene. Then place a white or light-colored surface (a sheet of white paper) on the surface of the trunk or other object and measure the paper's brightness. The ratio of the two readings gives the ratio of the brightness of the paper to the brightness of the object. Place the paper on the dark side of the tree or object and again measure its brightness. A proportion can now be formulated to determine the unknown factor; the brightness of the dark object.

c. Consider the following example: the problem is to get detail on the underside of a camouflaged artillery piece (fig. 3). Assuming a measurement of 40 for a bright spot on the upper side of the gun, place a sheet of white paper on the same spot and measure this. If the paper measures 400, the ratio between the two is 40 to 400 or 1 to 10. Then place the

Figure 3.—"The problem is to get detail in the underside of a camouflaged artillery piece."

sheet of white paper on the dark underside of the gun. If the paper in this position has a brightness of 2.5, it follows that the brightness of the underside of the gun is one-tenth of 2.5, or .25, which equals one-fourth. This value may be interpolated on all meters.

11. USE IN DARKROOM.—a. General.—When used to measure the amount of light passing through a negative, Exposure Meter PH-77-(&) or PH-252-(&) is used with its widest angle of acceptance. The meter may be used to aid in either contact or projection printing.

b. Contact printing.—(1) In contact printing, the first step is to determine, by experiment, the proper printing times for one negative on the particular grades of paper and in the developers being used. Place the exposure meter in a position so that the light will pass through the negative before reaching the photoelectric cell. Read the actual value of the light transmitted through the negative. This value is then used to set up a table of printing and developing times and is recorded as a standard for the particular conditions. Other negatives may then be measured and printing times determined by comparing the value of light transmitted through the tested negatives with the value of the light transmitted through the standard negative.

(2) Suppose the standard negative transmits an over-all light value of 40 and requires 3 seconds to print on No. 2 paper. A negative which transmits a light value of 20 then requires 6 seconds while a negative which transmits a light value of 60 requires 2 seconds to print on the same paper. The standard printing times for a certain value of light should be set up for each grade of paper.

(3) For greater accuracy, sections of the photoelectric cell are covered, and the light value transmitted by various sections of the negative is studied; the section in which the best reproduction is desired is used as the determining factor in the printing.

c. Projection printing.—In projection printing, the meter is placed in the plane of the printing paper, and the negative is placed in the enlarger. The light source in projection printing is usually much weaker than that used in contact printing, because of the increased sensitivity of the paper used for projection printing. This may necessitate setting up a standard table of printing times determined by holding the meter at the lens of the enlarger. This standard table will have to be set up for all distances from the enlarger lens to the plane of the printing paper, whether the meter is held at the enlarger lens or in the plane of the paper.

12. USE WITH FILTERS.—When a filter is being used, the exposure is read directly from the meter by setting a corrected emulsion speed on the calculator dial. If the filter factor is 3x and the emulsion speed, given in the emulsion-speed table in appendix I, is 24 Weston, then the proper

emulsion speed to set on the meter would be 8. No further correction need then be made. The exposure data is read directly from the calculator dial as in any of the methods previously given. Remember to change the emulsion-speed setting when the filter is removed. With this method of using the filter, it is more necessary than ever to know the exact filter factor for each filter with each type of film. This must be determined by experimentation on the part of the photographer. The light conditions in various parts of the world will have considerable influence on the filter factors. A filter-factor table is given in appendix III as a general guide.

13. USE OF EMULSION-SPEED TABLES.—The emulsion-speed tables in appendix I are provided only as a general guide and are not to be taken as setting forth the only speed that can be given to any film under varying conditions. If the light encountered is very flat, a different system of processing the film may have to be set up to produce the best negatives. This change in processing from the normal, on which the table was based, will necessitate a change in the emulsion-speed setting. The base laboratory charged with developing the film should experiment with the different types of light conditions prevalent in each particular area and should set up a supplementary emulsion-speed table, which is to be made available to all photographers working in that area. The general trend of such revisions in the emulsion speeds will be downward, but an occasional set of conditions may be encountered which will raise the emulsion speed. This must be determined by individual experimentation.

Section III. MAINTENANCE

NOTE: Unsatisfactory performance of this equipment will be reported immediately on W.D., A.G.O. Form No. 468. If this form is not available, use TM 38-250.

14. REPAIRS.—Exposure Meters PH-77-(&) and PH-252-(&) are not to be repaired by the user or his organization, if the repair necessitates disassembly of the meter. Certain minor repairs for each type of meter will be discussed in relevant chapters, but it must be remembered that these repairs require both highly trained personnel and special testing equipment not available to any organization except fourth or fifth echelon shops or the manufacturer. The meters are not to be lubricated.

15. HANDLING.—a. There are several general cautions which must be observed in handling the meter. It must at all times be treated with care; it is a precision instrument.

b. Never drop or bang the meter (fig. 4). There is a cord by which the meter hangs around the user's neck. When not actually reading the meter or the calculator dial, put the meter back in the pocket; do not allow it to dangle from the neck. The neck cord is long enough to allow the meter to be put in the pocket without removing the cord from the neck.

Figure 4.—"Never drop or bang the meter."

c. The meter must not be subjected to extreme heat; a temperature of 125°F may cause permanent damage to the photoelectric cell. The meter suffers electrical or chemical fatigue in the extreme heat and humidity of tropical regions and must be stored in a cool, dry place in such regions. Be careful when using the meter in the tropics; for, although the light may be of such brilliance as to be painful to the eyes, it may have less actinic value than the weak sunlight of an American winter afternoon. In tropical conditions, the readings of the meter must be followed exactly.

d. The effect of extreme cold is also detrimental to the operating mechanism of the meter. The lowest temperature at which it is safe to use the meter is —30°F. At temperatures below 50°F, the meter readings must be checked carefully against a known standard. The glass on the meter may receive an electrical charge from contact with the hands or clothing in dry cold weather. Such a charge will attract the needle and give an untrue reading. This electrical charge can be removed by breathing upon the glass, which always should be done whenever the temperature is below 50°F and the weather is dry.

Figure 5.—"Under no circumstances should the meter be pointed directly into the sun."

e. Under no circumstances should the meter be pointed directly into the sun (fig. 5). This may cause serious and permanent damage to the photoelectric cell and make the meter unfit for further use.

f. Sudden changes of temperature must be avoided because they are likely to break the coil winding (fig. 6) and open the circuit.

Figure 6.—"Sudden changes of temperature are likely to break the coil winding."

Section IV. LIST OF PARTS

16. GENERAL.—The parts of Exposure Meters PH-77-(&) and PH-252-(&) are not standard for all meters, and are listed in the following chapters where applicable.

CHAPTER 2

EXPOSURE METER PH-77

Section I. GENERAL INFORMATION

17. PURPOSE.—Exposure Meter PH-77 is used primarily to determine exposure data for still photography, but may be used also for *ciné* work. The methods of calculating exposure are the same as those described in paragraphs 3 and 4.

18. GENERAL DESCRIPTION.—a. Shape and size.—The meter is oval-shaped and measures 3½ inches wide, 2¼ inches high, and 1¼ inches thick (fig. 7).

b. Calculator dial.—(1) The calculator dial contains complete information for the settings of the variable elements, and is carefully labelled at all points.

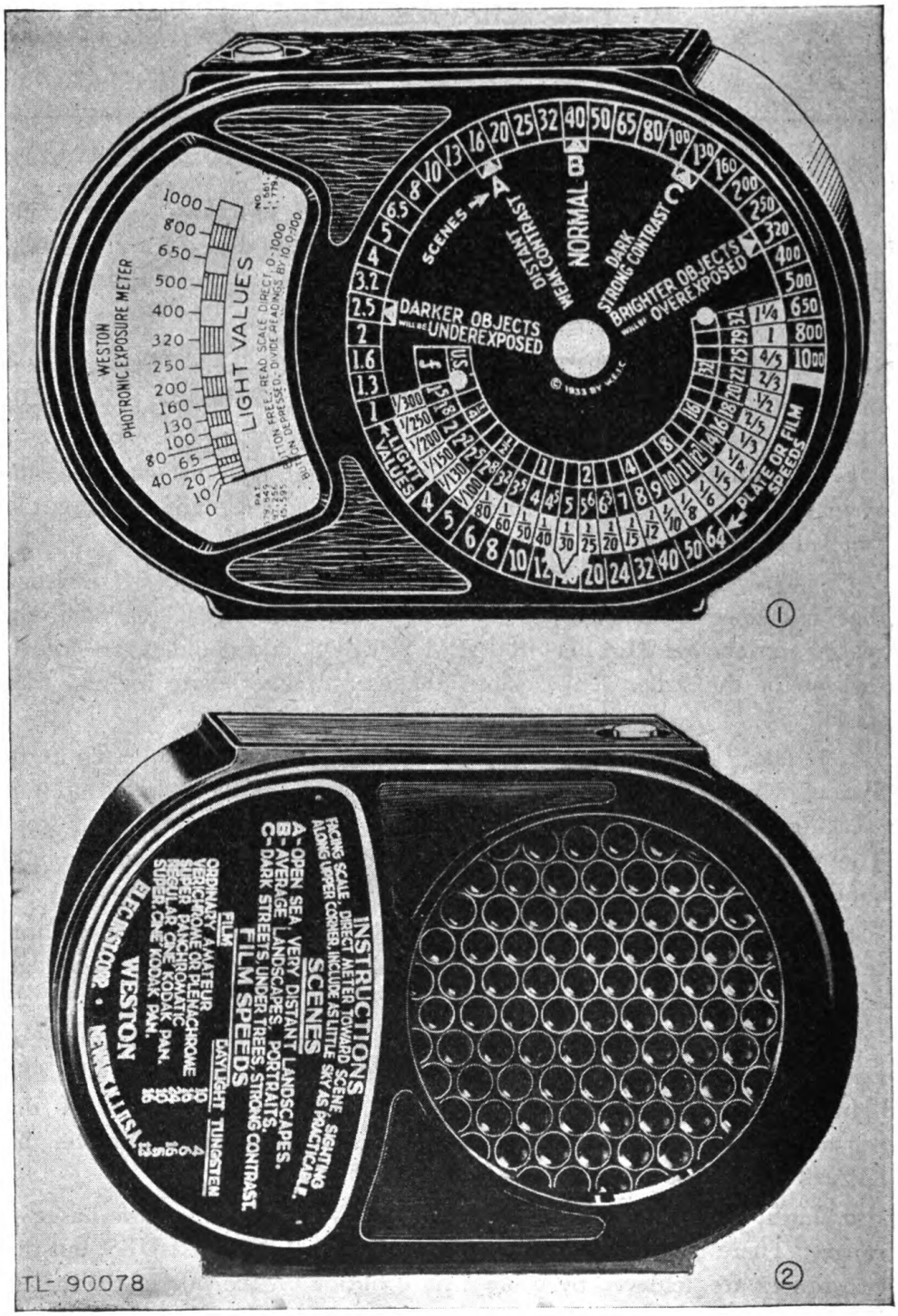
(2) The emulsion speeds on this dial range from 4 to 64, a range that has since been exceeded by film manufacturers. These emulsion speeds are labelled PLATE OR FILM SPEEDS, and double every fourth division of the scale. This enables the user to interpolate for any film speed.

(3) The *f* stops or lens apertures are given both for the Uniform System, which is no longer in general use, and for the standard *f* stop markings in which the exposure time varies with the square of the *f* stop. The first values are found in a band labelled US and the second in a band marked *f*.

(4) The range of light values is from 1 to 1000. The unit of calibration is candles per square foot. These values are found on the outer edge of the calculator dial and are marked LIGHT VALUES.

c. Photoelectric cell assembly.—The photoelectric cell assembly is similar to that in all exposure meters using the photoelectric principle. The light reflected from the scene or object being photographed strikes the cell and is instantly converted into electrical energy which operates the LIGHT VALUES indicator.

d. Light-value indicator.—The LIGHT VALUES indicator has two ranges. There is only one scale for reading the LIGHT VALUES, but the two ranges are achieved by using a push button on the side of the meter. When the push button is not depressed, the reading for the LIGHT VALUES range from 0 to 1000. When the push button is depressed, the LIGHT VALUES readings are still made on the 0 to 1000 scale, but the full scale value is only 100. Hence, the reading obtained when the button is depressed is divided by 10, or the last 0 is dropped from the scale value.



(1) Front (2) Reverse side

Figure 7.—Exposure Meter PH-77.

Section II. DETAILED USE

19. GENERAL.—The method of using this meter follows the general methods outlined in chapter 1. A thorough reading of that chapter is recommended before using any meter.

20. CAMERA-POSITION METHOD.—This method is used for scenes with no great range of light values; that is, without very bright or very dim areas.

a. Setting emulsion speed.—Consult the emulsion-speed tables in appendix I of this manual to determine the speed value of the film to be used in taking the photograph. Set this value underneath the V index projecting from the 1/30 setting on the shutter speed dial. The emulsion speeds are on the band marked PLATE OR FILM SPEEDS.

b. Determining light value.—(1) Hold the meter near the camera and point it toward the scene or object being photographed. Be careful to avoid excessive sky reflection. Read the figure on the LIGHT VALUES scale.

(2) If this figure is above 100, turn the top calculator dial until the NORMAL B arrow points to the figure on the calculator dial's LIGHT VALUES scale. The correct combination of *f* stops and shutter speeds now appear alongside each other. Select the combination which will produce the desired results. Choose a combination with a fast shutter speed if there is action to be stopped. If there is no action to be stopped, and depth of field is required, select a combination with a small lens opening and a slow shutter speed.

(3) If the figure reading on the LIGHT VALUES scale is below 100, depress the push button, and make another reading. Divide this reading by 10. Set the NORMAL B arrow opposite the result on the calculator dial's LIGHT VALUES scale. The remainder of the calculations are done as described above. Figure 7 (1) shows the calculator dial with a PLATE OR FILM SPEEDS setting of 16 and a LIGHT VALUES setting of 40.

c. Alternate dial settings.—Two further methods for selecting the proper exposure data are provided on the calculator dial.

(1) If the scene is at considerable distance from the camera and the contrast is poor, set the DISTANT WEAK CONTRAST arrow opposite the figure arrived at on the LIGHT VALUES scale. This cuts the exposure approximately in half, which is correct for a scene of this type, such as a group of parachutes in the sky.

(2) If the scene has great contrast, the arrow marked DARK STRONG CONTRAST is set opposite the figure measured on the LIGHT VALUES scale. This approximately doubles the exposure and permits full recording of details in the shaded areas.

(3) These indicators on the calculator compare with those marked A1/2 and C2x on the PH-77-C Weston M715. See paragraph 44*c* for further information on the use of these indicators.

21. DARKEST-OBJECT METHOD.—This method follows the principle, outlined in subparagraph 5*c*, of placing the darkest object within the film range as shown on the H&D curve (fig. 2).

a. Set the figure on the FILM OR PLATE SPEEDS band as described in subparagraph 20*a*.

b. Hold the meter at a distance from the darkest object of about one diameter of the object. This method may be used with push button either depressed or released. Read the brightness on the LIGHT VALUES scale.

c. Set the calculator dial arrow marked DARKER OBJECTS WILL BE UNDEREXPOSED opposite this value. By doing so, the darkest object in the scene is at the lower end of the film range, and the entire scene is within the film range, provided the brightness range is not more than 128 times the value of the darkest object.

d. Choose the proper combination of *f* stop and shutter speed as in subparagraph 20*b*(2).

22. BRIGHTEST-OBJECT METHOD.—This method is found useful when the brightness of the darkest object and the average brightness of the scene are below the range of the meter. It is always used with the push button depressed.

a. Set the correct value on the PLATE OR FILM SPEEDS band.

b. Hold the meter close to the brightest object in the scene in which full detail is desired. Read on the LIGHT VALUES scale the brightness of this object.

c. Set this figure opposite the calculator dial indicator marked BRIGHTER OBJECTS WILL BE OVEREXPOSED. This places the value of the brightest object at the top of the film range, and the entire scene is within the film range unless the brightness of the dimmest object is less than 1/128th the brightness of the brightest object.

d. Choose the proper combination of *f* stop and shutter speed.

e. If, in either of the two methods just outlined, the brightness range is outside the film range, the brightest object or the darkest object must be sacrificed. Choose the exposure which will give full detail in the final print to the more important object.

23. BRIGHTNESS-RANGE METHOD.—This method is used for measuring the brightness of both the darkest object and the brightest object, and for determining whether or not these two objects lie within the film

range. If both objects lie within the film range, the setting is made according to either of the two methods described in the preceding paragraphs, or an average brightness is determined and the NORMAL B arrow set opposite this average. If the brightness of the two objects does not lie within the film range, one or the other must be sacrificed as described in subparagraph 22*e*.

24. USE IN DARKROOM.—If a table of exposure times and light values of negatives is set up as described in paragraph 11, Exposure Meter PH-77 may be used to calculate the printing times for either contact or projection printing.

Section III. MAINTENANCE

25. GENERAL.—Like all exposure meters, this one must not be dropped, banged, or allowed to get wet. It becomes completely inefficient and unreliable at temperature outside the range of 125°F to —30°F. Any temperature above 125° may cause permanent damage to the photoelectric cell assembly and must be avoided. No lubrication is necessary. No periodic inspection or maintenance of the meter is required, but the meter must be checked carefully each time it is subjected to any abuse. The glass, covering the photoelectric cell, should be cleaned frequently, since the presence of any dust or dirt excludes light and causes a false reading. See paragraph 15 for further cautions.

26. TESTS.—The following tests are made to ascertain the cause of failure of the meter to function. The tests are not to be used by untrained personnel as a basis for making repairs. Any repairs involving even partial disassembly of the meter are classed as fourth or fifth echelon repairs and must be done by trained personnel using the proper precision equipment.

a. The first test is to check the zero reading of the LIGHT VALUES indicator. To do this, cover the photoelectric cell opening completely. The needle indicator should point to zero on the LIGHT VALUES scale and should remain in this position while the meter is rotated slowly. The needle indicator cannot be adjusted on this meter and, if the meter does not read zero with the cell completely covered, the readings are not to be relied upon, and the meter must be returned for repairs.

b. The meter then should be tested for jerky movements of the needle indicator. Point the cell towards a light source of sufficient brilliance to cause a full-scale reading on the meter. Then gradually cover the opening over the cell while observing the movement of the indicator. It should move evenly and gradually toward the zero point. Then gradually uncover the opening over the cell while observing the movement of the indicator, and while the meter is still pointing toward the same light

source. If, at any time during this test, the needle jumps suddenly or moves in a jerky manner, some obstruction exists inside the movement assembly, or some "short" or "open" is interrupting the path of the current created by the light striking the cell; if the needle does not register at all, there is an open in the circuit. Under any of these circumstances, the meter must be returned for repairs.

c. Be sure to check the accuracy of the meter occasionally. If possible compare its reading with the reading of another meter that is known to be reliable.

27. DISASSEMBLY AND REPAIRS.—Any repairs involving disassembly of the meter must not be attempted either by untrained personnel or without the proper equipment. This meter is assembled in such a manner that it is moistureproof, and the moistureproofing will lose its effectiveness if the meter is disassembled. Excessive moisture may damage the cell assembly. Checking the calibration of the light values read from the meter requires a very specialized test set and is beyond the scope of this manual.

Section IV. LIST OF PARTS

28. GENERAL.—No replaceable parts for this meter are being manufactured, nor is the manufacture of any contemplated. There are no more of these meters available for replacement or reissue. Hence no list of parts is given. The Signal Corps stock number of the meter is 8A1057. If this meter becomes unserviceable, it may be replaced by PH-77-C General Electric DW48, which is discussed in chapter 5.

CHAPTER 3

EXPOSURE METER PH-77-A

Section I. GENERAL INFORMATION

29. PURPOSE.—Exposure Meter PH-77-A is used primarily to determine exposure data for still photography, but may be used also for *ciné* work. The methods of calculating exposure are the same as those described in paragraphs 3 and 4.

30. GENERAL DESCRIPTION.—a. General.—This meter has several simplifications over Exposure Meter PH-77, but the general design and elements are the same (fig. 8). The meter is rectangular-shaped with bevelled corners, and is carried in a leather case which is issued with it. When in use, the meter will be carried around the neck by means of the attached cord. This cord is long enough to enable the user to place the meter in his pocket, without removing the cord from his neck. The meter is 3.95 inches long, 2.07 inches wide, and 1.06 inches thick.

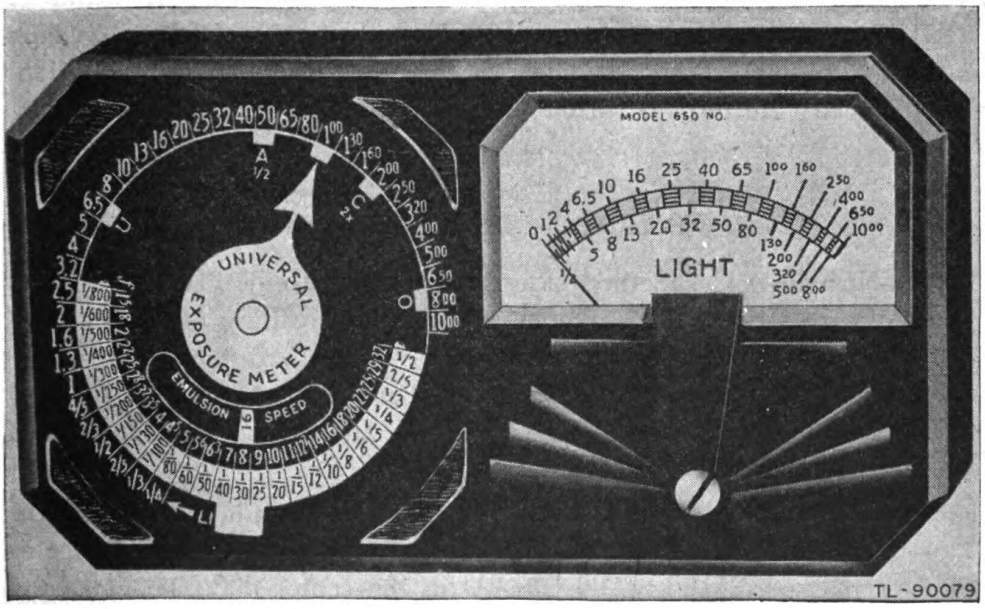


Figure 8.—Exposure Meter PH-77-A.

b. Calculator dial.—The calculator dial contains settings similar to those on Exposure Meter PH-77, but these settings are labelled differently.

(1) The emulsion speeds are labeled EMULSION SPEED, and range from 1 to 250.

(2) The *f* stops are shown in white on the center black dial. They are given only in the standard *f*-stop markings, are labelled *f*, and range from *f*1.5 to *f*32.

(3) The light values range from 1/4 to 1000 and appear in white on black on the band labelled LIGHT. This band is around the rim of the outer black dial.

(4) The selector indicators to be set alongside the light values are five small white rectangles on the rim of the dial and serve the same purpose as the selector arrows on Exposure Meter PH-77. However, they are labelled as follows: U, in place of DARKER OBJECTS WILL BE UNDEREXPOSED; O, in place of BRIGHTER OBJECTS WILL BE OVEREXPOSED; A1/2, instead of DISTANT WEAK CONTRAST; C2x, instead of DARK STRONG CONTRAST; and a large white arrow instead of NORMAL B. These changes simplify the reading of the dial since fewer words appear on the dial-face.

c. Photoelectric-cell assembly.—The photoelectric-cell assembly is similar to that in all Exposure Meters PH-77-(&). The angle of acceptance of the meter is a cone with an apex angle of 60°.

d. Light-value indicator.—The light-value indicator is a needle pointer reading on a scale labelled LIGHT to correspond with the band of LIGHT values on the calculator dial. The only range of LIGHT values is from 0 to 1000. When readings are made in either dim or very bright light, special care must be taken to insure a correct reading.

Section II. DETAILED USE

31. GENERAL.—The method of using Exposure Meter PH-77-A is similar to that described in chapter 1. A thorough reading of chapter 1 is recommended before using any meter.

32. CAMERA-POSITION METHOD.—This method is used for scenes having no great range of light values.

a. Setting film speed.—Consult the emulsion-speed tables in appendix I of this manual for the speed of the film being used. Set this speed in the slot marked EMULSION SPEED in the center dial. To make this setting, lift the white tab marked I in figure 9, and rotate the dial until the proper figure appears in the slot. This setting remains unchanged as long as the same type of film is being used, and provided no filters are used.

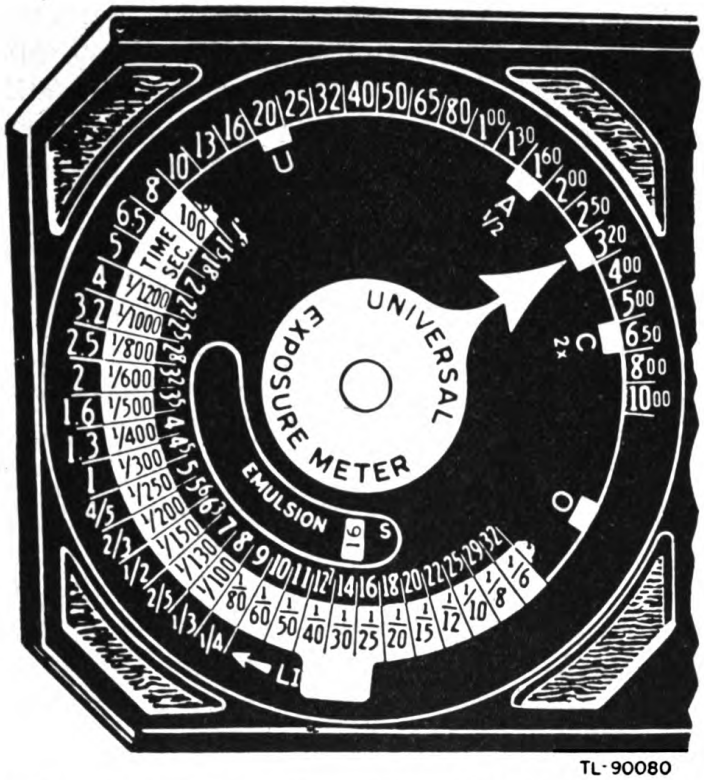


Figure 9.—Exposure Meter PH-77-A, calculator dial with EMULSION SPEED set at 16 and LIGHT value at 320.

b. Position of meter.—Hold the meter near the camera and point it toward the scene to be photographed. Aim the meter as directed in subparagraph 7*a*, so as not to include excessive sky or other reflections. Read the LIGHT value on the scale under the pointer.

c. Selecting proper combination.—If the scene is a normal one without extreme contrast, set the normal large white arrow on the top dial opposite the LIGHT value on the calculator which agrees with the meter reading just obtained. The combination of *f* stops and shutter speeds appearing on the calculator dial will each give a correct exposure. The determining factor in choosing the proper combination is, once again, the nature of the scene being photographed. If there is action in the scene, a combination with a fast shutter speed must be chosen. Otherwise, it is usually better to choose a combination with a small lens opening, since depth of field is gained thereby, and objects both much nearer to, and farther from, the camera will be in focus.

(1) If the scene is one with poor contrast and is quite distant from the camera, the indicator A1/2 should be set opposite the LIGHT value measured. This cuts the normal exposure in half, and produces better results with a scene of poor contrast, such as a desert scene with very little foliage or a shot of parachutes against the sky.

(2) If the scene has very strong contrast, the indicator C2x should be set opposite the LIGHT value. This doubles the normal exposure and allows ample time for the details in the shadows of the scene to register without blocking the highlights. Examples of this type of scene are a forest with shafts of sunlight coming through, and a street with tall buildings which create an irregular light pattern.

33. DARKEST-OBJECT METHOD.—This method places the darkest object in the scene within the lower portion of the film range as shown in the H&D curve (fig. 2).

a. Set the EMULSION SPEED as described in paragraph 32*a*.

b. Hold the meter near the darkest object in which detail is desired. The distance of the meter from the object should be about equal to one diameter of the object; this is about six inches if a face is being measured. Read the LIGHT value.

c. On the calculator dial set the indicator U opposite the LIGHT value. The combinations of *f* stops and shutter speeds now shown will place the darkest object within the film range, and the entire scene will be properly exposed, provided the LIGHT value of the brightest object is not more than 128 times that of the darkest object.

34. BRIGHTEST-OBJECT METHOD.—This method is used when the brightness of the darkest object and the average brightness of the scene are below the range of LIGHT values of the meter. It is also used to check the brightness of the brightest object in the darkest-object method.

a. Set the EMULSION SPEED as described in subparagraph 32*a*.

b. Hold the meter close to the brightest object in which full detail is desired. Be careful not to cast a shadow on the object from the meter or the user. Read the LIGHT value.

c. Set the figure thus measured opposite the calculator dial indicator marked 0. The combination of *f* stops and shutter speeds now shown will place the brightest object within the upper portion of the film range. The entire scene will lie within the film range unless the LIGHT value of the darkest object is less than 1/128th of the value of the brightest object.

35. BRIGHTNESS-RANGE METHOD.—See paragraph 47.

36. USE IN DARKROOM.—Exposure Meter PH-77-A may be used in the darkroom in the manner described in paragraph 11.

Section III. MAINTENANCE

37. GENERAL.—Exposure Meter PH-77-A is a precision instrument and must not be subjected to the abuses described in paragraphs 15 and 25. Treat it with the care that a precision instrument requires.

38. TESTS.—The following tests are to be used to ascertain the causes of failure of the meter to function. They are not to be used by untrained personnel as a basis for making repairs. Any repairs involving even partial disassembly are classed as fourth or fifth echelon repairs and must be made by trained personnel using the proper precision equipment.

a. Check the zero reading of the LIGHT value indicator. When the opening over the photoelectric cell is completely covered the pointer should rest at the zero mark on the scale. On Exposure Meter PH-77-A, the zero setting may be adjusted by means of the screw directly below the LIGHT value scale and indicator. Turn this screw slowly to the right or left until the pointer comes to rest over zero. Hold the meter at a 45° angle when setting zero to average out any balance error.

b. Then check the pointer for stickiness or jumpy movements. This test is the same as that described in subparagraph 26*b*.

c. Checking the calibration of the LIGHT values requires a special test set which is not available. It is suggested that the meter be checked occasionally against a meter that is producing consistently good results.

39. DISASSEMBLY AND REPAIRS.—It is again stressed that any repairs involving disassembly of the meter must not be attempted by untrained personnel or without proper equipment. This meter is assembled in such a manner that it is moistureproof. If it is disassembled, this moistureproofing loses some of its effectiveness, and the cell of the meter will become damaged by excessive moisture.

Section IV. LIST OF PARTS

40. GENERAL.—See paragraph 28. The Signal Corps stock number of this meter is 8A1057A.

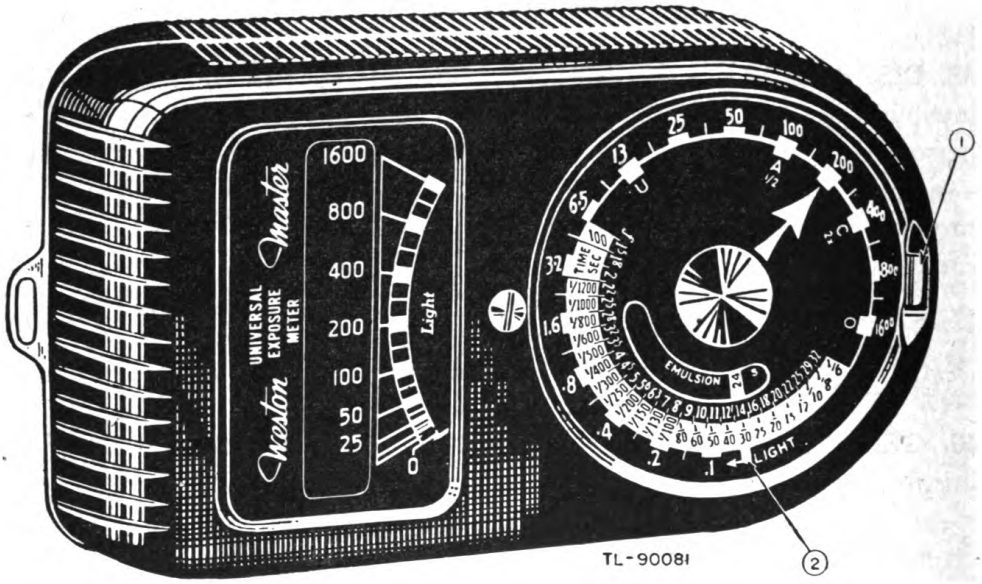
CHAPTER 4

EXPOSURE METER PH-77-C WESTON M715

Section I. GENERAL INFORMATION

41. PURPOSE.—Exposure Meter PH-77-C Weston M715 is used primarily to determine exposure data for still photography, but may be used also for *ciné* work if the shutter speeds of the motion picture camera are known.

42. GENERAL DESCRIPTION.—a. General.—This meter has the same basic parts as other exposure meters. The body is oblong, with one end rounded to accommodate the calculator dial. The meter is carried in a canvas or leather carrying case with a neck cord attached to the body of the meter, and threaded through a slot in the case. The meter is 4.18 inches long, 2.28 inches wide, and 1.15 inches thick.



(1) Lock (2) White tab to be used in setting EMULSION SPEED

Figure 10.—Exposure Meter PH-77-C Weston M715.

b. Calculator dial.—The user must become completely familiar with the data found on the calculator dial to make the fullest use of the meter.

(1) The EMULSION SPEED is so labelled, and ranges from .3 to 800. There is a lock which holds this setting in place once it has been made (fig. 10 (1)).

(2) The LIGHT values range from .1 to 1600 and are found on the outer rim of the lower calculator dial.

(3) The shutter speeds are marked in black on white and are found on the band just inside the LIGHT values.

(4) The lens apertures are labelled *f* and are in white on black just inside the band of shutter speeds.

(5) There are five indicators which may be set alongside the LIGHT value arrived at; they are marked U, to indicate the low or underexposure film range; 0 to indicate the high or overexposure film range; A1/2, to be used to cut the exposure in half; C2x, to be used in doubling the exposure; and the normal indicator, which is a large white arrow.

c. Photoelectric-cell assembly.—The photoelectric-cell assembly is similar to that in all Exposure Meters PH-77-(&) and PH-252-(&). The angle of acceptance is a cone with an apex angle of 30°, about half that of the normal camera angle of view. This makes the meter more directional than previous ones and enables the user to measure the LIGHT values of objects from camera position. The acceptance angle for low-range values (0-50) is approximately 80°.

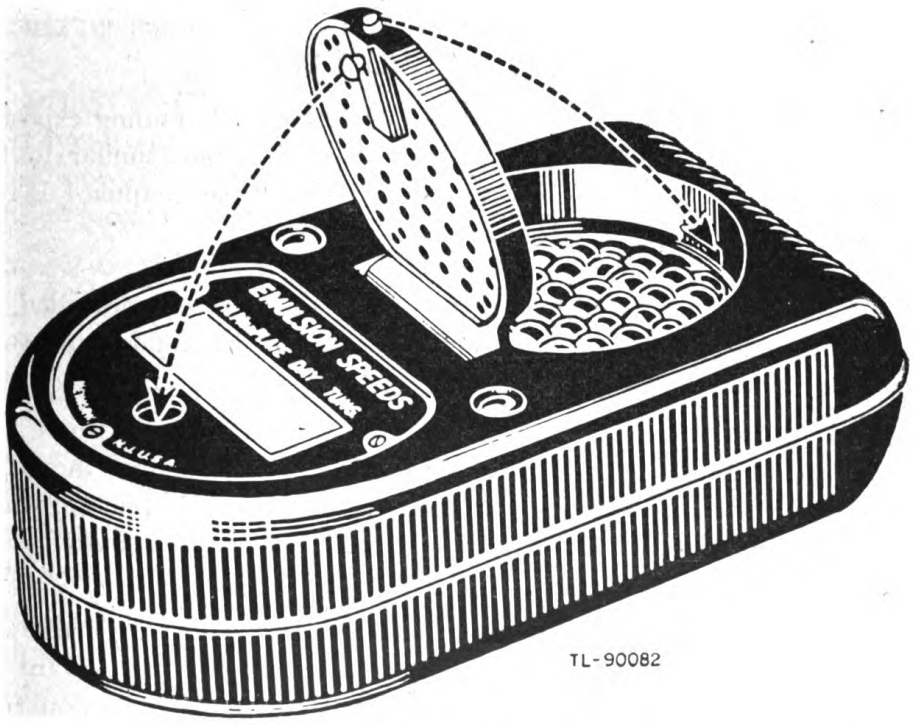


Figure 11.—Exposure Meter PH-77-C Weston M715, auxiliary baffle in an intermediate position.

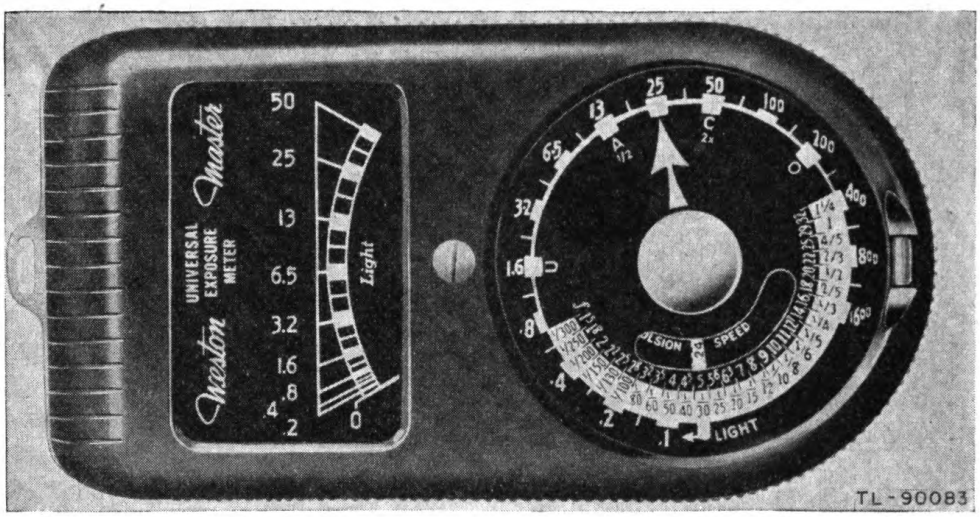


Figure 12.—Exposure Meter PH-77-C Weston M715, Light scale in view when auxiliary baffle in open.

d. Light-value indicator.—The light-value indicator is a needle pointer and the scale has two ranges. The full-range scale reads light values from 0 to 1600. This range is in view automatically when an auxiliary baffle is closed over the glass covering the photoelectric cell (fig. 11). The low-range scale reads light values from 0 to 50 and slides automatically into view in pace of the high range scale when the auxiliary baffle is opened (fig. 12).

Section II. DETAILED USE

43. GENERAL INFORMATION.—The methods of determining exposure data with Exposure Meter PH-77-C Weston M715 are similar to the methods described in chapter 1. A thorough reading of chapter 1 is recommended before using any exposure meter.

44. CAMERA POSITION METHOD.—This method is recommended for scenes of average brightness, with no outstanding light or dark spots.

a. Setting EMULSION SPEEDS.—First set the EMULSION SPEED according to the emulsion-speed tables in appendix I of this manual. The speed appears in the rectangular opening in the inner dial of the calculator. Set the speed by releasing the lock and turning the white tab which is found on the edge of the dial opposite the 1/30-second shutter speed (fig. 10 (2)).

b. Setting LIGHT values.—Close the auxiliary baffle over the cell. Hold the meter near the camera with the opening pointing toward the scene to be photographed. Avoid excessive sky or other reflection from some unusually brilliant object in the background. Read the light value.

(1) If the value is over 50, set the white arrow indicator opposite the LIGHT value. The correct combinations of *f* stops and shutter speeds now appear on the side of the dial opposite the white arrow. Each of these combinations will give a correct exposure. The deciding factor in choosing the combination to be used is the nature of the scene being photographed, as described in subparagraph 7*c*.

(2) If the light value is under 50, open the auxiliary baffle over the photoelectric cell and take another reading. Opening the auxiliary baffle automatically brings into view the LIGHT scale 0.50. Set the calculator dial to the new light value.

c. Selecting exposure for special scenes.—A further factor in choosing the proper exposure for special scenes is provided on the calculator. The inner dial contains on one side of the large white arrow an indicator marked A1/2, and on the other side an indicator marked C2x.

(1) When the scene is a considerable distance from the camera and has little contrast, such as a distant landscape, parachutes in the sky, seascapes, or over-all desert scenes, less exposure is required. In these cases, the indicator A1/2 should be set alongside the LIGHT value, automatically cutting the normal exposure in half.

(2) When the scene is quite dark with a great deal of contrast, such as a narrow street between tall buildings or scenes under trees, more exposure is required so that the shadow areas may become registered fully upon the emulsion. In these cases, set the indicator C2x alongside the LIGHT value; this automatically doubles the normal exposure (fig. 13).

45. DARKEST-OBJECT METHOD.—This method is reliable when the most important object in the scene is very dim. It may be used for any scene, since it follows the principle of placing the darkest object within the film range, as shown on the H&D curve (fig. 2).

a. Set the EMULSION SPEED as described in subparagraph 44*a*.

b. Hold the meter near the darkest object in the scene in which full detail is required. The distance of the meter from the object should be about one diameter of the object, and the user must be careful not to cast a shadow on the object from himself or from the meter. The auxiliary baffle may be either open or closed, but is usually open since the darkest object in the scene ordinarily has a light value below 50. Read the light value indicated while the meter is pointed toward the object.

c. Set this value alongside the indicator marked *U* on the calculator dial. This brings not only the darkest object but also the entire scene within the film range, provided that the value of the brightest object in the scene is not more than 128 times that of the darkest object.

d. Any combination of shutter speed and *f* stop which appears may be used as described in subparagraph 7*c*.

Figure 13.—Exposure Meter PH-77-C Weston M715, calculator dial with EMULSION SPEED set at 24; normal arrow at 13; A1/2 at 6.5; and C2x at 25.

46. BRIGHTEST-OBJECT METHOD.—This method is useful when the scene is so dim that the darkest object and the average brightness of the scene lie below the range of the meter.

a. Set the EMULSION SPEED as described in subparagraph 44*a*.

b. Read the light value of the brightest object in the scene, excluding such accidental highlights as an open window or a spot of very bright sunlight in a shaded ravine. The auxiliary baffle may be open or closed in this method.

c. Set the indicator marked *O* on the calculator dial opposite this LIGHT value. This brings the brightest object and the entire scene within the film range, provided that the value of the darkest object is not less than 1/128th of the value of the brightest object.

d. Any combination of shutter speed and *f* stop may be chosen to fit the scene as described in subparagraph 7*c*.

47. BRIGHTNESS-RANGE METHOD.—This method provides a more detailed way of arriving at results similar to those in the camera-position method.

a. Set the EMULSION SPEED as in the camera-position method in subparagraph 44*a*.

b. Light value.—Read the light value of both the darkest and the brightest objects in the scene. Then set the calculator dial so that these two LIGHT values lie between the U and O positions.

(1) If the LIGHT values cover a very narrow range, any one of several settings of the calculator dial will place the brightness range within the film range. In such a case, choose the center or average setting. For example, if the brightness range is from 25 to 200, the U may be set on 25 and the O will then fall beyond the 1600. The U may also be set on 13, which will place the O on 1600. Either of these two settings will produce a printable but thin negative. The next setting, the U on 6.5 and the O on 800, is the approximate center for the range of 25 to 200, and will produce the best negative. Setting the U farther down the scale on 3.2 will place the O on 400. The lowest setting possible for this range, the U on 1.6, will place the O on 200, the value of the brightest object. These last two settings will produce a dense negative.

(2) If the brightness range of the scene is from 3.2 to 400, there is only one position which will place the darkest object and the brightest object within the film range.

(3) If the brightness range is from 1.6 to 800, there is no correct exposure for the entire scene, and a compromise must be made depending upon whether the darkest portion of the scene or the brightest portion is more important. If details in the shadows are desired, set the U position on 1.6. If details in the highlights are important, set the O position on the 800.

Section III. MAINTENANCE

48. GENERAL.—This meter must not be subjected to abuses such as those described in paragraphs 15 and 25.

49. TESTS.—If the meter is ever dropped, banged, or allowed to get wet, it should be checked against another meter giving consistently satisfactory results. The glass covering the photoelectric cell must be cleaned before making these tests, and should be cleaned each time before using the meter.

a. The zero position of the light-value indicator is checked by completely covering the opening over the photoelectric cell. If the indicator does not indicate zero, the screw on the body between the calculator dial and the light-value indicator should be turned, with the cell covered and the meter in the 45° position, until the indicator is adjusted to zero. Then, with the cell still covered, rotate the meter slowly to test the balance of the indicator. At no point in this rotation of the meter should the needle sway from the zero point.

b. Next test the indicator for irregular movement. This test is made by slowly covering the opening over the photoelectric cell while it is ex-

posed to a light source sufficient to give full scale reading. The needle should move evenly from the full scale to zero, if the cell opening is gradually covered. Then uncover the cell opening gradually, again observing the movement of the needle. It should return to full scale reading evenly. If there are any uneven or jerky movements, the meter must be returned for repairs.

50. DISASSEMBLY AND REPAIRS.—The disassembly of the meter is not to be undertaken except by trained personnel equipped with proper tools. A sealing oil is used in the assembly of the meter, and this oil loses some of its effectiveness if the meter is disassembled. The photoelectric cell becomes extremely vulnerable to moisture, which damages it beyond repair. Also, there are four screws which hold the two main components of the meter together. These screws are of a special design, and require a special knurled socket wrench available only at fifth echelon repair shops to remove them.

Section IV. LIST OF PARTS

51. GENERAL.—The list of parts is not given in this manual since the meter is not to be disassembled. Neither the meter nor the parts are available for replacement. The Signal Corps stock number of the meter is 8A1057C. If this meter becomes unserviceable, it may be replaced by Exposure Meter PH-77-C General Electric DW48, which is discussed in chapter 5.

CHAPTER 5

EXPOSURE METER PH-77-C GENERAL ELECTRIC DW48

Section I. GENERAL INFORMATION

52. PURPOSE.—Exposure Meter PH-77-C General Electric DW48 is used primarily for determining exposure data for still photography, but may be used also for *ciné* work. The cell component may be used to measure incident light (light directly from the source) as well as reflected light.

53. GENERAL DESCRIPTION.—a. General.—The meter is divided into two distinct portions. At the top is a circular calculator dial fully marked and calibrated, and mounted on a hood which is completely detachable. At the bottom is the calibrated light-value indicator and the photoelectric-cell assembly. The meter is 4.75 inches long, 1.37 inches wide and 1.28 inches thick. It is equipped with a leather or canvas carrying case and a neck cord (fig. 14).

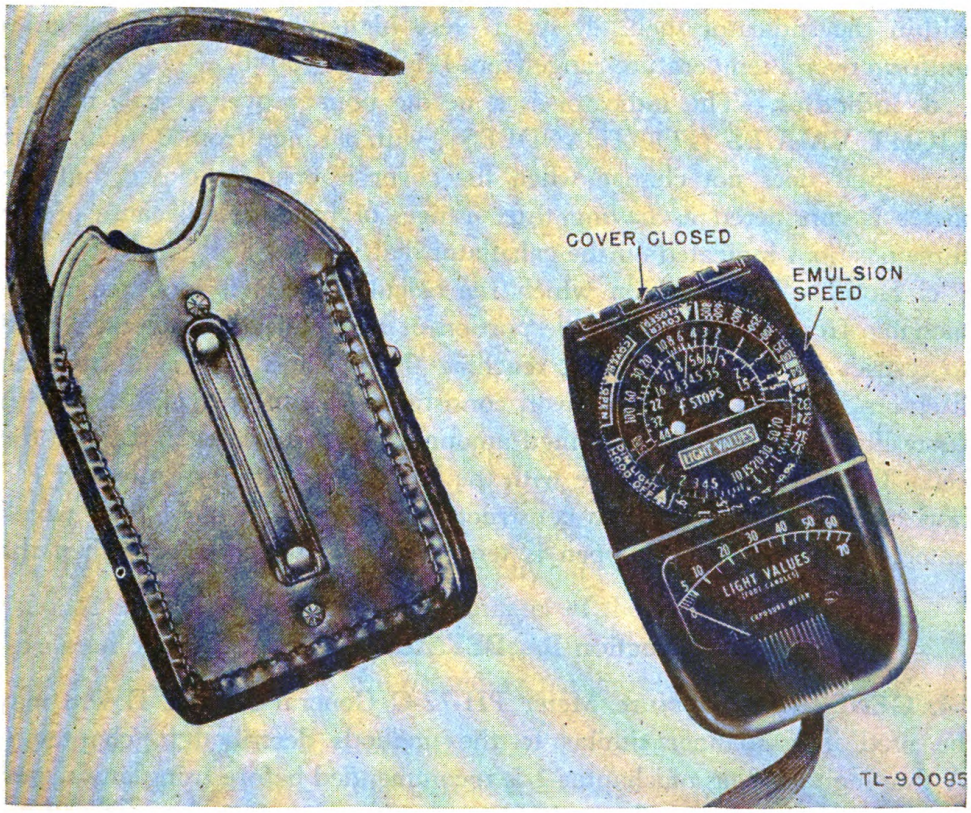


Figure 14.—Exposure Meter PH-77-C General Electric DW48, with Carrying Case PH-137.

b. Calculator dial.—The calculator dial mounted on the hood contains the same general information as other calculator dials, as described in paragraph 4.

(1) The band of emulsion speeds is not labelled; it appears around the outer rim of the dial and ranges from .6 to 800. The indicator for emulsion speeds is an arrow between two prongs. This indicator is between the 1/4- and the 1/5-second shutter speeds (fig. 14). These emulsion speeds are in the General Electric system. Equivalents in the Weston ratings are listed in appendix II of this manual.

(2) The shutter speeds range from 100 seconds to 1/2500 second and are found on the band which is printed in white or black.

(3) The lens apertures are labelled *f* STOPS and appear on the center dial which is fixed by two rivets. These *f* STOPS range from 1 to 44.

(4) The LIGHT VALUES appear on an extended flange of this center dial and range from 1 to 70.

(5) There are three indicators for use in conjunction with the LIGHT VALUES. They are labelled DIM LIGHT HOOD OFF, COVER OPEN, and COVER CLOSED. The use of these indicators is made apparent in later paragraphs.

c. Photoelectric cell.—The photoelectric cell is a single unit mounted within the indicator shell. It has a very high-current output, which is uniform over a temperature range from 125°F to —30°F.

d. Indicator.—The indicator is a needle pointer over a scale marked LIGHT VALUES (FOOTCANDLES), with a range from 0 to 70. The scale itself does not change when the cover is open or closed, but the meter is considered as having three ranges of brightness because of the three positions indicated on the calculator dial.

e. Hood.—The hood on which the calculator dial is mounted is detachable from the cell and scale portion of the meter. This hood is used to restrict the amount of light reaching the cell and the angle at which it enters. On this hood is a cover, consisting of a hinged metal door with four slits, which permits a limited amount of light to enter and strike the cell. The angle of acceptance with the hood on is 28° vertically and 40° horizontally. The hood is so constructed that the amount of light which enters when the cover is open is ten times that which enters when the cover is closed.

Section II. DETAILED USE

54. GENERAL.—Exposure Meter PH-77-C General Electric DW48 may be used in a manner similar to the methods described in chapter 1. A thorough reading of chapter 1 is recommended before using any meter.

55. CAMERA-POSITION METHOD.—a. General.—The camera-position method is recommended for scenes which reflect average light, such

as a sweeping landscape with no deep shadows. This method should not be used with strong back or side lighting, or with any scene which has a great deal of contrast. It may be used in dim light, with the hood of the meter removed, instead of the methods described in paragraph 57. Remember, however, that the angle of acceptance with the hood off is so great that unimportant objects may cause an untrue reading.

b. Emulsion speed.—Set the emulsion speed of the film. The Weston rating is found in appendix I of this manual. The equivalent General Electric rating is found in appendix II. This value is set on the calculator dial by lifting the small indicator arrow between the 1/4- and the 1/5-second shutter speed and moving it around the dial until it coincides with the proper emulsion speed (fig. 14).

Note: Because of the latitude of modern film emulsions there is no appreciable difference between the General Electric and the Weston film speed ratings. This enables the user to interchange these ratings, since the exposure data computed using one will not vary more than half an *f* stop from the data computed using the other.

c. Position of meter.—Close the cover as shown in figure 14. Hold the meter near the camera and point the opening over the cell toward the scene. Avoid excessive sky reflections unless the sky is of primary interest in the scene. Read the brightness on the LIGHT VALUES scale.

(1) Set the COVER CLOSED arrow opposite the figure on the LIGHT VALUES band.

(2) If the brightness is less than 7, open the cover and take another reading. Set the COVER OPEN arrow opposite the new value on the LIGHT VALUES band. See figure 15 for a view of the meter with the cover open.

d. Choice of exposure.—In either of the above cases each of the combinations of shutter speeds and *f* STOPS will give the correct exposure. The choice must depend upon the nature of the scene, as discussed in subparagraph 7*c*.

56. NEAR-OBJECT METHOD.—When the object being photographed is strongly side or back lighted, or when some very dark or very bright object within the general scene is of primary importance, the meter must be held near that object. The distance of the meter from the object should equal approximately one diameter of the object. This method may be used with the cover open or closed. The remainder of the steps are the same as described in the preceding paragraphs.

57. DIM SCENES.—a. General.—The hood of the meter may be removed altogether when the object being photographed is in very dim light. Holding the meter close to the object, point it toward the camera. Read the figure on the LIGHT VALUES scale and set the DIM LIGHT HOOD OFF arrow opposite the indicated brightness.

Figure 15.—Exposure Meter PH-77-C General Electric DW48, cover open.

b. Incident-light method.—The method described in the preceding subparagraph is sometimes called the incident-light method. The meter, when so used, gives the best average exposure for a poor illumination. If it is impossible to hold the meter near the object, the incident light can be measured from any other position where the intensity is the same.

(1) When the light is very dim but uniform, the meter may be held at the camera but pointed away from the subject.

(2) This method gives the exposure for the middle tones in the scene, regardless of the brightness range or of the predominant brightness of the unimportant parts of the scene. If important parts of the scene are very much darker than the general light, the lens opening may be increased by one to one-half stop; if they are much lighter, the lens opening may be decreased by one to one-half stop.

Section III. MAINTENANCE

58. GENERAL.—a. Exposure Meter PH-77-C General Electric DW48 must not be subjected to any of the abuses listed in paragraphs 15 and 25. Any repair or test requiring disassembly of the meter must be done only by trained personnel using the proper precision equipment.

b. Unlike the other meters described in this manual, Exposure Meter PH-77-C General Electric DW48 may, *in an emergency,* be repaired in the field. Repairs should be attempted, however, only by trained personnel. Instructions for the disassembly of this meter are given in paragraph 60.

59. TESTS.—a. General.—The LIGHT VALUES indicated should be checked against those indicated by a meter known to be providing consistently accurate measurements. There are other tests that may be made without disassembling the meter. Before making any of these tests, clean the window over the photoelectric cell thoroughly; any dirt on the window will absorb light and cause an incorrect reading.

b. Checking the zero reading.—(1) First check the zero reading of the LIGHT VALUES indicator. This indicator should read zero when no light is striking the photoelectric cell. To make this test, remove the hood, cover the light-sensitive cell, and observe the pointer's position. If the pointer does not indicate zero, move the ZERO SET, situated on the back plate of the instrument, up or down until the pointer rests at zero (fig. 16). This adjustment should be made with the scale horizontal.

Figure 16.—Exposure Meter PH-77-C General Electric DW48, ZERO SET on back.

(2) With the cell still covered, check the balance by holding the meter with the scale vertical and the shaft horizontal. Rotate the meter slowly first clockwise and then counterclockwise through an angle of about 180°. If at any time the pointer deviates from the zero reading in either direc-

tion, the meter must be repaired. This repair consists of readjusting the needle-indicator mechanism. In most instances, variation of tension of the glass bearings is all that is needed.

c. Checking for jerky movements.—If the meter is dropped, banged, allowed to become wet or subjected to any other unusual conditions, it must be tested for stickiness or jerkiness in the pointer. Point the cell opening toward a light of sufficient brilliance to cause a full scale reading. Cover the cell gradually and watch the pointer; then uncover the cell with the same slow gradual movement. During this test there should be no signs of irregular movement of the pointer.

(1) If irregular movements appear, remove the cover of the instrument and expel any obstruction from the air gap. To remove the cover, pry off the retaining ring, and then remove the four screws which hold the back plate of the instrument in place. Look down from the top of the air gap in which the armature rotates to detect any particles that may be obstructing the movement of the element. If particles are found, they can be removed with low-pressure dehydrated air. Use an ear syringe. DO NOT BLOW INTO THE METER. If the ear syringe fails to remove the particles, use a small camel's hair brush. If some particle is difficult to remove, use a small, nonmagnetic rod.

(2) If no particles are found in the air gap, the stickiness may be due either to the pointer rubbing on the stationary parts of the pole-piece assembly or to incorrectly adjusted bearings. The trouble can be found by inspection and the readjustment necessary to give adequate clearance can be made. If the bearings are damaged, they can be replaced, or the entire instrument returned to the factory for repairs.

d. Checking the calibration.—For those units equipped to check the calibration of the instrument, the following test should be made whenever the meter has been tampered with or disassembled. Remove the hood, and, for a period of approximately twenty minutes, point the light-sensitive cell toward an illumination of such intensity that the pointer indicates between fifteen and twenty-five footcandles. The meter then should be checked against at least two different known intensities of illumination. If the indicator is inaccurate, it needs adjustment and must be returned to the factory.

60. DISASSEMBLY AND REPAIRS.—The complete disassembly of the meter is shown in figures 17 through 25 for the guidance of those units qualified to make repairs.

a. Figure 17 shows the method of separating the meter in half by pressure of the hands.

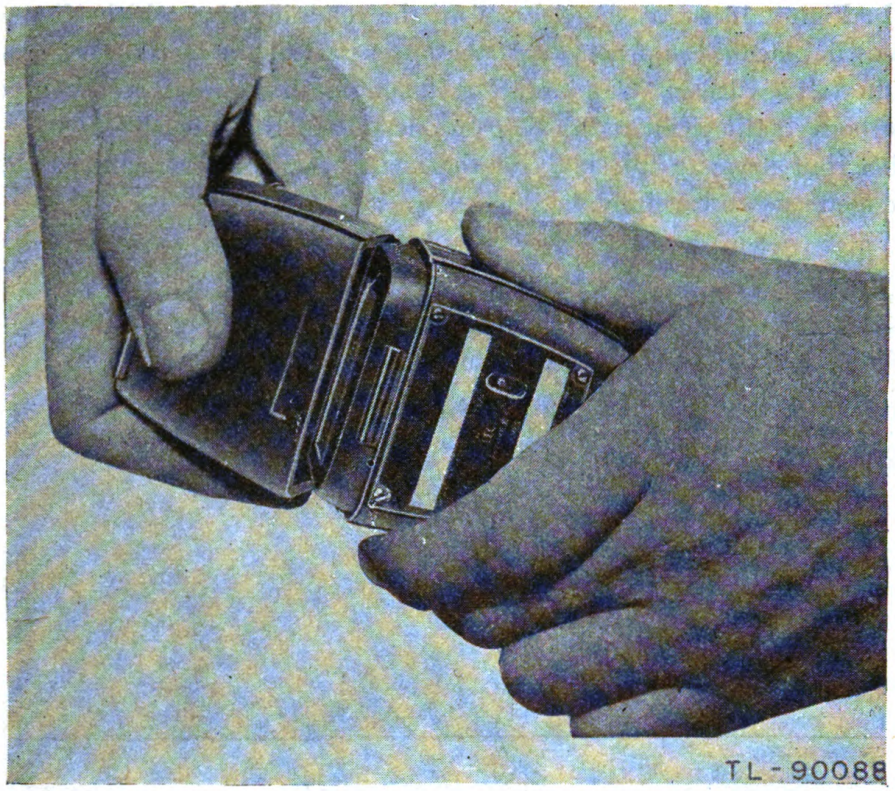


Figure 17.—Method of separating Exposure Meter PH-77-C General Electric DW48.

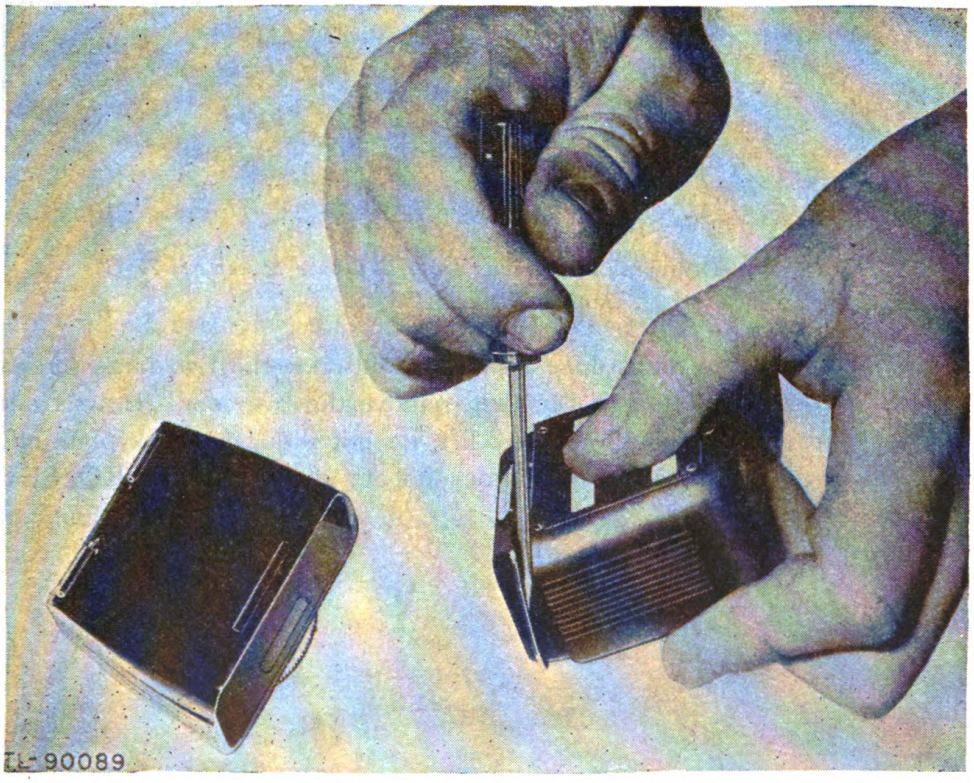


Figure 18.—Removal of retaining ring from Exposure Meter PH-77-C General Electric DW48.

b. Figure 18 shows the removal of the retaining ring which aligns and holds in place the top portion of the lower part of the meter. Pry upward with a screwdriver. Care must be taken in this operation not to chip the body of the meter. Pry first on one side of the ring and then on the other, but never on the body of the meter. After removing the ring, set the meter down carefully.

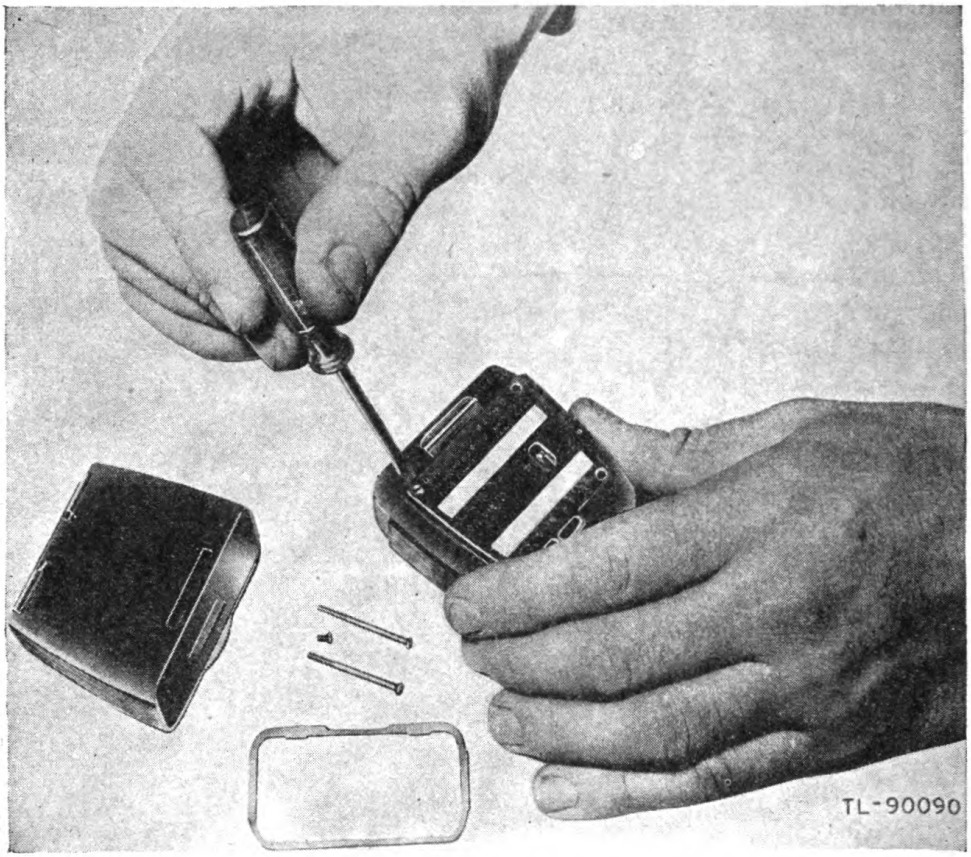


Figure 19.—Removing four screws from Exposure Meter PH-77-C General Electric DW48.

c. Then place the meter face down and unscrew the two large screws (fig. 19) from the bottom holes; then remove the two small screws from the top. After removing the screws, lift, do not slide, the back plate off. It is necessary to lift it off in order not to disturb the ZERO SET mechanism.

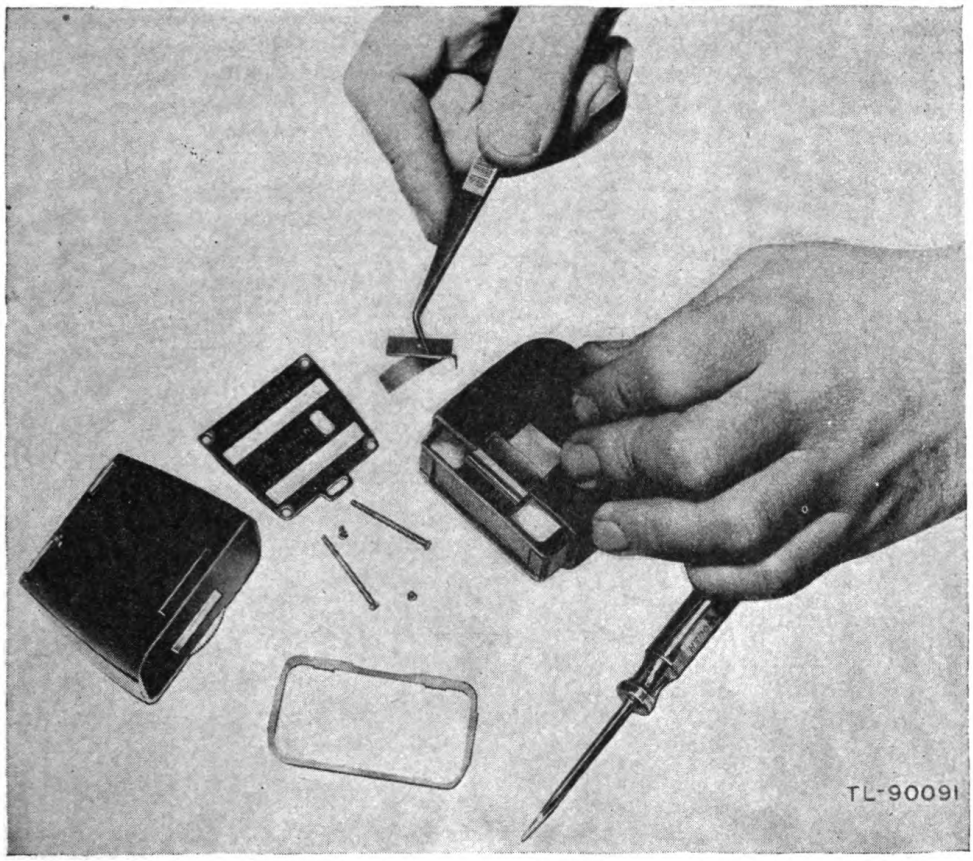


Figure 20.—Removing ZERO SET and copper spring from Exposure Meter PH-77-C General Electric DW48.

d. Then raise the black cardboard with the left hand and, using tweezers, grasp both the ZERO SET and the copper-colored spring immediately beneath it (fig. 20). Raise the two pieces of metal gently. Do not try to force the ZERO SET from its position. If it does not come out easily, the small hook on the end of it probably is jammed into the notch of the inside adjustment. In this case, proceed with the following step without removing the ZERO SET. When the meter is apart, the ZERO SET will fall out of its own accord.

e. Turn the meter over and hold it in the hands. Figure 21 shows the front of the meter being removed from the rest of the body. The parts sometimes stick because of heat and humidity. If this happens, pry loose the front of the meter gently with the small screwdriver.

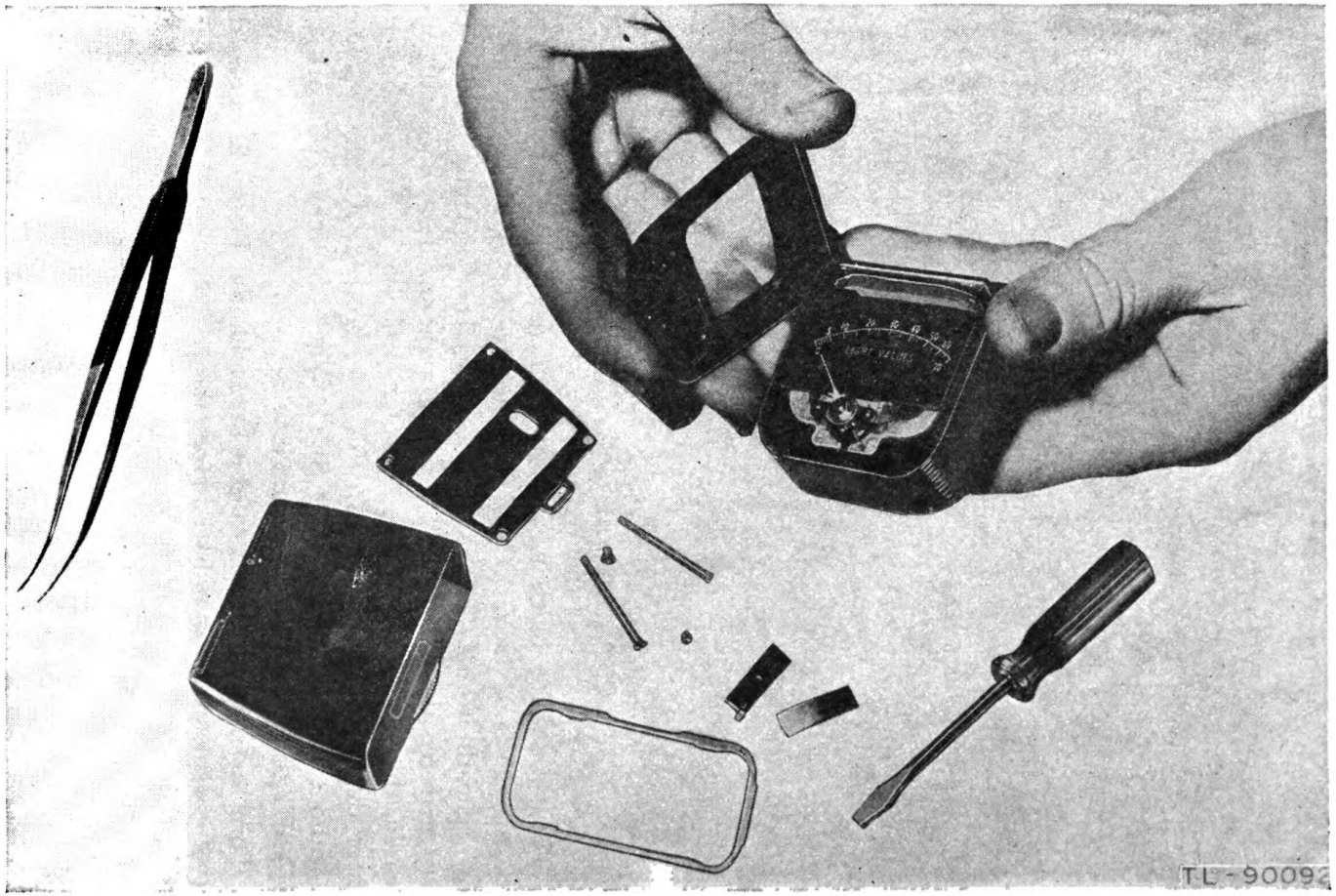


Figure 21.—Removing front of Exposure Meter PH-77-C General Electric DW48.

Figure 22.—Photoelectric cell of Exposure Meter PH-77-C General Electric DW48.

f. Then remove the two small screws which hold the LIGHT VALUES scale in place and remove the LIGHT VALUES scale. Figure 22 shows the meter almost completely disassembled. The tweezers point to one piece of mechanism that must never be touched or pried, or removed from the body: this is the photoelectric cell. If the glass above the cell is broken, the meter must be packed as described in paragraph 61 and returned to the manufacturer.

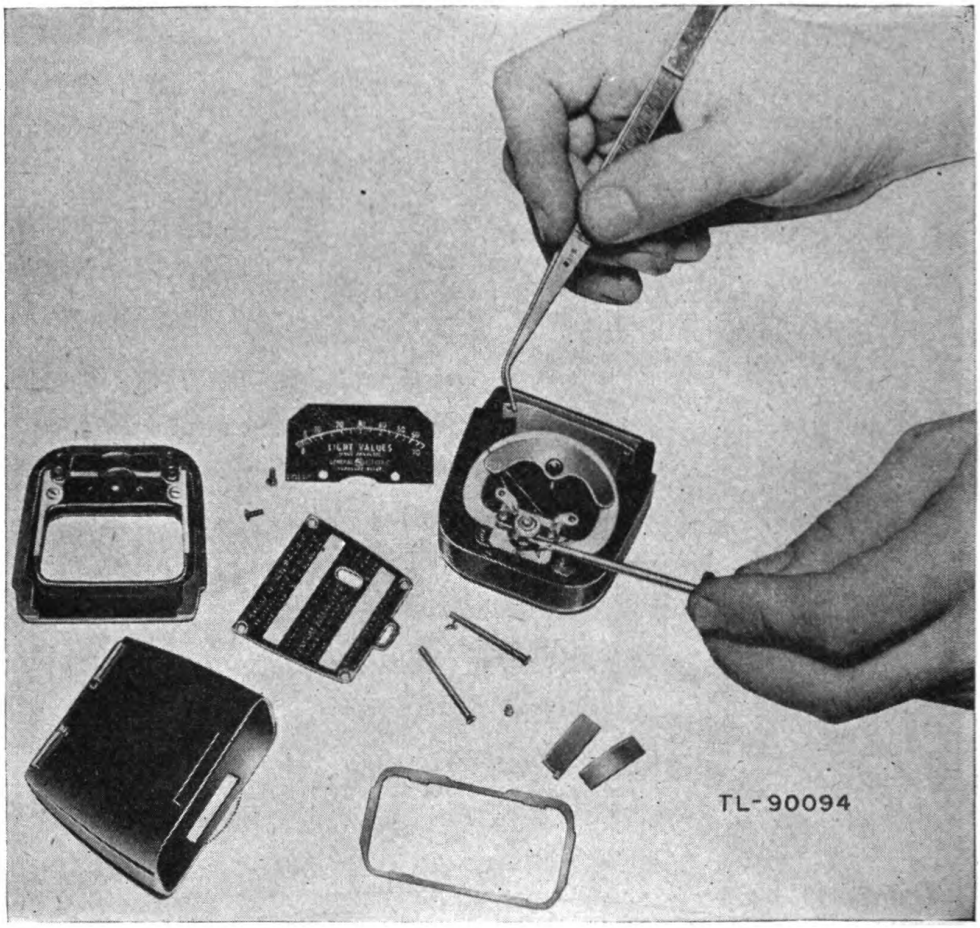


Figure 23.—Replacing hairspring in Exposure Meter PH-77-C General Electric DW48.

g. Figure 23 shows how the repair is made in one of the more common breakdowns. In this figure the hairspring has "jumped itself," and the outer portion of the spring has overlapped one of the inner portions. To adjust this spring, touch it with one end of the tweezers. If the spring does not jump back into its original position, grasp the outer ring of the spring with the tweezers and pull the spring downward and outward simultaneously. Do not touch the spring with a magnetic tool or subject the meter or any part of it to a magnetic tool.

h. The wires which carry the generated electricity to the armature may break at two points. These points may be recognized by the two small beads of solder present on each. If a contact is broken, use a very lightweight soldering iron to resolder it in its proper position.

CAUTION: Use only resin-core solder in resoldering any contact. Do not use acid-core solder under any circumstances.

i. For final disassembly, remove the brace plate (fig. 24) with exceptional care. The two green wires which pass over it are very fragile.

When the brace plate is removed, the nut into which the screw is based on the bottom side of the meter is free. This nut can be removed by turning the meter on its side. Force back the black cardboard. Remove the nut with tweezers. Then lift the entire mechanism out of its shell. The wires are then still connected to the photoelectric cell, but the shell is empty. To clean out this shell, use any type of dehydrated air pressure, or an ear syringe, or wipe it with a piece of lens tissue. Do not use any liquid to clean the interior of this shell. Do not oil any portion of this meter. Do not remove the contacts unless they are already broken. DO NOT REMOVE THE CELL BLOCK.

Figure 24.—Removing brace plate of Exposure Meter PH-77-C General Electric DW48.

j. Figure 25 shows the completely disassembled meter. Reading from left to right in the top row are the hood with the calculator mounted and the front cover opened, the face cover with the glass removed, and the shell with the meter mechanism. In the second row are the back cover,

the four screws which hold this cover in place, the glass from the front face cover, the two glass-holding rods and their accompanying screws, the dial face and its accompanying screws (the nut from the screw has been left in the mechanism), the ZERO SET tension spring, and the screwdriver and tweezers used in disassembling the meter.

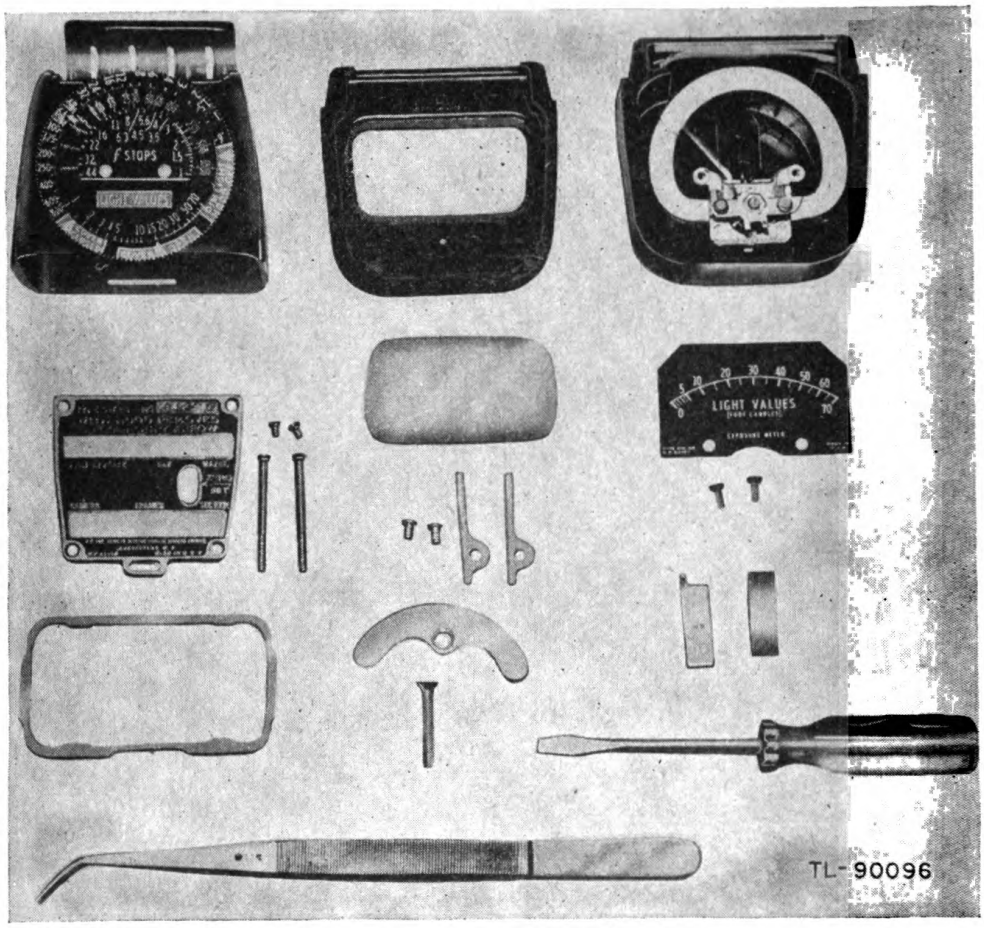


Figure 25.—Exposure Meter PH-77-C General Electric DW48, completely disassembled.

61. PACKING INSTRUCTIONS.—Exposure Meter PH-77-C General Electric DW48 is almost completely dustproof, moistureproof, and noncorrosive. It can be packed without special equipment or devices. The following packing instructions apply equally well to all exposure meters.

a. Wrap the meter tightly in a few folds of newspaper.

b. Place crumpled newspaper to a thickness of two to three inches about the meter.

c. Pack in a box made of heavy corrugated cardboard, wood, or metal.

d. If more than one meter is to be shipped, at least two inches of crumpled paper should separate each meter.

62. MAINTENANCE PARTS LIST FOR EXPOSURE METER PH-77-C (GENERAL ELECTRIC DW48).

Note: Order maintenance parts by stock number, name, and description.

Ref. Symbol	*Signal Corps stock No.*	*Name of part and description*	*Quan. per Unit*	*Running spares*	*Orgn. stock*	*3d ech*	*4th ech*	*5th ech*	*Depot stock*
Fig. 14	8A530-137	CASE, carrying; leather, with snapdown cover.	1		*		*	*	*
Fig. 22	8A1057C.1/C1	CELL, selenium, lacquered; 160 microamperes average output at 60 foot candles on a 300-ohm load at 30°C.	1				*	*	*
Fig. 25	8A1057C.1/C2	CLIP, steel, 1-1/16″ x 1/16″ x 1/32″, one side has shoulder 3/4″ from end to make overall width 1/4″ to allow 3/32″ diameter screw hole centered, 4/32″ from base.	2				*	*	*
Fig. 21	8A1057C.1/C3	COVER, bakelite, black, 2-3/16″ x 2-1/4″ x 5/16″ overall; with window aperture 7/8″ x 1-5/8″ overall to expose scale plate.	1				*	*	*
Fig. 25	8A1057C.1/E1	ELEMENT ASSEMBLY, with armature and pointer complete.	1				*	*	*
	8A1057C.1/G1	GASKET, fibre, 1-3/4″ x 1-1/4″ x .019″; fits under backplate.	1				*	*	*
Fig. 17	8A1057C.1/H1	HOOD ASSEMBLY, including multipher, spring and calculators.	1				*	*	*
Fig. 20	8A1057C.1/L1	LEVER, steel, 1/4″ x .030″ x 3/4″; with right angle protrusion from one end and even with one side, 1/4″ x 1/16″ x .030″; with thumb catch 1/3″ x 3/32″ centrally located on opposite side from angle.	1				*	*	*
Fig. 20	8A1057C.1/P1	PLATE, back steel, 1-3/4″ x 1-3/4″ overall; with opening for zero adjustment.	1				*	*	*
Fig. 14	8A1057C.1/R1	RIBBON, carrying, black, cotton, 1/4″ wide, 72″ long.	1	*			*	*	*

* Indicates stock available.

Ref. Symbol	*Signal Corps stock No.*	*Name of part and description*	*Quan. per Unit*	*Running spares*	*Orgn: stock*	*3d ech*	*4th ech*	*5th ech*	*Depot stock*
Fig. 19	6L20800-2.50	SCREW, machine, 0-86″ x 1/8″; O.H.B. nickel plate; holds top of back plate to case.	2				*	*	*
Fig. 19	6L20903-17.50	SCREW, machine, steel, oval head, 3-48 x 1-1/16″ overall length 5/16″ threaded; 3/4″ shank, nickel plated, used to hold bottom of back plate to case.	2				*	*	*
Fig. 20	8A1057C.1/S1	SPRING, flat, steel, 1/4″ x 25/32″ x .0085″; to keep tension against zero set lever.	1				*	*	*
Fig. 22	8A1057C.1/S2	SPRING, steel, flat, .016″ x 1-3/4″ x 7/8″; holds cell, washer and window in place.	1				*	*	*
	6L50324	WASHER, contact, copper, .018″ x 11/16″ x 7/8″; fits under cell window.	1				*	*	*
	1B826	WIRE, lead; insulated; copper; 3 strands of .005″; double silk insulation; varnished; used as lead on cell assembly.	2				*	*	*
		SECTION II							
	6L3104-48.3	NUT, 4-48, hex, brass, nickel plated; for magnet clamp screw.	1				*	*	*
	6L20904-12.7	SCREW, 4-48 x 3/4″; f.h.s.; nickel plate; holds magnet clamp in place.	1				*	*	*
	6L20703-2.2	SCREW, 3-48 x 1/8″; O.H., aluminum; for window clip.	2				*	*	*
Fig. 22	8A1057C.1/W1	WINDOW, glass, 1-11/16″ x 7/8″ x 1/16″, to cover cell.	1				*	*	*
Fig. 25	8A1057C.1/W2	WINDOW, glass 1″ x 1-13/16″ x 1/16″, rounded corners; to cover scale plate.	1				*	*	*

*** Indicates stock available.**

CHAPTER 6

EXPOSURE METER PH-77-C DEJUR AMSCO CRITIC

Section I. GENERAL INFORMATION

63. PURPOSE.—Exposure Meter PH-77-C DeJur Amsco Critic (fig. 26) is used primarily for determining exposure data for still pictures, although it may be used for motion picture photography if the shutter speed of the motion picture camera is known.

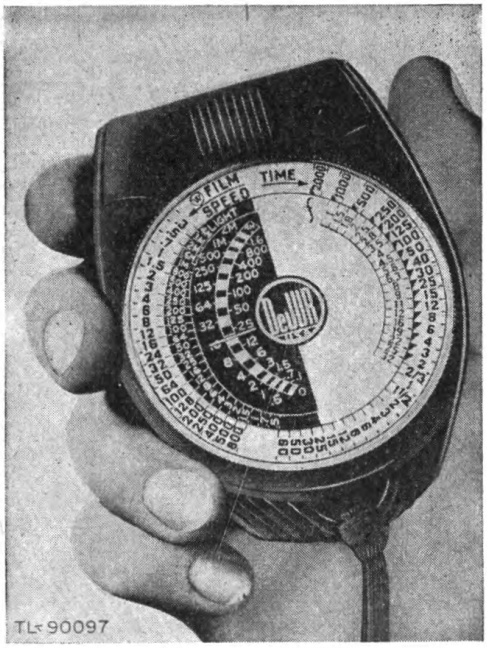


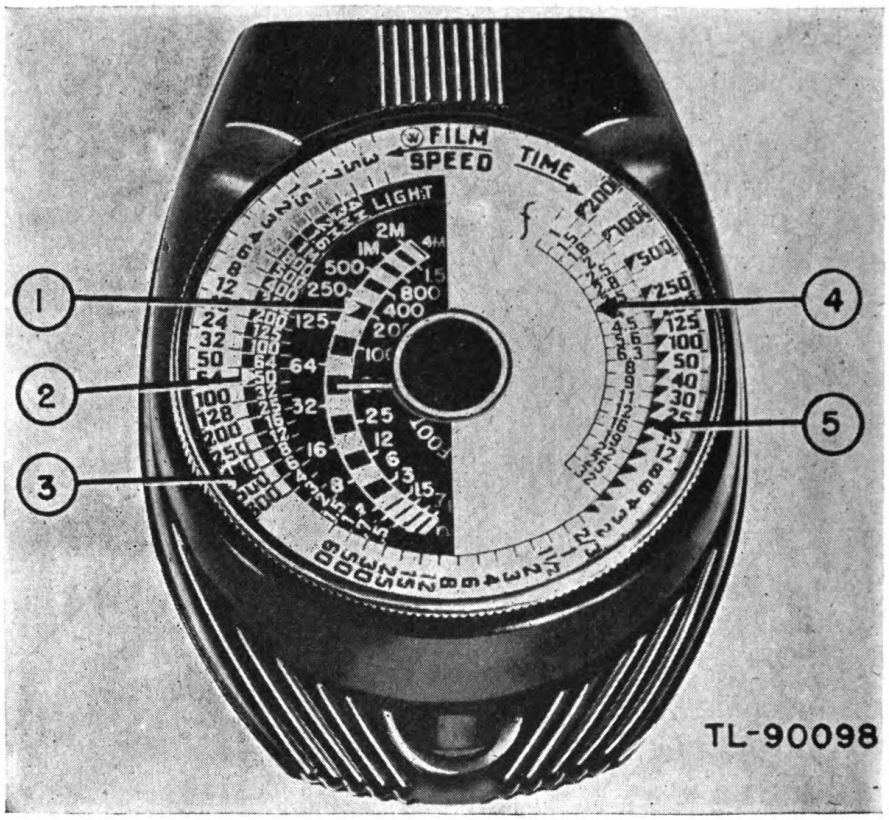
Figure 26.—Exposure Meter PH-77-C DeJur Amsco Critic.

64. GENERAL DESCRIPTION.—a. General.—This meter is operated, as are all others discussed in this manual, by the use of a photoelectric cell. The photoelectric cell converts the light striking it into electrical current which, in turn, operates a pointer indicator. This pointer moves along a scale calibrated in candles per square foot. The meter is 3.38 inches long, 2.50 inches wide, and 1.12 inches thick.

b. Light values.—The LIGHT values are in one range, from 0 to 4,000 candles per square foot. The angle of acceptance over the cell, governed by a louver which is built into the meter, is approximately 120° horizontally and 60° vertically. The cell and the louver are covered with glass, mounted in the front end of the case. The cell element is mounted within the moded housing, and connections are made between the cell and the meter by means of silver-plated contacts.

c. Calculator dial.—The calculator dial is mounted concentrically above the needle indicator and the LIGHT value scale (fig. 27). It is in four parts, but has no provisions for selecting any exposure other than the one for average brightness.

(1) The LIGHT values appear on the inner circle of the calculator dial and range from .5 to 4,000, the latter marked 4M. The divisions are the same as those on the scale under the needle indicator.



(1) LIGHT value indicator.
(2) LIGHT value setting.
(3) Emulsion-speed setting
(W) FILM SPEED.
(4) *f* stops.
(5) Shutter speeds.

Figure 27.—Calculator dial of Exposure Meter PH-77-C DeJur Amsco Critic.

(2) The emulsion speeds appear on the outer circle on the same side as the LIGHT values. They are marked (W) FILM SPEED, the (W) indicating Weston, since the emulsion speeds to be used in setting this meter are taken from the Weston emulsion-speed chart. They range from .3 to 800 on the meter.

(3) The *f* stops appear on the opposite side of the inner circle and are printed in red. They range from *f*1 to *f*32.

(4) The TIME setting on the outer circle, also printed in red, indicates the shutter speed. These range from 60 seconds to 1/2000 second.

Care must be taken to read all those figures printed with a small solid triangle alongside them as denominators of fractions with 1 as the numerator. The figures without this small triangle are to be read at their printed value in seconds.

Section II. DETAILED USE

65. GENERAL.—The method of using Exposure Meter PH-77-C DeJur Amsco Critic is similar to the method described in chapter 1. A thorough reading of chapter 1 is recommended before using any exposure meter.

66. CAMERA-POSITION METHOD.—This method, more than any other, is used with Exposure Meter PH-77-C DeJur Amsco Critic because this meter has only one method of selecting the combinations of shutter speeds and *f* stops to be used. Although the light value of the darkest object and that of the brightest object may be measured, these values can not be set directly on the meter.

a. In the camera-position method, hold the meter near the camera and point it toward the scene in such a manner that excessive reflection is avoided, and so that the calculator dial can be read while the meter is registering the LIGHT value. Read the LIGHT value.

b. Set this LIGHT value opposite the (W) FILM SPEED of the film in the camera. The correct combinations of *f* stops and shutter speeds now appear in the red bands on the opposite side of the calculator dial. The deciding factor in selecting the combination to be used is the nature of the scene being photographed. If this meter is being used with a motion picture camera, the shutter speed is fixed by the number of frames per second being shot, and by the type of shutter in the camera. The shutter speeds of the cameras now in use by the Army are listed in appendix V of this manual.

67. BRIGHTNESS-RANGE METHOD.—a. General.—The meter may be used to estimate both the brightness of the darkest object and that of the brightest object in the scene. These measurements will be made close to the object in question. An average is then taken between the two measurements and this average set as the average brightness of the scene.

b. Estimating average brightness.—(1) The average LIGHT value is the middle one between the low and the high value. For example, if the brightest object has a LIGHT value of 400 and the darkest object has a LIGHT value of 12, it will be seen by examining the LIGHT value divisions that there are nine between these two. The middle one, 64, which is the fifth from either end, is the average LIGHT value for this scene. Set this value opposite the (W) FILM SPEED and proceed as in paragraph 66.

(2) Remember that if the LIGHT values have a range greater than the film range of 1 to 128, this average exposure does not record both the highlights and the shadows; one or the other must be sacrificed. For example, if the value of the brightest object is 500 and that of the darkest object is 2, then they cannot be recorded properly since the ratio between them is 1 to 250, which is beyond the range of the film. The decision as to which to sacrifice will depend on the relative importance of the two objects in the final photograph.

68. USE IN DARKROOM.—Exposure Meter PH-77-C DeJur Amsco Critic may be used to calculate the printing times in either contact or projection printing, if a table of times and brightness values is set up as described in paragraph 11.

Section III. MAINTENANCE

69. GENERAL.—Exposure Meter PH-77-C DeJur Amsco Critic must not be subjected to any of the abuses described in paragraphs 15 and 25. Treat it with the care that a precision instrument requires.

70. TESTS AND REPAIRS.—The following tests are to be used to ascertain the reasons for the meter's failure to function and are not to be used as a basis for making repairs. No repairs involving disassembly of the meter will be attempted except by trained personnel equipped with highly specialized equipment.

a. Testing zero position of indicator.—The first test to be made is on the zero position of the pointer indicator. Cover the glass window over the photoelectric cell with an opaque material. When this is done, the instrument should indicate zero. The zero position is the first white graduation above the figure 0. If the pointer does not indicate zero, turn the zero set screw located on the back of the instrument until the pointer rests over zero. This test should be made while the scale lies horizontally which is the natural balance position.

b. Testing for balance.—(1) The balance may be checked, while the cell is still covered, by holding the instrument with the calculator scales in a vertical position. Thus the pointer is in a vertical position. Rotate the instrument slowly first in a clockwise and then a counterclockwise direction, and watch the action of the pointer carefully. The pointer should not sway from the zero position in either direction. If it does, the readings obtained are not reliable and the meter must be returned for repair.

(2) A qualified repairman may disassemble the meter as described in subparagraphs 71*a* through *d* and then correct the balance by readjusting the jewel-bearing screw as described in subparagraph *c*(2) below.

c. Testing for irregular or jerky movement.—The meter should now be checked for jerky movements of the pointer indicator. Point the cell

opening toward a light source of sufficient brilliance to cause a full scale reading. Cover the cell opening gradually and observe the movement of the pointer. Then uncover the cell opening slowly and gradually. During this operation, the needle should move evenly without sticking or jerking.

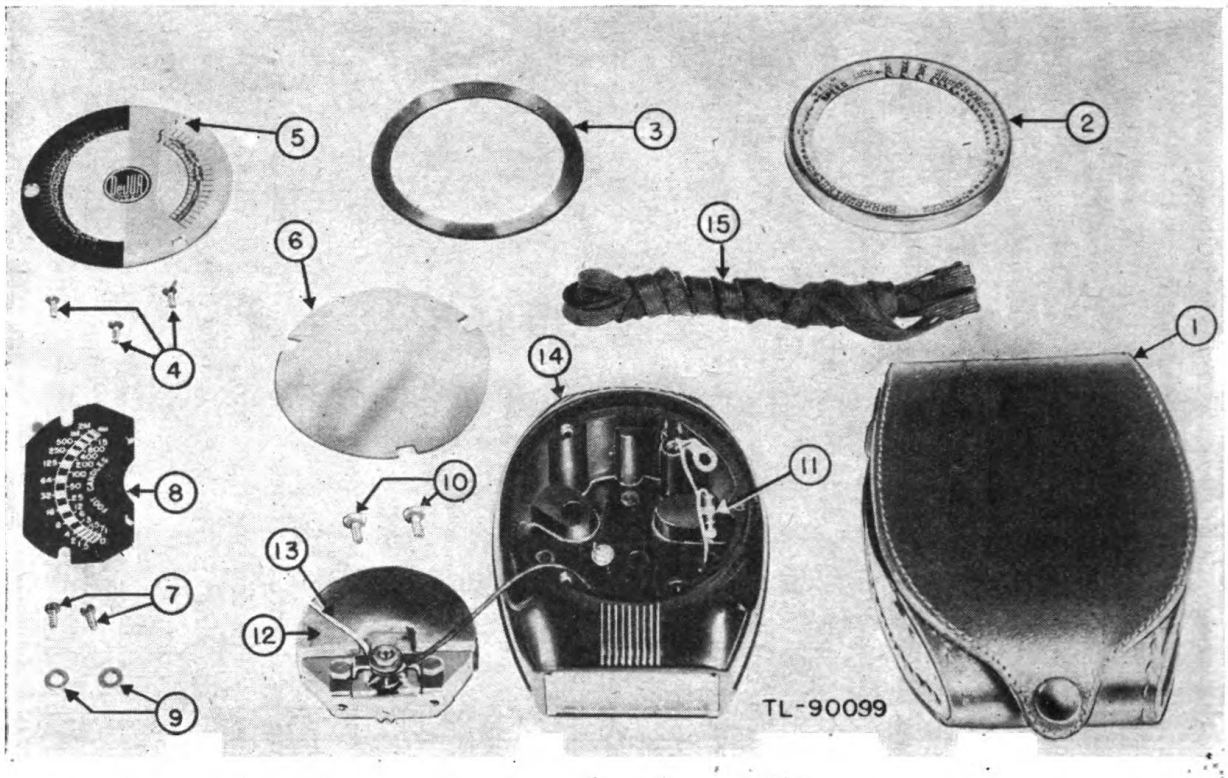
(1) If the needle does not function properly, a qualified repairman should disassemble the meter as described in subparagraphs 71*a* and *b*. Do not disassemble the meter any further than described in subparagraph 71*b* for this repair. Place the instrument under a strong light and examine the galvanometer assembly. If particles of foreign matter are obstructing the movement, remove them with low-pressure dehydrated air. DO NOT BLOW INTO THE METER. Use an ear syringe. If this action fails to remove the particles, use a small camel's hair brush. If some particle is difficult to remove, by any of these methods, use a small, sharp, non-magnetic rod.

(2) If no foreign particles are found, the irregular movement may be caused by the pointer rubbing on the scale or by excess tension of the armature. The pointer probably is bent if it is rubbing on the scale. Straighten it and test the meter again. If the armature tension is excessive, loosen the jewel nut and adjust the armature-tension screw with a small screw driver until the proper tension has been achieved. Then retighten the nut.

71. DISASSEMBLY.—Disassembly of the meter must be undertaken only by trained personnel using the equipment necessary to make proper repairs. All disassembly and reassembly should be done in a room as nearly dust-free as possible. The encircled numbers in the following subparagraphs refer to figure 28.

a. Remove the meter from the leather carrying case (1) and place the meter on a flat surface with the calculator scales facing upward. Remove the rotating ring assembly (2) by inserting a knife between the knurled side of the ring and the inner support. Press slightly on the ring, being careful not to bend or distort it. Loosen the ring from its base and lift it from the instrument. The rotating calculator dial is part of this assembly and comes off when the ring is removed. Immediately beneath the ring assembly is a brass friction shim (3) which allows the rotating ring to turn easily. Lift off this shim. Then remove the three brass filister-head screws (4) and lift off the bottom calculator plate (5). Remove the transparent dust shield (6) which is just beneath the bottom calculator plate.

b. If further disassembly is necessary, loosen the two screws (7) holding the footcandle scale (8) and slip the scale carefully from beneath the indicator needle (13). In removing the scale be careful not to bend the indicator by contact with either of the two punched-out "stops" on the scale. Immediately beneath the scale are two brass washers (9) which bring the scale slightly closer to the indicator, thus giving more accurate readings. These washers are held in place by the two screws (7) which



(1)	Case, leather, carrying	(6)	Shield, dust	(11)	Resistor
(2)	Ring assembly, rotating	(7)	Screws	(12)	Magnet assembly
(3)	Shim, brass	(8)	Scale, footcandle	(13)	Indicator, needle
(4)	Screws	(9)	Washers	(14)	Case
(5)	Plate, calculator	(10)	Screws	(15)	Cord, carrying

Figure 28.—Exposure Meter PH-77-C DeJur Amsco Critic, disassembled.

hold the footcandle scale in place. The complete galvanometer movement and magnet assembly are now visible and may be inspected and cleaned without removal from the case.

c. If it is necessary to remove the magnet assembly (12) from the case, remove the screws (10). In removing these screws be careful not to break the soldered connection of the resistor (11) which is in series from one leg of the photoelectric cell to the "ground" of the instrument. This resistor is located immediately above the two screws (10). The entire magnet assembly may now be lifted from the case. The instrument is now completely disassembled except for the removal of the armature. This is not to be attempted because of the special tools required for the reassembly of this part.

d. When the magnet assembly is removed from the case, the aligning prod for the zero-set screw remains within the case as a fixed component. This prod, by controlling the position of the armature, controls the tension of the spring. In addition to the aligning prod a brass holding-pin remains within the case. This pin holds the photoelectric cell in place. It must not be removed.

e. Examine all contacts for corrosion or oxidation. Examine the instrument carefully for general cleanliness.

72. REASSEMBLY.—a. Replace the magnet assembly (12) in the case. Be sure that the aligning prod of the zero-set screw falls in its proper track in the aligning slot. Replace the two screws (10). The screw which is farther from the photoelectric cell must be placed through the eye in the end of the resistor contact.

b. After the magnet assembly is fastened into the case, point the meter toward a light source. If the needle reacts, the connections are unbroken. If the needle fails to react, a contact is broken and must be resoldered before proceeding with the reassembly of the meter.

CAUTION: Use only resin-core solder in resoldering any contact. Do not use acid-core solder under any circumstances.

c. Slide the footcandle scale (8) into place being careful not to bend the indicator needle. Replace the two brass washers (9) underneath the footcandle scale and then insert the two screws (7) through the scale and the washers, and into the case. In placing the dust shield (6), align the three notches with the three tapped holes. Replace the fixed calculator plate (5) and secure it with the three brass filister-head screws (4). Place the brass shim (3) over the fixed calculator plate. Snap on the rotating ring assembly (2). The meter is now completely reassembled and should be checked for accuracy. Compare its readings with those of another meter known to be giving satisfactory results.

d. After the reassembly, the instrument should be pointed toward a bright light and the pointer observed to see that it moves up to full scale. The meter is now ready for testing as described in paragraph 70.

Section IV. LIST OF PARTS

73. GROUP ASSEMBLY PARTS LIST.—The group assembly parts list is a compilation of major assemblies and is divided into main and minor serviceable assemblies and detail parts which together constitute the final assembly. The system of breakdown in this parts list places the component parts in their sequence of assembly. Subassemblies and details are arranged and indented in order, indicating their relation to the main assembly. The Signal Corps stock number of the meter is 8A1057C. The list of parts follows:

GROUP ASSEMBLY PARTS LISTS

Name	*Manufacturer's Part No.*	*Quantity required*
Meter assembly photoelectric exposure	Z–22.17	1
Magnet assembly	Z–20.85	1
Magnet	Z–9.21	1
Piece, Pole	Z–6.87	1
Bracket and jewel screw assembly	Z–20.71	1
Bracket and core assembly	Z–20.70	1
Bracket	Z–6.59	1
Core and core support assembly	Z–20.63	1
Core	Z–7.42	1
Support, core	Z–6.64	1
Jewel screw assembly	Z–20.16	2
Blank, jewel screw	Z–1.17-2-1/2	2
Jewel, bearing	Z–10.19	2
Lock nut	Z–7.11	2
Washer, tension	Z–6.16	2
Washer, slip	Z–5.12	1
Regulator, bottom	Z–6.63	1
Washer, insulating	Z–5.14	2
Washer, insulating inside	Z–5.13	1
Regulator, top	Z–6.30	1
Coil assembly	Z–20.143	1
Plate assembly, pivot, upper and lower	Z–20.144	2
Plate, pivot	Z–7.81	2
Pointer	Z–6.76	1
Spring, hair, lug	Z–6.6	2
Form, coil	Z–6.228	1
Wire		As required
Insulator, paper	Z–8.13	2
Spring, hair, formed	Z–10.209	2
Pivot	Z–7.18	2
Weight, balance	Z–10.207-4	1
Weight, balance	Z–10.207-2	2
Plate, magnet, mounting	Z–6.73	1
Screw, magnet, mounting	Z–7.51	2
Nut, magnet, mounting	Z–1.12	2
Case assembly	Z–20.145	1

GROUP ASSEMBLY PARTS LISTS (Contd.)

Name	*Manufacturer's Part No.*	*Quantity required*
Case	Z–8.54	1
Insert	Z–7.50	2
Screw, zero, regulator	Z–7.48	1
Washer, tension	Z–6.222	1
Lever, zero, regulator	Z–6.62	1
Cell assembly	Z–20.146	1
Cell assembly, band	Z–6.74	1
Insulator, cell	Z–8.25	2
Spring, cell	Z–6.75	1
Cell	Z–10.47	1
Band, contact	Z–6.82	1
Grid	Z–6.86	1
Glass, cell	Z–10.119	1
Wire, lead	Z–10.200-32	1
Wire, negative	Z–10.210	1
Pin	Z–7.49	1
Terminal	Z–10.130	1
Resistor	Z–10.131	1
Screw, magnet, plate	Z–1.31	2
Washer, scale, plate	Z–5.25	2
Plate, scale—Alternatively to suit cells	Z–15.1105	1
Plate, scale—Alternatively to suit cells	Z–15.1105-1	1
Screw, scale, plate	Z–81.2	2
Plate, bottom, calculator	Z–6.77	1
Window[a]	Z–10.118	1
Screw	Z–1.32	3
Ring, friction	Z–6.83	1
Bezel assembly[b]	Z–20.91	1
Bezel[b]	Z–10.11	1
Glass cover	Z–10.116	1
Plate, top, calculator	Z–10.117	1
Plate, name	Z–5.198	1
Pin, holding	Z–7.93	2
Cord, carrying	Z–10.56	1
Case, leather, carrying	Z–10.129	1

[a] This part is the dust shield and is referred to as such in the text.

[b] This assembly is referred to in the text as the rotating dial assembly, and the bezel is referred to as the rotating ring.

CHAPTER 7

EXPOSURE METER PH-252-A WESTON M720

Section I. GENERAL INFORMATION

74. PURPOSE.—Exposure Meter PH-252-A Weston M720 is used in calculating exposure data for motion picture photography. It is used by general assignment units equipped with motion picture cameras, and is issued also as part of Spotting Set PH-32-A.

75. GENERAL DESCRIPTION.—a. General.—Exposure Meter PH-252-A Weston M720 is similar in design and construction to Exposure Meter PH-77-C Weston M715 with the exception of the calculator dial, which is designed for use in motion picture photography (fig. 29). The meter is oblong, with one end rounded to accommodate the calculator dial. The entire meter is 4.18 inches long, 2.28 inches wide, and 1.15 inches thick. It is provided with a leather or canvas carrying case, and a neck cord which enables the user to keep the meter around his neck while using it, thereby lessening the danger of dropping it.

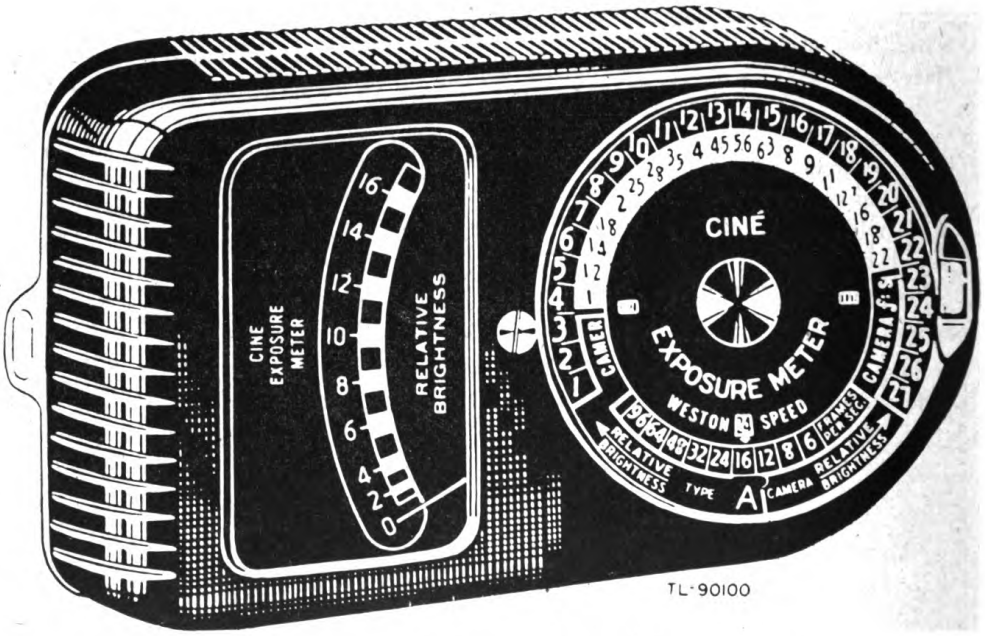


Figure 29.—Exposure Meter PH-252-A Weston M720.

b. Calculator dial.—The calculator dial contains settings for the variable elements in the computation of data used in exposing motion picture film.

(1) The setting must be made for the type of camera in use. This setting is labelled TYPE CAMERA and has two positions, A and B, depending upon the angle of the shutter opening. A listing will be found in the appendix of this manual of the types of camera under A and of the types under B.

(2) The light values range from 1 to 27 and are found around the calculator dial's outer rim, which is labelled RELATIVE BRIGHTNESS.

(3) The inner circle contains provisions for setting the number of frames per second at which the camera is operating. These range from 6 to 96 and are labelled FRAMES PER SEC.

(4) Also found on the inner circle are the CAMERA *f* STOPS, which range from 1 to 22.

(5) The emulsion speeds are set in an oblong slot labelled WESTON SPEED, and range from .1 to 800.

(6) A dial release, which is located on the rounded end of the meter, locks the dial into its position until the release is pressed down. It is again locked when pressure is released.

c. Photoelectric cell assembly.—The photoelectric cell assembly is similar to that in all Exposure Meters PH-77-(&).

d. Light-value indicator.—The light-value indicator consists of a needle pointer and a scale labelled RELATIVE BRIGHTNESS. The scale has two ranges which are automatically changed by the opening and closing of an auxiliary baffle over the cell. The full range is in view when the baffle is closed and extends from 0 to 26, and the low range, which comes into view when the baffle is opened, is from 0 to 16. When the RELATIVE BRIGHTNESS is below 16, the auxiliary baffle should be opened. Since the figures are more widely spaced on this low scale of RELATIVE BRIGHTNESS, the user can read the meter more easily and more accurately.

Section II. DETAILED USE

76. GENERAL.—The method of using Exposure Meter PH-252-A Weston M720 is similar to the method described in chapter 1. A thorough reading of chapter 1 is recommended before using any meter.

77. METHODS OF USE.—a. Set the TYPE CAMERA on the calculator dial. The type designation of the camera being used is found in the table in appendix IV of this manual.

b. Set the emulsion speed of the film being used by holding the center dial and rotating the top dial until the correct speed appears in the slot marked WESTON SPEED.

c. Set the FRAMES PER SEC. at which the scene is being photographed. The speed used for all sound film, or for film on which sound may be added, is 24 frames per second. Other speeds may be used in an emergency or for special effects but are not recommended for sound quality. This is set by rotating both the top and middle dials until the index below the WESTON SPEED opening is opposite the correct figure in the FRAMES PER SEC. band.

d. The method of holding the meter to measure the amount of light reflected is the same for either still photography or motion picture photography. In general, it is better to underexpose motion picture film than to overexpose it. Special care must be taken to avoid excessive background reflections. The meter should be placed near the most important object in the scene, rather than near the camera. Several readings should be taken, and an average determined for the scene. Since the subject is moving, provisions must be made to modify any extreme shadows or highlights into which the subject may move. Since the use of the meter is controlled by these provisions, they must be made before the light is measured.

e. Read the RELATIVE BRIGHTNESS. Consult this figure on the calculator dial, and the figure appearing below it is the CAMERA *f* STOP to be used in photographing the scene.

f. No provisions are made for either cutting down or increasing the exposure, in case the scene being photographed is of a special nature requiring such compensation. This changing of the exposure is accomplished without special setting of the meter by consulting the CAMERA *f* STOP to the right or left of the indicated one. It must be remembered that the higher *f* number decreases the exposure, while the lower *f* number increases it. For example, if the exposure indicated is *f*5.6, the higher *f* number, *f*6.3, cuts the exposure down, while the lower number, *f*4.5, increases the exposure.

Section III. MAINTENANCE

78. GENERAL.—Exposure Meter PH-252-A Weston M720 must be treated as carefully as all other exposure meters to prevent the cell or meter mechanism from being damaged. The same precautions are to be taken to avoid abuses to the meter, which are described in paragraphs 15 and 25.

79. TESTS.—The tests to be made upon the meter, whenever its accuracy is questioned or whenever the meter has been subjected to any abuses, are the same as those described in paragraph 49.

80. DISASSEMBLY.—a. Disassembly of the meter is not to be undertaken under any circumstances. There is a special sealing oil, used in the manufacture of the meter, to protect the mechanism and the cell from moisture. This oil loses some of its effectiveness if the meter is disassembled.

b. Another reason for not disassembling the meter is the fact that there are four screws of special design which hold the two main components together. The removal of these screws requires a special knurled socket wrench available only at fifth echelon repair shops.

Section IV. LIST OF PARTS

81. GENERAL.—The list of parts is not included in this manual, since the meter is not to be disassembled. Neither the meter nor the parts are available for replacement. This meter is no longer being manufactured. The Signal Corps stock number is 8A1058A. If this meter becomes unserviceable, it may be replaced by PH-252-A General Electric DW49, described in chapter 8.

CHAPTER 8

EXPOSURE METER PH-252-A GENERAL ELECTRIC DW49

Section I. GENERAL INFORMATION

82. PURPOSE.—Exposure Meter PH-252-A General Electric DW49 is used to calculate exposure data for motion picture photography. It is used by general assignment units and all other units equipped with motion picture cameras. This meter is also issued as part of Spotting Set PH-32-A, which is described in paragraph 1*c*.

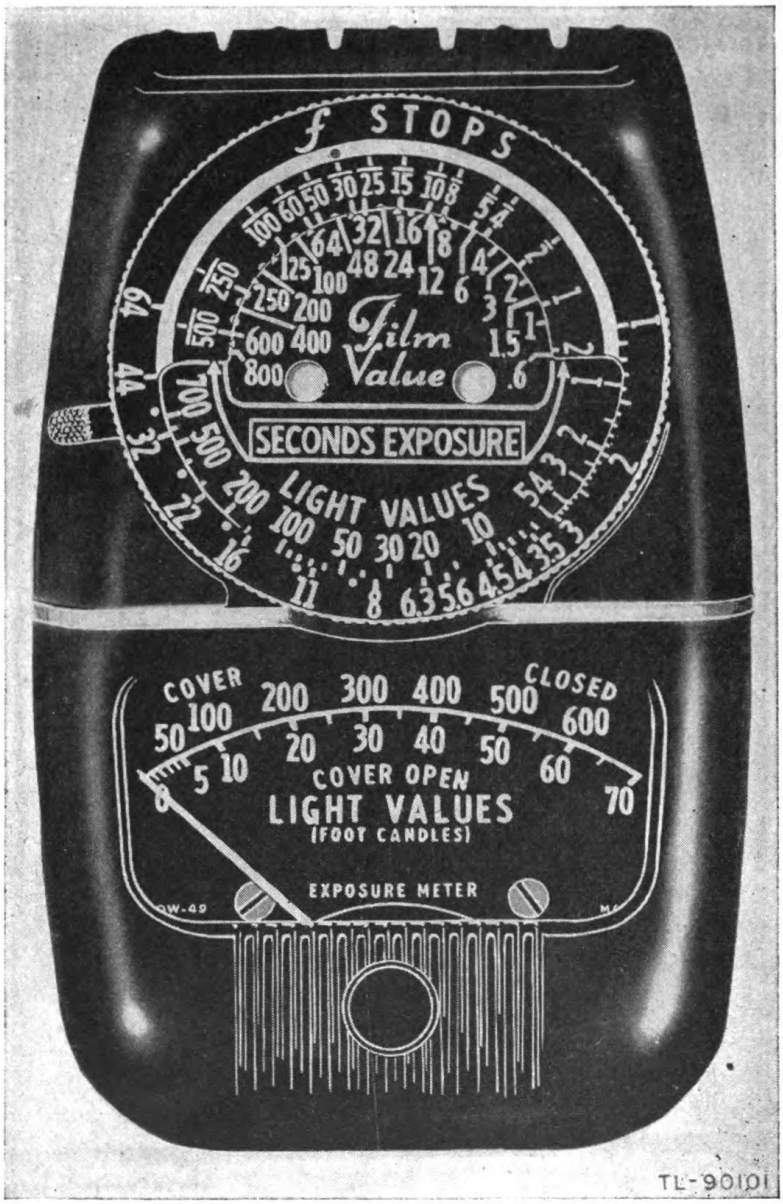


Figure 30.—Exposure Meter PH-252-A General Electric DW49.

83. GENERAL DESCRIPTION.—a. General.—Exposure Meter PH-252-A General Electric DW49 (fig. 30) is of a design similar to Exposure Meter PH-77-C General Electric DW48, but the calculator dial is designed for the specific purpose of calculating exposures for motion picture cameras.

b. Calculator dial.—The calculator dial contains settings for all the variable elements used in computing the exposure data.

(1) The band of *f* stops, ranging from 1 to 64, appears around the outer edge of the dial.

(2) The settings for the LIGHT VALUES, which range from 1 to 700, appear on the second circle. These numbers are on a raised, fixed, semi-circular flange.

(3) The shutter speeds, which are labelled SECONDS EXPOSURE, are also on the inner circle but are on the movable dial.

(4) The emulsion speeds, which are labelled FILM VALUE and range from .6 to 800, are on the center circle and printed on the same fixed dial as the LIGHT VALUES. These FILM VALUES are in the General Electric system; the equivalents in the Weston ratings are listed in appendix II of this manual.

c. Photoelectric cell assembly.—The photoelectric cell assembly is exactly the same as that in Exposure Meter PH-77-C General Electric DW48, described in subparagraph 53*c*.

d. Light-value indicator.—The light-value indicator, consisting of a needle pointer and a scale which is calibrated in footcandles, is labelled LIGHT VALUES (FOOT CANDLES). A cover over the hood provides two ranges on the indicator. With the cover open, read the bottom scale labelled COVER OPEN, which ranges from 0 to 70. With the cover closed, read the top scale labelled COVER CLOSED, which ranges from 0 to 700. The LIGHT VALUES thus measured are set on the calculator dial in the same manner, whether the cover is open or closed.

Section II. DETAILED USE

84. GENERAL.—The use of this meter is similar to that of Exposure Meter PH-77-C General Electric DW48, except for the setting of the calculator dial.

85. METHODS OF USE.—a. Before taking the reading of the LIGHT VALUE, set the shutter speed on the SECONDS EXPOSURE dial opposite the emulsion speed on the FILM VALUE dial. Consult appendix I for the Weston speed of the film and then find the equivalent General Electric value in appendix II. Since the shutter speed and emulsion speed remain constant for any one scene taken with a single camera, these values do not change until the shutter is set at a different angle, the film

is changed, or another camera is used. To make the setting, first press the dial-lock release, freeing the dial to be turned, and then align the proper values alongside each other. See note in subparagraph 55*b*.

b. Point the meter toward the scene being photographed. The user must be especially careful not to include extraneous reflections in the angle of acceptance of the meter. Readings should be taken near the object of importance in the scene, rather than from the camera position. Several readings should be taken and an average brightness determined.

c. Consult this brightness value on the LIGHT VALUES band of the calculator dial. The figure alongside it on the *f* STOPS band is the proper lens aperture for that particular scene.

d. The only provision made for an additional range of brightness is on the indicator dial and in the cover over the hood, as described in subparagraph 83*d*. Although the calculator dial does not provide for choosing an exposure half or double the normal one indicated, this may be done by using the *f* STOP to the right of the one indicated to increase the exposure, or the one to the left to decrease the exposure.

Section III. MAINTENANCE

86. GENERAL.—Exposure Meter PH-252-A General Electric DW49 must be treated as carefully as all other exposure meters to prevent the cell or meter mechanism from becoming damaged. The same precautions must be taken as described in paragraphs 15 and 25.

87. TESTS.—The same tests will be made as those described for Exposure Meter PH-77-C General Electric DW48 in paragraph 59.

88. DISASSEMBLY.—The disassembly is done in exactly the same manner as the disassembly of Exposure Meter PH-77-C General Electric DW48 described in paragraph 60. The same restriction is imposed on the repairing of the meter, however; repairs must be made only by trained personnel using the proper precision equipment.

Section IV. LIST OF PARTS

89. LIST OF PARTS.—The parts of Exposure Meter PH-252-A General Electric DW49 may be ordered by manufacturer's drawing number, since there are no Signal Corps stock numbers assigned to the parts of this equipment. The Signal Corps stock number of the meter is 8A1058A. An alphabetical list of parts follows:

LIST OF PARTS

Name	*Manufacturer's Part No.*	*Quantity required*
Back plate	NP–82112A	1
Carrying case, snap type	K–1299772	1
Carrying ribbon	V–4141376	1
Case, plastic	P–4142042 Pt. 1	1
Cell contact assembly	V–4141715 Gr. 1	1
Cell only	K–4126640	1
Clip, window	V–4126049	2
Collar	V–4141036	1
Cover assembly	V–4141440 Gr. 1	1
Element assembly	T–4120512 Gr. 54	1
Gasket	V–4141449	1
Hood assembly	M–4142460 Gr. 5	1
Lead	K–4145511 Pt. 1	2
Magnet	K–4122742	1
Magnet clamp	V–4126050	1
Nut, magnet-clamp screw	P–4142040 Pt. 11	1
Photoelectric cell	K–4126640	1
Pole-piece (element) screw	P–4142040 Pt. 26	2
Scale plate	NP–84603A	1
Screw, case	V–4141662 Pt. 1	2
Screw, case	V–4141443 Pt. 1	2
Screw, magnet clamp	P–4142040 Pt. 11	1
Screw, scale plate	V–1385716 Pt. 6	2
Screw, window clip	V–4126083	2
Spring catch, hood	K–1299933	1
Spring, cell retaining	V–4141448	1
Window, instrument	V–4141444	1
Window, cell	V–4126002	1
Zero set lever	V–4148357	1
Zero set lever spring	V–4148349	1

Appendix I. EMULSION SPEEDS

1. GENERAL.—a. Use.—(1) The speeds given in the following paragraphs are all in the Weston system of emulsion rating. Appendix II contains a comparison between the Weston type rating and other systems in common usage. Correct exposure depends upon the accurate measurement of the light reflected from the object and the application of the proper speed rating to the emulsion of the film being used. Development practices have a great influence on these emulsion ratings. The Weston speeds are assigned on the basis of the development recommended by the manufacturer. If this system of development is not used, tests must be made to ascertain the correct rating for the type of development being used.

(2) The emulsion speeds in the following tables represent a group of speeds instead of one single value. Each group contains a rating based on the recommended processing, a value above this figure, and another below it. If, by using the recommended rating, negatives are thinner or denser than desired, the use of another number within the group will give the desired result. A lower number produces greater density and greater shadow detail while a higher number produces thinner negatives. This group rating does not remove the necessity of making test shots to determine the correct rating for the film under the particular conditions of exposure and development. The group numbers are given in subparagraph *b* below. They will apply to all Weston ratings given except those for color film and for 16mm reversible motion picture film. In the latter only the single number given applies.

b. Group values.

Daylight		*Tungsten*[a]	
Group number	*Speed range*	*Group number*	*Speed range*
200	160—200—250	125	100—125—160
100	80—100—125	64	50— 64— 80
50	40— 50— 64	32	24— 32— 40
24	20— 24— 32	16	12— 16— 20
12	10— 12— 16	8	6— 8— 10
6	5— 6— 8	4	3— 4— 5
3	2.5 3— 4	2	1.5 2— 2.5
1.5	1.2 1.5 2		

2. AGFA FILMS.

Type of film	*Weston group number*	
	Daylight	*Tungsten*
Roll film and film pack:		
Standard	24	8
Plenachrome	50	32
Super Plenachrome (packs only)	50	32
Superpan Supreme	50	32
Superpan Press	100	64
Finopan	[b]12	[b]8
Cut film:		
Superpan Press	100	64
Superpan Portrait	[b]50	[b]32
Supersensitive Panchromatic	[b]50	[b]32
Triple "S" Pan	200	125
Isopan	50	32
Triple "S" Ortho	100	64
Super Plenachrome Press	100	32
Portrait	12	8
Supersensitive Plenachrome	50	16
Commercial	12	4
Commercial Ortho	12	8
Commercial Panchromatic	12	8
Process	12	4
35mm film:		
Fine Grain Plenachrome	[b]12	[b]8
Finopan	[b]12	[b]8
Superpan Supreme	[b]50	[b]32
Ultra-Speed Panchromatic	100	64
Superpan Reversible	24	16
Infra-Red (with filter)	2	.....
Positive	10	2.5
Minipan	.....	[c]5
Ciné film—16mm:		
Triple "S" Pan Reversible	100	64
Hypan Reversible	32	24
Fine Grain Plenachrome Reversible	12	.....
Superpan Supreme Negative	64	40
Finopan Negative	24	16
Panchromatic Reversible	16	12
Positive	10	2.5

3. DEFENDER FILMS AND PLATES.

Type of film	Weston group number	
	Daylight	Tungsten
Cut film:		
Arrow Pan	[b]100	[b]64
XF Pan Press	50	32
XF Panchromatic	50	32
XF Ortho Press	50	16
XF Orthochromatic	50	16
Portrait	24	8
Portrait H. G. S.	50	16
Pentagon	24	16
Fine Grain Pan	24	16
Commercial	12	4
Panchromatic Process	12	8
Process	[b]12	4
Tri-Color	1.5	3
Tripac	1.5	3
Dupac	6	12
Plates:		
Seed 23	6	2
Seed 26X	12	8
Seed 27	24	8
Seed L Ortho	12	8
Seed Panchromatic	2.5	1.3
Seed Process	3	.5
Standard Orthonon	12	8
Stanley Ex. Imp.	12	8
Stanley Regular	12	8

4. DUPONT FILMS.

Type of film	Weston group number	
	Daylight	Tungsten
35mm films:		
Superior 1	24	16
Superior 2	50	32
Superior 3	[b]100	[b]64
Microcopy[c]	.....	2.5
Infra-D	16	.....
Positive[c]	10	2.5
Sound Recording Positive	6	3
16mm Ciné films:		
Superior Pan Reversible (302)	100	80
Superior Pan Negative	32	20
Regular Panchromatic Reversible	12	8
Regular Panchromatic Negative	12	8
Positive Safety[c]	10	2.5

5. EASTMAN KODAK FILMS AND PLATES.

Type of film	*Weston group number*	
	Daylight	*Tungsten*
Roll film and film pack:		
Regular N. C.	12	4
Verichrome	50	32
Super XX Pan	100	64
Plus-X	50	32
Panatomic X	24	16
Process Film Packs	3	1
Super Ortho Press (packs only)	[b]50	[b]32
35mm and Bantam films:		
Super XX Pan	100	64
Plus X Pan	50	32
Panatomic X	24	16
Panatomic (Bantam only)	24	16
Background X Pan Negative	16	10
Positive	10	2.5
Microfile[c]	.....	2.5
Direct Positive Pan	50	32
16mm Ciné films:		
Ciné-Kodak Safety	12	8
Ciné-Kodak Super X Negative	32	24
Ciné-Kodak Super XX Negative	64	48
Ciné-Kodak Super XX	100	64
Measurement	100	64
Safety Positive	10	2.5
Sheet films:		
Tri-X Panchromatic	200	125
Ortho-X	100	64
Super Panchro Press	100	64
Super Ortho Press	100	32
Portrait Panchromatic	[b]50	[b]32
Super XX Pan	100	64
Panatomic X	24	16
Process Pan	12	8
Super Speed Ortho Portrait AH	50	16
Commercial Ortho	12	8
Commercial AH	12	4
Contrast Process Ortho	12	8
Contrast Process Pan	12	8
Plates:		
Eastern Super Panchro Press	100	64
Wratten Panchromatic AH	12	8
Wratten Process Pan	50	32
Wratten H	50	32
Ortho Press	50	16
Eastman 50 AH	24	8
Eastman Polychrome	24	8
Eastman Commercial	12	4
Wratten Metalographic	.....	16
Eastman 40	24	8
Eastman 33 AH	12	4
Eastman Process AH	6	1
Lantern Slide Medium AH	2	1.7
Lantern Slide Contrast AH	.7	.3
Kodak Ortho Tropical AH	24	16
Kodak Ortho Special Tropical	24	18
Kodak Polychrome UR Tropical	24	16
Kodak Panatomic	24	16
Kodak Panatomic X	24	16

6. COLOR FILMS.

Type of film	*Weston rating*	
	Daylight	*Tungsten*
Defender:		
Dupac	6	12
Tripac	1.5	3
Dufavcolor Roll films:		
Daylight (no filter)	8	.....
Photoflood or Photoflash (3R filter)	.....	3
Mazda (4R filter)	.....	2
Dufavcolor Cut films:		
Daylight (1D filter)	6	.....
Daylight (3D filter) in Photoflood	.....	3
Daylight (4D filter) in Mazda	.....	3
Photoflood (1PF filter)	4	.....
Photoflood (3PF filter) in Photoflood	.....	4
Photoflood (4PF filter) in Mazda	.....	2
Eustman Kodak Kodachrome:		
8, 16, and 35mm Regular	8	[d]3
8, 16, and 35mm Type A	[c]8	12
Professional, Daylight	10	.....
Professional, Type B	[f]4	[g]6

[a] Photoflood lamps require tungsten values.
[b] Tentative rating dependent on local conditions. Experiments must be made with this type of film.
[c] Normal arrow of calculator dial set to a reading obtained from the white surface with lights set up for copying.
[d] With Kodachrome Photoflood filter.
[e] With Kodachrome Daylight filter.
[f] With Wratten filter No. 85B.
[g] Used in "3,200° K" lamps only.

Appendix II. COMPARISON OF EMULSION-SPEED VALUES

American Standards Association film numbers	*Weston*	*General Electric*	*H & D*	*American Scheiner*	*European Scheiner*	*Din*
. . . . .	.3	. . . . .	7.5	4	10	. . . . .
. . . . .	.35	. . . . .	8.75	5	11	. . . . .
0.6	.5	. . . . .	12.5	6	12	. . . . .
0.8	.6	. . . . .	15	7	13	. . . . .
1.0	.7	1	17.5	8	14	1/10
1.2	1.0	1.5	25	9	15	2/10
1.6	1.2	2	30	10	16	3/10
2.0	1.5	. . . . .	38	11	17	4/10
2.5	2.0	3	50	12	18	5/10
3	2.5	4	63	13	19	6/10
4	3	4.5	75	14	20	7/10
5	4	. . . . .	100	15	21	8/10
6	5	7.5	125	16	22	9/10
8	6	9	150	17	23	10/10
10	8	12	200	18	24	11/10
12	10	15	250	19	25	12/10
16	12	18	300	20	26	13/10
20	16	24	400	21	27	14/10
25	20	30	500	22	28	15/10
32	24	36	600	23	29	16/10
40	32	48	800	24	30	17/10
50	40	60	1,000	25	31	18/10
64	50	75	1,250	26	32	19/10
80	64	100	1,600	27	33	20/10
100	80	120	2,000	28	34	21/10
125	100	150	2,500	29	35	22/10
160	125	200	3,120	30	36	23/10
200	160	250	4,000	31	37	24/10
250	200	300	5,000	32	38	25/10
320	250	400	6,250	33	39	26/10
400	320	500	8,000	34	40	27/10
500	400	600	10,000	35	41	28/10
650	500	800	12,500	36	42	29/10
800	650	900	16,250	37	43	30/10
1,000	800	1,000	20,000	38	44	31/10

Appendix III. FILTER FACTORS

Filter	Agfa Film				Eastman Film					Dupont Film			
	Supreme	*Ultra Speed*	*M.P. Finopan*	*Infra-red Type B*	*Super XX*	*Plus X*	*Back-ground X*	*Back-ground*	*Pan K*	*Sup. 1*	*Sup. 2*	*Sup. 3*	*Infra D*
K 1	1.4	1.4	1.4	.....	.....	.....	.....	.....	.....	1.5	1.5	1.5	.....
K 2	2.0	2.0	2.0	.....	.....	.....	.....	.....	.....	2.0	2.0	2.0	.....
Aero 1	1.4	1.4	1.4	.....	1.25	1.25	1.25	1.25	.....	2.0	1.5	1.5	.....
Aero 2	2.0	2.0	2.0	.....	1.5	1.5	1.5	1.5	.....	2.5	2.0	2.0	.....
3 N 5	4.0	3.0	4.0	.....	4.0	4.0	4.0	4.0	.....	4.0	4.0	6.3	.....
5 N 5	6.0	6.0	6.0	.....	5.0	5.0	5.0	5.0	.....	6.3	5.5	8.0	.....
12	2.0	2.0	2.0	.....	2.5	2.5	2.5	2.5	.....	2.5	2.0	.....	.....
15 G	2.0	2.0	2.0	4.0	3.0	3.0	3.0	3.0	.....	3.2	2.5	2.5	.....
21	3.0	3.0	3.0	5.0	3.5	3.5	3.5	3.0	.....	3.2	2.5	2.5	.....
23 (A)	4.0	4.0	4.0	5.0	4.0	4.0	4.0	3.0	.....	5.0	4.0	3.2	.....
25 (A)	6.0	6.0	6.0	5.0	7.0	7.0	7.0	4.0	.....	10.0	5.0	3.2	16.0
29 (F)	12.0	8.0	12.0	5.0	15.0	15.0	15.0	8.0	[a]15.0	16.0	10.0	5.0	16.0
47 (C5)	4.0	6.0	4.0	.....	5.0	5.0	5.0	5.0	.....	7.0	6.5	6.5	.....
56 B	.....	.....	.....	.....	5.0	5.0	5.0	6.0	.....	3.5	3.0	.....	.....
58 (B)	8.0	8.0	8.0	.....	6.0	6.0	6.0	8.0	.....	.....	.....	.....	.....
72	.....	.....	.....	.....	[a]15.0	[a]15.0	[a]15.0	[a]15.0	[a]30.0	.....	.....	.....	.....
70	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	32.0
25 N.D.	1.8	1.8	1.8	.....	1.8	1.8	1.8	1.8	.....	1.8	1.8	1.8	.....
50 N.D.	3.1	3.1	3.1	3.1	3.0	3.0	3.0	3.0	.....	3.1	3.1	3.1	.....
75 N.D.	5.6	5.6	5.6	.....	6.0	6.0	6.0	6.0	.....	5.6	5.6	5.6	.....
100 N.D.	10.0	10.0	10.0	.....	10.0	10.0	10.0	10.0	.....	10.0	10.0	10.0	.....
Pola Screen	4.0	4.0	4.0	.....	4.0	4.0	4.0	4.0	.....	.....	.....	.....	.....

Note: These filter factors are variable depending upon the light conditions and the type of film being used. Experimentation will be necessary to determine the exact filter factor for the conditions present.

[a] For night effects in daytime.

Appendix IV. TYPES OF MOTION PICTURE CAMERAS

Type A	*Type B*
DeVry	Filmo 141
Eastman (all models except Ciné Kodak Special, which has a variable shutter angle)	Filmo Golf
Filmo (all regular 70's)	Filmo 71's
Filmo 121	Filmo 75
Eyemo (all models)	

Note: 35mm cameras not given above have variable shutter angles and cannot be classified as either Type A or Type B. Specific shutter speeds for these cameras will be found in the operating instructions accompanying the camera.

Appendix V. SHUTTER SPEEDS FOR MOTION PICTURE CAMERAS

Camera	*No. of Speeds*	*Frames per second*						
		8	*12*	*16*	*24*	*32*	*48*	*64*
Eastman K	2	1/15	.....	1/30	.....	.....	.....	.....
Eyemo (all models)	7	1/20	1/30	1/40	1/60	1/80	1/120	1/160
Ciné Kodak Special	[a]	1/18	1/24	1/36	1/48	1/72	1/96	1/144
DeVry	.....	1/15	1/24	1/30	1/45	1/60	1/90	1/120
Filmo 70-D & DA	7	1/12	1/20	1/25	1/40	1/50	1/80	1/100
Filmo 70-A-C	2	1/12	.....	1/25	.....	.....	.....	.....
Filmo 70-A-C	2	.....	.....	1/25	.....	1/50	.....	.....
Filmo 70-A-C	3	1/20	.....	1/40	1/60	.....	.....	.....
Filmo 71-A-B	2	1/15	.....	1/30	.....	.....	.....	.....
Filmo 71-A-B	2	.....	.....	1/30	.....	1/60	.....	.....
Filmo 71-A-B	3	.....	1/25	1/40	1/50	.....	.....	.....
Filmo 75	1	.....	.....	1/50	.....	.....	.....	.....
Filmo Kodacolor 75	1	.....	.....	1/40	.....	.....	.....	.....

Note: The comparatively large difference in shutter times corresponding to the same number of frames per second is due to the fact that the angular openings of the shutters vary from 110° to 216°. Most 35mm cameras have variable shutter angles, and the shutter speeds will vary as the angle is changed. Information for this change will be found in the operating instructions for the cameras. The shutter speeds are in all cases proportional. If the speed is 1.30 second for 16 frames per second, it will then be 1/60 second for 32 frames per second, or twice as fast. For 24 frames per second it will be one and one-half times as fast, or 1/45 second.

[a] The Ciné Kodak Special has a variable shutter angle. The speeds given are to be used when the shutter angle is set at 180°.

Appendix VI. GLOSSARY OF TERMS

Actinic rays—Incident electro-magnetic rays of wavelengths which can cause a latent image, potentially developable, in a photographic emulsion.

Aperture—The diameter of the circular passage for light through a lens. The effect of the aperture is measured by the *stop*.

Brightness—The brilliance of a source of light or a surface reflecting light. The latter meaning is used throughout this manual.

Cell—*see photoelectric cell.*

Contrast—The conflict between light and shade, lines and curves, and other prominent elements in the composition of a photographic image.
Depth of focus—The distance between the nearer and farther planes in which the image is in reasonably sharp focus. The term *depth of focus* applies to the planes in the camera on either side of the plane of the film or plate.

Depth of field—The distance, in the scene being photographed, between the nearest plane in focus and the farthest plane in focus. This distance is dependent upon the type of lens and the lens aperture in use.

Emulsion—The light-sensitive coating which, when applied to film, plate, or paper, forms the basis of photography.
Focal length of a lens—The distance, measured along the principal axis, between the optical center of the lens and the focal plane, when the lens is set for infinity.

Focal plane—The plane in which light rays from external objects are focused in a camera. The normal location of the sensitive surface of a film, plate, or ground-glass focusing screen.

f number or f stop—The measurement of lens aperture by reference to focal length of the lens; e. g., *f*2.8 means that the focal length is 2.8 times the diameter of the effective aperture determining the maximum area used in the center of the lens by light passing through it.

Photoelectric cell—Generally, this term means any device in which the incidence of light causes an alteration in the electrical state. In the exposure meters using a photoelectric cell, that alteration takes the form of an electro-motive force being emitted from the cell whenever light strikes the surface of the cell.

Reduction—The decreasing of excessive contrast or density which arises from over-exposure or overdevelopment of a negative or a print. The specifically photographic term is often confused by untrained personnel with the chemical term "reduction" in the sense of reducing silver salts to metallic silver.

Shutter—The device in a camera for exposing the sensitized surface to light rays reflected from the object being photographed during a known time and at will.

Shutter speed—The length of time the shutter remains open to allow the light to pass through it.

★U. S. GOVERNMENT PRINTING OFFICE: 1944—601541