DRY CELLS AND DRY BATTERIES
DESCRIPTION

1. GENERAL

1.01 This section describes the dry cells and dry batteries used in telephone and telegraph plants.

1.02 This section is reissued to add the KS-15936 primary battery, to revise the information for maintenance tests and Table A. Since this reissue covers a general revision, the arrows ordinarily used to indicate changes have been omitted.

1.03 A dry cell is a primary battery. It produces electrical energy through an electrochemical reaction which is not efficiently reversible except in the earlier stages of discharge. Hence, the cell when fully discharged cannot be recharged. The electrolyte is completely enclosed in the absorbent materials within the cell.

1.04 A dry battery is a combination of one or more dry cells electrically connected to produce electrical energy. The term battery refers to a source of electrical energy which may be composed of one or more individual cells.

2. DESCRIPTION OF APPARATUS

Construction

2.01 The construction of the ordinary Lechanché cylindrical cell is shown in Fig. 1. The cell is enclosed in a zinc can which serves as the negative electrode and which is usually lined with a layer of paste or absorbent paper. The positive electrode consists of a central carbon rod surrounded by a layer of material known as the depolarizer or mix. The mix consists of a mixture of ground carbon or graphite and manganese dioxide. Both the mix and the lining are moistened with electrolyte consisting of a water solution of ammonium chloride (sal ammoniac) and zinc chloride.

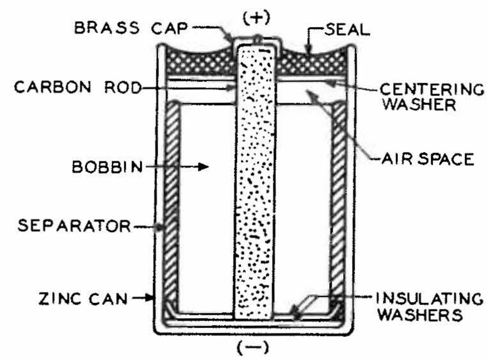

Fig. 1 – Typical Cylindrical Cell

Seal

2.02 The open end of the zinc can is closed by a layer of insulating compound, a washer of insulating material, or an insulated metal top to hold the materials in place and prevent evaporation of the moisture in the cell.

Other Constructions

2.03 The inside-out type cell is one in which a molded carbon shell becomes the container and the zinc is located centrally inside the cell.

2.04 The flat construction is similar to the cylindrical cell in its component parts but differs radically in form. Generally it is confined to multicell assemblies comprising batteries.

2.05 Batteries may be provided with a cardboard jacket or an insulated metal container. The open side may be closed with cardboard or a seal of insulating compound or an insulated metal cover. Special arrangements to guard against leakage of electrolyte are provided on some battery blocks depending upon their particular service requirements.

ASA Designations

2.06 Cell size and batteries are designated by the American Standards Association (ASA) using the code system formulated as follows:

(a) The size of cell is indicated by the ASA cell designation (letter) given in Table A.

(b) Preceding the cell designation is a numeral showing the number of cells (or 1-1/2 volt groups) in series in the battery. If no numeral appears, the battery is a 1-1/2 volt battery.

(c) Following the cell designation is a numeral indicating the number of cells or groups of cells connected in parallel. If no such parallel-indicating number appears, it is understood that the battery consists of only a single series group. If there is a possibility of confusion between a cell designation and a parallel-indicating number, a dash will be used to separate them. Therefore, 15G2 will represent a 22-1/2 volt battery of 30 G-size cells connected 15 in series, in two parallel groups. The 15F100-2 designates a 22-1/2 volt battery of 30 F100-size cells connected 15 in series, in two parallel groups.

3. THEORY OF OPERATION OF LECLANCHE CELL

3.01 When the external circuit between the terminals of the cell is closed, chemical changes within the cell produce electrical energy. These changes result in the conversion of metallic zinc to one of several possible zinc compounds and the reduction of manganese dioxide. The formation and accumulation of reaction products at the surfaces of the electrodes makes further reaction more difficult and polarizes the cell. This reduces the operating voltage and increases its apparent internal resistance. The reaction products which form at the electrodes are slowly removed by diffusion processes; consequently, on open circuit the cell depolarizes and tends to return to its original voltage. When it is no longer able to deliver current at a suitable voltage, the cell is considered to have reached the end of its useful life.

4. OPERATING CHARACTERISTICS

4.01 The life of a cell depends upon many variables such as its size, ingredients, processes of manufacture, age, and also on the frequency, duration, and rate of discharges, and the circuit voltage limits.

4.02 Local internal action is responsible for the consumption of some of the chemical energy in the cell. This loss of energy which occurs while on open circuit (either in storage or assembled in equipment) is known as shelf depreciation.

Depletion

4.03 The chemicals in the cell, including the water, gradually become exhausted due to useful current output and shelf depreciation. When this condition is reached, no more electrical energy can be supplied. In order to obtain reliability of service, it is economical in most telephone applications to discard cells before their capacity is completely exhausted. However, if the cell has become exhausted due to a high rate or extended period of discharge, it may recover to some extent if allowed to stand idle and will then be capable of rendering further service.

Effect of Temperature

4.04 High temperatures greatly increase shelf depreciation, and low temperatures decrease it; hence, refrigeration may be used to improve the keeping qualities of dry batteries during storage and shipment. If refrigeration is not available, batteries should be kept as cool and dry as possible.

4.05 The voltage of a dry battery both on open circuit and on discharge increases with rising temperature and decreases with falling temperature. On open circuit, the change is small and can generally be disregarded. Under discharge the output obtainable is greater at a high temperature than at normal 70 F, provided the time of use does not extend over such a long period that the shelf loss is greater than the gain due to the increased chemical activity of the cell.

4.06 At low temperatures, the chemical activity of the cell is decreased and long life is obtained on open-circuit and low-drain services. However, for most uses the capacity and life are greatly reduced during exposure to low temperature. The extent of this reduction depends upon the temperature, current drain, cutoff voltage, size of cells, etc.

4.07 With decreasing temperatures a condition is finally reached where the cell is unable to deliver any current. Except for grid service or very light current drain, dry batteries should be considered inoperative at temperatures of −10 F to −20 F. At 0° F, the capacity may be reduced to as little as one-fourth that at 70 F, but, as noted above, this proportion will vary widely depending on the specific conditions.

4.08 Batteries subjected to low temperatures incur no permanent injury and regain their normal operating characteristics when the internal temperature again reaches normal. Since there is a considerable lag in the drop of the internal temperature, the adverse effects may be retarded by the use of thermal insulation. Conversely, batteries once frozen require an appreciable time in which to warm up internally.

Voltage at Which Cells or Batteries Should be Discarded (cutoff point)

4.09 Batteries in low current-drain service will deliver almost all of the available ampere-hour output at a relatively high operating voltage, after which the voltage drop will be comparatively rapid. Hence, in this service a high cutoff point is desirable in order to ensure reliability. For batteries in high current-drain service, the higher current will produce a greater internal resistance drop and a lower operating voltage. A lower cutoff point is therefore necessary in order to obtain efficient use of the available energy contained in the cells. When it is necessary to maintain the battery voltage within close limits under high current drains, it is frequently desirable to add one or more cells in series when the cutoff point is first reached in order to take advantage of the increased output thereby obtainable from the whole battery.

Maintenance Tests

4.10 In general it is desirable to replace a battery before it reaches the end of its useful life; for this reason periodic maintenance tests should be made. For many applications, specific maintenance tests have been provided on circuit schematic drawings and circuit description sheets to cover individual practices on standard circuits. For further information on tests and inspections refer to Section 157-421-501.

5. ELECTROLYTE LEAKAGE

5.01 Cells and batteries showing bulging or leaking of electrolyte or a deposit of salts on the outside should be replaced at once. Leakage of electrolyte may cause a short circuit, resulting in dissipation of the energy of the battery, and may create a fire hazard.

5.02 Leakage of electrolyte may be caused by any of the following factors:

(a) Abnormally heavy drains or short circuits.

(b) Damage due to handling.

(c) Cells left in service after exhaustion.

(d) Excessively high ambient temperatures.

(e) Manufacturing defects.

5.03 Factors contributing to the danger of fire due to electrolyte leakage, especially where higher capacity multiunit assemblies are used, may be:

(a) Missing or damaged insulating shelf liners.

(b) Battery units pushed too close together or to grounded metal shelf parts. An air space of at least 1/8 to 1/4 inch should be allowed where practical.

(c) Nonstandard arrangements so that batteries are placed in a U formation resulting in full voltage between the two batteries at the terminal ends.

(d) Battery jackets wet from an external source.

5.04 For multiunit assemblies of individual cells or batteries, it is recommended that the entire battery be replaced when any one unit shows low voltage on test or shows leaking or bulging. This procedure assures that units of various ages and conditions are not connected in the same circuit so that the poorest ones may be discharged completely and develop leaking. With the following exceptions, this is a general rule. In order to maintain voltage within specified limits and still obtain efficient use of the battery, it may be desirable to move connections to higher voltage taps on battery blocks or to add a relatively small number of cells into the circuit. This is particularly applicable for batteries requiring close voltage regulation where, without the addition of extra cells, only a relatively small proportion of normal ampere-hour capacity could be obtained. Additions should not be carried to the point where any one unit will be in danger of being entirely depleted since such a condition will increase the hazard of sudden failure, leakage, and fire.

6. STORAGE

6.01 Since batteries are a perishable product, they should not be stored any longer than necessary before being placed in service. During storage, a cool, dry location away from radiators and other sources of heat should be selected if practicable, since shelf depreciation is accelerated by heat.

7. STANDARD TYPES OF BATTERIES

7.01 Table A lists the standard Bell System dry cells and batteries together with information regarding dimensions, voltages, standard package quantities, etc. Table B shows information regarding the life of these cells and batteries when used under varying load conditions. Illustrations of batteries are shown in Fig. 2 through 33.

> *Note:* Where flat cells are used the words "FLAT CELL TYPE" shall precede the number of cells furnished and the proper ASA coding for cell size. For example: FLAT CELL TYPE 31F80.

TABLE A — STANDARD BELL SYSTEM DRY CELLS AND BATTERIES

KS NO.	NOMINAL VOLTAGE	TERMINAL DESIGNATIONS (if marked)	ASA DESIG	MAXIMUM BATTERY DIMENSIONS LENGTH (inches)	WIDTH (inches)	OVER-ALL HEIGHT (inches)	USUAL TYPE SERVICE	STD PKG QUANT
6522	1-1/2		D	1-11/32	Diameter	2-13/32	Flashlight	48 or 192
6542	1-1/2		No. 6	2-5/8	Diameter	6-3/4	Transmitter Supply, Grid, Test Set, Aux, and Emergency Reserve (see note)	25
6567	3	+, −	2B	2-1/2	27/32	2-5/8	Grid	5
6568	4-1/2	+, −	3B	2-1/2	27/32	2-5/8	Grid	24
6569	4-1/2	+, −1-1/2, −3, −4-1/2	3D	4-1/16	1-1/2	3-9/16	Grid, Test Set	10
6570	4-1/2	−, +	3D	4-1/16	1-1/2	3-5/8	Test Set	60
6571	**24	−, + **24	15A or 16F80†	3-1/2	2-3/32	3-1/16	Plate, Test Set	20
6572	22-1/2	−, +22-1/2	15C	3-1/4	2-5/8	6-1/4	Plate, Test Set	6
6573	22-1/2	−, +16-1/2, +18, +19-1/2, +21, +22-1/2	15D	6-3/4	4-1/8	3-15/16	Plate, Test Set	6
6700	4-1/2	−, +	*	6-5/8	4-3/8	7-3/8	Transmitter	8
6948	45	−, +6, +12, +18, +22-1/2, +40-1/2, +42, +43-1/2, +45	30G	8-1/4	4-9/16	7-15/16	Plate, Test Set, Aux, Reserve	4
7105	22-1/2	+, −4-1/2, −9, −19-1/2, −21, −22-1/2	15B	4-3/16	2-5/8	3-1/2	Plate, Test Set, Grid	10
7342	4-1/2	+, −4-1/2	3D	4-1/16	1-1/2	3-15/16	Grid, Test Set	10
7595	3	−, +	*	5-3/8	2-13/16	7-3/8	Transmitter	12
7889	46-1/2	+, −	31B	2-11/16	2-11/16	9-1/2	Grid Only	6
7890	90	−, +90	60A or 60F80†	8-1/4	3-5/8	2-9/16	Grid Only	4
8128	22-1/2	−, +4-1/2, +9, +19-1/2, +21, +22-1/2	15G2	8-1/4	4-9/16	7-15/16	Plate, Aux, Reserve	4
8587	31-1/2	+3, GT, −3, −7-1/2, −16-1/2, −18, −24, −25-1/2, −27, −28-1/2	21G	9-7/16	4-3/16	5-1/2	Grid, Plate, Test Set	6
8588	22-1/2	+, −16-1/2, −18, −19-1/2, −21, −22-1/2	15G	6-13/16	4-3/16	5-1/2	Grid, Plate, Test Set	6
9025	22-1/2	−, +22-1/2	15D or 15F100-2†	6-3/4	4-1/8	3-15/16	Plate, Test Set	6
13493	7-1/2	−, +7-1/2	5G	4-1/16	2-13/16	4-5/8	Test Set	6
14196	45	−, +22-1/2, +45	30AA	3	2-5/16	4-1/8	Test Set, Plate	15
14367	1-1/2		No. 6	2-5/8	Diameter	6-3/4	Test Set, Aux, Reserve	12
14368	1-1/2		AA	3-7/64	Diameter	1-31/32	Flashlight	144
14369	45	−, +45	30N or 30F40†	2-21/32	1	3-11/16	Plate, Test Set	12
14370	45	−, +22-1/2, +45	30BR or 30F90†	3-19/32	1-27/32	5-1/2	Plate, Test Set	12
14371	6	+, −	4F	2-11/16	2-11/16	4-3/8	Lantern	25
14495	1-1/2	−, +	F2	2-11/16	1-3/8	4-1/2	Test Set	10
14711	1-1/2	+, −	D	1-11/32	Diameter	2-13/32	Test Set	48 or 192
14757	45	−, +22-1/2, +45	30F100†	5-1/8	2-1/16	7-1/4	Plate & Highway Flasher	6
14773	22-1/2	+	15F20†	1-1/16	41/64	2	Plate, Test Set	24
15936	22-1/2	−, +	15F15	5/8	19/32	2	Test Set	100

†Flat-cell construction.

*No designation: KS-6700 consists of three No. 6 cells in series,
KS-7595 consists of two No. 6 cells in series.

**For flat-cell construction. Alternative constructions, when permitted, may result in batteries of slightly different voltage.

Note: "Aux" — battery in central office for coin control, ringing, tripping, or superimposed ringing. "Reserve"—battery used for rectifier power supply in case of ac power failure.

TABLE B — STANDARD BELL SYSTEM DRY BATTERIES — SERVICE LIFE EXPECTANCY UNDER VARYING LOAD CONDITIONS

KS NUMBER	NOMINAL VOLTAGE	TOTAL DAILY DISCHARGE PERIOD	LOAD RESISTANCE	CURRENT AT NOMINAL VOLTAGE	CUMULATIVE DISCH TIME TO CUTOFF VOLTAGE	CUTOFF VOLTAGE	OPEN-CIRCUIT AVERAGE LIFE
			ohms	ma	hours		years*
6522	1.5	32 min 128 min	4 4	375 375	22.5 22.5	0.9	
6542	1.5	37 min	16.7 6.67 3.33	90 225 450	670 335 167	1.08 0.93 0.90	
6567 6568	3.0 4.5						4-1/2
6569	4.5	4 hr	500 125	9 36	1170 315	3.0	4
6570	4.5	37 min 37 min 6 hr	50 20 37.5	90 225 120	112 42 68	3.25 2.8 2.7	
6571	24.0	4 hr	5000 1250	4.8 19.2	630 180	15.0	
6572	22.5	4 hr	5000 1250	4.5 18	1260 360	15.0	
6573	22.5	4 hr	2500 625	9 36	1170 315	15.0	3-1/2
6700	4.5	37 min	50 20 10	90 225 450	670 335 167	3.25 2.8 2.7	
6948	45.0	4 hr	2500 625	18 72	1080 270	30.0	
7105	22.5	4 hr	5000 1250	4.5 18.0	1080 270	15.0	3-1/2
7342	4.5	4 hr	500 125	9 36	1170 315	3.0	4
7595	3.0	37 min	33.3 13.3 6.67	90 225 450	670 335 167	2.17 1.87 1.8	
7889 7890	46.5 90.0						3-1/2
8128	22.5	4 hr	625 156	36 144	1080 270	15.0	

* Open-circuit average life figures apply for test temperatures of 70 F and drop to 1.33 volts per cell.

TABLE B (Cont)

KS NUMBER	NOMINAL VOLTAGE	TOTAL DAILY DISCHARGE PERIOD	LOAD RESISTANCE	CURRENT AT NOMINAL VOLTAGE	CUMULATIVE DISCH TIME TO CUTOFF VOLTAGE	CUTOFF VOLTAGE	OPEN-CIRCUIT AVERAGE LIFE
			ohms	ma	hours		years*
8587	31.5	4 hr	1750 437	18 72	1080 270	21.0	4
8588	22.5	4 hr	1250 312	18 72	1080 270	15.0	4
9025	22.5	4 hr	2500 625	9 36	1350 450	15.0	3-1/2
13493	7.5	4 hr	125	60	270	5.0	
14196	45.0	4 hr	10,000 2500	4.5 18	200 30	30.0	
14367	1.5	6 hr 2 hr	12.5 2.67	120 560	670 162	0.9 0.85	
14368	1.5	5 min	4	375	4.5	0.75	
14369	45.0	4 hr	45,000 10,000	1 4.5	810 225	30.0	
14370	45.0	4 hr	10,000 2500	4.5 18	756 162	30.0	
14371 14495	6.0 1.5	4 hr 4 hr	32 25	188 60	68 495	3.6 1.0	
14711	1.5	32 min 128 min	4	375	22.5	0.9	
14757	45.0	4 hr	5000 1250	9 36	990 225	30.0	
14773	22.5	4 hr	90,000 22,500	0.25 1	855 315	15.0	
15936	22.5	2 hr	150,000	0.15	540	18.0	

* Open-circuit average life figures apply for test temperatures of 70 F and drop to 1.33 volts per cell.

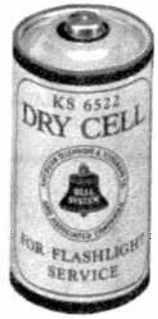

Fig. 2 – KS-6522

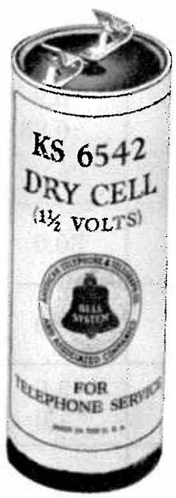

Fig. 3 – KS-6542

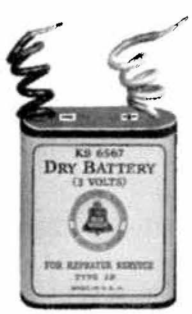

Fig. 4 – KS-6567

Fig. 5 – KS-6568

Fig. 6 – KS-6569

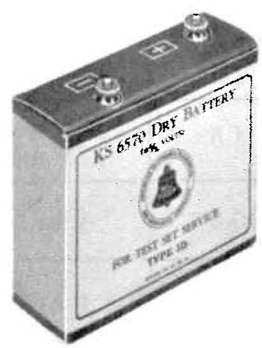

Fig. 7 – KS-6570

Fig. 8 – KS-6571

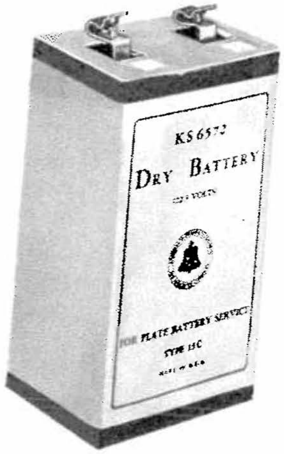

Fig. 9 – KS-6572

Fig. 11 – KS-6700

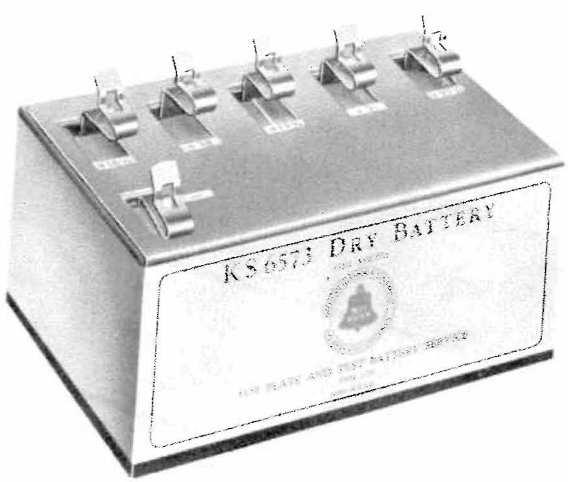

Fig. 10 – KS-6573

Fig. 12 – KS-6948

Fig. 13 – KS-7105

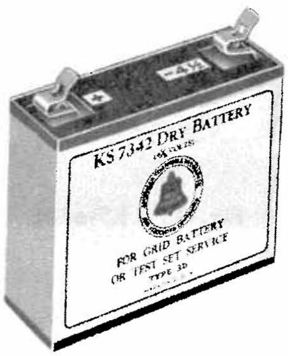

Fig. 14 – KS-7342

Fig. 15 – KS-7595

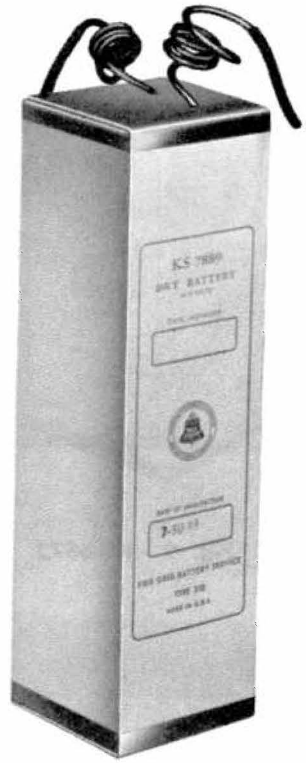

Fig. 16 – KS-7889

Fig. 17 – KS-7890

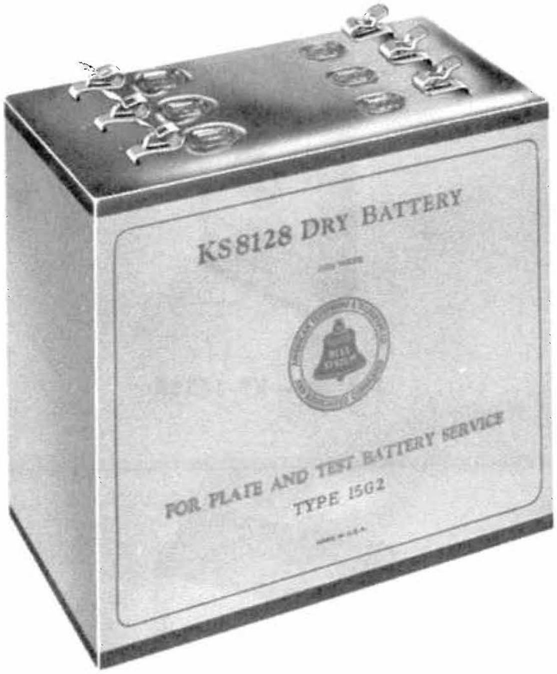

Fig. 18 – KS-8128

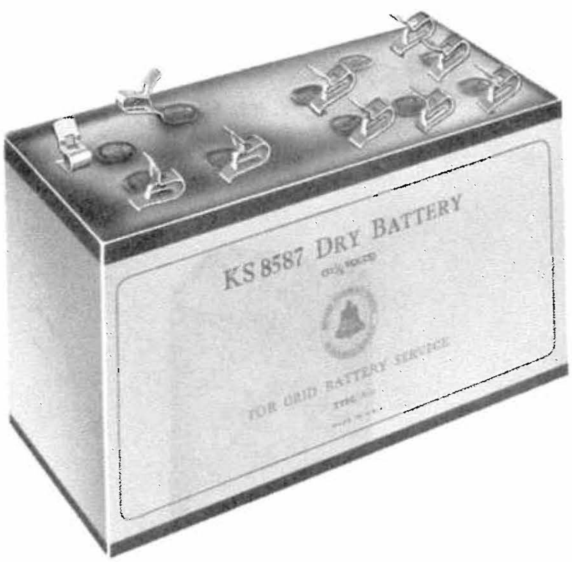

Fig. 19 – KS-8587

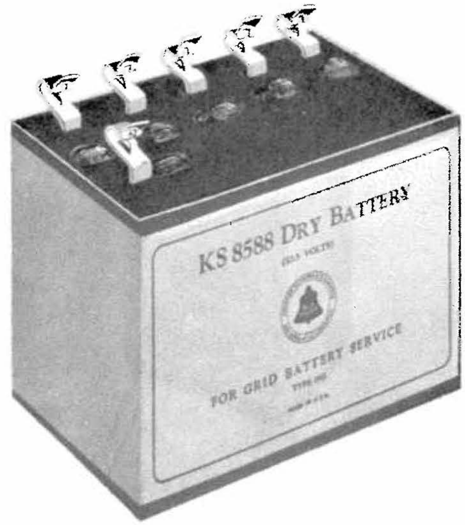

Fig. 20 – KS-8588

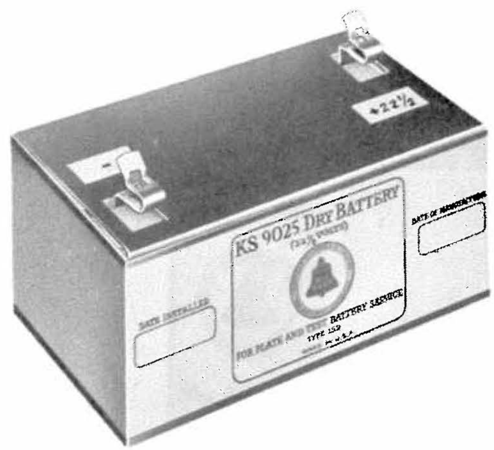

Fig. 21 – KS-9025

Fig. 22 – KS-13493

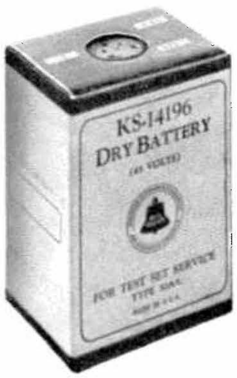

Fig. 23 – KS-14196

Fig. 26 – KS-14369

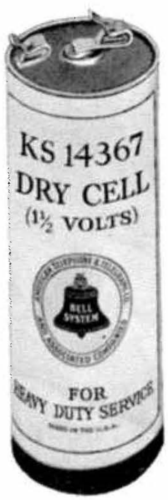

Fig. 24 – KS-14367

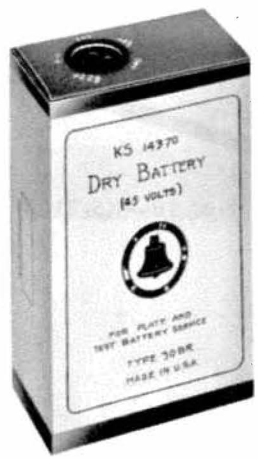

Fig. 27 – KS-14370

Fig. 25 – KS-14368

Fig. 28 – KS-14371

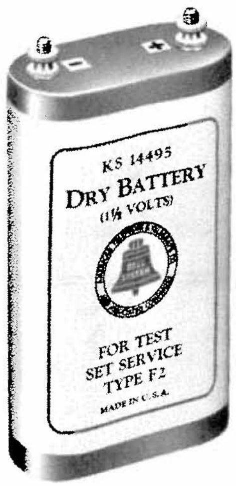

Fig. 29 – KS-14495

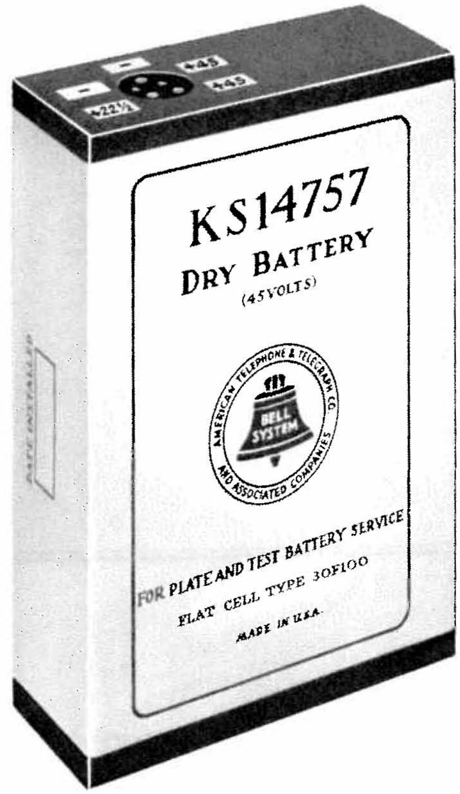

Fig. 31 – KS-14757

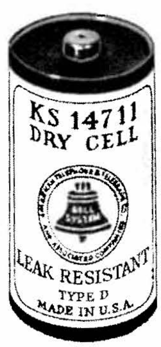

Fig. 30 – KS-14711

Fig. 32 – KS-14773

Fig. 33 – KS-15936