

## STORAGE BATTERIES LEAD-ACID ENCLOSED-TYPE DESIGN AND CONSTRUCTION

CONTENTS	PAGE	CONTENTS	PAGE
<b>1. GENERAL</b> . . . . .	2	<b>2.19 Explosion-proof Features—Shields &amp; Vents</b> . . . . .	5
<b>2. CONSTRUCTION &amp; DEFINITIONS</b> . . . . .	2	<b>2.20 Charge Indicators</b> . . . . .	5
<b>2.01 Storage Cell</b> . . . . .	2	<b>2.21 Electrolyte Withdrawal Tubes</b> . . . . .	5
<b>2.02 Factors Determining Ampere Hours &amp; Voltage</b> . . . . .	2	<b>2.22 Spray Caps</b> . . . . .	5
<b>2.03 Active Materials</b> . . . . .	2	<b>2.23 Hardened Site Cell Construction</b> . . . . .	5
<b>2.04 Electrolyte</b> . . . . .	2	<b>3. ACCESSORIES</b> . . . . .	6
<b>2.05 Grids</b> . . . . .	2	<b>3.01 Hydrometers</b> . . . . .	6
<b>2.06 Positive Plates</b> . . . . .	3	<b>3.02 Thermometers</b> . . . . .	6
<b>2.07 Negative Plates</b> . . . . .	3	<b>3.03 Electrolyte Level Indicators</b> . . . . .	6
<b>2.08 Straps</b> . . . . .	3	<b>3.04 Filling Funnels</b> . . . . .	6
<b>2.09 Separators</b> . . . . .	3	<b>3.05 Syringe-Type Cell Filler</b> . . . . .	6
<b>2.10 Retainers</b> . . . . .	3		
<b>2.11 Separator Protectors</b> . . . . .	3	<b>ILLUSTRATIONS</b>	
<b>2.12 Elements</b> . . . . .	3	<b>Fig. 1—240 Ampere-hour Cell With Perforated Retainers</b> . . . . .	2
<b>2.13 Jars, Jar Covers, and Cover Seals</b> . . . . .	4	<b>Fig. 2—Groups of Plates</b> . . . . .	3
<b>2.14 Tanks</b> . . . . .	4	<b>Fig. 3—50 Ampere-hour, 2-cell Case</b> . . . . .	3
<b>2.15 Cases</b> . . . . .	4	<b>Fig. 4—5000 Ampere-hour, Floor Mounted Cell</b> . . . . .	4
<b>2.16 Trays</b> . . . . .	4	<b>Fig. 5—1680 Ampere-hour Cell With Rubber Container</b> . . . . .	4
<b>2.17 Cell Connectors</b> . . . . .	4	<b>Fig. 6—KS-15544 L508 Cell With Electrolyte Withdrawal Tubes</b> . . . . .	5
<b>2.18 Terminal Posts and Post Seals</b> . . . . .	4		

CONTENTS	PAGE
Fig. 7—KS-20048 L1 Hardened Site Cell—6000 Ampere-hour . . . .	7
Fig. 8—Post Seals (Typical) . . . .	7
Fig. 9—Jar-cover Seals for KS-15544 Plastic Cells . . . . .	8

**1. GENERAL**

**1.01** This section describes the design and construction of the lead-acid storage batteries of the enclosed type used in telephone and telegraph power plants.

**1.02** This section is reissued to add information on construction of hardened site cells; to include information on electrolyte withdrawal tubes, spray caps, combination vent and filling funnels, and plastic explosion-proof vents; to delete reference to wooden separators and tanks; and to add a Table of Contents and generally update the section. Since this is a general revision, arrows ordinarily used to indicate changes have been omitted. This reissue does not affect Equipment Test List.

**1.03** Additional information covering the theory of batteries of this type is covered in Section 157-601-101. Trouble conditions of jars, jar covers, and plates are treated in Section 157-601-703. Part replacement procedures are covered in Section 157-621-801. General requirement and procedures are contained in Section 157-601-701. See Section 157-000-000 for the numerical index of all battery Sections.

**2. CONSTRUCTION AND DEFINITIONS**

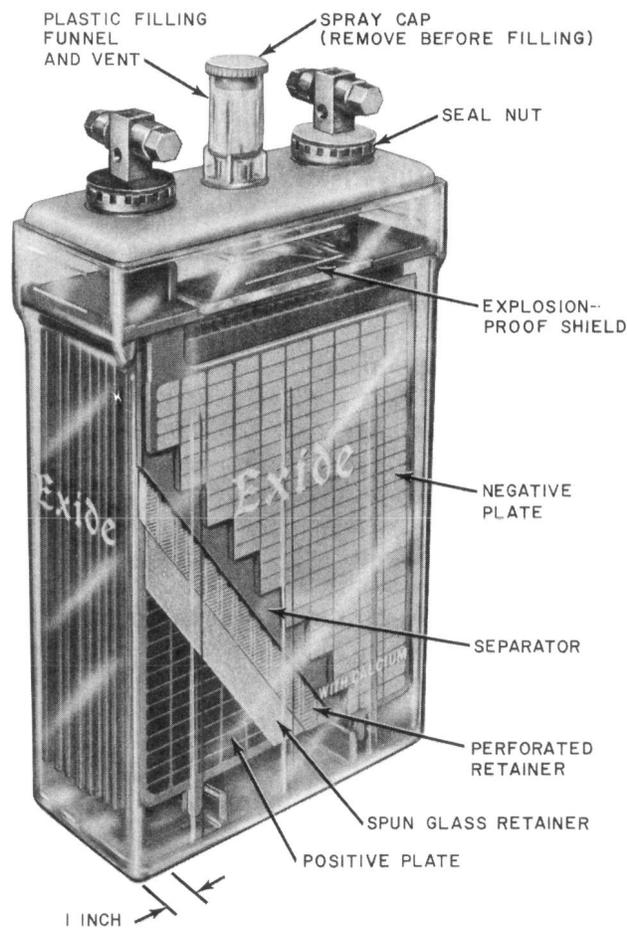
**2.01** A *storage cell* includes the active materials in a suitable container with the necessary accessories. The cell is arranged for connection to charge and discharge circuits. Details of construction and the principal accessories are described in 2.02 through 2.23 and Part 3, respectively.

**2.02** *Factors Determining Ampere-hours and Voltage:* The ampere-hour capacity which a cell can produce depends primarily on the size and number of plates connected in parallel. The voltage of a battery depends on the number of cells connected in series.

**2.03** The *active materials* of a storage cell are the electrolyte and the materials of the plates which react chemically to produce electrical energy when the cell discharges. The active materials are restored to their original composition by the charging current through oxidation and reduction processes.

**2.04** The *electrolyte* is an aqueous solution of sulfuric acid.

**2.05** A *grid* is the metallic framework of the plate in a storage cell for supporting the active materials and conducting the electric current. The grids are made of two different alloys, either lead-antimony or lead-calcium. The ribs of the grid are usually horizontal and vertical (see Fig. 1), but may be diagonal (see Fig. 2).



**Fig. 1—240 Ampere-hour Cell With Perforated Retainers**

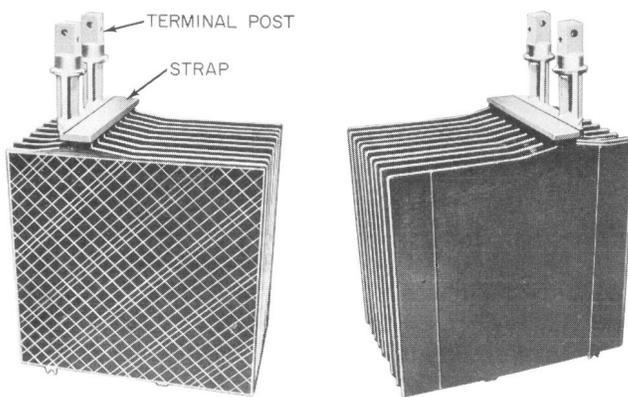


Fig. 2—Groups of Plates

**2.06** A *positive plate* consists of the grid and the active material from which current flows to the external circuit when the cell is discharging. The original paste of the positive plate is a mixture of lead oxide, sulfuric acid, and water. After it has dried and hardened, the plates are immersed in dilute sulfuric acid solution and charged. During this formation process, lead oxide is converted to lead dioxide which is dark brown in color. Designations, such as (+) or POS appear on or near the terminal associated with the positive plates and in addition, the positive terminal is often marked with red.

**2.07** A *negative plate* consists of the grid and the active material to which current flows from the external circuit when the cell is discharging. The original paste of the negative plate is lead oxide, sulfuric acid, water, and expanders. The oxides are reduced during formation to sponge lead which is light gray in color. The terminal associated with the negative plates is usually unmarked but sometimes carries a designation, such as (–) or NEG.

**2.08** A *strap* is a casting to which a plate or group of plates of the same polarity are burned. The terminal post to which electrical connection is made to the external circuit is also burned to the strap (see Fig. 2).

**2.09** A *separator* is a spacer used to prevent contact between the positive and negative plates (see Fig. 1). Separators are made of microporous rubber.

**2.10** A *retainer* is a perforated sheet of hard rubber or plastic, a glass-fiber mat, or a similar material held in intimate contact with the surface of the positive plate to hold the active material in place. See Fig. 1.

**2.11** A *separator protector* (see Fig. 3) is a perforated shield of polyvinyl-chloride which some cells are equipped with to prevent possible damage to the separators by a hydrometer syringe or thermometer.

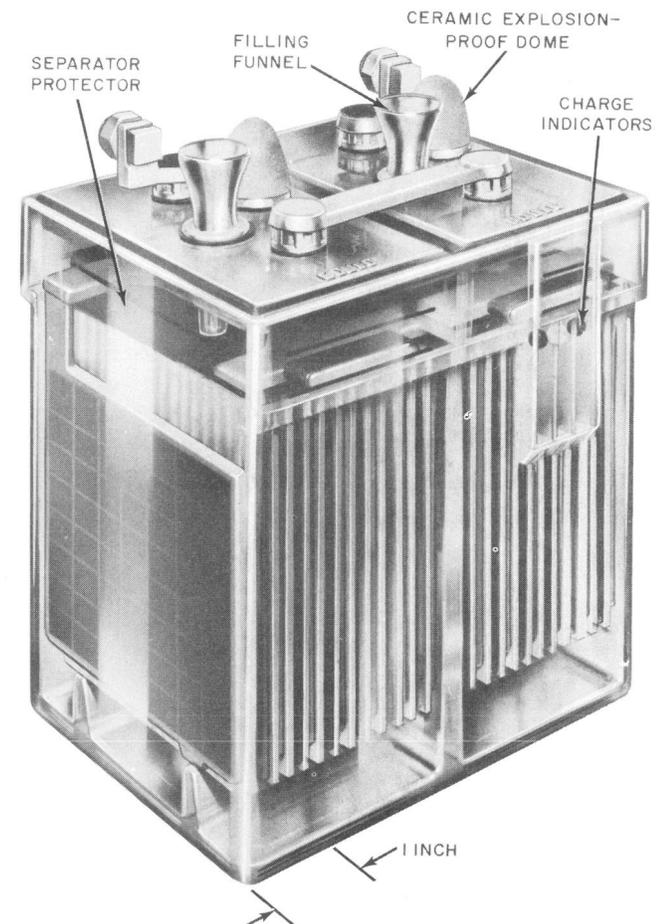


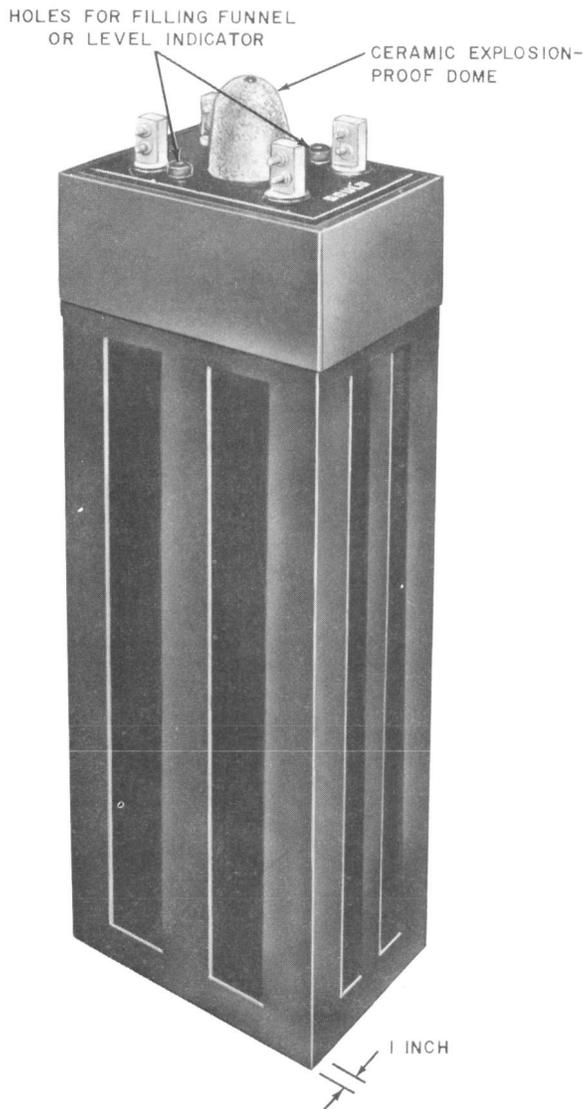
Fig. 3—50 Ampere-hour 2-cell Case

**2.12** An *element* consists of the positive and negative groups with separators or separators and retainers assembled for one cell. The number of negative plates in the cells usually exceeds the number of positive plates by one so that the end plates are negative plates. This is necessary so

**SECTION 157-621-101**

that both sides of each positive plate will face a negative plate to provide uniform current distribution.

**2.13** A *jar* is a glass, rubber, or plastic vessel which contains the element and electrolyte of a single cell (see Fig. 4). Since 1958 all jars have been furnished in plastic with the exception of tank cell jars which are furnished in hard rubber or fiberglass. See Sections 157-601-701 and 157-601-703 for information on jar covers and jar cover seals. See Fig. 9 for cover seals for KS-15544 plastic cells.



**Fig. 4—5000 Ampere-hour Floor Mounted Cell**

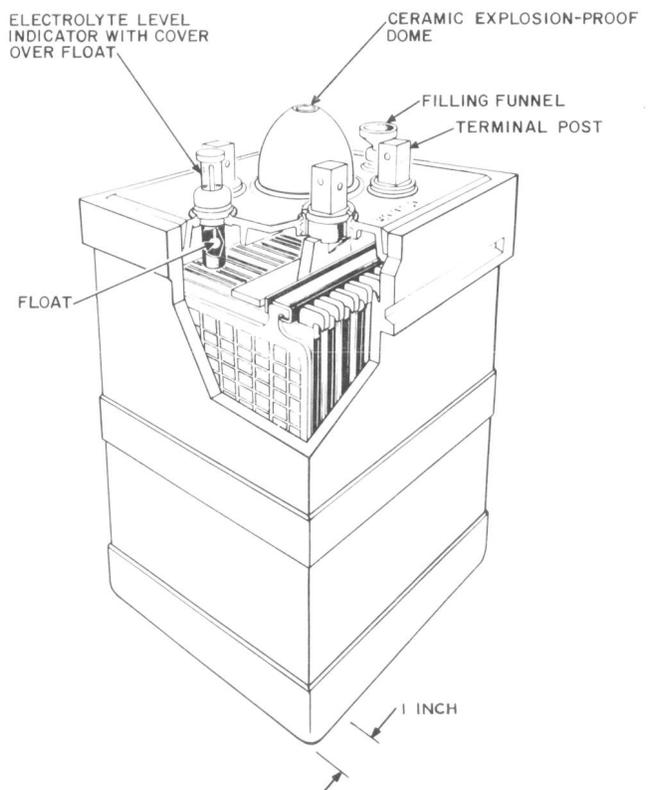
**2.14** The term *tank* is also used to describe large floor-mounted jars (see Fig. 4).

**2.15** A *case* is a multicompartment container for the elements and electrolyte of two or more cells (see Fig. 3).

**2.16** A *tray* is a holder for one or more cells. The term tray has also been applied in the past to the rubber or lead pan set under a glass jar battery, particularly in rented quarters. Trays are not normally supplied with plastic jar batteries. Trays should be of nonporous material. Trays reduce fire hazard by catching electrolyte if leakage occurs.

**2.17** A *cell connector* is an electric conductor used for carrying current between cells.

**2.18** *Terminal Posts and Post Seals:* Terminal posts are the parts of a battery to which the external circuit is connected (see 2.08 and Fig. 2 and 5). Fig. 8 illustrates typical post seals. See Fig. 9 for post seals for KS-15544 plastic cells.



**Fig. 5—1680 Ampere-hour Cell With Rubber Container**

**2.19** *Explosion-proof features* are now employed with all cells of 50 ampere-hours or larger. For smaller cells, see 2.22. Explosion-proof features may be of the following types.

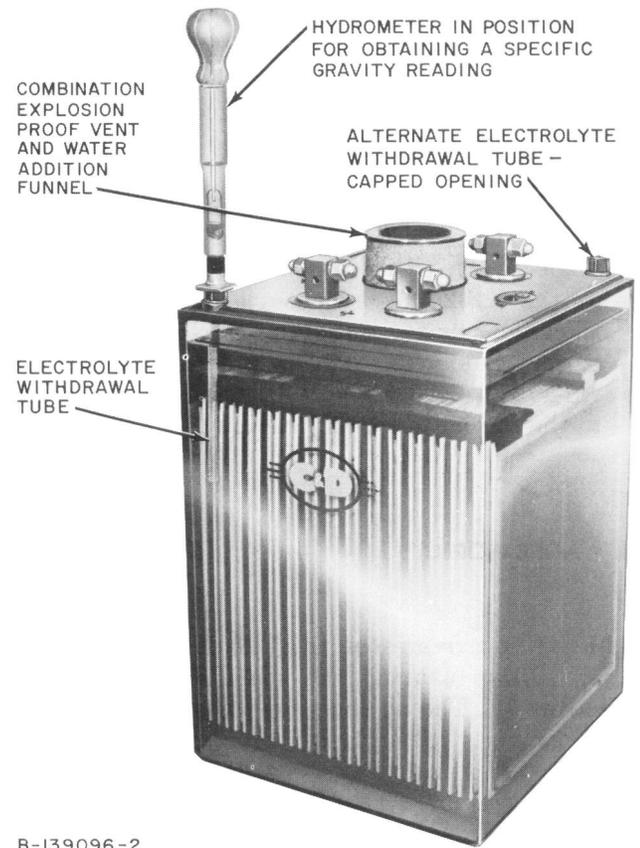
(a) The most common type is a combination porous explosion-proof vent and water addition funnel which is mounted on top of the cell cover as shown in Fig. 6. The porous vent permits gases to escape from the cell but prevents the possibility of a flashback into the cell.

(b) A second type is a porous explosion-proof vent or dome mounted on the top of the cell cover which is separate from the filling funnel. Fig. 3, 4, and 5 show typical porous explosion-proof vents or domes.

(c) A third type is a shield (see Fig. 1), located over the top of the plates but below the electrolyte level, which clears the sides of the jar by only a small amount to permit electrolyte to flow past the edges. The lower face of the shield is slightly concave with an opening at the center. The vent tube extends down to the opening in the top of the shield. The gas rising from the plates comes in contact with the concave surfaces and flows toward the center and out through the vent tube. The maximum gas accumulation is limited, therefore, to the space within the tube between the top of the electrolyte and the top of the tube. The space between the top of the shield and the cover is vented through a clearance space between the filling tube and the cover. Very little gas can enter this space as the shield is quite efficient.

**2.20** *Charge indicators* are furnished on some smaller cells. The indicators are wax balls of selected specific gravity so that the number of balls floating is an approximate indication of the specific gravity of the electrolyte (see Fig. 3). Reference should be made to Section 157-601-701 for more detailed information on charge indicators and specific gravity readings. For accurate specific gravity readings, a hydrometer is used (see 3.01).

**2.21** Some cells are equipped with *electrolyte withdrawal tubes* which are designed to facilitate taking specific gravity readings with a hydrometer (see Fig. 6). Electrolyte withdrawal tubes should not be used for taking the temperature of electrolyte because the withdrawal tubes have no bottom and the thermometer can fall to the bottom of the cell.



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**Fig. 6—KS-15544 L508 Cell With Electrolyte Withdrawal Tubes**

**2.22** *Spray caps* vary in form from a simple rubber cap with a breather hole (see Fig. 1) to the type used on most automobile batteries. The breather hole prevents pressure build-up and possible explosion of smaller cells without explosion-proof features (see 2.19).

**2.23** *Hardened Site Cell Construction:* Two general types of enclosed hardened site cells are presently available. These cells are constructed so as to enable them to better withstand the shocks of earthquakes or nuclear blasts. Reference should be made to Section 157-601-701 for specific characteristics of these cells. The general construction characteristics of these two types of cells are as follows:

(a) *KS-20048 List 1* (see Fig. 7): These cells were initially designed for hardened site use. The container jar or tank is fabricated from reinforced fiberglass. An acid resistant

rubber liner is fitted to the inside of the jar. The internal parts are specially constructed for strength. Special internal clamps, restrainers, and liners are used to reduce the chance of shock damage. At installation, the cells are specially mounted in racks that can absorb strong shocks.

(b) **KS-20106 Lists 101 & 108:** These cells are hardened KS-15544 List 501 & 508 cells, respectively. The cells are hardened by means of the KS-20054 accessories which include a fiberglass base, top retainer, side plates, and rubber cushions. The accessories enclose the KS-15544 cell and provide means for mounting to the hardened battery rack.

### 3. ACCESSORIES

**3.01** A *hydrometer* (Fig. 6) is an instrument for measuring the specific gravity of the electrolyte. The syringe type used with enclosed cells consists of a glass float properly weighted and provided with a scale graduated in terms of specific gravity. This is enclosed in a syringe, consisting of a plastic or glass tube with rubber bulb at one end and a tip at the other, arranged so that electrolyte can be drawn out of the cell into the tube to float the hydrometer. Hydrometer holders are available for mounting on wall or framework.

**3.02** *Thermometers* provided for reading electrolyte temperature are graduated in degrees Fahrenheit. Electrolyte temperature readings are taken by inserting the thermometer through the filling hole in the cover of the cells. The thermometers currently supplied have a scale indicating the correction to be made in the observed hydrometer reading to correct it to the reference temperature of 77°F.

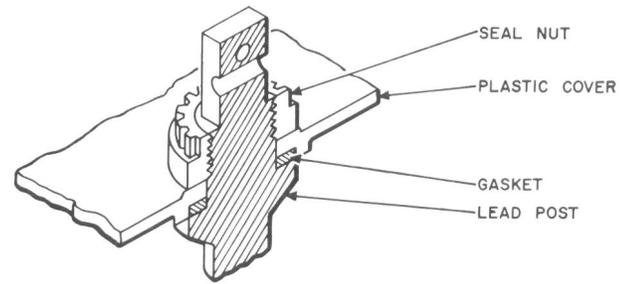
**3.03** *Electrolyte level indicators* are provided with cells contained in black rubber jars where the electrolyte level cannot be observed. The indicator float extends through a hole in the cover. The stem of the indicator is colored part way so that a change in color indicates the electrolyte is at the maximum level as soon as it appears. The minimum level occurs when the top of the stem is flush or level with the top of the hole in the cover. Some of the older indicator stems were enclosed in a glass tube above the cover as in Fig. 5. In this case, a line on the stem of the indicator is used in connection with two lines on the covering tube to determine the maximum and minimum level of the electrolyte. (See Section 157-621-801 for level indicator replacement procedures).

**3.04** A *filling funnel* separate from the vent, is furnished on some cells (see Fig. 3 and 5).

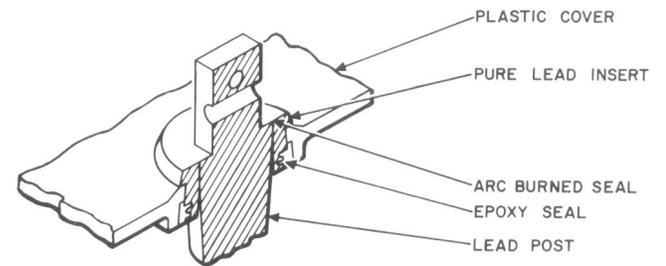
**3.05** A *syringe-type cell filler* is used to fill smaller cells, particularly where clearances make other methods of filling awkward.



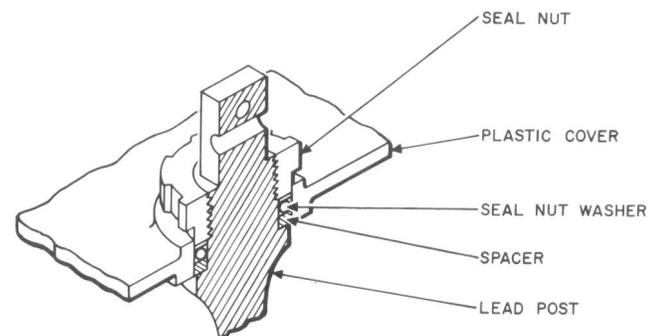
**Fig. 7—KS-20048 L1 Hardened Site Cell—6000 Ampere-hour**



**TYPE 1 (EXIDE)**

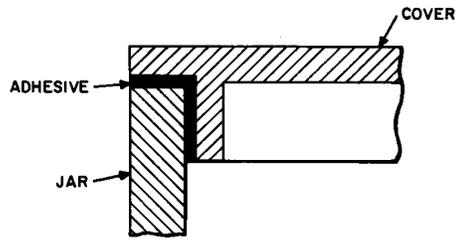


**TYPE 2 (C & D)**

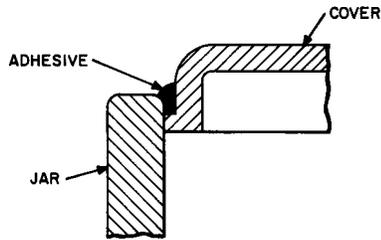


**TYPE (GOULD)**

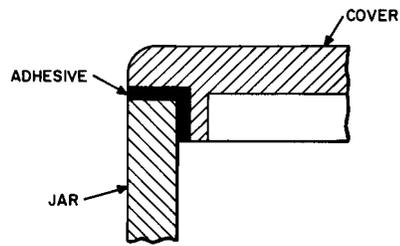
**Fig. 8—Post Seals (Typical)**



C AND D



EXIDE



GOULD

TPA 550669

Fig. 9—Jar-cover Seals for KS-15544 Plastic Cells