American Standard
C18—1947

U. S. DEPARTMENT OF COMMERCE
W. AVERELL HARRIMAN, Secretary

NATIONAL BUREAU OF STANDARDS
E. U. CONDON, Director

CIRCULAR OF THE NATIONAL BUREAU OF STANDARDS C466
[Supersedes Circular C435]

AMERICAN STANDARD SPECIFICATION FOR DRY CELLS AND BATTERIES

(Leclanché Type)

[Issued December 1, 1947]

Approved August 6, 1947, by the
American Standards Association (ASA designation C18—1947)

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PREFACE

The fifth edition of the American Standard Specification for Dry Cells and Batteries which is contained in this circular was approved by the American Standards Association on August 6, 1947. It supersedes the previous specification which was approved November 28, 1941, and published in Circular C435 of the National Bureau of Standards.

This new standard for dry cells marks the completion of another step in a project that was begun about 30 years ago. At that time the need for a governmental specification arose as a result of World War I. Since then manufacturers of dry cells and large industrial users have cooperated with representatives of the Government in perfecting tests and specifications for the varied kinds of dry cells and batteries. This work has been accomplished since 1926 by a Sectional Committee of the American Standards Association, acting under the sponsorship of the National Bureau of Standards.

New types of cells have been developed to meet new industrial needs, and the available electrical output of better brands of the older types has been materially increased. Successive editions of this specification have reflected these changes. During World War II great numbers of cells were needed, the production amounting to several billion units per year.

Advances in the dry-cell industry were made possible by the ability and willingness of manufacturers to improve their product. The National Bureau of Standards cooperates with them in the tests, specifications, and some phases of research. It is glad to have a part in this work. The resulting benefits accrue to the Government and to the public alike.

Future revisions of the specification will undoubtedly become necessary, as they have in the past, because the value of the specification depends on its keeping pace with advances made in the art.

E. U. Condon, *Director.*

Washington, August 18, 1947.

HISTORY OF THE PROJECT

In 1912 a committee [1] of the American Electrochemical Society recommended standard methods of testing dry cells. Although much has been accomplished in developing specifications for dry cells and batteries since that time, the influence of these early recommendations on some of the later specifications is still discernible.

The preparation of nationally recognized specifications to include sizes of cells, arrangement of batteries, tests, and required performance began in 1917 with the drafting of specifications which were later submitted by the National Bureau of Standards to a committee including representatives of manufacturers, the War Industries Board, and several Government departments. The specifications which were approved at that time were published in 1919 as an appendix to the Bureau's Circular [2] on dry cells. Within a few years the need for revision became apparent and the Bureau was asked to call a conference of representatives of manufacturers, Government departments, and some of the largest individual users of dry cells. This conference met in December 1921 and agreed on a standardization program for sizes of cells and batteries, tests, and performance. New specifications were published in the second edition of the Bureau's circular [3] on dry cells, and following their adoption as a Government standard they were issued separately.[4]

In 1924 a committee consisting of representatives of the Government, battery manufacturers, and several large users of dry cells agreed on a standard system of nomenclature for dry cells and batteries. This has been used in subsequent revisions of the specifications. This committee initiated a movement for a more representative and permanent organization to deal with subsequent revisions of the dry-cell specifications with the result that the American Engineering Standards Committee (now the American Standards Association) authorized the formation of a sectional committee on dry cells under the sponsorship of the National Bureau of Standards. This committee has been active since its organization in 1926 and has prepared five revisions of the specifications, which became American Standards in 1928,[5] 1930,[6] 1937,[7] 1941,[8] and 1947.[9]

Close cooperation has been maintained between this sectional committee and the technical committee on dry cells reporting to the Federal Specifications Board with the result that Federal specifications issued in 1931 [10] and 1935 [11] have been concordant with

[1] Trans. Am. Electrochem. Soc. 21, 275 (1912).
[2] Cir. BS 79, 39 (1919).
[3] Cir. BS 79, 2d ed., 54 (1923).
[4] Cir. BS 139 (1923) ; U. S. Government Standard Specification No. 58.
[5] Cir. BS 139, 2d ed. (1927) ; U. S. Government Master Specification No. 58a ; ASA Standard C18—1928.
[6] Cir. BS 390 (1930) ; ASA Standard C18—1930.
[7] Cir. BS C414 (1937) ; ASA Standard C18—1937.
[8] Cir. NBS C435 ; ASA Standard C18—1941.
[9] Cir. NBS C466 ; ASA Standard C18—1947.
[10] Federal Standard Stock Catalog, Specification Symbol W–B–101 (March 31, 1931).
[11] Federal Standard Stock Catalog, Specification Symbol W–B–101a (May 7, 1935).

the American standard specification, although differing in form. The 1935 specification anticipated many of the changes incorporated in the 1937 American Standard, but did not include batteries intended primarily for use with hearing-aid devices. The Federal specification is being again revised in 1947.

Periodic revision of the American Standard specifications becomes necessary as a result of changes in the art. New types and uses for batteries require the drafting of new specifications, and the improved performance of batteries justifies some increase in the requirements. The new specifications, therefore, reflect the advances made by manufacturers in their product. How great these advances have been during the past years may be judged from a few examples taken from a paper by Gillingham.[12] His performance figures relate to the better brands available at the time, but are not necessarily confined to the product of any particular manufacturer.

The spontaneous shelf deterioration of dry cells of the ordinary No. 6 size for general purposes, occurring in 6 months, was reduced from 35 percent in 1901 to 25 percent in 1916 and to 7 percent in 1934.

The useful output of dry cells, measured by their service life on various tests, described in the accompanying specifications, has been materially increased. Cells of the telephone type, made in 1910, gave 155 days of service on the light intermittent test; those made in 1916 gave 165 days and the output was increased in 1926 to 230 days. About 1930, special grades of telephone cells became available giving 360 days, and some cells of 1934 reached 450 days.

In 1910, flashlight cells of the D size gave 260 minutes of service on the 4-ohm intermittent test, but in 1934, cells of this type yielded as high as 750 minutes.

Industrial flashlight cells, intended for heavier service than the ordinary flashlight cells, appeared on the market about 1930, at which time they gave 250 minutes of service on the heavy-industrial test. Subsequent improvements were made rapidly with the result that 975 minutes of service on the same test were obtainable from cells made in 1935.

Radio *B* batteries, which appeared about 1918, gave 377 hours on the 5,000-ohm continuous test, but in 1926, batteries containing the same size of cell gave 1,000 hours, and this was increased to 1,500 hours of service from batteries made in 1934.

Hearing-aid batteries (*CD* size) gave 18 hours of service in 1932. In 1935, similar batteries gave 50 hours of service.

These examples illustrate improvements which are the result of organized research and development on the part of manufacturers and of standardized test procedures and specifications attained through cooperation of the groups represented on the sectional committee. To allow for manufacturing variations and to obtain adequate competition, it is necessary that the minimum required performance of the various types and sizes of cells included in the specifications be somewhat less than the maximum figures quoted above. The proportion of poorer brands on the market has decreased during the past few years. The result of all these factors has been a considerable gain to the public at large.

[12] Trans. Electrochem. Soc. 68, 159 (1935).

The personnel of the sectional committee is as follows:

Organization Represented	Name and Business Affiliation
Americal Institute of Electrical Engineers.	W. B. Kouwenhoven. Johns Hopkins University, Baltimore, Md.
American Hearing Society.	Douglas Macfarlan, M. D., Philadelphia, Pa.
ASA Sectional Committee on Acoustical Measurements and Terminology Z24.	H. A. Carter, American Medical Association, Chicago, Ill.
ASA Sectional Committee on Radio, C–16.	F. T. Bowditch, National Carbon Co., Cleveland, Ohio.
Association of American Railways, Signal Section.	H. L. Killian, Signal Supervisor, New York Central R. R., 1 Monroe Street, Toledo 3, Ohio.
Association of American Railways, Telephone & Telegraph Section.	C. O. Ellis, Chicago, Rock Island & Pacific Railway, Chicago, Ill.
Association of Edison Illuminating Companies.	H. C. Koenig, Electrical Testing Laboratories, New York, N. Y.
Bell Telephone Laboratories, Telephone Group, ASA.	J. H. Bower, Bell Telephone Laboratories, New York, N. Y.
Bright Star Battery Co.	F. A. Keller, Bright Star Battery Co., Clifton, N. J.
Burgess Battery Co.	J. J. Coleman, Burgess Battery Co., Freeport, Ill.
Electrochemical Society.	C. C. Rose, Willard Storage Battery Co., Cleveland, Ohio.
General Dry Batteries, Inc.	C. G. Birdsall. General Dry Batteries, Inc., Cleveland, Ohio.
Independent Engineer.	W. B. Kouwenhoven, Johns Hopkins University, Baltimore, Md.
Institute of Radio Engineers.	H. M. Turner, Yale University, New Haven, Conn.
Marathon Battery Co.	G. H. Schroeder, Marathon Battery Co., Wausau, Wis.
National Bureau of Standards.	J. P. Schrodt. G. W. Vinal (chairman of committee) U. S. Department of Commerce, National Bureau of Standards, Washington 25, D, C.
National Carbon Co.	F. J. Wolfe (secretary of committee), National Carbon Co., Cleveland, Ohio.
Navy Department.	Officer in Charge, Standards Branch, Shipbuilding Division, Bureau of Ships, -Navy Department. Washington, D. C.
Ray-O-Vac Co.	R. E. Ramsay, Ray-O-Vac Co., Madison, Wis.
War Department.	G. B. Ellis, Signal Corps, Squier Signal Laboratory, Fort Monmouth, N. J.
Winchester Repeating Arms Co.	John Martinez, Winchester Repeating Arms Co., New Haven, Conn.

AMERICAN STANDARD SPECIFICATION FOR DRY CELLS AND BATTERIES

(Leclanché Type)

American Standard C18-1947
(Revision of C18-1941)

CONTENTS

1. DEFINITIONS.

1.1 Dry cells and batteries to be included under this specification shall fulfill the following requirements in addition to those in other paragraphs of this specification:

The cells shall be of sal-ammoniac type with depolarizer.

The cells shall have a nonspillable electrolyte.

2. NOMENCLATURE.

2.1 For reference in this specification, the following system of nomenclature shall be used to designate sizes and types.

2.2 Cells listed and designated in table 1 are considered standard. This table shows nominal dimensions over the can for cylindrical cells,

Table 1. Sizes of standard cylindrical cells

Cell designation	Nominal diameter	Nominal height over can
	Inches	*Inches*
No. 6	2½	6
J	1¼	5⅞
G	1¼	4
F	1¼	3 7/16
E	1¼	2⅞
D	1¼	2¼
CD	1	3 3/16
CL	15/16	2⅝
C	15/16	1 13/16
B	¾	2⅛
BR	¾	1½
BF	¾	1 5/16
A	⅝	1⅞
AA	17/32	1⅞
R	17/32	1 5/16
P	17/32	1
N	7/16	1 1/16
NS	7/16	¾
U	5/16	½

but the designations may apply also to cylindrical cells of other dimensions and to cells of other shapes, which, when used in assembled batteries, correspond approximately to the standard size in volume or capacity rating. Such batteries shall be subject to standard dimension and performance requirements.

2.3 Assembled batteries are designated by a code system formulated as follows:

(1) The size of cell is indicated by a capital letter as shown in table 1. For the *No. 6* cell, the number 6 is used in place of the letter.

(2) Preceding the cell letter is a numeral showing the number of cells (or 1½-volt groups) in series in the battery. If no numeral appears, it is to be understood that the battery is a 1½-volt battery.

(3) Following the cell-size letter is a numeral indicating the number of cells or groups of cells connected in parallel. If no numeral appears, it is to be understood that the battery consists of only a single series group.

(4) When a small letter *s* or *d* is used at the end of the code, it indicates either of two structural arrangements identical as to number and size of cells and electrical connections; *s* indicating a single and *d* a double-row arrangement.

3. Standard Voltages of Dry Batteries.

Voltages in common use for dry-battery combinations are as follows:

1.5	9	45
3	15	67.5
4.5	22.5	90
6	30	
7.5	33	

4. General Classification of Cells and Batteries.

4.1 The following classes of dry cells and batteries are included in this specification:

(a) General-purpose *No. 6* dry cells.
(b) Industrial *No. 6* dry cells.
(c) Telephone cells, in *No. 6*, *E*, and *D* sizes.
(d) Assembled batteries of *No. 6* cells.
(e) Group batteries of small cells, intended for *No. 6* dry-cell applications.
(f) General-purpose flashlight cells.
(g) Industrial flashlight cells and batteries.
(h) Batteries for hearing aids.
(i) *A* batteries.
(j) *B* batteries.
(k) *C* batteries.
(l) *A–B* battery packs.

5. Standard Sizes of Cells and Batteries.

5.1 *No. 6 Dry Cells.* The dimensions for the zinc container of the cell, measured without the jacket, are: Diameter, 2½ inches; height, 6 inches. Deviations shall not exceed $\frac{1}{16}$ inch in diameter and ⅛ inch in height, from the dimensions as given. The over-all dimensions, including the jacket and terminals, shall not exceed: Height, 6¾ inches; diameter, 2⅝ inches.

5.2 *Assembled Batteries of No. 6 Cells.* Standard batteries of this class are shown with their required dimensions in table 2.

Table 2.—*Assembled batteries of No. 6 cells*

Battery designation	Number of cells in series	Arranged in—	Nominal battery voltage	Maximum dimensions		
				Length	Width	Height
			Volts	*Inches*	*Inches*	*Inches*
46s	4	1 row	6	10 5/8	2 3/4	7 1/2
46d	4	2 rows	6	5 3/8	5 3/8	7 1/2
56d	5	---do	7.5	8	5 3/8	7 1/2
66d	6	---do	9	8	5 3/8	7 1/2

5.3 *Group Batteries of Small Cells (for No. 6 Cell Applications).* Cells contained in these batteries may be of various sizes as preferred by the manufacturer. Batteries shall comply with the dimension requirements of table 3.

Table 3.—*Group batteries of small cells*

[*No. 6* cell applications]

Nominal battery voltage	Maximum dimensions		
	Length	Width	Over-all height
Volts	*Inches*	*Inches*	*Inches*
1.5	2 5/8	2 5/8	6 1/4
3	4	2 3/4	6 1/4
4.5	4	4	6 1/4
6	2 3/4	8 1/4	6 3/8
7.5	4	7 5/16	6 3/8
9	4	8 1/2	6 3/8

5.4 *Flashlight Cells and Batteries.* Those which are considered standard are listed in table 4, and shall comply with the dimensions shown therein.

Table 4.—*Flashlight cells and batteries*

Cell or battery designation	Maximum dimensions		Minimum dimensions	
	Diameter	Height	Diameter	Height
UNIT CELLS [a]				
	Inches	*Inches*	*Inches*	*Inches*
D	1 11/32	2 13/32	1 9/32	2 5/16
C	1 1/32	1 31/32	31/32	1 7/8
BF	27/32	1 15/32	25/32	1 3/8
AA	19/32	1 31/32	17/32	1 29/32
LANTERN BATTERY				
4*F*	[b] 3 3/8	[c] 4	-------	3 13/16

[a] Cells may be supplied as tubular batteries as follows if required: *2D, 3D, 2C, 2BF, 2AA.*
[b] Maximum diagonal. This battery must pass through a circle 3 3/8 inches in diameter.
[c] Height over body, exclusive of terminals.

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5.5 *Batteries for Hearing Aids.* These batteries are of several groups, according to the type of instrument for which they are intended, and are so arranged in table 5. Such batteries shall comply with dimensions listed in the table. Codes referring to the various batteries are described in section 2.3.

TABLE 5.—*Batteries for hearing aids*

Battery designation	Battery voltage (nominal)	Recommended terminal arrangement	Maximum dimensions			
			Diameter	Length	Width	Over-all height
PART I. *A* BATTERIES FOR VACUUM-TUBE INSTRUMENTS						
	Volts		*Inches*	*Inches*	*Inches*	*Inches*
AA2	1.5	Fl. cell	—	$1\frac{9}{64}$	$\frac{19}{32}$	$2\frac{1}{64}$
C	1.5	Fl. cell	$1\frac{1}{32}$	—	—	2
CL	1.5	Fl. cell	$1\frac{1}{32}$	—	—	$2\frac{25}{32}$
D	1.5	Fl. cell	$1\frac{11}{32}$	—	—	$2\frac{15}{32}$
CL	1.5	I	$1\frac{3}{32}$	—	—	$3\frac{7}{16}$
CD	1.5	I	$1\frac{1}{8}$	—	—	4
F	1.5	I	$1\frac{11}{32}$	—	—	$4\frac{3}{16}$
PART II. *B* BATTERIES FOR VACUUM-TUBE INSTRUMENTS						
10U	15	XVI	—	$1\frac{1}{16}$	$\frac{5}{8}$	$1\frac{1}{2}$
15U	22.5	XVI	—	$1\frac{1}{16}$	$\frac{5}{8}$	2
20U	30	XVI	—	$1\frac{1}{16}$	$\frac{5}{8}$	$2\frac{9}{16}$
10NS	15	XVI	—	$1\frac{3}{8}$	$1\frac{1}{16}$	$1\frac{9}{16}$
15NS	22.5	XVI	—	$1\frac{3}{8}$	$1\frac{1}{16}$	$2\frac{3}{16}$
20NS	30	XVI	—	$1\frac{3}{8}$	$1\frac{1}{16}$	$2\frac{13}{16}$
15NS	22.5	VIII	—	$1\frac{3}{8}$	$1\frac{1}{16}$	$2\frac{3}{4}$
20NS	30	VIII	—	$1\frac{3}{8}$	$1\frac{1}{16}$	$3\frac{3}{8}$
15N	22.5	VIII	—	$1\frac{13}{32}$	$1\frac{1}{16}$	$4\frac{1}{32}$
22N	33	VIII	—	$2\frac{21}{32}$	$1\frac{1}{16}$	$3\frac{1}{8}$
30N	45	VIII	—	$2\frac{21}{32}$	$1\frac{1}{16}$	$4\frac{1}{32}$
PART III. BATTERIES FOR "CARBON" TYPE INSTRUMENTS						
2CD	3	XVII	—	$2\frac{3}{16}$	$1\frac{3}{16}$	$4\frac{1}{8}$
3CD	4.5	XVII	—	$3\frac{1}{4}$	$1\frac{3}{16}$	$4\frac{1}{8}$

5.6 *A Batteries.* Standard types of *A* batteries are listed with dimension requirements in table 6. For descriptive code, see section 2.3 of this specification.

A batteries are designed to supply filament current for vacuum tubes, especially in portable receivers.

TABLE 6.—*A batteries*

Battery designation	Battery voltage (nominal)	Terminal arrangement [a]	Maximum dimensions		
			Length	Width	Body height
	Volts		*Inches*	*Inches*	*Inches*
F4	1.5	I	$2\frac{5}{8}$	$2\frac{5}{8}$	$4\frac{1}{8}$
F6	1.5	I	$3\frac{15}{16}$	$2\frac{3}{4}$	$4\frac{1}{8}$
F4s	1.5	I	$3\frac{7}{8}$	$1\frac{3}{8}$	$5\frac{5}{8}$
F8s	1.5	I	$3\frac{15}{16}$	$1\frac{7}{16}$	$10\frac{13}{16}$
F8d	1.5	I	$3\frac{15}{16}$	$2\frac{3}{4}$	$5\frac{1}{2}$
F18 [b]	1.5	I	$7\frac{13}{16}$	$2\frac{15}{16}$	$7\frac{1}{8}$
3G	4.5	III	4	$1\frac{3}{8}$	$4\frac{3}{4}$
4F2s	6	IV	$3\frac{15}{16}$	$1\frac{7}{16}$	$10\frac{7}{8}$
4F2d	6	IV	$3\frac{15}{16}$	$2\frac{15}{16}$	$5\frac{1}{2}$
4F	6	IV	$2\frac{21}{32}$	$2\frac{21}{32}$	$4\frac{1}{4}$
5Gd	7.5	V	$3\frac{7}{8}$	$2\frac{11}{16}$	$4\frac{9}{16}$

[a] Terminals located on top of battery.

[b] Other batteries for similar service include *F20, G15, G16, G18, G19, J11, J12.* Alternate maximum dimensions may be $4\frac{5}{8}$ by $3\frac{7}{8}$ by $7\frac{13}{16}$ inches.

5.7 *B Batteries.* These batteries are for vacuum-tube plate-current supply, and are usually furnished in series-assembled units of 22½ volts and multiples thereof, table 7.

TABLE 7.—*B batteries*

Battery designation	Battery voltage (nominal)	Terminal arrangement	Maximum dimensions		
			Length	Width	Body height [a]
	Volts		*Inches*	*Inches*	*Inches*
15U	22.5	XVI	1 1/16	5/8	2
20U	30	XVI	1 1/16	5/8	2 9/16
15NS	22.5	XVI	1 3/8	1 1/16	2 3/16
20NS	30	XVI	1 3/8	1 1/16	2 13/16
30N	45	XV	2 5/8	1	3 11/16
45N	67.5	XV	2 13/16	1 3/8	3 23/32
30AA	45	IX or X	3 1/8	2 3/8	4 3/16
30A	45	IX or X	3 9/16	2 5/16	4 5/8
15A	22.5	Screw	3 17/32	2 3/16	2 21/32
30BR	45	IX or X	3 5/8	1 27/32	5 5/8
30B	45	IX or X	4 3/8	2 11/16	5 1/2
15B	22.5	XII	4 1/4	2 5/8	3
30D	45	VII	8 1/4	3 5/16	7 3/8
30F	45	VII	8 1/4	4 1/2	7 3/8
30G	45	VII	8 1/4	4 9/16	7 3/8

[a] Users must provide clearance above battery if adapter or other terminal connections are used.

5.8 *C Batteries.* Standard types are listed with dimensions in table 8. They are intended to supply bias voltage to vacuum tubes.

TABLE 8.—*C batteries*

Battery designation	Battery voltage (nominal)	Terminal arrangement	Maximum dimensions		
			Length	Width	Body height
	Volts		*Inches*	*Inches*	*Inches*
3B	4.5	Screw or spring clip	2 1/2	7/8	3
5B	7.5	([a])	4 1/4	15/16	3
15B	22.5	XII	4 1/4	2 5/8	3
3D	4.5	XI	4 1/16	1 1/2	3 1/16

[a] One flexible wire terminal at −7½ volts and 5 screw terminals.

5.9 *A–B Pack Batteries.* Batteries in this classification comprise suitable combinations of *A* and *B* units assembled in a single battery. Standard types are listed with dimension requirements in table 9.

TABLE 9.—*A-B pack batteries*

Battery designation	Battery voltage (nominal)		Terminal arrangement	Maximum dimensions		
	A	*B*		Length	Width	Body height
	Volts	*Volts*		*Inches*	*Inches*	*Inches*
60D-F18	1½	90	XIII	16	4 1/2	7 1/16
60BR-6G	9 and 7½	90	XIV	10 9/16	3 3/8	4 5/16
60A-6F	9 and 7½	90	XIV	9 5/8	2 7/8	4 1/2

6. Material and Workmanship.

6.1 Material and workmanship shall be first class in every particular. Cells or batteries having any of the following defects shall be considered as not complying with this part of the specification: Loose terminals, spring clips or plug-in terminals that do not make and maintain positive connections to the external circuit, high or low carbons, corrosion of metal cap on carbon rods, carbon rods off center, loose or cracked seals, leaking or distorted zinc containers. Cells and assembled batteries shall be free from deformation and leakage during their useful life under specified test conditions.

7. Jackets.

7.1 Single No. 6 dry cells and flashlight unit cells shall be enclosed in close-fitting jackets usually of paperboard, but may be of plastic or other suitable material. For special purposes jackets may be treated when so specified, with paraffin or other waterproofing material.

When metal-clad jackets are provided on unit cells, they shall be insulated from both terminals of the cell, and shall be covered outside with insulating material which is adherent and resistant to penetration by exposed metal switch parts of flashlights or other equipment in which the cells are used.

8. Marking.

8.1 On the outside of the jackets of individual cells and outside of batteries shall be printed the following information:

The trade name of the cell or battery.

The name of the manufacturer or supplier, or such trade-mark as will identify him.

Number or other designation of size.

The date of manufacture, or the expiration of a guaranty period, indicated as such. (Option: This may be shown on the zinc container, provided jacket is removable.)

9. Zinc.

9.1 The anode shall be made from zinc, free from flaws, blisters, and cracks.

10. Top Closure for Cells and Batteries.

10.1 Sealing compound used for closing cells and batteries at the top shall be an insulating compound that will not flow at a temperature of 45° C (113° F) during a static test in which the sealed surface is held vertical for a period of 24 hours.

10.2 Metal or composition covers for tops of cells may be used in lieu of sealing compound, provided such covers and accessory parts shall not become adversely affected by leakage, corrosion, or deformation during the useful life of the cell. Metal covers shall be insulated from at least one electrode.

10.3 Metal boxes and covers for assembled batteries shall, unless otherwise specified, be insulated from the cells comprising the battery. The top closing means may be metal, fiber, paperboard, sealing compound, or plastic.

11. BATTERY CONNECTIONS.

11.1 In all assembled batteries, electrical connections between cells and between cells and terminals shall be secure and permanent.

11.2 All soldered connections shall be made in such a manner as to not interfere with subsequent battery performance.

11.3 Welded connections may be used in lieu of soldered connections, provided they are equally permanent.

12. TERMINALS.

12.1 Terminals in common use for batteries of various classifications are as follows:

(a) KNURLED NUT AND SCREW TERMINALS. These shall have standard 8–32 threads, and shall be of brass or other suitable metal.

(b) SPRING CLIP TERMINALS. These shall be of spring brass, or other material of equivalent properties.

(c) FLASHLIGHT CELL TERMINALS. In the case of flashlight cells, the metal cap on the carbon electrode and the bottom of the can serve as the terminals.

(d) FLAT OR SPIRAL SPRING TERMINALS. These terminals shall consist of either flat metal strips or spirally wound wire, in a form suitable to provide a pressure contact. They shall be made of spring brass, or other metal of equivalent properties.

(e) WIRE TERMINALS. These shall be flexible insulated tinned copper conductor and may be covered with single cotton braid if so specified. The positive terminal wire covering shall be red and the negative, black. Unless otherwise specified, the size of wire shall be equivalent to No. 18 (AWG) and the length shall be 6 inches ± ½ inch. When the free ends of wire terminals are stripped bare, the separate strands shall be soldered together at the tip. Under certain circumstances wire terminals may be required to terminate with a ring, open-ring, soldering lug or other type of connector.

(f) "PLUG-IN" SOCKETS. This type terminal shall consist of a suitable assembly of metal contacts, mounted in an insulating housing or holding device and adapted to receive corresponding pins of a mating plug in such manner as to make good electrical contact. The metal contacts shall be of tinned brass or other equally suitable metal. Dimensions and arrangement of socket contacts shall be in conformity with figures 1 to 4 inclusive, for various voltages as required.

(g) SNAP FASTENER TERMINALS. This type of terminal consists of a combination comprising a stud for the positive and a socket for the negative terminal as illustrated in figure 5. These shall be made from tinned brass or other suitable metal. They shall be designed in such a way as to provide a secure electrical connection when fitted with corresponding parts for connection to an electrical circuit.

(h) FLAT CONTACT TERMINALS. These shall be essentially flat metal surfaces as shown in figure 6 adapted to make electrical contact by suitable contacting mechanisms bearing against them.

12.2 *No. 6 Cells* shall be equipped with terminals of either the knurled nut and screw type or with spring clips, as required. Spacing between centers of screw terminals shall be $1\frac{1}{16}$ inch $\pm\frac{1}{16}$ inch. In the case of spring-clip terminals the design and location of the negative terminal shall be such that no part of it will extend outside the periphery of the jacket when the connecting wire is in place.

12.3 *Assembled Batteries of No. 6 Cells* (*table 2*). These shall be equipped with terminals of either the knurled nut and screw, or spring-clip type, as required. Terminals shall be located on the top of the battery and the polarity of each shall be clearly marked.

12.4 *Group Batteries of Small Cells* (*table* 3). These batteries shall have terminals similar to those used on *No. 6* dry cells.

12.5 *Flashlight Cells* (*table 4*). Terminals for these shall be as described in 12.1 (c). They shall be clean to assure good electrical contact.

12.6 *Lantern Batteries* (*table 4*). Terminals shall be of flat or spiral-spring type brought out thru the cover at the top. The point of contact of one terminal shall be at the center and that of the other 1 inch $\pm\frac{1}{16}$ inch from it.

12.7 *Radio A, B, and C Batteries and A–B Pack Batteries* (*tables 6, 7, 8, and 9*). Batteries in these classifications are usually equipped with terminals of plug-in-socket type, but other types of terminals may in some cases be required. Socket terminals, if used, shall be as called for in the tables listing the various types of batteries.

12.8 *Hearing-Aid Batteries.* Terminals for hearing-aid batteries shall be as called for in table 5 for the various sizes and voltages listed. It is especially important in hearing-aid batteries that the terminals be such that good contact is maintained at all times with instrument terminals in order to avoid noise and unsatisfactory transmission, and they shall preferably be of such design that reversal of polarity of instrument terminals is impossible.

13. Voltage Tests.

13.1 The voltage of individual cells shall be not less than the values shown in table 10 when measured with a voltmeter having a resistance of not less than 100 ohms per volt and having not less than 50 divisions of its scale per volt.

13.2 The voltage of batteries of two or more cells shall be not less than the product of the required minimum voltage per cell and the number of cells (or 1½-volt groups) in series in the battery. The voltage of cells and batteries other than *B* and *C* batteries shall be measured with a voltmeter having a resistance of not less than 100 ohms per volt and a scale having at least 100 divisions, or 10 divisions per volt, whichever is greater. The voltage of radio batteries for the plate (*B*) circuit and for the grid (*C*) circuit shall be measured with a voltmeter having not less than 1,000 ohms resistance per volt and a scale having at least 100 divisions, or 1 division per volt, whichever is greater.

13.3 Voltage tests are intended to apply to fresh cells or batteries and shall be made within 30 days of receipt of samples by the testing agency.

Table 10.—*Minimum cell voltage*

Cell size	Minimum voltage
	Volts
Smaller than *BF*	1.47
B, BR, BF	1.48
C	1.49
Larger than *C*	1.50

14. Capacity Tests.

14.1 The size and kind of dry cell or battery and the conditions of service determine the kind of test to be applied. The test which best represents any particular service is that which most nearly duplicates the rate-of-energy output of the battery when in actual use. Intermittent tests are preferred to continuous tests and shall be used wherever possible, since there is no direct relation between the results of continuous tests and intermittent tests of longer duration.

"Initial" tests intended to show the condition of fresh batteries shall be started within 30 days of the receipt of the batteries by the testing agency. All tests not otherwise designated shall be understood to be "initial" tests.

"Delayed" service tests are intended to mesaure the keeping quality of cells and batteries before use. Cells and batteries for delayed test shall have been stored on open circuit at an even temperature of 21° C (70° F) for the period of time specified before being subjected to the procedure for the test specified in the tables of requirements under 15.

The standard temperature for tests is 21° C (70° F), unless otherwise specified. Deviations from this temperature shall be stated.

The resistance of the discharge circuit shall be maintained within 0.5 percent of its nominal value.

In making capacity tests on *B* and *C* batteries, readings of working voltage shall be taken with a voltmeter having a resistance of not less than 1,000 ohms per volt.

To determine compliance with this specification, those tests shall be applied for which requirement figures are given in tables 11 to 18, inclusive.

In the tests described below the frequency of readings specified for each test relates to the larger and more commonly used sizes of cells and batteries. When the smaller sizes are tested, more frequent readings are required.

14.2 *Description of Tests.*

(a) light intermittent test. Three cells connected in series shall be discharged through a resistance of 20 ohms for 10 periods of 4 minutes each, beginning at hourly intervals during 6 days per week. On the remaining day, every other discharge period shall be omitted. (There are 65 such discharge periods per week, or a total weekly service of 260 minutes.)

The following readings shall be taken: Initial open-circuit voltage of the battery; initial closed-circuit voltage of the battery; closed-circuit voltage at the end of the tenth discharge of each succeeding fourteenth day.

The test shall be continued until the closed-circuit voltage of the battery falls below 2.8 volts. The service shall be reported as the total number of days on test to 2.8 volts.

(b) fifty-ohm telephone test. This test shall be conducted exactly as called for in section (a) above, except that the three cells shall be discharged through 50 instead of 20 ohms, and the cut-off voltage shall be 3.25 instead of 2.8 volts.

(c) HEAVY INTERMITTENT TEST. The battery shall be discharged through a resistance of 2⅔ ohms for each cell in series for two periods of 1 hour each daily according to the following schedule:

1 hour discharge.
6 hours' rest.
1 hour discharge.
16 hours' rest.

The following readings shall be taken: Initial open-circuit voltage of the battery; initial closed-circuit voltage of the battery; closed-circuit voltage every alternate working day thereafter at the end of the second discharge period of the day.

The test shall be continued until the closed-circuit voltage of the battery falls below 0.85 volt per cell. The service shall be reported as the total number of hours of actual discharge to 0.85 volt per cell.

(d) GENERAL-PURPOSE 4-OHM INTERMITTENT TEST. Each cell shall be discharged through a resistance of 4 ohms for 5-minute periods, at 24-hour intervals.

The following readings shall be taken: Initial open-circuit voltage of the cell; initial closed-circuit voltage of the cell; closed-circuit voltage of the cell at the end of a discharge period twice each week thereafter.

The test shall be continued until the closed-circuit voltage of the cell falls below 0.75 volt. The service shall be reported as the total number of minutes of actual discharge to 0.75 volt.

(e) GENERAL-PURPOSE 2.25-OHM INTERMITTENT TEST. Each cell shall be discharged through a resistance of 2.25 ohms for 5-minute periods, at 24-hour intervals.

The following readings shall be taken: Initial open-circuit voltage of the cell; initial closed-circuit voltage of the cell; closed-circuit voltage of the cell at the end of a discharge period twice each week thereafter.

The test shall be continued until the closed-circuit voltage of the cell falls below 0.65 volt. The service shall be reported as the total number of minutes of actual discharge to 0.65 volt.

(f) LIGHT-INDUSTRIAL FLASHLIGHT TEST. Each cell shall be discharged through a resistance of 4 ohms for 4-minute periods beginning at hourly intervals for 8 consecutive hours every day, with 16-hour rest periods intervening. (There are eight such discharge periods each day or a total daily discharge of 32 minutes.)

The following readings shall be taken: Initial open-circuit voltage of the cell; initial closed-circuit voltage of the cell; closed-circuit voltage of the cell daily at the end of the last discharge period.

The test shall be continued until the closed-circuit voltage of the cell falls below 0.90 volt. The service shall be reported as the total number of minutes of actual discharge to 0.90 volt.

(g) HEAVY-INDUSTRIAL FLASHLIGHT TEST. Each cell shall be discharged through a resistance of 4 ohms for 4-minute periods, beginning at 15-minute intervals, for 8 consecutive hours every day, with 16-hour rest periods intervening. (There are 32 such discharge periods each day or a total daily discharge of 128 minutes.)

The following readings shall be taken: Initial open-circuit voltage of the cell; initial closed-circuit voltage of the cell; closed-circuit voltage of the cell at the end of the sixteenth and thirty-second discharge periods daily.

The test shall be continued until the closed-circuit voltage of the cell falls below 0.90 volt. The service shall be reported as the total number of minutes of actual discharge to 0.90 volt.

(h) RAILROAD-LANTERN BATTERY TEST. The battery shall be discharged every day during eight periods of 30 minutes each, beginning at intervals of 1 hour for 8 consecutive hours, through a resistance of 8 ohms for each cell in series in the battery.

The following readings shall be taken: Initial open-circuit voltage of the battery; initial closed-circuit voltage of the battery; closed-circuit voltage of the battery daily thereafter at the end of the last period of discharge for the day.

The test shall be continued until the closed-circuit voltage of the battery falls below 0.90 volt per cell. The service shall be reported as the total number of hours of actual discharge to 0.90 volt per cell.

(i) HEARING-AID *A* BATTERY TEST. The battery shall be discharged through a resistance of 20 ohms for each cell in series in the battery, for one continuous 12-hour period each day.

The following readings shall be taken: Initial open-circuit voltage; initial closed-circuit voltage; closed-circuit voltage at the end of each 12-hour period of discharge, with readings during the discharge period if necessary to determine accurately the end of the test.

The test shall be continued until the closed-circuit voltage falls below 0.90 volt per cell. The service shall be reported as the total number of hours of actual discharge to 0.90 volt per cell.

(j) HEAVY HEARING-AID *B* BATTERY TEST. The battery shall be discharged through a resistance of 1,500 ohms for each cell in series in the battery for one continuous 12-hour period each day.

The following readings shall be taken: Initial open-circuit voltage: initial closed-circuit voltage; closed-circuit voltage at the end of each discharge period.

The test shall be continued until closed-circuit voltage falls below 1.0 volt per cell. The service shall be reported as the total number of hours of actual discharge to 1.0 volt per cell.

(k) LIGHT HEARING-AID *B* BATTERY TEST. The battery shall be discharged through a resistance of 3,000 ohms for each cell in series in the battery for one continuous 12-hour period each day.

The following readings shall be taken: Initial open-circuit voltage; initial closed-circuit voltage; closed-circuit voltage at the end of each discharge period.

The test shall be continued until closed-circuit voltage falls below 1.0 volt per cell. The service shall be reported as the total number of hours of actual discharge to 1.0 volt per cell.

(l) 5-OHM *A* BATTERY TEST. Each complete 1½-volt battery shall be discharged through a resistance of 5 ohms, during a continuous period of 4 hours daily.

The following readings shall be taken: Initial open-circuit voltage: initial closed-circuit voltage; closed-circuit voltage at the end of alternate discharge periods.

The test shall be continued until the closed-circuit voltage falls below 1.0 volt. The service shall be reported as the total number of hours of actual discharge to 1.1 and 1.0 volts.

(m) 25-OHM *A* BATTERY TEST. Each complete battery shall be discharged through a resistance of 25 ohms for each 1½ volts of nominal battery voltage during a continuous period of 4 hours daily.

The following readings shall be taken: Initial open-circuit voltage; initial closed-circuit voltage; closed-circuit voltage at the end of alternate discharge periods.

The test shall be continued until the closed-circuit voltage falls below 1.0 volt per cell in series in the battery. The service shall be reported as the total number of hours of actual discharge to 1.1 and 1.0 volts per cell.

(n) 5,000-OHM INTERMITTENT TEST. Each 22½-volt (nominal voltage) battery unit shall be discharged through a resistance of 5,000 ohms during a continuous period of 4 hours daily, the intervals between successive discharge periods being not less than 16 hours.

The following readings shall be taken: Initial open-circuit voltage of the battery; initial closed-circuit voltage of the battery; closed-circuit voltage at the end of alternate discharge periods.

The test shall be continued until the closed-circuit voltage falls below 15 volts. The service shall be reported as the total number of hours of actual discharge to 15 volts.

(o) 2,5000-OHM INTERMITTENT TEST. This test shall be as specified in paragraph (n) of 14.2 above, with the exception that 2,500 ohms shall be used in place of 5,000 ohms.

(p) 1,250-OHM INTERMITTENT TEST. This test shall be as specified in paragraph (n) of 14.2 above, with the exception that 1,250 ohms shall be used in place of 5,000 ohms.

(q) *C* BATTERY TESTS. The *C* batteries shall be stored on open-circuit at an even temperature of approximately 21° C (70° F), and voltage readings shall be taken at intervals of not exceeding 1 month.

The test shall be continued until the open-circuit voltage falls below 1.45 volts per cell. The service shall be reported as the number of months to 1.45 volts per cell.

(r) *A–B* PACK BATTERY TESTS. *A–B* pack batteries shall be subjected to the same test for their *A* and *B* sections as are applicable respectively to separate *A* and *B* batteries of the same cell sizes. The service shall be reported as the total number of hours of actual discharge to 1.0 volt per cell for the *A* section and tc 15 volts per 22½-volt unit for the *B* section.

15. REQUIRED PERFORMANCE.

Batteries and cells of the various types and sizes shall comply with the performance requirements listed in tables 11 to 18, inclusive, as indicated below:

	Table
(a) *No. 6* dry cells and telephone cells	11
(b) Group batteries of small cells intended as equivalent to *No. 6* cells shall meet the requirements shown for the corresponding type of *No. 6* cells in	11
(c) General-purpose flashlight cells	12
(d) Industrial flashlight cells and batteries	13
(e) Hearing-aid batteries	14
(f) *A* batteries	15
(g) *B* batteries	16
(h) *C* batteries	17
(i) *A–B* pack batteries	18

TABLE 11.—*No. 6 dry cells and cells for telephone applications*

Sizes and types	Light intermittent test	50-ohm telephone test	Heavy intermittent test	
			Initial	6 months delayed
	Days	*Days*	*Hours*	*Hours*
No. 6 general purpose[a]	200	----------	70	60
No. 6 industrial[b]	275	500	100	90
No. 6 "Special" telephone[c]	325	625	----------	----------
No. 6 "Regular" telephone[c]	250	470	----------	----------
Size *E* telephone	40	80	----------	----------
Size *D* telephone	30	60	----------	----------

[a] Cells not otherwise specifically marked or represented by the manufacturer shall be considered as general-purpose cells and tested according to the requirements thereof.
[b] This type of cell is intended for applications where highly efficient performance is required on both heavy and light services.
[c] No requirements are shown for telephone cells on heavy intermittent test as these types are not usually intended for heavy service.

TABLE 12.—*General-purpose flashlight cells*

Cell designation	General-purpose 2.25-ohm intermittent		General-purpose 4-ohm intermittent		Light-industrial test
	Initial	6 months delayed	Initial	6 months delayed	
	Minutes	*Minutes*	*Minutes*	*Minutes*	*Minutes*
D	400	360	625	575	550
C	----------	----------	300	250	----------
AA	----------	----------	65	50	----------

TABLE 13.—*Industrial flashlight cells and batteries*

Type designation	Heavy-industrial test		Light-industrial test		Railroad-lantern test	
	Initial	3 months delayed	Initial	3 months delayed	Initial	6 months delayed
	Minutes	*Minutes*	*Minutes*	*Minutes*	*Hours*	*Hours*
D, heavy-industrial	750	650	----------	----------	----------	----------
D, light-industrial	----------	----------	850	750	----------	----------
4F, railroad-lantern	----------	----------	----------	----------	45	40

TABLE 14.—*Hearing-aid batteries*

Classification and type designation	Hearing-aid *A*-battery test	Heavy-hearing aid *B*-battery test	Light-hearing aid *B*-battery test
PART I. *A* BATTERIES			
	Hours	*Hours*	*Hours*
AA2	10	----------	----------
C	15	----------	----------
CL	30	----------	----------
CD	60	----------	----------
D	60	----------	----------
F	100	----------	----------

TABLE 14.—*Hearing-aid batteries*—Continued

PART II. *B* BATTERIES

30N, 22N, 15N		400	800
20NS, 15NS, 10NS		200	400
20U, 15U, 10U		50	100

PART III. BATTERIES FOR CARBON-TYPE INSTRUMENTS

2CD, 3CD	60		

TABLE 15.—*A batteries*

Battery designation	5-ohm *A*-battery test		25-ohm *A*-battery test	
	1.1 volts	1.0 volt	1.1 volts [a]	1.0 volt [a]
	Hours	*Hours*	*Hours*	*Hours*
F4, F4s	85	115		
F6	130	170		
F8s, F8d	170	230		
F18	525	600		
3G, 5Gd			130	160
4F2s, 4F2d			240	325
4F			110	140

[a] Cut-off voltage stated as volts per cell, or 1½-volt group, in series.

TABLE 16.—*B batteries*

Battery designation	Test to be applied per 22½-volt unit	Initial test [a]	6-month delayed test [a]
		Hours	*Hours*
15U, 20U	5,000-ohm intermittent	4	3
15NS, 20NS	do	30	25
30N, 45N	do	75	65
30AA	2,500-ohm intermittent	75	60
30A, 15A	do	125	110
30BR	do	150	130
30B, 15B	do	210	190
30D	2,500-ohm intermittent	600	540
	1,250-ohm intermittent	300	270
30F	1,250-ohm intermittent	550	490
30G	do	650	590

[a] To 15 volts for each 22½-volt unit.

TABLE 17.—*C batteries*

Battery designation	*C*-battery test
	Months
3B, 5B, 15B	18
3D	24

TABLE 18.—*A-B pack batteries*

Battery designation	Test to be applied	Initial test	6-month delayed test
		Hours [a]	*Hours* [a]
60*A*-6*F*	*A*—25-ohm *A*-battery test; *B*—2,500-ohm intermittent	125	110
60*BP*-6*G*	*A*—25-ohm *A*-battery test; *B*—2,500-ohm intermittent	150	130
60*D*-*F*18	*A*—5-ohm *A*-battery test; *B*—2,500-ohm intermittent	600	540

[a] To 1.0 volt for each 1½-volts of nominal *A*-battery voltage and to 15 volts for each nominal 22½ volts of *B* battery.

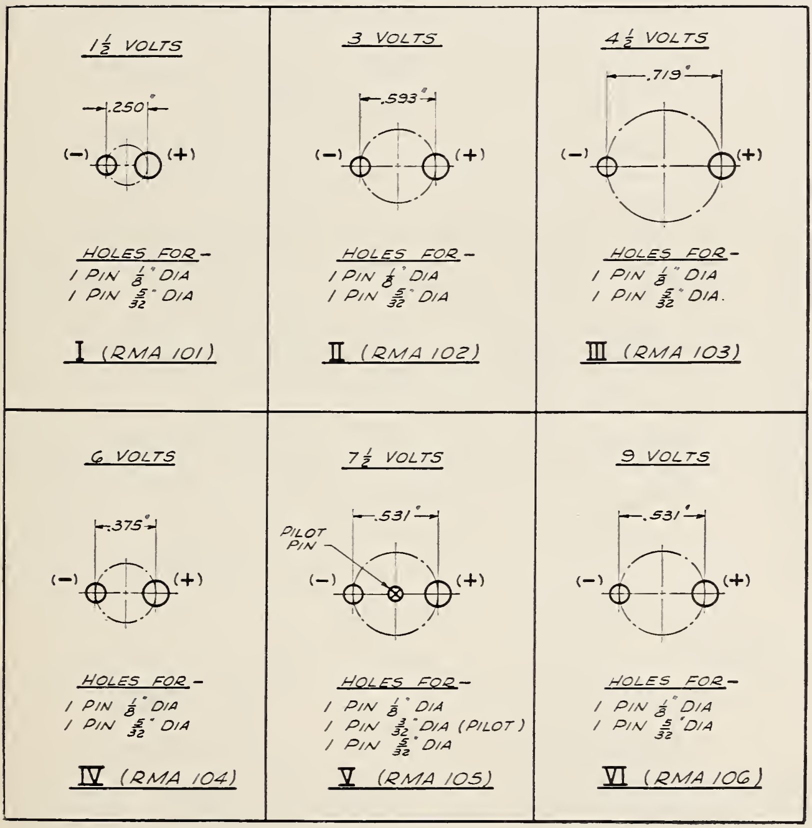


FIGURE 1.

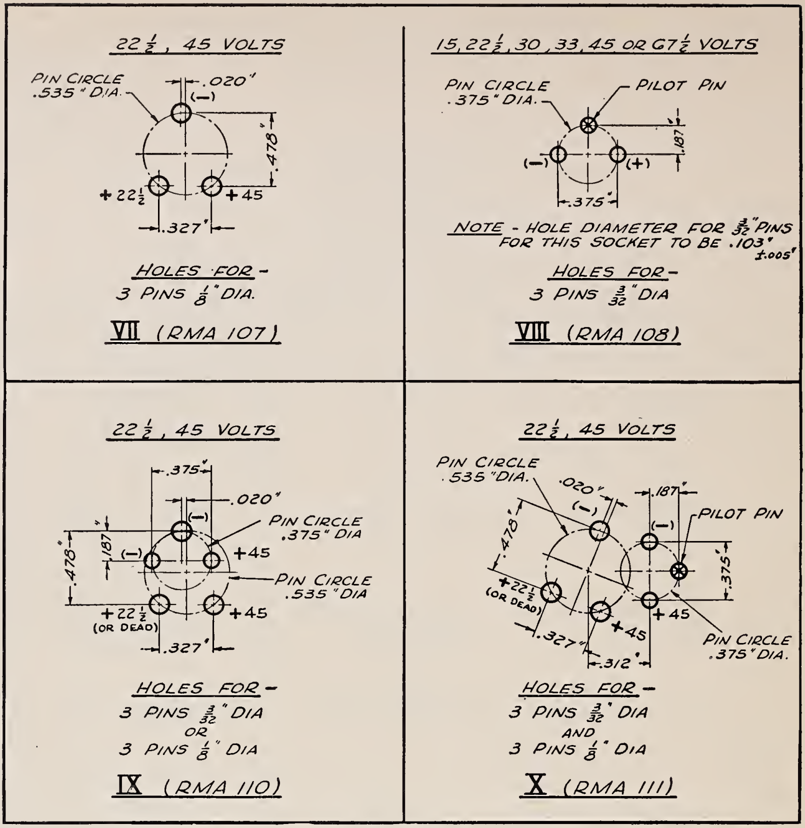


Figure 2.

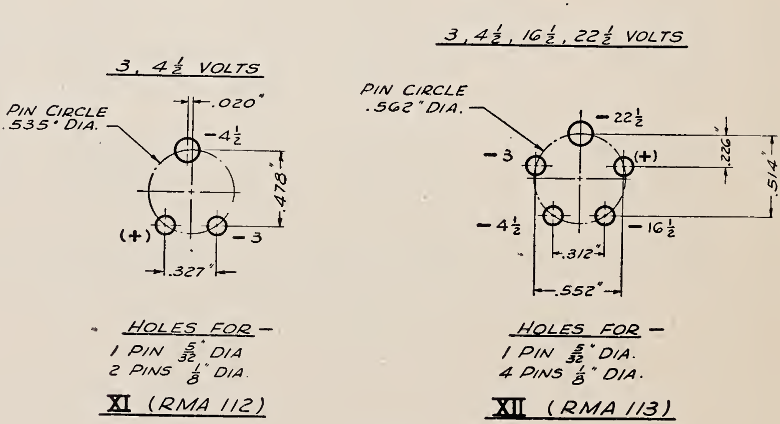


Figure 3.

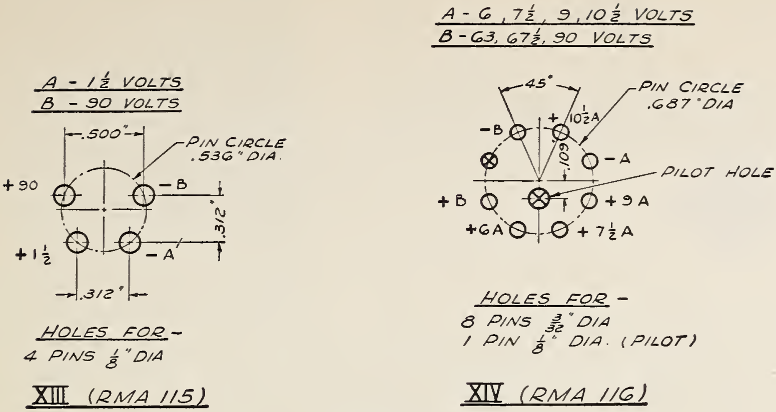


FIGURE 4.

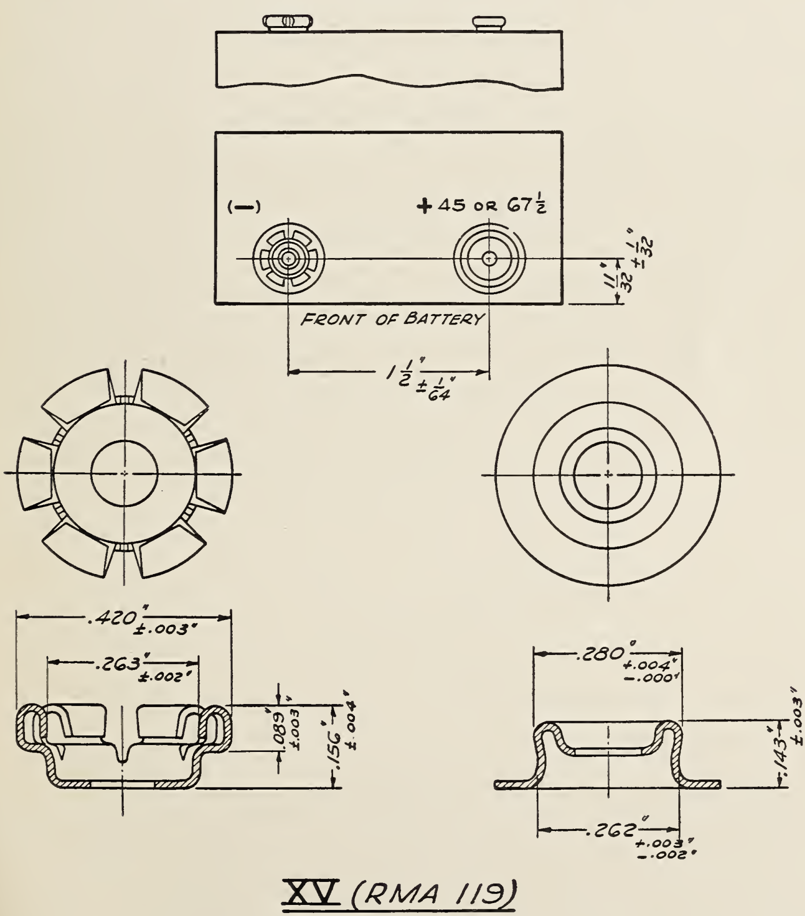
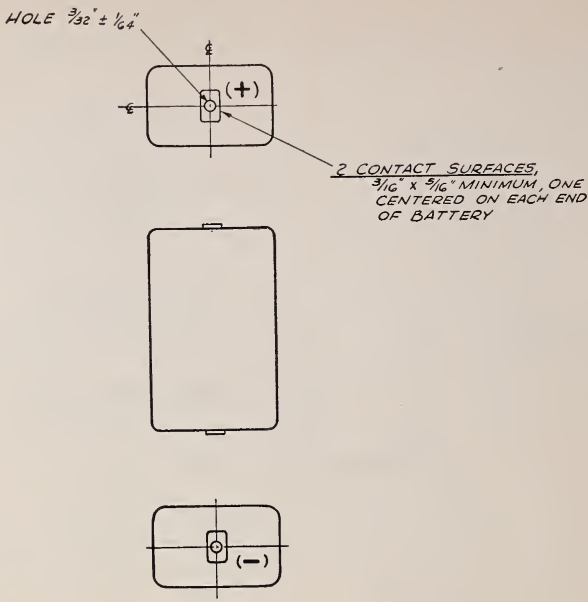
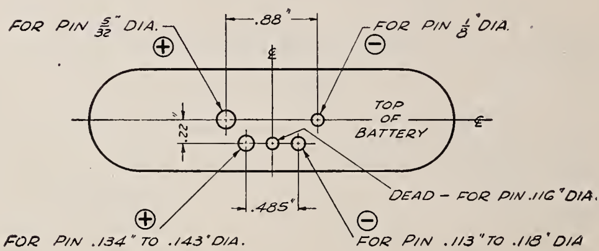


FIGURE 5.



XVI (RMA-120)

FIGURE 6.



XVII (RMA 121)

FIGURE 7.

WASHINGTON, August 19, 1947.

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