LEAD-ACID BATTERY
TROUBLE CONDITIONS
(WITH COLOR PHOTOS)

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1. GENERAL

1.01 This section describes the trouble conditions of lead-calcium and lead-antimony cells and batteries.

1.02 This issue affects Equipment Test List.

1.03 Evaluation of the design of lead-acid batteries in plastic jars indicates they have been prone to mechanical failure in about 10 to 15 years as a result of stresses produced by growth of internal members causing jar breakage and resultant

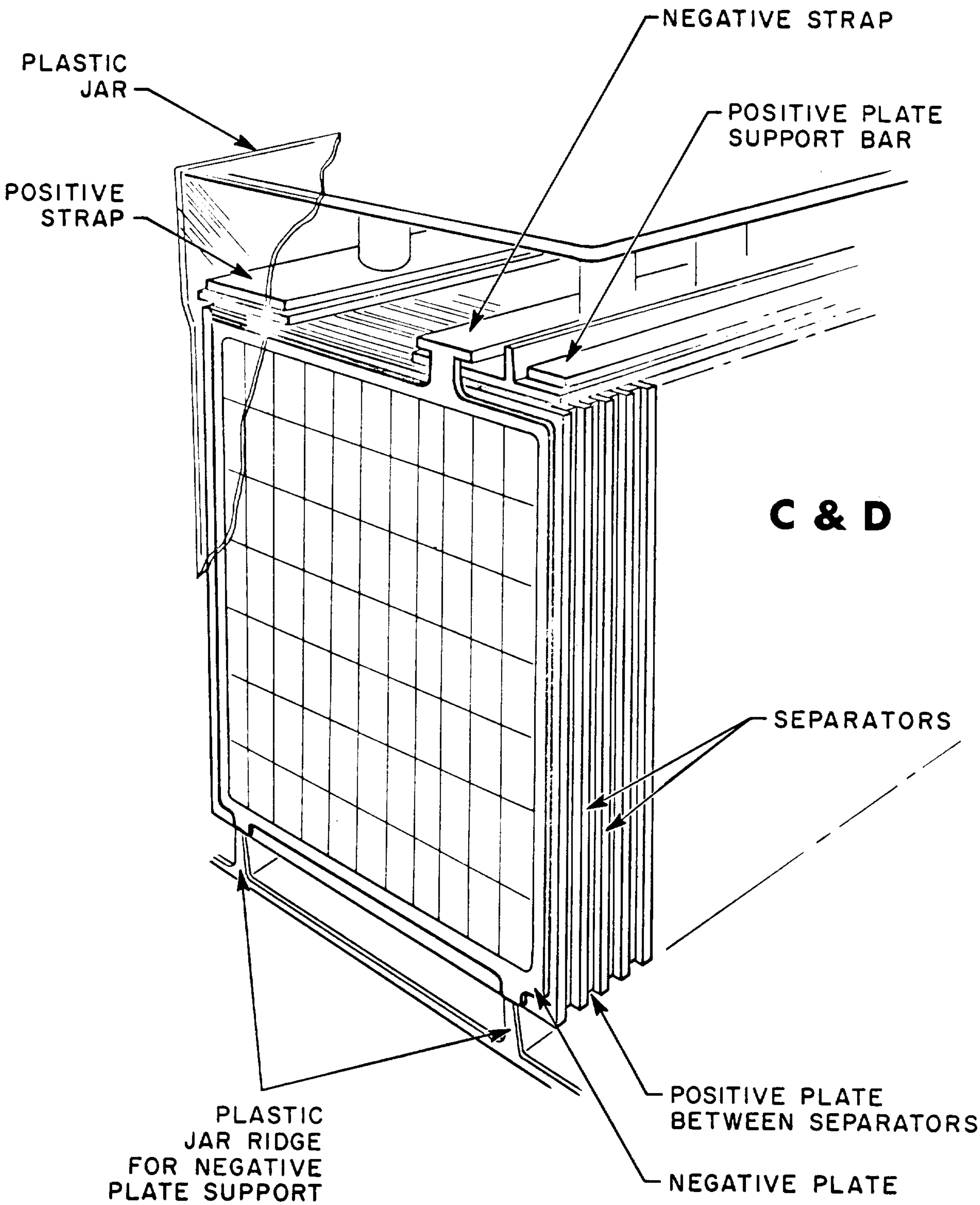

Fig. 1—C&D Cutaway View

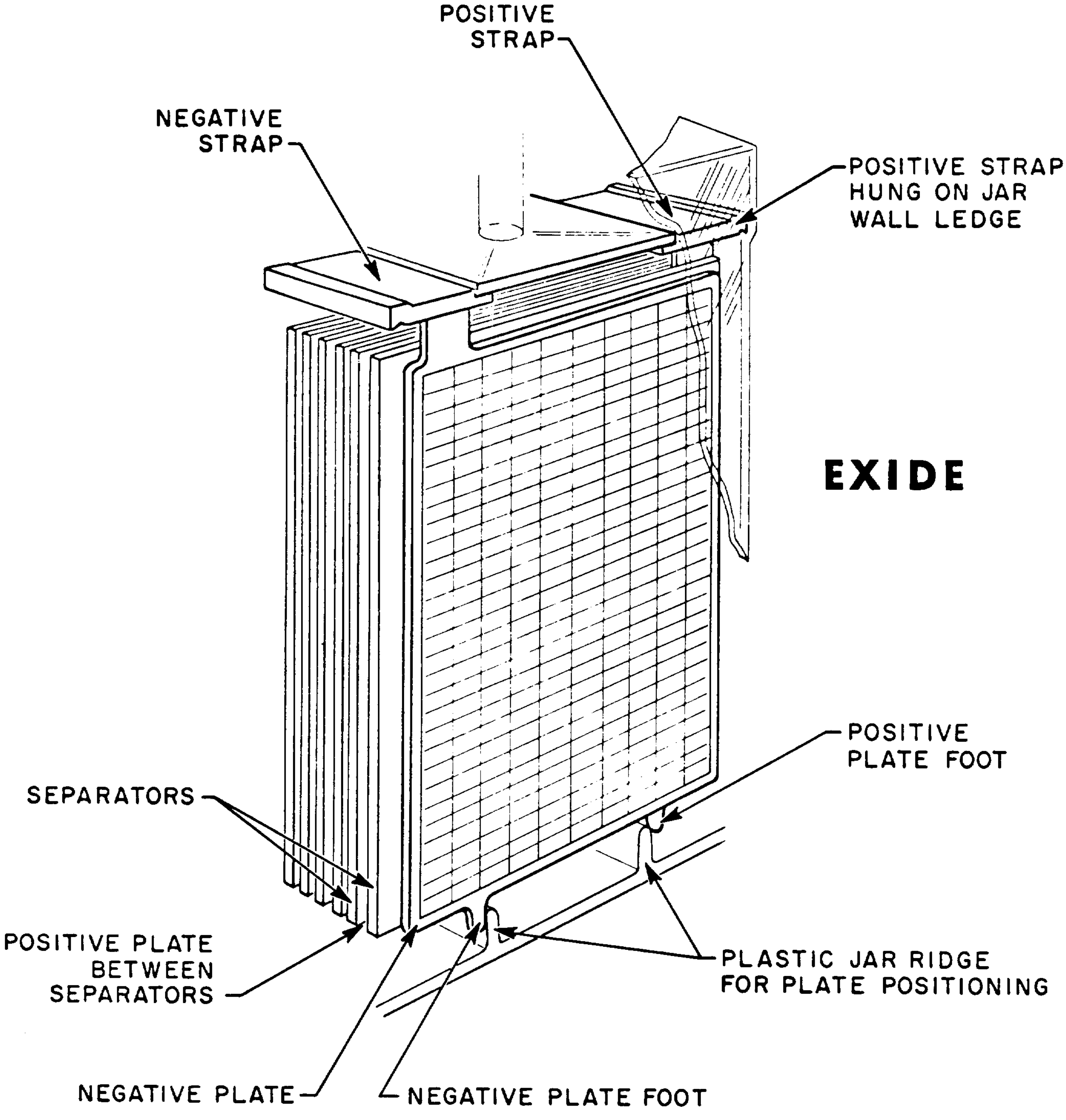

Fig. 2—Exide Cutaway View

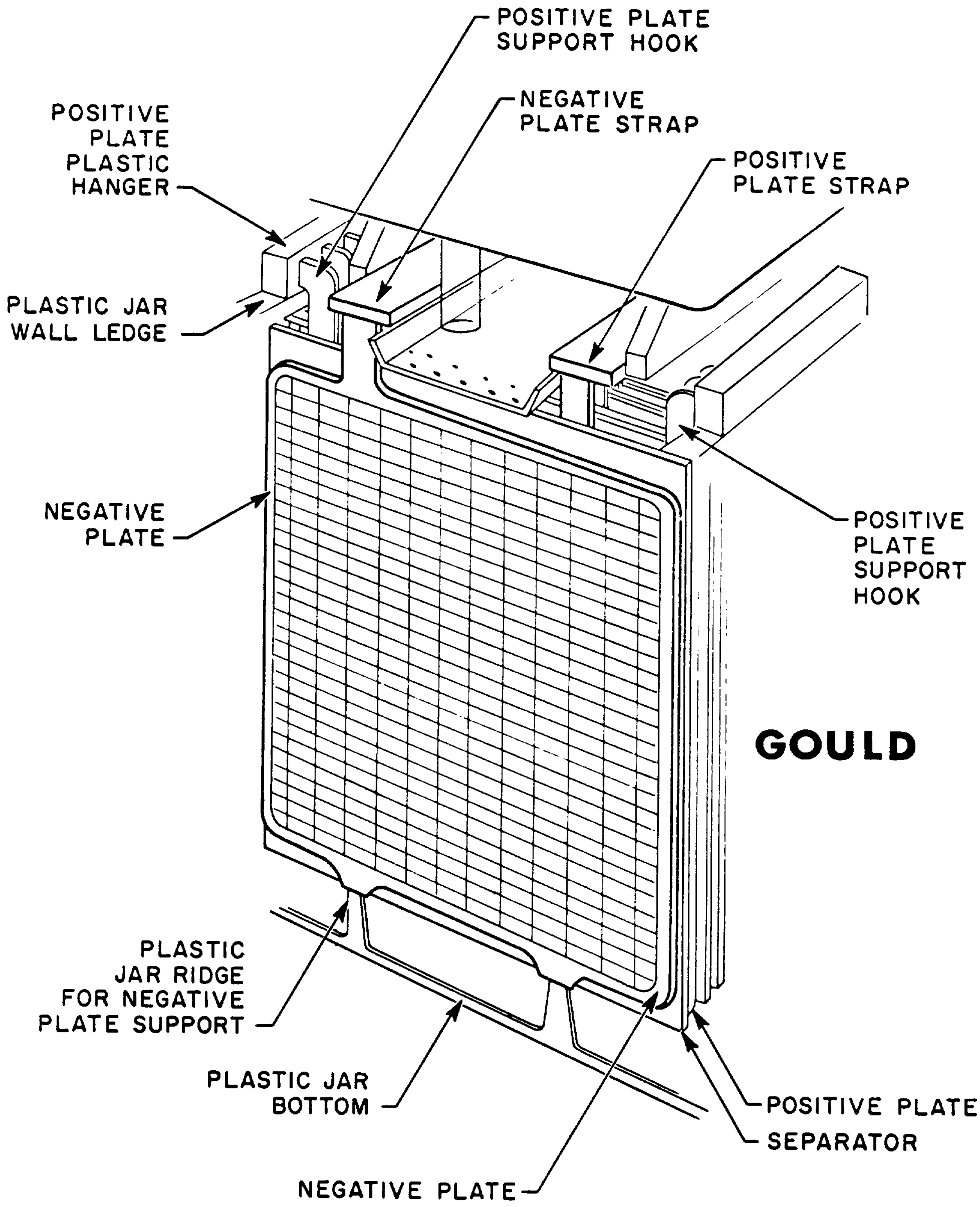

Fig. 3—Gould Cutaway View

electrolyte loss. Failures occur even sooner in cells where clearances between the internal members and the jar are minimal, or where poor casting quality causes accelerated growth of internal members such as straps, plates, and posts.

1.04 Hard-rubber jars generally constrain lateral growth of the plates, but the covers can be pushed up due to the method of construction. Where the plates are bottom-supported, cover rise should be anticipated. However, cover rise can also occur with top-supported plates.

1.05 Plate and strap growth is due to oxidation of the lead, causing lead to change to lead dioxide. Lead dioxide occupies more volume than lead, consequently the positive plates and straps expand. This growth occurs in both lead-calcium and lead-antimony cells.

1.06 Field forces should be on the alert to detect crazed and cracked cell containers and should arrange to order cell replacements before leaks occur. ***Acid leakage can cause short circuits and corrosion and create a potential fire hazard.***

1.07 For supplementary information on lead-acid batteries, refer to those Sections listed in the NUMERICAL INDEX—DIVISION 157 of Section 157-000-000, with special attention to Sections 157-601-101, -301, -701, and -702, and Section 157-621-101.

2. TROUBLE CONDITIONS

PLASTIC JARS

2.01 ***Causes of Mechanical Failure:*** The more prevalent causes of mechanical failure which may be expected in batteries with plastic jars are listed as follows:

(a) ***C&D:*** (Prior to 1962) growth of positive strap and positive plate support bar. Fig. 1.

(b) ***Exide:*** (Prior to April 1965) growth of positive strap. Fig. 2.

(c) ***Gould:*** Grid growth causing positive plate support hooks (fingers) to exert pressure on jar. Fig. 3.

(d) ***Common to All:*** Growth of positive posts and plates (all age periods).

2.02 ***Positive Plate Growth and Bowing:*** Plate growth can be gauged by eye. Only the positive plates are expected to grow. When new, the positive plate edges do not project beyond the separators. As growth progresses, the plate edges will gradually grow out past the separators and eventually touch the inner wall of the jar. Further plate growth will apply pressure to the jar wall which may be indicated by nosing of the plate edges or flattening of the black plastic wrapper (where so equipped) against the jar wall. Plate growth will also occur in the vertical plane, and in some designs, apply pressure on the cover in an upward direction or grow vertically downward and touch the plastic jar ridge used for positioning or supporting the negative plate. An estimate of plate growth can be obtained by comparing the position of the lower edge of the positive plates with the bottom of the adjacent negative plates which do not grow.

2.03 In Fig. 4, the positive plates have grown laterally beyond the separators with maximum growth visible at the point just above the vertical arrows. Nosing is just beginning in the area indicated by the two horizontal arrows (2). Plate growth in the thickness dimension (or bowing or cupping of the plates as shown in Fig. 5) can cause the outside negative plates to exert pressure on the end walls of the plastic jar and may cause crazing and, ultimately, cracking to occur at the point of contact between the jar wall and the plastic jar ridge which supports or positions the negative plate. The KS-5553 and KS-15544 List 300 and 400 cells of all manufacturers are subject to this difficulty. The KS-5553 and KS-15544 List 500 series C&D cells and Gould cells prior to 1963 would be expected to show this defect. The KS-5361 List 140 through 151 Gould and C&D cells may also show this defect. In Fig. 5, a vertical red reference line has been superimposed between the arrows to more clearly indicate the degree of bowing.

2.04 ***Strap Growth:*** The upper edges of the positive plate are burned into a lead bar which is called a strap. These straps can grow enough to apply pressure to the jar wall as illustrated in Fig. 6. In some designs the Exide and C&D straps are adjacent to the plastic jar wall. The Gould strap is located inward from the wall and has individual plate hangers hung into a plastic hanger which rests on the inner wall edge of the jar. Where either the strap or the plastic hanger is nosing on the jar wall, flattened air bubbles are usually evident.

2.05 ***Crazes and Cracks:*** Fig. 6 and 7 illustrate crazing. Fig. 8, 9, and 10 illustrate crack patterns typical of each supplier's product. Jar cracks are usually preceded by crazing of the jar at the plate or strap pressure point. Compare Fig. 6 with 9 and Fig. 7 with 10. Crazing is hard to see but shows up under a light beam as a group of hairline cracks. For safety, use a flashlight housed in a nonconducting material (plastic or rubber).

2.06 ***Cracks and Leakage:*** Cracks due to plate or strap growth may occur in the jar cover (see Fig. 8) and extend over to the jar. Replace cracked or leaking containers. See Section 157-601-201 for allowable limits on scratches at installation. Where the cracks are above the electrolyte level, leakage may not occur but the explosion-proof vent is bypassed. Effort should be made to detect cracks and to order replacement cells before leaks occur. Where cracks are below the electrolyte level, but not leaking, it is only a matter of time before continued strap or plate growth will cause leakage. (See Section 157-601-701 for procedure to temporarily seal plastic jar cracks.)

2.07 ***Leaking Jar-cover Seals:*** Because of poor design or workmanship, or as a result of stresses caused by vertical plate growth, jar-cover seals may in time crack, separate, and leak electrolyte (see Fig. 11). Where cracks and leaks occur, the effectiveness of the explosion-proof feature is bypassed, the potential fire hazard is increased, and cell repair or replacement is indicated. See Section 157-601-701 for possible repair of seals on hard-rubber cells. In small power cell designs (L140 through 151), the use of flexible connectors permits accidental contact of adjacent cells in crowded installations. Where such cells have leaking or cracked jar-cover seals, experience has indicated that an intercell short can develop from the leaking electrolyte which may cause either a fire or explosion or both. In general, the seals used in Gould cells of the L140 through L151 design appear most prone to this defect, but cells of other manufacturers should be carefully checked. ➧A faulty jar-cover seal with electrolyte leakage can be detected with the use of a voltmeter (Weston Model 931, range 300/150/75/30). One lead of the voltmeter is connected to ground and the other lead is used to probe the seal area. If the reading obtained is greater than 50 percent of the battery voltage measured between ground and the higher voltage terminal on the tested cell, a serious leak is indicated. In the case of tank cells where a convenient ground point may not be available, one of the cell terminals can be used in place of a ground point. In such a case, a reading of more than 1 volt indicates a leak. If a leak is detected, the top of the jar cover and cover seal should be thoroughly cleaned and neutralized, rinsed and dried, and the voltage rechecked to locate the source of the leak. Check for leaks annually or more often if required.⬥

2.08 ***Negative Plate Troubles:*** The outside negative plates in C&D cells and Exide cells have one surface visible. The outer surface of Gould negative plates has a much closer grid structure that is not expected to show defects. On the outer surfaces of C&D or Exide negative plates, minor cracks or voids (up to three missing paste pellets) are permissible when new. With aging, however, the active materials can shrink or crack heavily, thus separating the active material from the lead grid structure and degrading electrical contact with the lead grid structure. A 5-hour discharge capacity test (see Section 157-601-701) will determine whether or not the cell should be replaced. Fig. 12 shows an Exide battery with heavy cracks in the negative plate.

2.09 ***Needle growth*** or other crystalline-looking growths, have been observed on the negative plates of some cells (see Fig. 13). All C&D cells with plastic separators manufactured from 1954 to 1965 are expected to show this defect. Cells of other manufacturers may also be affected. No serious effect on battery performance is expected unless these growths lengthen to the point of contacting the positive plates and this has never been known to happen. Although needle growth does not normally cause trouble, cells showing needles should be carefully checked to insure that voltage and specific gravity remain within limits (per Section 157-601-701) and show no declining trend. In case of any doubt, run a discharge capacity test.

2.10 ***Sulfation:***

(a) ***Indications of Sulfation:***

(1) Sulfation may occur after a long period on an open circuit, after long operation at abnormally low float voltage, or when contaminating material is contained in the electrolyte (see Section 157-601-101). A decline

in the voltage of one or more cells indicates possible sulfation. This is not to be confused with low voltage of a few cells immediately after a charge where the voltage will return to normal after a month or two at proper float voltage.

(2) In lead-antimony cells, sulfate usually appears first in the outside surface of the outside negative plate in the bus bar lug corner of the plate. The affected area is

lighter in color than the rest of the plate, and the line of separation between the two areas frequently runs diagonally across the lug corner of the plate.

(3) A cell with little gassing, when the other cells in the same string are gassing heavily, should be suspected of sulfation.

(b) ***Correcting Sulfation:***

(1) Sulfation can sometimes be overcome by a special charge, consisting of a boost charge (see Section 157-601-701), followed by sufficient charging to put in 2 or 3 times the 8-hour rated capacity of the battery in ampere-hours.

(2) If there is reason to believe that sulfation is caused by contaminating materials, such as iron in the electrolyte, an electrolyte sample should be sent to the battery manufacturer for analysis and recommendations.

(3) For further information on sulfation, refer to Section 157-601-101. If sulfation is suspected, it should be reported through supervisory channels.

HARD-RUBBER JARS

2.11 ***Cover Rise:*** Cover rise occurs on all hard-rubber jar batteries. The cover rise is due to plate growth in the vertical direction and may be accentuated by the method of construction. With Exide batteries of early design, the plates are bottom-supported and cover rise is a direct measurement of plate growth. Excessive cover rise results in breakage of the jar cover seal. This usually occurs when cover rise is greater than 3/4 inch. When it reaches this amount, the positive plates are very likely to short against the negative strap. See Section 157-601-701 for procedures on resealing cover to jar seals of hard-rubber cells.

2.12 ***Allowable Plate Growth:*** If plate growth is excessive in the lateral direction, the batteries will bulge and may eventually crack and burst. Bulging should not exceed 3/4 inch on larger cells such as KS-5562 and should be correspondingly less on smaller cells. To measure jar bulge, place a straight edge along the jar wall and measure the maximum amount of protrusion from a plane formed by the jar wall corner edges.

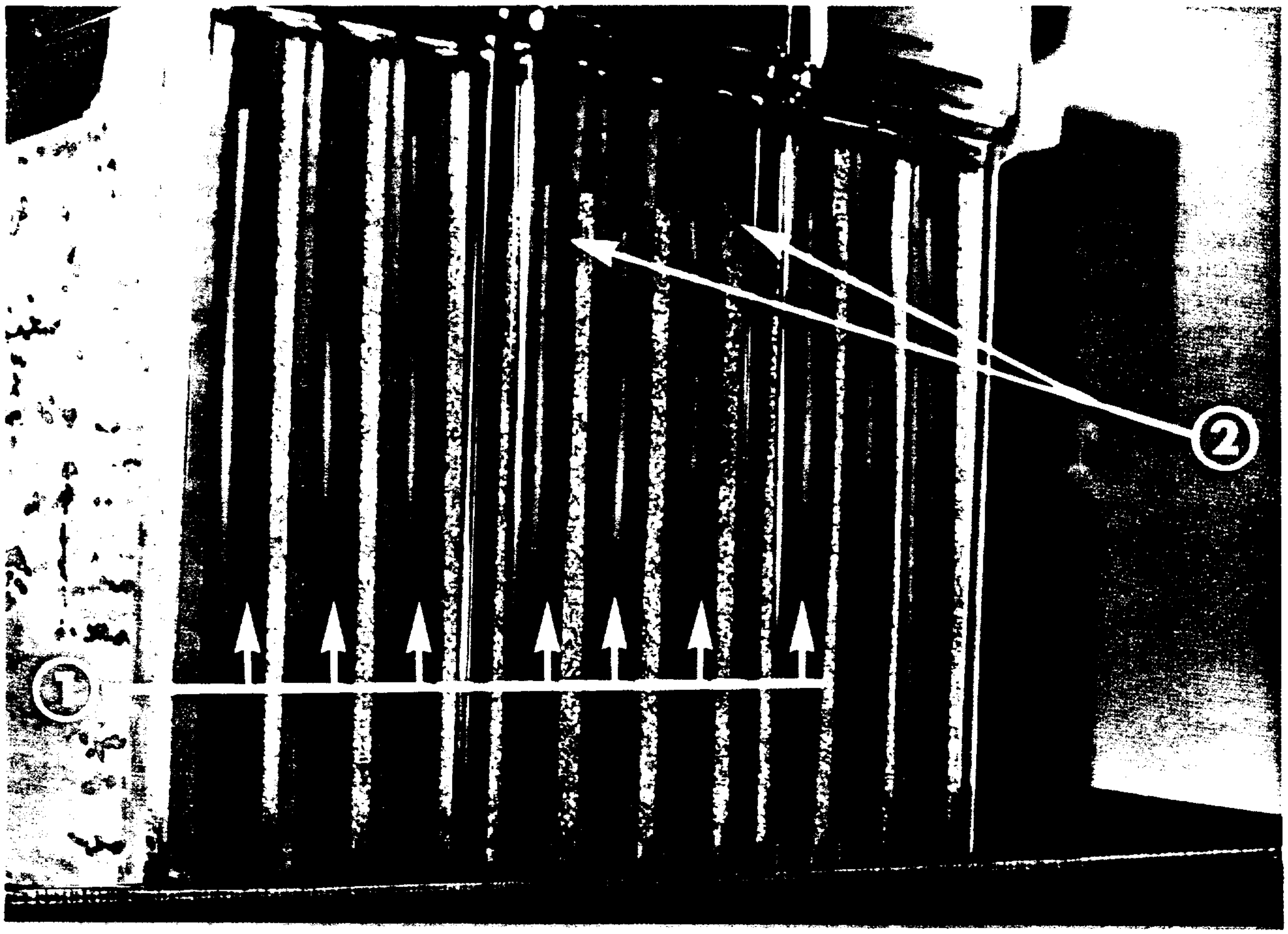

Fig. 4—Positive Plate Growth, Plate Touching Jar, Nosing Effect (Gould Cells)

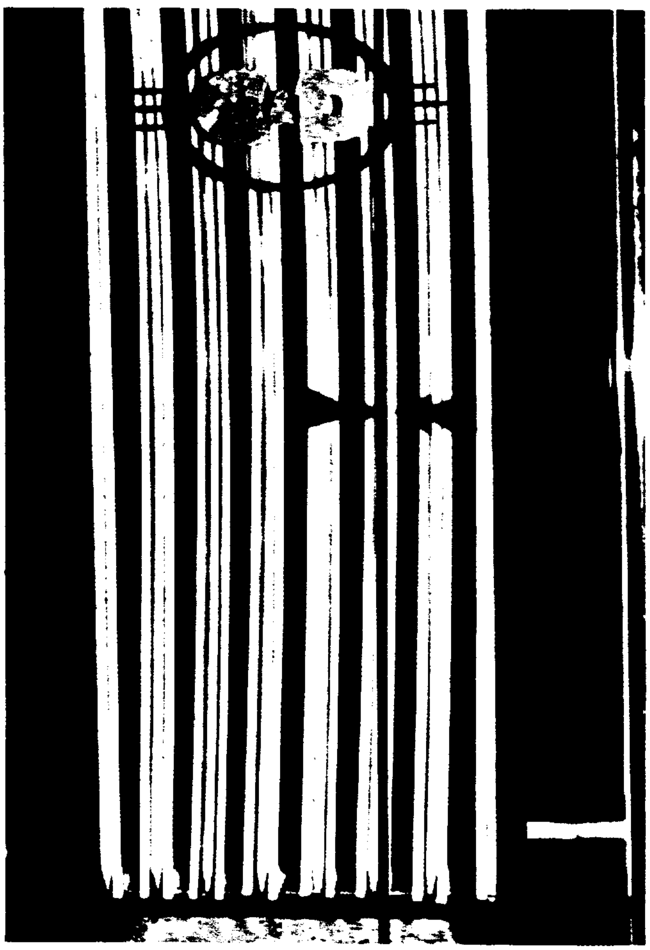

Fig. 5—Plate Bowing (C&D Cells)

Fig. 6—Strap Growth—End of Strap Nosing on Jar (Exide Cells)

Fig. 7—Crazing in Strap Area—(C&D Cells)

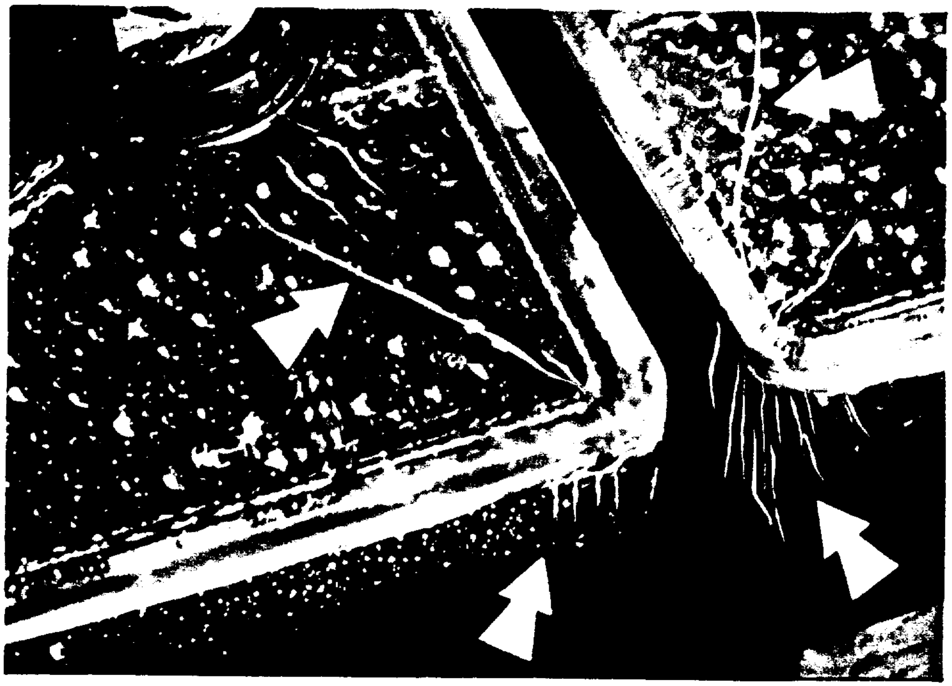

Fig. 8—Cover Cracks (Gould Cells)

Fig. 9—Jar Crack in Strap Area—Typical With Exide Cells

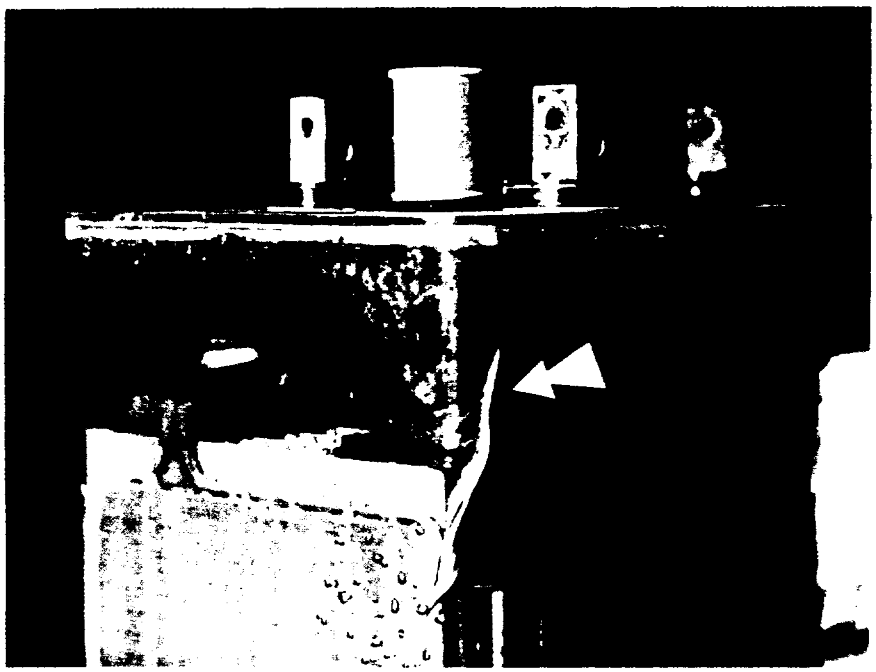

Fig. 10—Leaking Jar Crack in Strap Area—Typical With C&D Cells

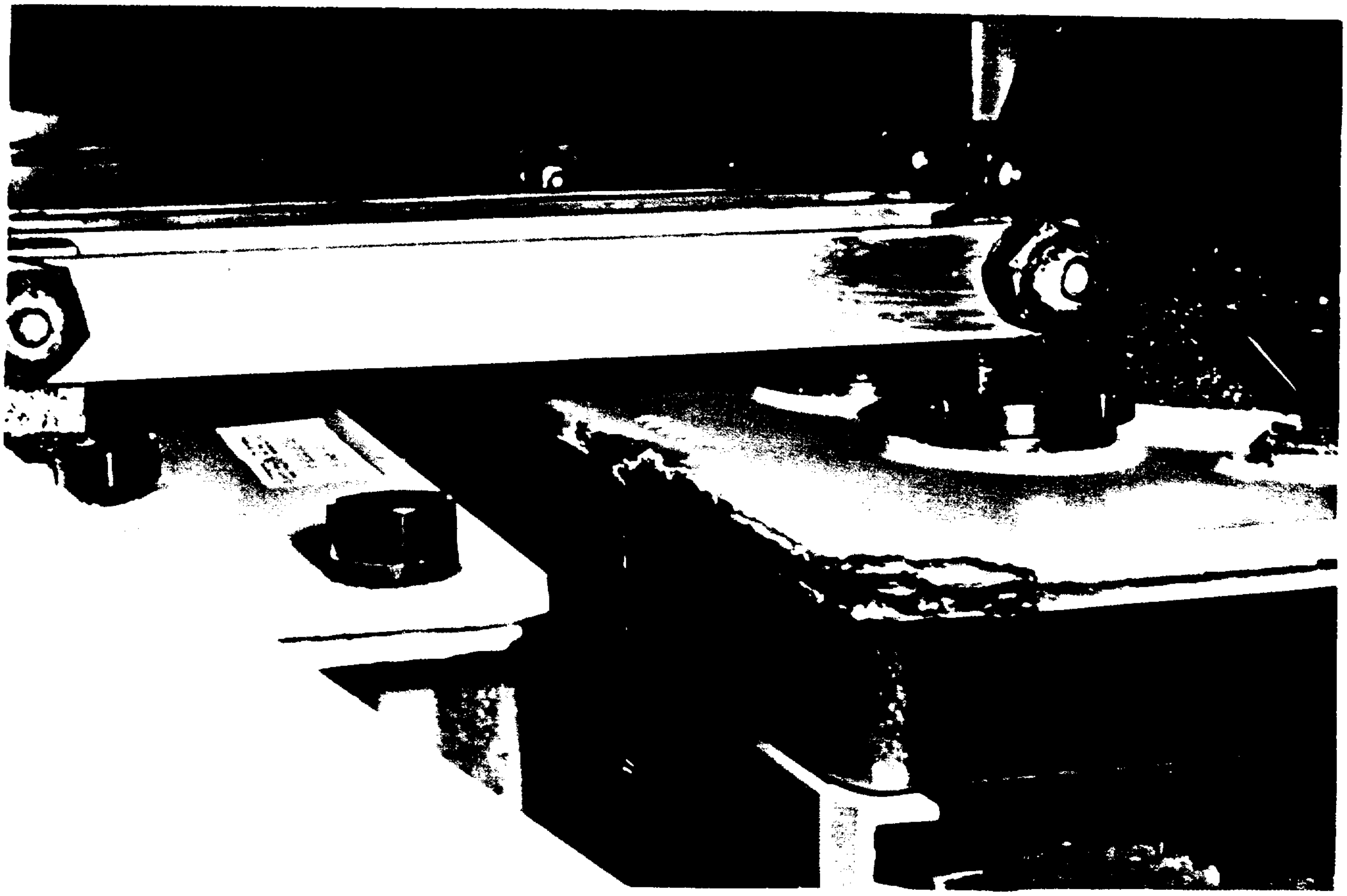

Fig. 11—Jar-Cover Seal Seam Leakage (Gould L152C-1965)

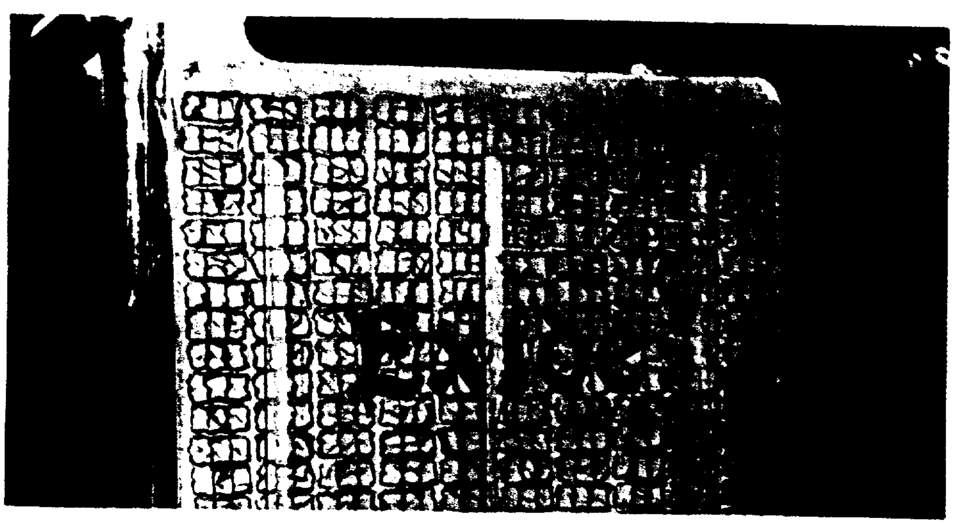

Fig. 12—Negative Plate With Heavy Cracks (Exide Cells)

Fig. 13—Needle Growth—Needles Grown More Than 1/4 Inch (C&D Cells)