DN 13029

INSTRUCTIONS

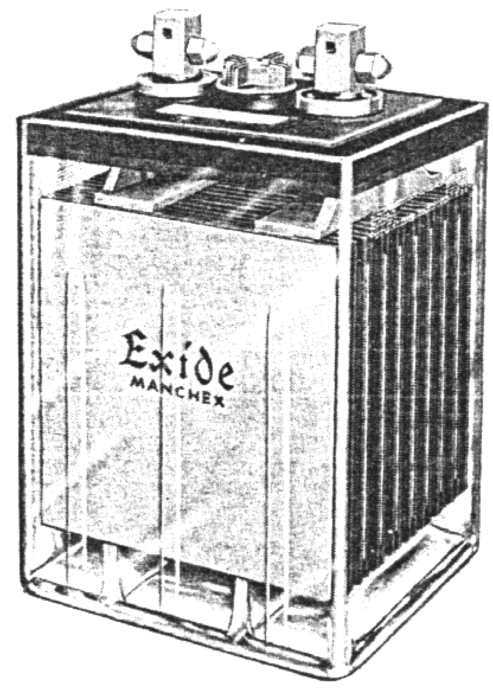
Installing and Operating

Exide BATTERIES

In Sealed Glass Jars

Shipped Assembled, Charged and Wet

(Electrolyte in Cells)



Type EME Cell

EXIDE INDUSTRIAL DIVISION
The Electric Storage Battery Co.
Philadelphia 2, Pa.

Sixth Edition

Form 4676

CONDENSED OPERATING RULES

For All Batteries

Keep the outside of the battery *clean and dry.*

Add approved water to the mark for maximum level.

Never add electrolyte or acid, except under conditions explained in Paragraph 11.

Ventilate battery compartment freely when charging and never bring a lighted match or other *exposed flame* near the battery (Par. 13).

At yearly intervals *tighten the connector bolts* of each cell.

Keep written records of amount of water added, as well as the cell readings (Par. 16, 19).

Charging for Floated Batteries (Par. 14, I)

Keep the voltage directly at the battery terminals so adjusted that it will average 2.15 volts per cell. Once a month give equalizing charge (Par. 15).

Charging for Manually Cycled Batteries (Par. 14, II)

If the battery requires *charging only once a week* or less frequently, charge until *all* the cells gas freely and until half-hourly readings of the specific gravity of any certain cell and of the voltage for the battery *both* show no further increase over a period of one hour. This is termed an *Equalizing Charge* (Par. 15).

If the battery requires *charging more often than once a week,* charge until the cells are gassing and until the specific gravity of the certain cell is within 5 to 10 points of the highest obtained on that cell during the Equalizing Charge last given. *Then stop the charge.* Every sixth or seventh charge should be continued into an Equalizing Charge.

Charging for System-Governed Batteries (Par. 14, III)

The adjustment which controls the amount of charge should normally keep the specific gravity of the electrolyte above the half-charged value and without requiring unusually frequent addition of water to the cells.

EXIDE INDUSTRIAL DIVISION

The Electric Storage Battery Company

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In Canada: Exide Batteries of Canada, Ltd., 153 Dufferin St., Toronto

Printed in U.S.A. Form 4676—2-'55—D

1. Ratings

These ratings are based on an electrolyte temperature of 77°F. at beginning of discharge and full charge specific gravity of 1.210, see Par. 11. The final voltage at end of discharge will average 1.75 volts per cell for ratings shown.

	Type of Cell	Charge Rate Amps.	8-Hour Discharge Capacity			Max. Water Floated Cell (Par. 16) Pints per Month	Approx. Wt. lbs.
			Amp. Hrs.	Amps.	Points Drop		
DME Manchex	5-A	5	40	5	67	.037	23
	7-A	7½	60	7½	68	.055	29½
	9-A	10	80	10	69	.073	36
	11	12½	100	12½	69	.092	42½
	13	15	120	15	70	.110	49
	15	17½	140	17½	70	.129	55½
	17	20	160	20	71	.147	62
EME Manchex	11	23	200	25	97	.18	81
	13	27	240	30	98	.22	93
	15	32	280	35	99	.26	105
	17	36	320	40	100	.29	117
	21	45	400	50	100	.37	141
	25	54	480	60	101	.44	165
FME Manchex	15	56	560	70	104	.51	206
	17	64	640	80	104	.69	230
	21	80	800	100	105	.74	277
	25	96	960	120	105	.88	325
DOE Tytex	5-A	6	50	6¼	71	.046	21½
	7-A	9	75	9⅜	72	.070	27½
	9-A	12	100	12½	73	.092	33
	11	16	125	15⅝	74	.115	39½
	13	19	150	18¾	75	.138	45½
	15	22	175	21⅞	76	.160	50½
	17	25	200	25	76	.183	57
EOE Tytex	13	27	240	30	78	.22	76
	15	32	280	35	79	.26	85
	17	36	320	40	80	.29	95
	19	41	360	45	80	.33	104
	23	50	440	55	81	.41	122
	29	63	560	70	82	51	150
FOE Tytex	17	61	608	76	85	.54	182
	19	69	684	85½	85	.61	200
	23	85	836	104½	86	.75	243
	29	106	1064	133	86	.95	288
KXHS	5	4	36	4½	27	.033	24
	7	6	54	6¾	47	.050	27
	9	8	72	9	35	.067	37
	11	10	90	11¼	46	.083	40
	13	12	108	13½	59	.10	44
	15	14	126	15¾	52	.116	46
	17	16	144	18	64	.133	50

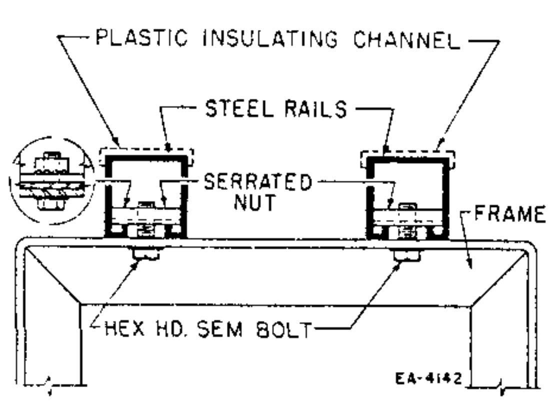


Fig. 1 Mounting of steel rail to frame. (Plastic Insulating Channel applied later.)

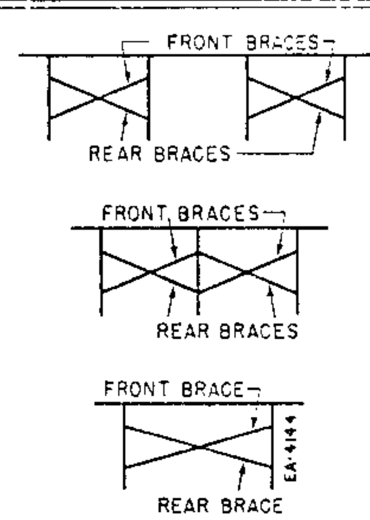


Fig. 2 Sketch showing position of braces for single tier racks.

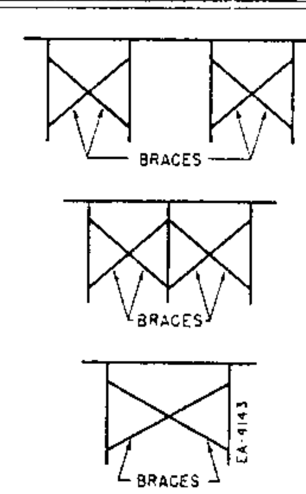


Fig. 3 Sketch showing position of braces for 2-tier, also 2- and 3-tier step racks.

INSTALLATION

2. Condensed Installing Notes

(Detailed Information is given in Paragraphs 3 to 8)

Inspect cells for damage in transit. (Par. 3.)

Unpack cells and set on rack or stand. (Pars. 4 and 6.)

Clean post sides bright where connectors will contact. Clean connector ends bright. With these contact surfaces bright and clean, coat on them a thin film of No-Ox-Id grease or vaseline. (Par. 7*d*.)

Bolt the connectors to cells. Tighten several times. (Par. 7*d*.)

Give freshening charge to battery. (Par. 8.)

3. Inspecting Cells

a. These cells are shipped assembled, charged, and filled with electrolyte to the bottom of cover flange or top of stipled "window" mark on jar (to upper red line on jar for type KXHS). Upon delivery from carrier, unpack all or certain cells, and examine electrolyte level or height to see that none is spilled. If electrolyte has been lost in transit and level is higher than ½ inch below top of plates, add water or preferably electrolyte of 1.210 specific gravity, then give a thorough charge. If the level is lower than ½ inch below top of plates, claim should be made against carrier for a new cell, as the "spilled" cell is more than likely to have been permanently damaged.

b. The battery should be given a freshening charge (Par. 8.) upon receipt, and if not put into service shortly after this, a freshening charge should be given every six months.

4. Battery Location

a. Racks (Par. 5) and suitable direct current for charging should be available. Battery room must be ventilated, but in such a way as to keep out water, oil, dirt, etc. Each cell should be accessible for adding water to it, and for taking readings of it. For cells connected in one series, arrange so that all cells will be at about the same tempera ture. For example, do not have several alongside a steam radiator or exposed to sunshine which would make them much warmer than the others.

5. Racks

a. Racks are supplied knocked down; the main parts being steel frames, rails and braces, and plastic insulating channels. In each package of steel frames, the necessary number of serrated nuts and SEM bolts are included for mounting the rails (SEM = bolt with washer attached under head); as well as the machine bolts and nuts for bolting the braces. In the package of rails and braces, the necessary number of 3- and 4-ft. lengths of plastic insulating channels will be found.

b. The several typical racks, with cells mounted thereon, are shown on Pages 3 to 7. One tier racks, see Page 3; Two tier racks, see Pages 4 to 5; Two step racks, see Page 6; Three step racks, see Page 7.

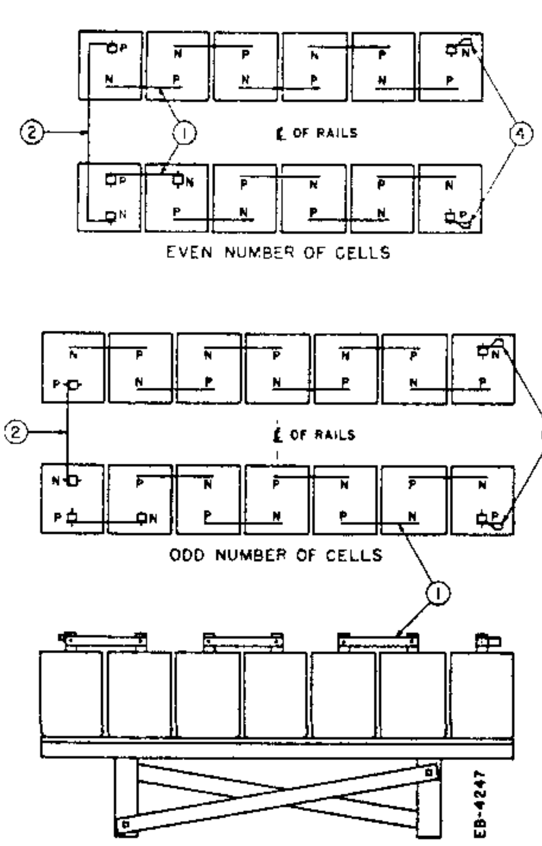
c. The first step in assembly of the rack is to set up the steel frames and bolt the braces to the respective frames as in Figs. 2 or 3. (For racks having four frames, observe that there is no bracing between the two central frames, which establishes the spacing ordinarily. For these, after bolting the twin sets of frames together, put four marks on floor, equally spaced and corresponding to space between frames of one of the sets bolted together, so that the twin sets when bolted together and placed on floor marks can be centrally located with regard to the rail length, and with all the frames uniformly spaced.)

d. Locate the steel rails on the frames so that the overhang of the two rail ends beyond the frames, is equal. Line up the holes in the frames so that the open slot of the rail is above the holes. Bolt rail to frame by locating serrated nut in rail slot, and insert SEM bolt through hole in frame and engage serrated nut (Fig. 1, page 2). Tighten with a wrench. Make sure that floor and rack are level.

(Text continued on Page 8)

Cells on Single Tier Racks

(All Types of Cells)



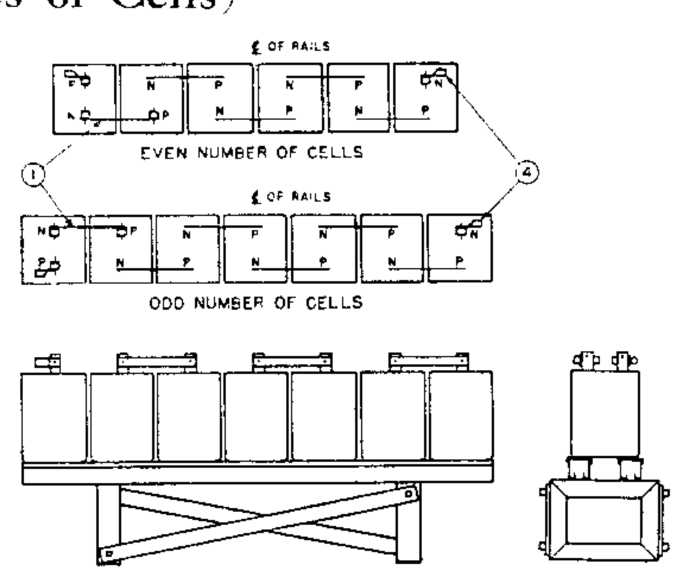
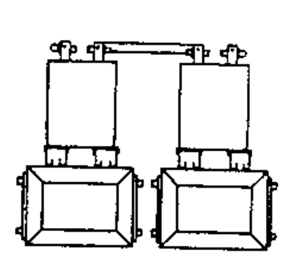


Fig. 5 Typical single-tier rack, showing intercell connection (1) in upper views.



←Fig. 4 Two single-tier racks, typical, back to back. Upper views show intercell connections (1) and interrack connector (2).

Cells on Typical 2 Tier Racks

(For cells with "flat" or rectangular posts, as types DME-5, 7, 9A, DOE-5, 7, 9A, and KXHS. All have intertier connector (2) beyond end of row, see below.)

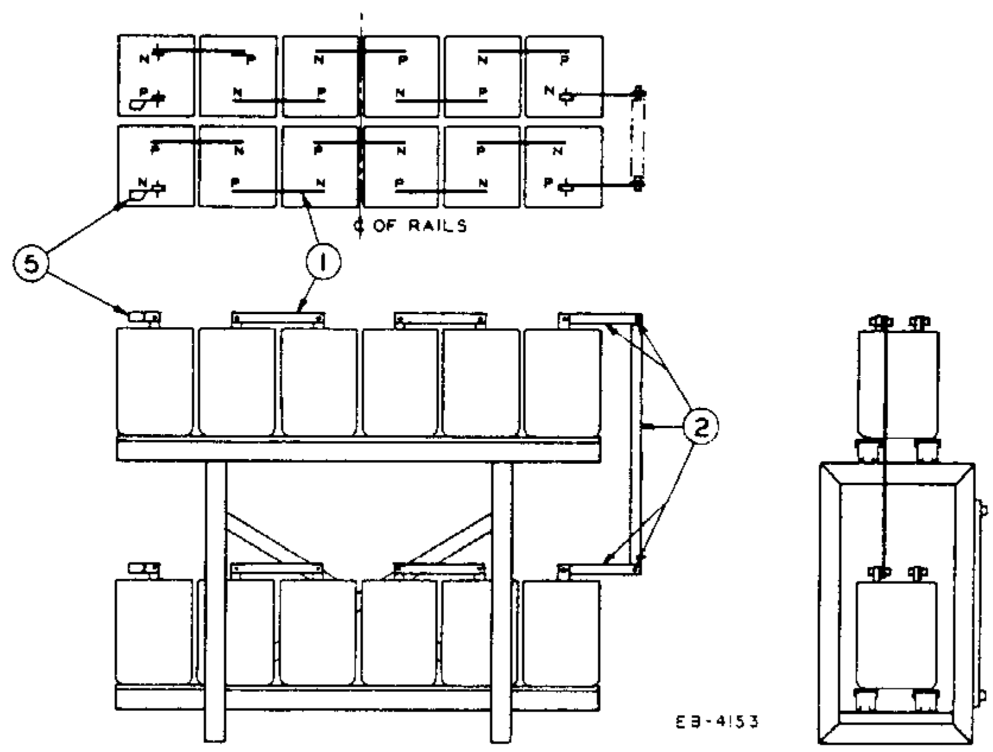


Fig. 6

Upper view shows intercell connection (1) and side view the intertier connector (2). For intertier connector detail, see Figs. 15, 16.

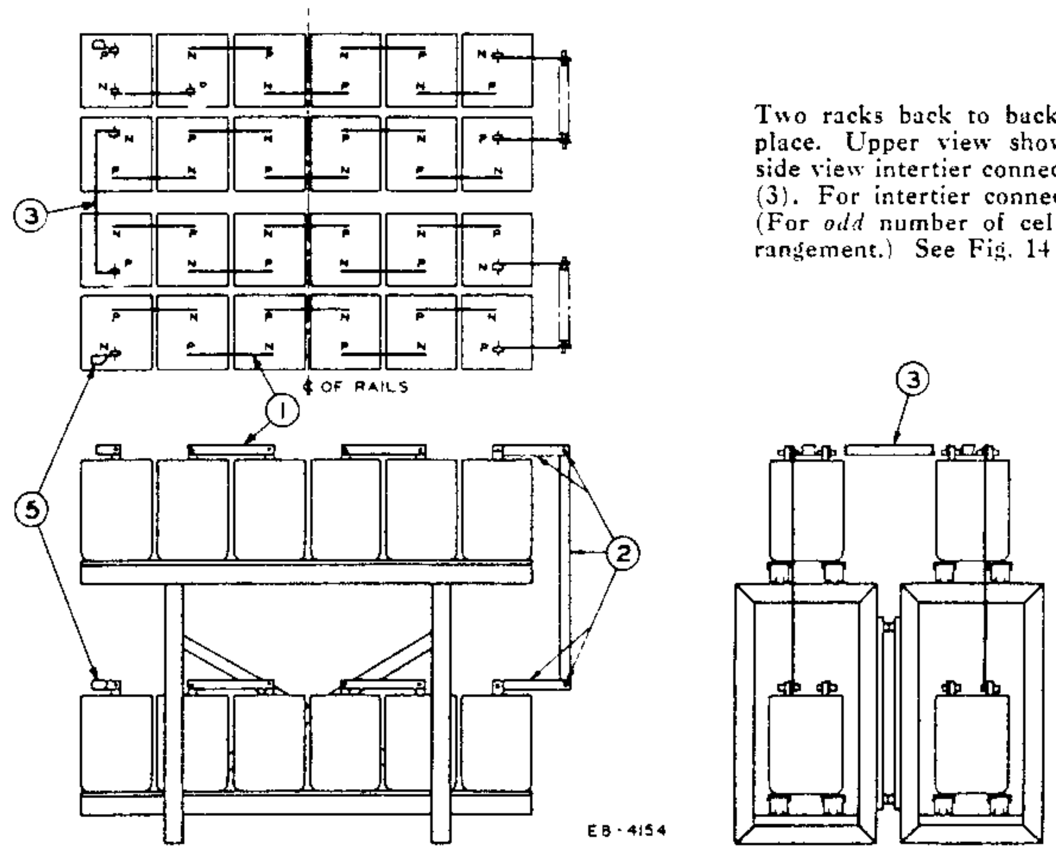


Fig. 7

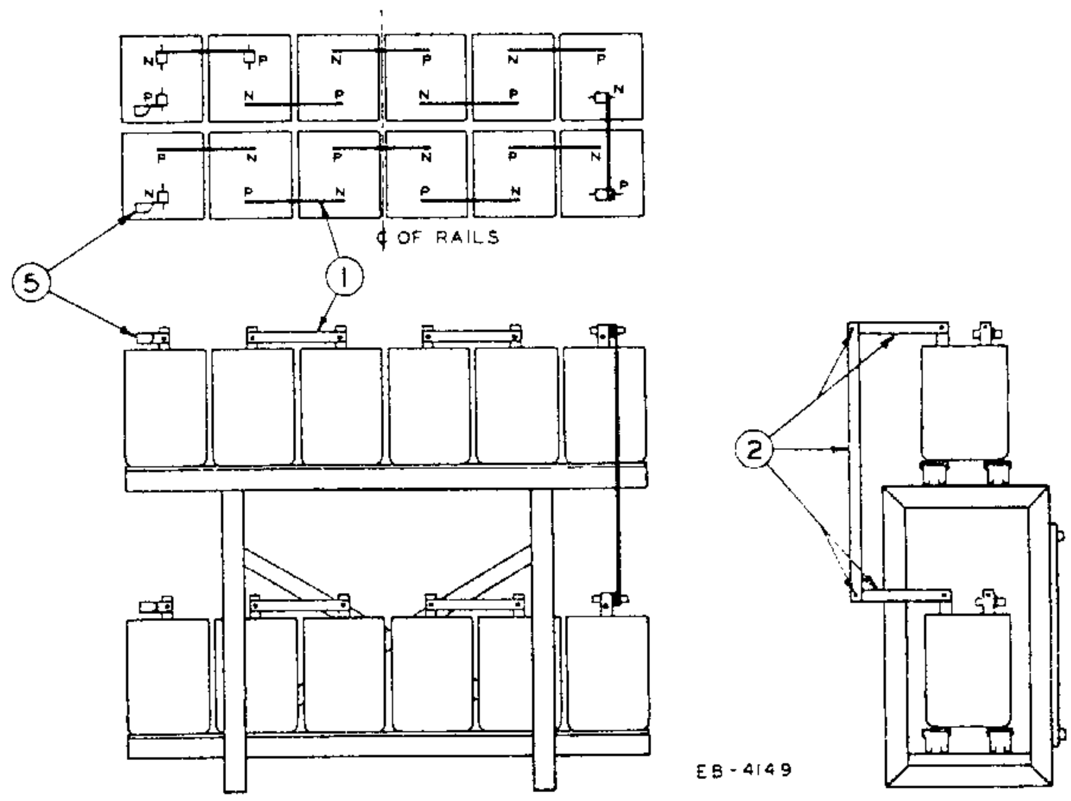
Two racks back to back, with *even* number of cells in place. Upper view shows intercell connection (1) and side view intertier connectors (2), and interrack connector (3). For intertier connector detail, also see Figs. 15, 16. (For *odd* number of cells, see Fig. 11 for connector arrangement.) See Fig. 14 for interrack connector detail.

Cells on Typical 2 Tier Racks

(For cells with square posts as types DME-11 to 17, DOE-11 to 17, EME, EOE, FME, FOE. All have intertier connector (2) in "front," see below.)

Fig. 8

Upper view shows intercell connection (1), and side view intertier connector (2). For intertier connector detail, also see Figs. 15, 16.



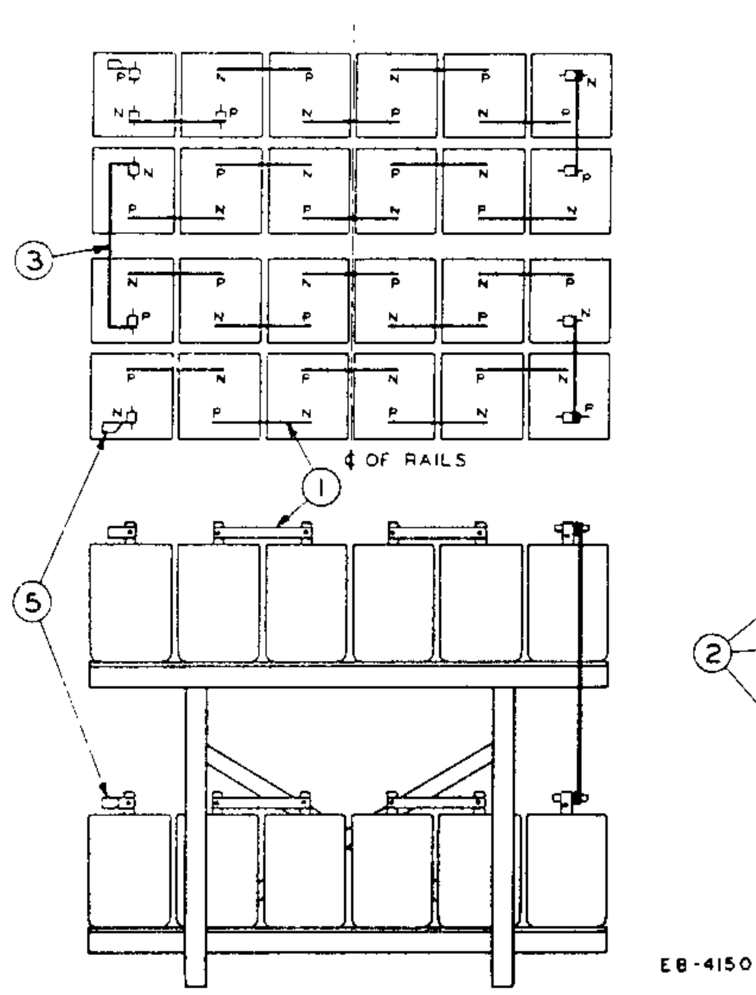
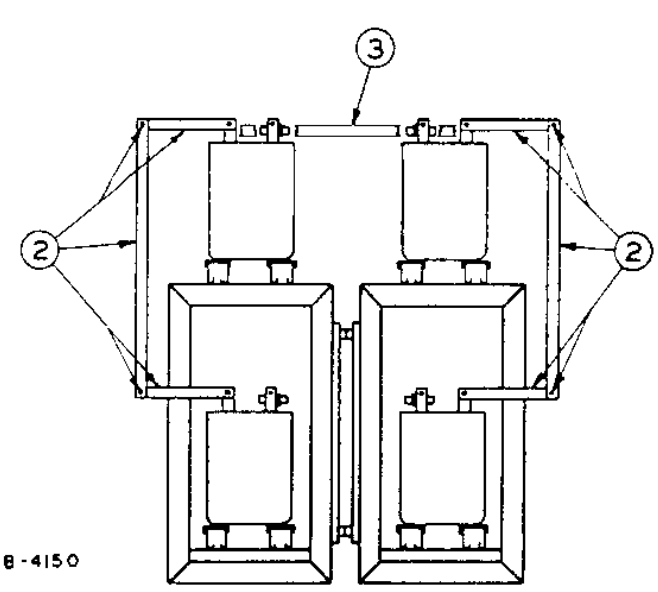


Fig. 9

Two racks back to back, with *even* number of cells in place. Upper view shows intercell connection (1) and side view intertier connectors (2) and interrack connector (3). For intertier connector detail, also see Figs. 15, 16. (For *odd* number of cells, see Fig. 11 for connector arrangement.) See Fig. 14 for interrack connector detail.



Cells on Typical 2 Step Racks

(All Types of Cells)

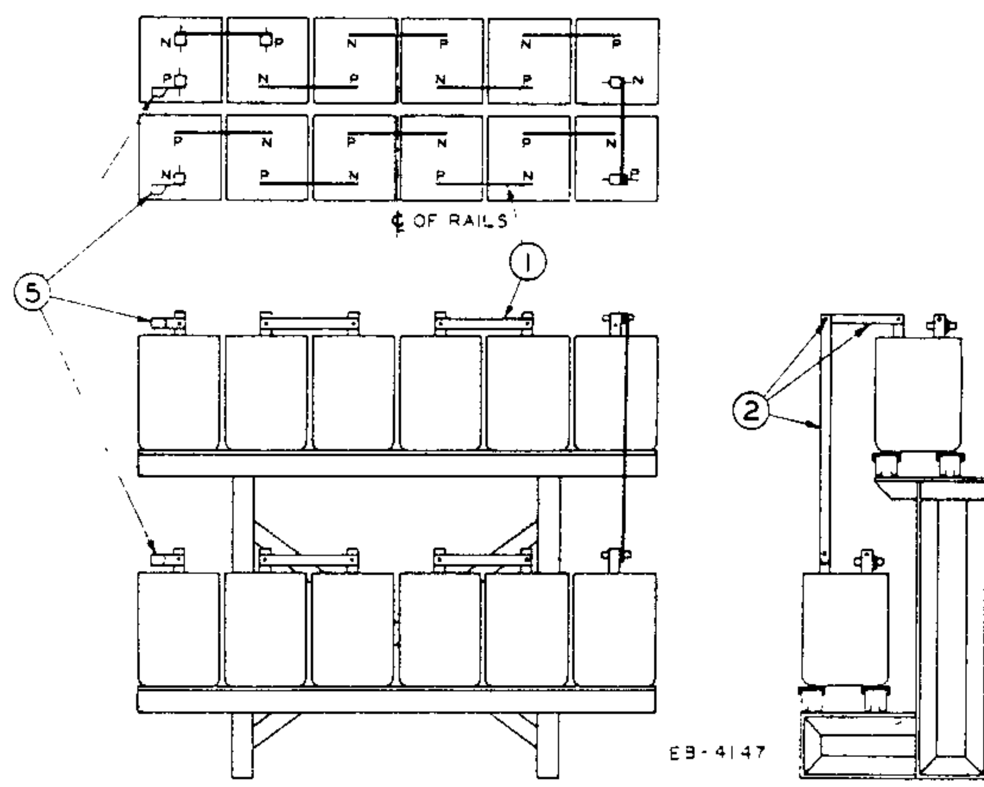


Fig. 10

Upper view shows intercell connection (1) and side view interstep connector (2).

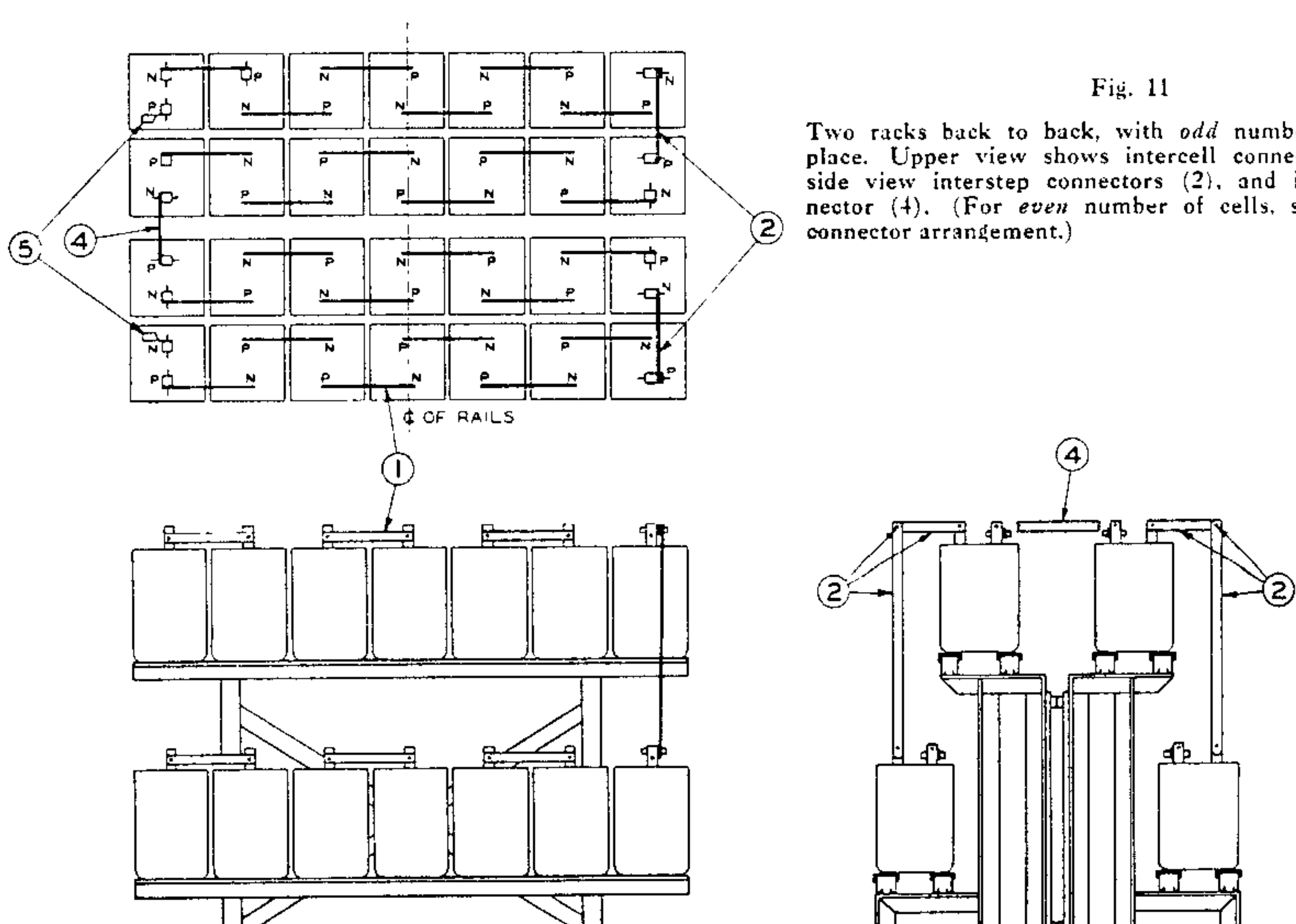
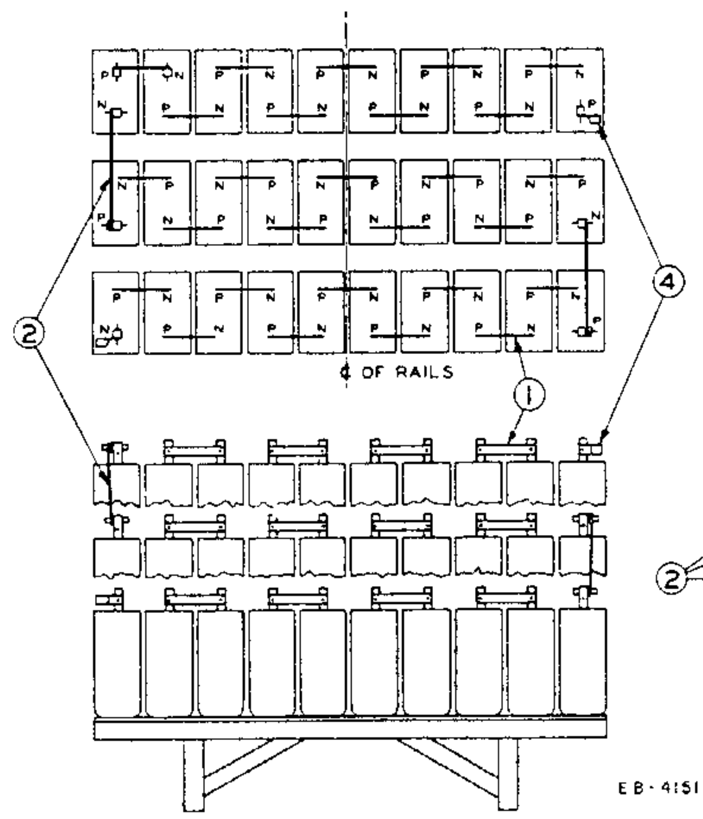


Fig. 11

Two racks back to back, with *odd* number of cells in place. Upper view shows intercell connection (1) and side view interstep connectors (2), and interrack connector (4). (For *even* number of cells, see Fig. 9 for connector arrangement.)

Cells on Typical 3 Step Racks & Other Details



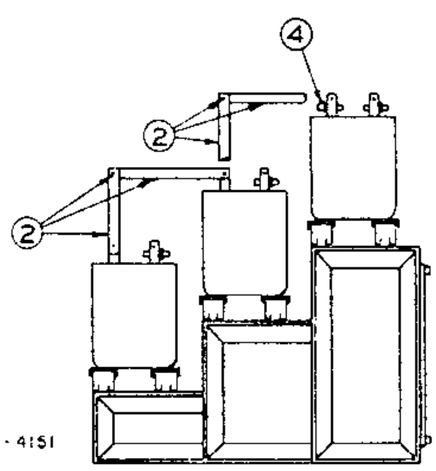


Fig. 12. Typical three step rack, with thirty cells in place. Upper view shows intercell connection (1), and side view interstep connectors (2). Note that base is longer than the height for cells shown in this book.

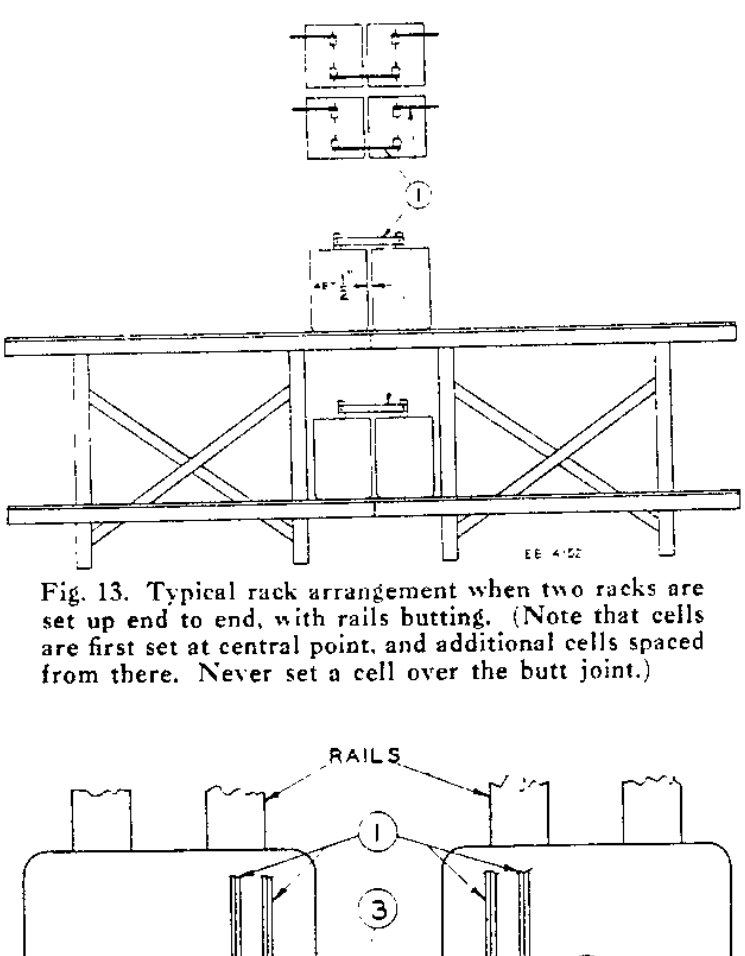


Fig. 13. Typical rack arrangement when two racks are set up end to end, with rails butting. (Note that cells are first set at central point, and additional cells spaced from there. Never set a cell over the butt joint.)

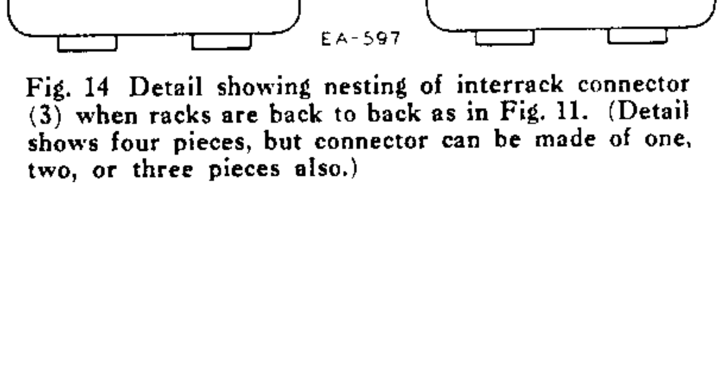


Fig. 14 Detail showing nesting of interrack connector (3) when racks are back to back as in Fig. 11. (Detail shows four pieces, but connector can be made of one, two, or three pieces also.)

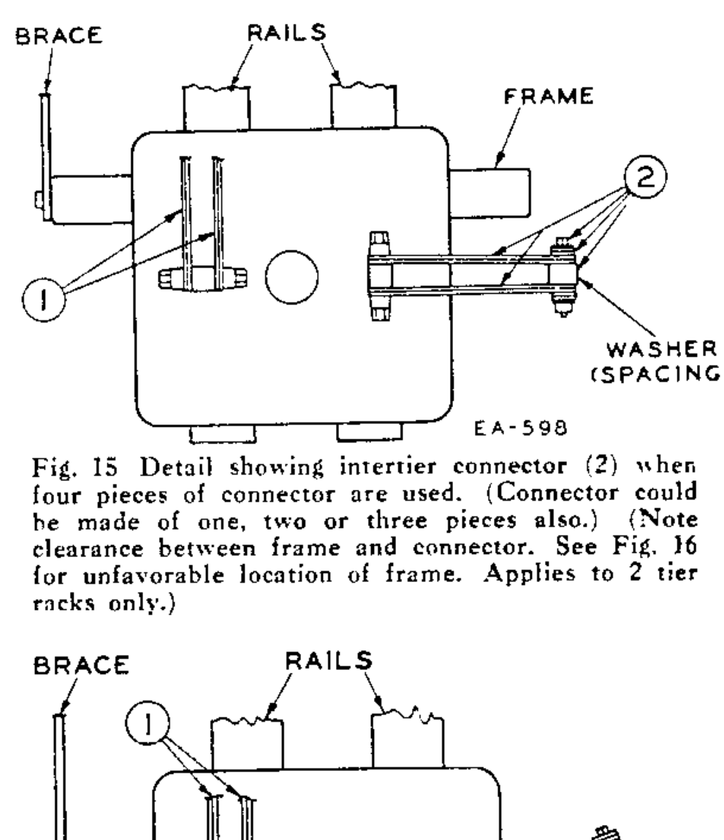


Fig. 15 Detail showing intertier connector (2) when four pieces of connector are used. (Connector could be made of one, two or three pieces also.) (Note clearance between frame and connector. See Fig. 16 for unfavorable location of frame. Applies to 2 tier racks only.)

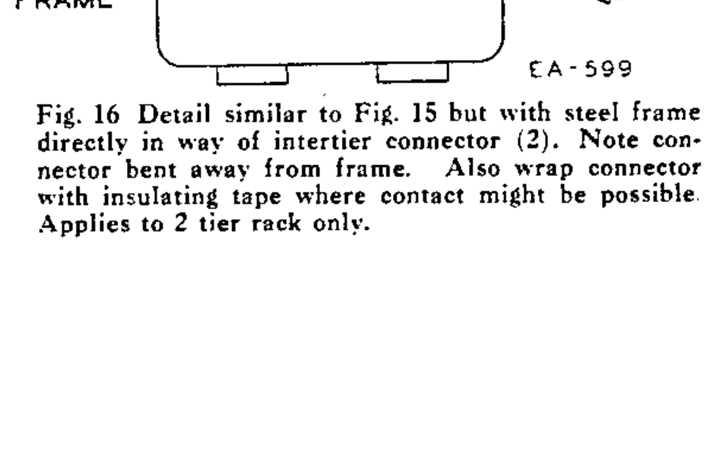


Fig. 16 Detail similar to Fig. 15 but with steel frame directly in way of intertier connector (2). Note connector bent away from frame. Also wrap connector with insulating tape where contact might be possible. Applies to 2 tier rack only.

e. Apply the plastic insulating channels to tops of rails (Fig. 1). No adhesive or liquid is needed, as the channels make a snug fit. The channels are supplied in 3- and 4-ft. lengths which can thereby take care of any length of rail, by combinations of 3 and 4, except the 5-ft. rail. With the 5-ft. rail, one or more of the pieces will need to be cut with shears or knife, to match the rail length.

f. To locate the cells on the racks, mark the center point of each rack. These marks will indicate the center points of the center cell whenever the number of cells on the rack is odd in number. Whenever the number of cells is even, the marks will indicate the center point between the two center cells. Cells should be set on the racks starting from these central marks.

g. Observe the location of the positive and negative terminals for connection to the battery. They are shown on the left side of the rack in Figs. 6 to 11. If desired on the right side, turn illustration upside down. The location of the terminals is controlled by the intertier, interstep, or interrack connectors, their position being shown best in the side views of the rack illustrations.

6. Unpacking and Handling

a. The cells are shipped in (1) Wire Bound boxes, assembled on a pallet, or (2) Nailed wooden boxes. For lifting the large "E" and "F" types there is packed in a separate box with other accessories, a rubberized belt, and a wood spreader. Figs. 19, 20. Depending on the cell size, handle cells in the following way:

For Wire Bound Boxes on Pallet

b. Cut the strapping bands that hold the individual crates together and to the pallet. Then move each case so that the sides and ends can be laid open. At the top corner of the case, bend open the "Rock Fasteners" (on the FME-25, FOE-29 cell cases, two strapping wires also need to be cut). The top, sides, and ends of the case can then be laid flat. Remove corrugated paper.

c. For all DME, DOE, KXHS, EME-11 to 15, EOE-13 to 19 cells — One cell only in the crate will have a lifting cable around it (Fig. 17), which may be lifted first. All cells should be carried by putting hands under bottom of jar, and set in the desired location. Remove lifting cable. Do not lift by grasping cell posts.

d. For EME-17 to 25, EOE-23, 29 and all "F's" — Tilt a cell about one inch to locate rubber belt underneath. Place wood spreader on top of cell, beveled ends up. For these "E" sizes, thread free end of belt through link (Fig. 19). Introduce bar through free end of belt for lifting. For the "F" sizes, bring belt ends together over spreader (Fig. 20). Introduce hook of lifting device through holes in belt ends. Always lift vertically and balance cell. Remove belt after setting cell in place. Do not lift by grasping cell posts.

For Nailed Wooden Boxes

e. Remove top of box, and corrugated paper.

f. For all DME, DOE, KXHS, EME-11 to 15, EOE-13 to 19 cells — One cell only in the crate will have a lifting cable around it (Fig. 17). Lift this cell first. All cells are carried by putting hands to bottom of jar, and set in the desired location. Remove lifting cable. Do not lift by grasping cell posts.

g. For EME-17 to 25, EOE-23, 29 and all "F's" — As shipped each cell has a plastic cord wrapped around it and with the two ends of the cord on top of the cell. To one end of this cord, temporarily, but securely, fasten the belt through a hole in its end. Pull on the free end of the cord to locate the belt under the cell. After belt is located under cell, place wood spreader on top of cell, beveled ends up. Proceed as in Par. 6*d* for the "E" and "F" sizes.

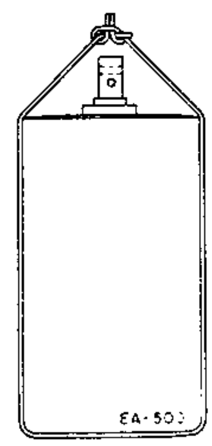


Fig. 17

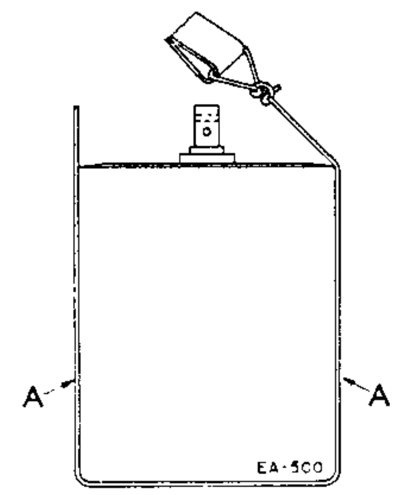


Fig. 18

Fig. 17 Lifting wire tied around smaller cells (see Par. 6*c*).

Fig. 18 Large cells (Par. 6*g*) with lifting belt tied to plastic cord for pulling under cells. Cord is around when shipped.

7. Connecting Cells

a. Arrange the cells so that the positive terminal of one cell will connect with the negative terminal of the next throughout the battery and so that positive of charging source will connect with positive of battery, and negative of charging source with negative of battery. Connectors to battery terminal posts should be pliable if they are held rigid at the other end. Rigid terminal connections transmit vibrations to cell posts which may eventually break.

b. Cells should be set on racks with plates at right angles to rails, the intercell connectors being made accordingly. Place the cells so that there is ½ inch (+ or — ⅛") between top of adjoining cells.

c. For intercell connection, lead plated connectors are bolted to adjoining cell posts by means of lead covered

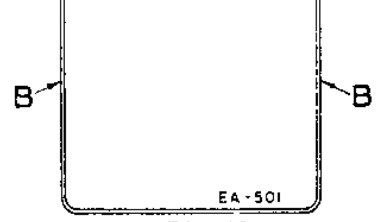


Fig. 19

Large EME or EOE cell (Par. 6*d*) with belt in place for lifting.

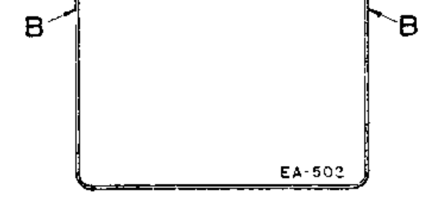


Fig. 20

Large FME or FOE cell (Par. 6*d*) with belt in place for lifting.

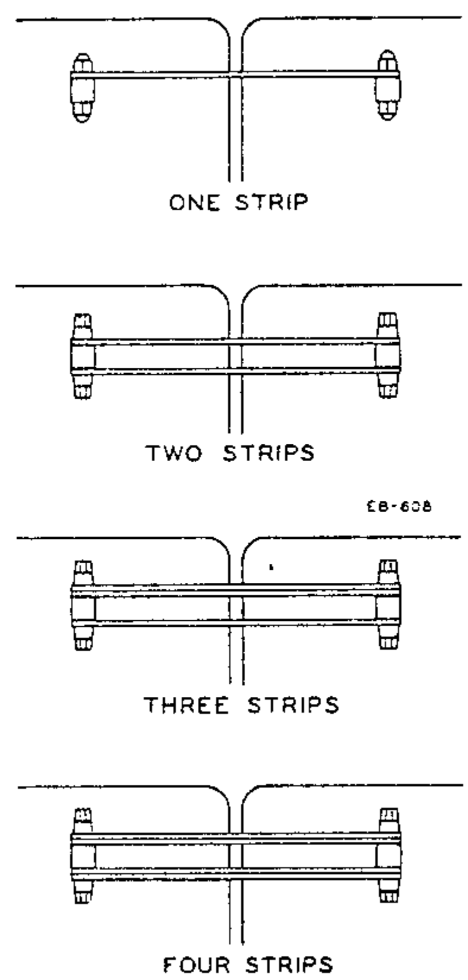


Fig. 21 Typical arrangement of intercell connectors (Par. 7c).

Type of Cell	No. of Strips per Connector
all DME, DOE, KXHS	one
EME-11 to 17	one
EOE-13 to 21	one
EME-21, 25, EOE-23, 29	two
FME-15, 17, FOE-17	two
FOE-19	three
FME-21, 25, FOE-23, 29	four

bolts, the bolts being put on the cells before shipment. When more than one connector per cell is supplied, bolt on each side of the post, see Fig. 21.

d. Before bolting the intercell connectors to the terminal posts of the battery, scrape the sides of the posts to be in contact bright and clean. Then apply a thin film of No-Ox-Id grease (or vaseline), which should also be put on the studs of the bolts. Wipe the lead plated copper intercell connector clean (do not scrape it or use sandpaper), and apply a film of No-Ox-Id grease for about one inch around the bolt holes. Tighten bolt connections. Wipe off surplus grease that squeezed out. Check connections to see that polarity is correct. Retighten bolts several times.

e. After all connections are completed, check over each connection to make sure the polarity is correct. Number the cells starting from the negative terminal of the battery. The Kum-Kleen cell numbers supplied should be adhered to the rails or to the jars. No adhesive or liquid is necessary. Use clean hands when applying the numbers. Numbers are removed from the backing sheet and are applied by pressure from one's hand. Installing information for the numbers is also on the envelope containing the numbers.

8. Freshening Charge

a Cells lose some of their charge during shipment and while standing idle. Therefore, before the installation can be considered complete it should be made certain that the battery is fully charged by giving it a freshening charge.

b. A freshening charge means continuing a charge as long as the specific gravity (Par. 10) of the lowest gravity cell shows any increase and then for three hours after the last increase is shown. The specific gravity at the end of this charge should be as shown in Par. 11. If the charge rate used is considerably below the rate shown on page 2, this three-hour period should be lengthened in proportion.

c. When this charge is completed, take and record the specific gravity of each cell and the temperature and level of the electrolyte in two or three cells so that they may be compared, when necessary, with similar readings in the future.

OPERATION

9. Condensed Operating Information

Exide batteries are easily kept in good condition for a long time of trouble-free service if the following four simple rules are followed:

1. *Maintain battery in a healthy state of charge. The method varies with the kind of service. See Par. 14.*
2. *Add water at regular intervals. Par. 16.*
3. *Keep battery clean outside. Par. 18.*
4. *Keep a written record on the above items. Par. 19.*

There are some general characteristics of Exides which should be understood by all persons taking care of them. These are discussed in paragraphs 10 to 13.

10. Hydrometer Readings—Specific Gravity

a. The specific gravity of all cells in an Exide battery lowers on discharge and rises again on charge.* Consequently, if the specific gravity or hydrometer reading is known, one can tell if the battery is fully charged or the amount it is discharged. With all cells connected in one series, the gravity reading of one cell, known as a "pilot cell," will indicate the state of discharge or charge of the whole battery.

b. The specific gravity is easily determined by allowing a hydrometer to float in the electrolyte. When the specific gravity is high, the hydrometer will not sink as far into the electrolyte as when the specific gravity is low See Fig. 22.

c. To take a reading, insert the nozzle of the hydrometer syringe (Fig. 23) into the cell, squeeze the bulb and then slowly release it, drawing up just enough electrolyte from the cell to float the hydrometer freely Holding the syringe vertically the reading on the stem of the hydrometer at the surface of the liquid is the gravity reading of the electrolyte. After testing, always return the electrolyte to the cell from which it was taken

* Exide booklet, "Fundamentals of a Storage Battery," Form 4250, explains this and will be supplied upon application.

Hydrometer Reading 1.220

Hydrometer Reading 1.120

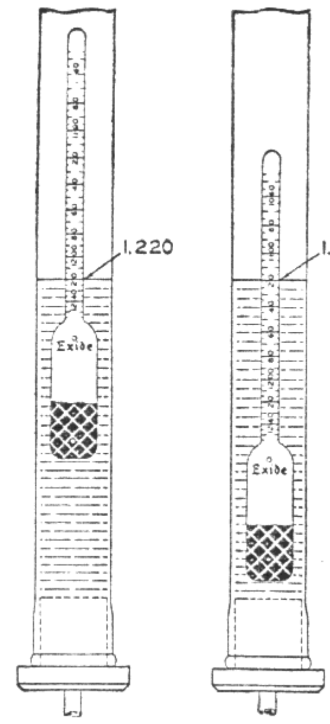


Fig. 22

d. Both temperature and level of electrolyte affect the specific gravity reading somewhat (Par. 11), and it is therefore desirable to record the temperature and level of the electrolyte at the same time as its gravity reading. A gravity reading should not be taken immediately after adding water, otherwise the reading is false. Allow a day or so for the water to mix with the electrolyte by gassing (bubbling) of the electrolyte resulting from charging or floating the battery.

e. After every 50 or so gravity readings of the pilot cell, a different cell should be used as a pilot, in order to avoid lowering of its gravity due to possible loss of a small amount of electrolyte each time the gravity is read.

f. An Exide hydrometer syringe is available for mounting through the vent plug of the pilot cell. Being continuously in place, no dripping is experienced and the pilot cell need not be changed after every 50 or so readings.

11. Full Charge Specific Gravity

a. The specific gravity of the electrolyte with the cells fully charged, and the electrolyte level at the bottom of the cover flange or top of stipled window (at upper red line for type KXHS) should be as shown in the following table for the temperatures indicated:

Temperature	107° F.	77° F.	47° F.
Electrolyte Level at *Bottom of Cover Flange	1.190 to 1.210	1.200 to 1.220	1.210 to 1.230

*For type KXHS, at upper red line.

b. It is adjusted within these limits at the factory and will not require adjusting during the life of the battery unless electrolyte is actually lost out of the battery. If, however, electrolyte is lost it should be replaced with electrolyte of about the same specific gravity as in the surrounding cells.

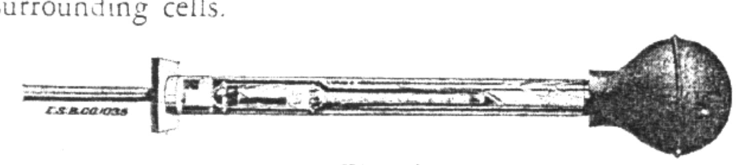


Fig. 23
Hydrometer Syringe
Exide Type V-2-S

c. The above table shows the effect on gravity of changes in electrolyte temperatures. For example, a change of 30° F. changes the gravity 10 points (.010 sp. gr.).

d. During use, the level falls slowly because the water, and water only, is used up. As a result, the specific gravity will increase a few points. For the cells shown on Page 2, if the level decreases one-half inch, the specific gravity will increase approximately 15 points (.015 sp. gr.). Addition of water (Par. 16) restores the gravity to its previous value.

e. The full charge specific gravity will decrease in value as the battery ages. No definite value can be given, but this decrease is very small, not over a few points per year at the most. This change is mentioned so that it will be understood.

f. Before adjusting low gravity, *first make sure charging will not raise gravity.* To do this, continue charge until specific gravity shows no rise, and then for three more hours. *Never make a gravity adjustment on a cell which does not gas on charge.*

g. To adjust low gravity, first have ready sufficient sulphuric acid of any specific gravity between 1.200 and 1.300. The sulphuric acid should be sufficiently pure for storage battery use. Add this instead of water when restoring level until the gravity at the end of an equalizing charge is normal. Then stop adding acid and return to the use of water. A quicker method, but one requiring more work and acid, is to withdraw some of the low gravity electrolyte and at once replace it with the new electrolyte. Do not allow a cell to stand partly empty. The amount to withdraw will have to be determined by trial, as it depends upon the gravities of both the old and new electrolyte. Charge until all cells have been gassing for an hour. Then, if the gravity is not normal, repeat adjustment until it is.

h. To adjust high gravity, remove some of the electrolyte and replace with water until the gravity at the end of an equalizing charge is normal.

12. Discharging Rates and Capacity

a. The capacity of a storage battery is measured in units of ampere hours, which is the product of the electrical current in amperes multiplied by the time in hours. For example, on Page 2, a DME-13 battery has a capacity at the 8-hour rate of 120 ampere hours, or 8 hours x 15 amperes = 120 ampere hours. Although current may be obtained after the end of this time, the voltage of the battery has dropped to a point beyond which it is not very useful. For instance, in lighting service, because the lamps would become dim.

b. In an emergency, little if any permanent harm will result if the battery is discharged to the full amount that it will give, provided it is promptly recharged.

c. The ampere hours which may be obtained from a battery are greater for a long, low-rate or intermittent rate discharge than for a short high rate. This is because the voltage drops faster at the higher discharge rates (amperes).

d. High discharge rates (amperes) should not be confused with over-discharge (too many ampere hours taken out). An Exide battery may be discharged, without any injury to the plates, at any rate of current it will deliver. The maximum permissible rate of discharge is limited only by the current-carrying ability of the cell terminals and connectors and not by the plates themselves.

e. Another indication which may be used in ascertaining when the discharge should stop is the drop or difference between the full charge specific gravity and the discharge specific gravity. This drop varies with the type of cell and the rate of discharge and is given on Page 2. For example, if the full charge gravity of a DME-13 cell is 1.210, after discharging the 8-hour capacity, the gravity should be 1.210 minus .070 or 1.140. The values shown are averages and may differ from that of a particular cell by as much as 10 per cent. A point is considered equal to .001 specific gravity, in the example the difference between 1.210 and 1.140 being 70 points.

13. Charging—In General

a. Direct current only must be used, never alternating.

b. The positive terminal of the battery must connect with positive of charging circuit, and the negative of battery with negative of charging circuit. If connected reversed, serious injury will result. Positive is marked POS, negative is marked NEG.

c. For a SERIES connection between a cell or battery, the positive of one must connect with the negative of the next. For PARALLEL connection, it is preferable to connect strings of cells in series, and have these strings of like polarity connected together at the switchboard by equal length and size of conductors. Provision should be made at the switchboard for disconnecting strings when necessary.

d. CAUTION: In the operation of the battery, gases are formed which may be explosive if ignited. Never bring burning material, such as lighted matches, cigarettes and the like, or sparks of any kinds near the battery. Ventilate the battery compartment when charging, in order to dispose of gas generated by battery.

e. Keep the vent plugs in the cells. Do not remove them at any time except to take specific gravity or temperature readings or to add water.

14. Charging Methods

For convenience in discussing, charging is grouped under three methods:

I. FLOATED. These batteries are continuously connected to the electrical system with which they are used in such a manner that they are normally kept fully or nearly fully charged (except for momentary or emergency discharge) by being constantly maintained at a voltage and current that will result in a small net charge. Examples are in oil switch control bus and emergency reserve service. See Pars. 14*a* to *g*.

II. MANUALLY-CYCLED. These batteries are usually connected to the electrical system until they become discharged to a certain extent. By starting a charge manually, the batteries are restored to their full charge gravity in several hours, when the charge is stopped. The batteries again carry the load and become discharged, and the cycle of charge and discharge is repeated. Examples are in isolated plant or farm lighting service. See Pars. 14*h* to *p*.

III. SYSTEM GOVERNED. Batteries charged in this way are continuously connected to the electrical system. They are discharged and charged automatically and as governed by the schedule and adjustment of the system. Familiar examples are batteries where the battery supplies current (discharges) to crank an engine, and takes care of lighting and other accessories until a certain engine speed is reached, when the control throws the load off the battery and onto a generator, which then also charges the battery. "System governed" differs from "floated" in that the normal state of charge is continually changing between rather wide limits. See Pars. 14*q* to *v*.

I. Floating Charge Method

a. The *"floating charge rate"* is the sum of the very low current (generally termed *"trickle rate"*) required to counteract the small internal battery losses plus the average current requirements for the remainder of the circuit. If the latter is zero, the floating rate required becomes the trickle rate for the battery. The required floating or trickle current is automatically provided when the proper voltage is maintained across the battery.

b. The voltage *directly at the battery terminals* should average very close to 2.15 volts per cell (for example, 129 volts for 60 cells in series). If the voltage is continually below this value, the charging may be insufficient and low cells may eventually develop, as indicated by the cell readings (Par. 19). If continually above, charging may be excessive, in which case unusually frequent addition of water (Par. 16) will be required and short life may result. Temporary voltage variations above and below this value are not harmful if they cancel each other daily.

c. Since the true average floating voltage is not always maintained consistently as high as conscientiously believed, resulting eventually in a number of the cells (usually in the warmest section of the battery) becoming irregular from unintentional low floating, a monthly equalizing charge (Par. 15) is recommended as standard practice for all floated batteries wherever practicable. If the battery is really being maintained at 2.15 volts, this additional monthly equalizing charge will not be detrimental and will amount to less than the extra charging required if the cells were allowed to become irregular.

d. With the proper voltage across its terminals, the actual current taken by the battery at any time depends on (1) the conditions which the battery has had to meet prior to the time under consideration, (2) temperature of the battery, (3) age of the battery, but these variations are in all cases corrective; that is, the battery takes such current as is necessary to keep it in proper condition. This makes it impossible to assign definite values to the current which might be read on an ammeter in the battery circuit and therefore makes voltage operation of the battery much more satisfactory than current operation. As a general guide in using ammeter readings, it may be stated that at normal temperature the normal current flowing to a fully charged battery that has been under constant voltage of 2.15 volts for approximately an hour or more should be between one-quarter and one percent of the eight-hour rate of the battery. At higher temperatures or if a discharge has been recently taken (such as a circuit breaker movement), a current in excess of this will be observed. At lower temperatures, or if the battery has been subject to higher voltage the observed current will be less or in the latter case may even be temporarily in a discharge direction If the trickle rate (Par. *a* above) is consistently less than one-quarter of one percent or more than one percent of the eight-hour rate of the battery it is recommended that the meters be checked.

Attention is called to the fact that in some cases it is not practicable to permanently connect an ammeter in the battery circuit to indicate the amount of the floating current, as any high discharge currents required would, of course, pass through the meter in a reverse direction.

e. If the system is allowed to remain idle, the battery should be charged at least once every six months.

f. If the battery becomes discharged, as by its carrying the load for sometime, or on account of abnormal operation, as soon as charging current is available, promptly recharge at the maximum safe rate (Par. *h*), raising the voltage above the floating values. The charge should be continued into an equalizing charge (Par. 15). After the battery is thus fully charged, the charge rate and voltage limits should be reduced to the floating limits.

g. For strings of cells connected in parallel, each string should float at an average of 2.15 volts per cell (Par. 15*b*)

Generally this is readily obtained. However when charging at higher current rates and voltages, which occur during an equalizing charge (Par. 15), if a contrast in cell voltage or gravity in the different strings is observed, the individual strings should have their equalizing charge given separately.

II. Manually Cycled Charge Method

h. The battery may be charged at any rate in amperes that will not produce gassing or bubbling of the electrolyte or a cell temperature in excess of 110 degrees Fahrenheit (43 degrees Centigrade). As soon as gassing starts, or before if the temperature reaches this limit, the rate should always be reduced, and the charge should be completed at not higher than the charging rate given on Page 2. *Do not charge at a higher rate than this while the cells are gassing.* If charging at constant current is more convenient, the entire charge may be given at the rate shown on Page 2 or at a lower rate.

i. The best method of charging a battery will depend on the number of cells in the battery, the time available for charging and the voltage and capacity of the charging apparatus. Wherever possible the charging equipment should be permanently arranged so that the rate of charge is automatically (and not manually) tapered to the rate shown on Page 2, or to less, by the time the charge is completed. Usually, this is not only possible but very easy and simple to arrange.

j. Charge the battery at least frequently enough to keep the specific gravity of the electrolyte from falling below the discharge limits referred to in Paragraph 12.

k. If the battery has been completely discharged, it should be charged promptly and not allowed to stand completely discharged. Part of a charge is better than none, but is must be remembered that a charge longer than usual is required after a long discharge. Ordinarily too much charge is harmful, but in such a case it is better to give too much charge rather than too little.

l. The battery should be charged at least once every six months.

m. If the battery has been idle, it should be given a prolonged charge just before using it, continuing until the gravity stops rising.

n. If the battery requires less than one charge a week, make every charge an equalizing charge (Par. 15).

o. If the battery requires more than one charge a week, charge until the cells are gassing and until the specific gravity of the pilot cell is within 5 to 10 points of the maximum obtained on the last equalizing charge. *Then stop the charge.* Every sixth or seventh charge should be continued into an equalizing charge.

p. For strings of cells connected in parallel it is advisable to charge each string separately and with its own control. All strings may be placed on charge at the same time, but it is desirable that the control of the charge be independent so that each string takes its correct amount of charge.

III. System-Governed Charge Method

q. This system should be adjusted to obtain a balance between the amount taken from the battery and the amount put back into the battery. If too little current is put back into the battery, it will become discharged, and the specific gravity reading will be below the half-charged value. If too much current is put into the battery, it will use more than the allowable amount of water (Par. 16), and will cause unnecessary wear on the plates. Adjust the system as necessary to keep the charging current within the above limits.

r. If the battery is abnormally discharged, or if it has been operating for a long time in a half or less than half charged condition, it should be given a long charge (Par. *h*), continuing such a charge into an equalizing charge (Par. 15).

s. If the battery is made up of strings of cells connected in parallel, the strings should be of the same age, service condition, specific gravity and temperature, and be located adjacent to each other. Pilot cell gravity and voltage readings of each string should be compared each week to be certain that uniformity prevails and that unbalance does not occur. If it does occur, each string should be given an equalizing charge separately (Par. 15).

t. If the system is idle, charge battery at least every six months.

u. Where schedules or loads are very irregular, a method of charge control using the Exide Charge Control Model ES may apply. This control and circuits are described in Form 3868.

15. Equalizing Charge

a. Equalizing Charges should be given as follows:

For *Floated Batteries*—once a month (Par. 14*c*) and whenever the battery becomes discharged (Par. 14*f*).

For *Manually Cycled Batteries*—each month one, two, three or four regular charges continued into an equalizing charge (Pars. 14*n* and *o*).

For *System Governed Batteries*—whenever the battery becomes abnormally discharged (Par. 14*r*).

b. An equalizing charge is a charge at a rate not higher than the rate on Page 2 and continued until *all* the cells gas freely and until it is certain that any low cells have been fully charged. Low cells are usually found in the warmest section of the battery (for example, in the top tier of two or three tier racks or in the section nearest the heating equipment) and are indicated by lowest voltage while on charge or, in advanced stages, by lowering in gravity between equalizing charges as compared with adjacent cells.

c. For *floated batteries,* a convenient method of giving the equalizing charge is to raise the battery voltage, and hold this voltage for a definite period of time, in accordance with the following table. Use the highest voltage which circuit and equipment limitations will permit and as near the longer time shown for that voltage as will fit in with the working shifts. For example, if 140 volts is the highest permissible voltage with a certain 60 cell battery and work shifts are 8 hours long, the 140 volts may be held for three, two or one shift, although the three shift period is preferable.

Battery Voltage per Cell	Battery Voltage for 60 Cells	Length of Monthly Charge
2.42 volts	145 volts	3 to 8 hrs.
2.39 volts	143 volts	4 to 12 hrs.
2.36 volts	142 volts	6 to 16 hrs.
2.33 volts	140 volts	8 to 24 hrs.
2.30 volts	138 volts	11 to 34 hrs.

d. In raising the voltage, particularly to the higher values in the above table, it may be necessary to do so in several steps to avoid current rates momentarily too high for the equipment. After completing the equalizing charge with a motor generator set, lower the generator voltage slowly watching its ammeter so as not to motor the generator. Lower the generator voltage for a few minutes to below the floating value. Then reset the field rheostat to its previous float position. Do not wait for the battery voltage and current to stabilize at values which may have been noticed just before starting the charge, since such stabilization may require several hours.

e. For *other-than-floated batteries* (or as an *alternate method for floated batteries*), the charge may be given by maintaining approximately constant either (1) the voltage across the battery terminals or (2) the charge rate into the battery. When the voltage across the battery terminals is held constant, stop the charge when two consecutive hydrometer readings of a low cell show no increase over the period of time in table below. When the charge rate into the battery is held constant, stop charge when both hydrometer and voltmeter readings of a low cell show no increase over the period of time in table below.

Average Voltage per Cell Across Battery Terminals (Constant Voltage Method)	No Increase in Hydrometer Reading	Charge Rate Into Battery (Constant Current Method)
2.45 volts or higher	For 1 hour	Ampere rate on Page 2
2.40 volts	For 2 hours	½ of rate on page 2
2.35 volts	For 4 hours	¼ of rate on page 2
2.30 volts	For 8 hours	⅛ of rate on page 2

16. Adding Water

a. During operation water must be added regularly to each cell. *Do not allow the level of the electrolyte to get below the top of the separators*; keep it above by removing the vent plugs and adding approved water. Do not fill higher than the bottom of the cover flange or top of stipled window (to upper red line on jar for type KXHS) and after filling be sure to replace the plugs. The intervals at which water must be added depend largely on the operating schedule. Keep written record of amount of water added.

b. The amount of water necessary to add bears a definite relation to the amount of overcharge and may be used as a check against excessive charging, provided that the level is not carried too high and that the vent plugs are kept in place. Under these conditions, if the amounts shown on Page 2 are exceeded for a floated battery (Par. 14, I), the overcharging is harmful. For example, a 60-cell DME-13 floated battery should not require more than 60 x .11 = 6.6 pints of water per month. A worked battery (manually-cycled, Par. 14, II, or system-governed, Par. 14, III) will require more water, the maximum for a heavily worked battery being three to four times the amounts shown on Page 2.

c. In cells in which gravity readings are taken, the level should be kept within ¼ inch of the maximum Par. 16*a*. Otherwise the gravity readings are misleading.

d. In cold weather the time to add water is just before or at the beginning of a charge, so that gassing (bubbling of the electrolyte resulting from charging or floating the battery) will insure thorough mixing and any danger of the water freezing will be avoided.

e. Electrolyte loses some of its water by the charging of the battery and some by evaporation, but its acid is never lost in this manner. Therefore, *it will never be necessary to add new electrolyte,* unless some should get outside the cell through carelessness or by adding water above the cover flange. Nothing but water is required to be added to Exide batteries. Never add special powder, solutions, or jellies.

17. Quality of Water

a. The quality of water to add is distilled (not merely boiled) or other approved water. By approved water is meant that of which The Electric Storage Battery Co. has analyzed a sample and found safe for Exide Batteries. The local source of water is usually suitable, but before using it The Electric Storage Battery Co. should be consulted. When advised by the nearest office of The Electric Storage Battery Co. to send a quart sample, it will be analyzed at our works, Rising Sun and Adams Aves., Phila. 20, Pa. Transportation charges should be prepaid and sample marked for identification.

b. If water is drawn from a tap or spigot it should be allowed to run a few moments before using to remove pipe accumulations. Water should not be transported or stored in any metallic vessel except lead. Glass, earthenware, rubber or wooden receptacles that have not been used for any other purpose are satisfactory.

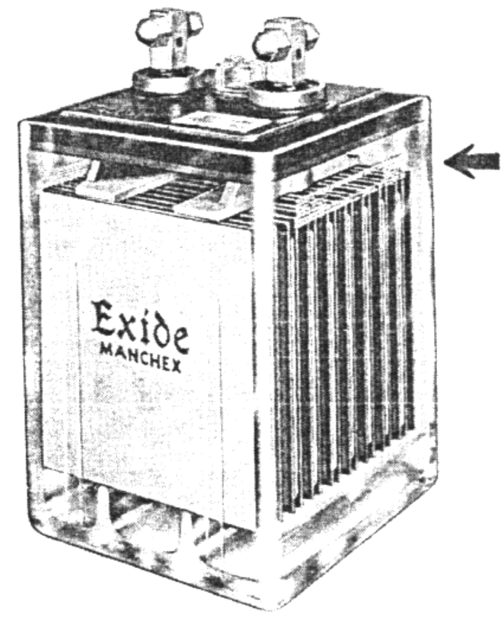


Fig. 24
Typical cell to show stippled "window" (arrow), for high and low watering heights.

18. Cleanliness

a. Keep the battery, its connections, and surrounding parts clean and dry by wiping with a dry rag. Keep the vent plugs in place; make sure their gas escape holes are open. If electrolyte is spilled or if surrounding parts are damp with acid apply a solution of bicarbonate of or baking soda (in the proportions of one pound of soda to one gallon of water). Apply until bubbling stops, then rinse with water and dry; do not allow solution to get into cells. Soda solution or ammonia will neutralize the effect of acid on clothing.

b. If terminals or connectors show any tendency to corrode, scrape the corroded surface clean, wash it with the soda solution and coat it thinly with vaseline or No-Ox-Id grease. No corrosion will be experienced unless electrolyte is spilled and allowed to remain.

19. Readings—Written Records

a. To facilitate following the operation of the battery, it is advisable to record the specific gravity and voltage of each cell at intervals.

b. Cell voltage readings should be taken while the charging current is being maintained and not after it is reduced or interrupted. During these readings the battery voltage or the charging current into the battery should be kept constant. Cell gravities should be taken 10 or 15 minutes after charge is completed and not while cells are gassing heavily.

c. The individual cell voltages, read to the hundredth of a volt, should be recorded once a month, in which case three of four times a year will be sufficient to record the cell gravities. Otherwise cell gravities should be recorded monthly.

d. Review the monthly cell readings and compare with those for the previous month promptly. Plotting the readings saves time in reviewing and comparing.

IMPORTANT POINTS

20. Tightening Connector Bolts

At yearly intervals go over the connector bolts with the wrenches, tightening them to insure good connection.

21. Trouble

The chief indications of trouble in a cell are:

a. Falling off in gravity or voltage relative to the rest of the cells.

b. Lack of gassing on charge.

c. Color of plates markedly lighter or darker than the surrounding cells.

d. If two successive sets of monthly cell readings (Par. 19*d*) show the same cell low in either voltage or gravity, check to see if this cell gasses as much as the other cells while on charge. If it does, no action is required, unless readings go still lower the following month. If this happens or if the cell does not gas as much as the others, trouble is indicated and this may be due to insufficient charge, short-circuits or impurities in the electrolyte. The trouble should be corrected promptly. If necessary consult the local representative of the Service Div. of The Electric Storage Battery Co.

e. First aid treatment for a low cell consists of removing approximately 20 to 25 per cent of the volume of electrolyte and replacing this with water. Follow this as soon as practicable with an extra long equalizing charge (Par. 15).

22. Impurities

Impurities in the electrolyte will cause a cell to work irregularly. Should it be known that any impurity has gotten into a cell, it *should be removed at once.* In case removal is delayed and any considerable amount of foreign matter becomes dissolved in the electrolyte, this solution should be replaced with new immediately, thorougly flushing the cell with water before putting in the new electrolyte. If in doubt as to whether the electrolyte contains impurities, a sample should be submitted for test. Before sending, consult the nearest office of The Electric Storage Battery Company. *Pint* samples are analyzed at its works (Rising Sun and Adams Aves., Philadelphia 20, Pa.), *if transportation charges are prepaid, and if sample is marked for identification.*

23. Sediment

The sediment which collects underneath the plates need cause no alarm unless it deposits too rapidly, in which case there is something wrong with the way the battery is operated. In a new battery there is always a thin layer at the start. As the battery wears the sediment becomes higher, but for batteries which are floated (Par. 14, I), the plates usually wear out before the sediment space is filled.

24. High Temperature

a. Normal temperature for a battery is generally accepted as averaging between 60° and 80° F., and the expected life of the plates and separators is based on those temperatures, as well as upon proper operation.

b. High temperatures for long periods of time result in abnormal wear, and anticipated life may therefore not be realized. There may, however, be times. such as during the latter part of equalizing charge (Par. 15), when the temperature may rise rather rapidly and for these charges temperatures up to 110° F. are permissible, but it is expected such high temperatures will be maintained for a short time only.

c. When there is more than approximately 5° F. variation in electrolyte temperature among cells in the same battery, this is often caused by heating pipes or coils mounted much closer to some cells (usually those on the top tier where there is more than one tier) than to others, and unsatisfactory plate life often results.

25. Low Temperature

The capacity of any battery is temporarily reduced during periods of low temperature, but there is no danger of freezing if care is taken when adding water to do so just before or during charging, so that it will be thoroughly mixed with the electrolyte by the gassing.

26. Broken Jar

a. If a jar should become broken do not allow the negative plates or separators to dry, but disconnect the cell from the circuit at once. Syphon off the remaining electrolyte, using rubber tubing. Remove the cell, handling it as discussed in Paragraph 6.

b. Unseal the cell by running warm putty knife through compound and close to jar. Remove the element. The entire element, including positive plates, may be kept assembled under water in a non-metallic receptacle for a week or so, but for a longer period the positives should be withdrawn and allowed to dry and stand dry until used, keeping the negatives and separators under water.

c. Examine the element for damaged separators and replace any that are cracked or broken. To reinstall, put element into jar, fill it with previously prepared electrolyte, so that the element will not dry. The exact gravity of electrolyte cannot be given, but it should be between 1.175 and 1.225.

d. To reseal, wipe the cover and inside jar wall at top with a rag moistened with a solution of bicarbonate (baking) soda and water to neutralize the acid. Do not allow solution to get into cell. Wipe with cloth dampened with water. Allow surface to dry. Seal the cell by pouring hot compound just as it liquifies. Fill the groove half full at first, and then fill to top.

e. In handling electrolyte, wear goggles, rubber apron, gloves and overshoes. Avoid spilled electrolyte. If some is spilled, neutralize as in Par. 18*a*.

f. Charge the cell until its outside negative plates are gassing freely and until the specific gravity of its electrolyte has ceased rising. Then charge for an hour longer. If the negative plates are allowed to dry, this charge should be given to the cell before it is connected back into circuit and the charge should be continued for five hours, instead of one hour, longer. Otherwise connect cell back in circuit (Par. 7) when the battery is discharged, so that the cell can be fully charged with least overcharge for the remainder of the battery. Be sure the positive of one cell connects with the negative of the next.

g. After the charge, if the gravity of the repaired cell differs from that of surrounding cells by more than 10 points, adjust as in Paragraph 11*g* or *h*.

27. Replacing Cover

For Threaded Nut Post Seal

a. To remove cover from element having threaded seal nuts, unscrew nuts with seal nut wrench or gas pliers. Make sure gasket under each nut is not lost and that it is in place when reassembling.

b. Run a warm putty knife through compound and close to jar. When compound is cut through, lift up cover over posts. Wipe post threads dry, apply new cover, reseal cell as in Par. 26*d*, reapply gaskets and seal nuts. Countersink threads at posts at two or three places, using a punch or nail to avoid nut backing off. Apply No-Ox-Id grease into seal nut groove (Par. 28).

For Burned Ring Post Seal

c. To remove cover from element having a burned ring seal, examine Fig. 25 to note a slight clearance between ring and cover. The ring can be broken off by prying under alloy ring with a screw driver. Run a warm putty knife through compound and close to jar. When compound is cut through, lift up cover over posts.

d. Before reapplying cover, clean and dry posts where new rings will fit. Apply cover, gaskets and new seal rings. Clamp or press down on ring with a tool to secure a tight fit, at same time lead burn the alloy ring to the post. If lead burning is done with a flame. puddle the joint between the post and alloy ring, using lead alloy burning strip for puddling metal. If a carbon burning outfit is used, flatten carbon to a blunt chisel shape, put carbon side against post and blunt end against alloy ring until welding takes place. Repeat on opposite side of post and the alloy ring will then be positioned and it need no longer be held down. Proceed to spot weld all around the post, slightly lapping each weld on the preceding one. Do not move the carbon while in contact, nor hold it too long after welding takes place.

e. Put grease in post seal (Par. 28).

28. Renewing Grease in Post Seal

Whenever it becomes necessary to renew the grease in the post seal, first clean out the old material, wipe out the groove with a rag moistened with a solution of bicarbonate of soda and water, and apply pure vaseline or No-Ox-Id grease. Do not use ordinary grease for this purpose, as animal or vegetable grease is harmful. A good method of applying the vaseline or No-Ox-Id grease is to heat it over a slow flame in an ordinary spoon and pour it into the groove when in a melted condition.

29. Putting Battery Into Storage

a. If the use of the battery is to be temporarily discontinued, give it a charge until *all* the cells gas and add water to the cells during this charge so that the gassing will insure thorough mixing and prevent its freezing in cold weather. Add enough water to raise the level of the electrolyte to the cover flange. After the charge is completed, remove all fuses to prevent the use of the battery during the idle period. Make sure all vent plugs are in place.

b. Repeat the procedure under Paragraph *a* at least once every nine months. If this cannot be done, write for further instructions.

c. To put battery into commission again, give a freshening charge (Par. 8).

30. Taps

Part of an electrical system may require a voltage less than the terminal voltage of the battery. For instance, six volts for bell ringing may be required from a 56-cell 110-volt battery. Taps are sometimes put on three of the fifty-six cells, which means that these three cells do more work than the others, and eventually reach a discharged state, when a separate charge and attention are necessary. Or, if the three cells are kept charged, then it means that the remaining fifty-three cells are overcharged.

In either case, unevenness in operation results, and the life of the complete battery is shortened. Therefore, taps on a battery are not recommended. The only connection to the battery should be those on the terminal cells.

If a low voltage is desired, a separate battery should be purchased, or a resistor in the cicuit should be employed.

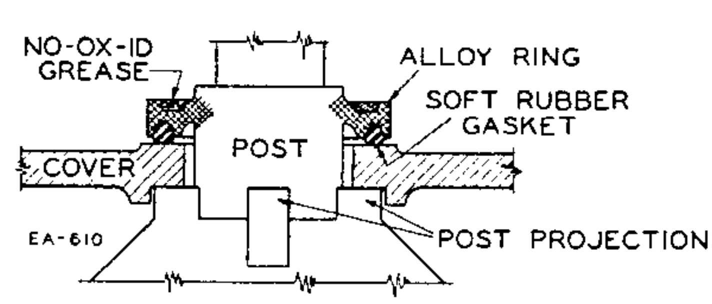


Fig. 25
Cross-Section of Burned Ring Post Seal

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