Signal Training Bulletin

COMMITTEE G: Education & Training
Communication & Signal Section, AAR

B-9 Charging Lead Acid Storage Battery

Approved January 1974

Definitions:

Storage Cell: A secondary cell for storing electrical energy at one time for use at another.

Charging: The restoration of the active materials in a battery by passing a direct current through it in the opposite direction to that of discharge. Charging is the process of putting electrical energy into a battery — simply a means of keeping a battery in operating condition.

Rectifier: A device which converts alternating current into direct charging current by virtue of a characteristic permitting an appreciable flow of current in one direction only.

Battery: A combination of two or more galvanic cells electrically connected to work together to produce electrical energy. (Common usage permits this designation to be applied also to a single cell used independently.)

Symbol: None

Description: While a storage battery is supplying energy to operate signal apparatus, it is discharging. When charging a battery, current must be passed through it in the opposite direction from discharge to reverse the chemical process that has taken place to supply the electrical energy.

Charging a lead acid storage battery consists essentially of replenishing the energy to the battery that has been used because of discharge current.

Purpose and Application: The lead acid storage battery, used in conjunction with a rectifier, furnishes an important, reliable source of direct electrical energy to operate signal circuits and apparatus.

Lead acid storage batteries are used as a standby power system to provide direct current energy in case of alternating current power interruptions.

General Information: Five methods of charging lead-acid storage battery follow:

Initial Charge—A term used in expressing the first charge given a storage battery after it has been set up, also to designate the recommended current applied to electrical apparatus at the beginning of a series of tests.

This type of charge is necessary for the lead-acid storage battery loses some of its charge while standing idle or during shipment.

Freshening Charge—Defined as applying the necessary charge to a storage battery to get the maximum specific gravity reading as specified by the manufacturer. This reading indicates the fully charged state.

Equalizing Charge—An extended charge which is given to a storage battery to insure the restoration of the active material in all the cells. An equalizing charge is a charge at a rate not higher than the normal eight-hour rate and continued until all cells gas freely and it is certain that any low cells have been fully charged.

Trickle Charge—A continuous input of current to a storage battery to compensate for internal losses only — such as local action.

The trickle charge is employed to keep spare batteries fully charged and ready for immediate use.

Floating Charge—A continuous input of current to a storage battery to operate the signal systems, and compensate for internal losses, where lead acid storage battery is employed.

The floating charge must supply current to not only operate the associated signal circuits and apparatus, but supply sufficient current to the battery to maintain nominal terminal voltage as specified by the manufacturer.

The floating charge current is the sum of the signal system load current and the trickle charge current.

NOTE: Always remember, whenever anything is done to the charging rate of a rectifier or to any cell of the storage battery involved, the appropriate battery card should be recorded or noted to reflect these changes.

Detailed Operation: During normal application of the lead-acid storage battery, the floating charge is employed to furnish the necessary energy to operate the associated signal systems.

Reviewing: the initial or freshening charge is employed to restore a newly installed or heavily discharged cell to the fully charged state; the equalizing charge is employed to insure restoration of the active material in all cells of a storage battery; the trickle charge is employed to compensate for internal losses such as local action.

Due to the significance of the floating charge method of signaling, it will be explained in detail.

All battery charging systems are not necessarily connected as shown in Figure 1. However, in all cases where the floating charge method is employed, the rectifier must supply enough current to:

(a) Operate the normal, steadily connected load (relays and/or signals load).

(b) Return to the battery the energy available prior to intermittent discharge from normal traffic and/or commercial power interruptions.

(c) Compensate for internal battery losses such as local action.

Temperature of Electrolyte	Voltage per Cell	Specific Gravity Per Cell
38C (100 F)	2.08	1.207
25C (77 F)	2.15	1.215
10C (50 F)	2.22	1.224
− 1.11C (30 F)	2.30	1.231
−12.22C (10 F)	2.37	1.238
−17.78C (0 F)	2.40	1.241
−23.33C (−10 F)	2.44	1.244
−28.88C (−20 F)	2.47	1.248
−34.44C (−30 F)	2.50	1.251

A properly adjusted rectifier used for floating charge installations must supply sufficient current to operate the circuit under normal conditions and to maintain the charge on the battery at the same time, that is, the sum of the steady signal load current plus the trickle charge current should equal the floating charge current.

The floating charge must supply sufficient current to not only operate the associated signal circuits and apparatus, but supply sufficient current to the battery to maintain nominal terminal voltage between 2.10 and 2.20 volts per cell as well as a specific gravity reading as specified by the manufacturer per cell with the electrolyte temperature at 25 degrees centigrade (77 F).

The relationship between electrolyte temperature and specific gravity or voltage readings is an inverse one, that is, as electrolyte temperature decreases the specific gravity and voltage readings will increase. The specific gravity reading of a lead acid storage cell is an indicator of the state of charge of that cell.

During cold weather, the voltage readings at continued low temperatures may be allowed to increase to the following approximate values. Note also that the specific gravity readings have been adjusted to compensate for the change in temperature.

Specific gravity is also affected by the electrolyte level and it is therefore good practice to maintain the electrolyte at its proper level as indicated on the cell.

In summary, the rectifier floating charge current rate should be high enough to supply the signal load, compensate for the internal losses of the battery but not too high which would result in boiling away the electrolyte.

Conventional current flow, that is, current flow in the external circuit from positive potential to negative potential, is used to analyze the charging circuits of Figure 1 through Figure 6.

The rectifier current is used to operate the circuit under normal conditions and to maintain the charge of the battery at the same time. Under heavy load conditions such as a train shunting a track circuit, or a switch machine operating, the battery will be called upon to deliver the extra current required for the operation of these circuits or devices. In the event of an ac power interruption, the battery will carry the complete load until the power is restored.

Figures 2 and 3 illustrate where the ammeter is inserted to determine the current output of the rectifier.

Figures 4, 5 and 6 show the current paths for each operating condition listed.

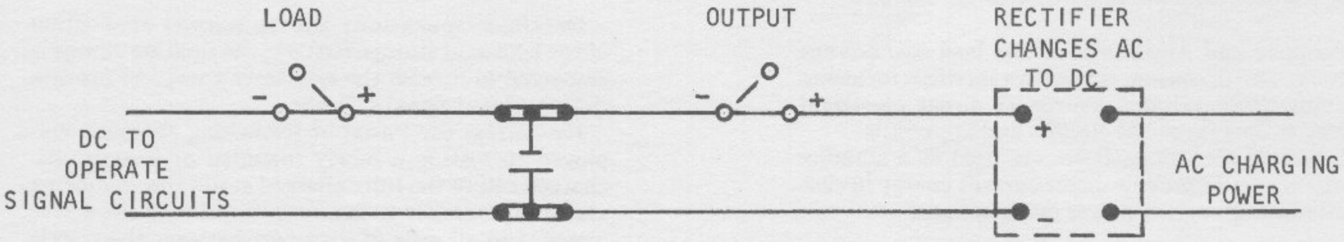

Figure 1

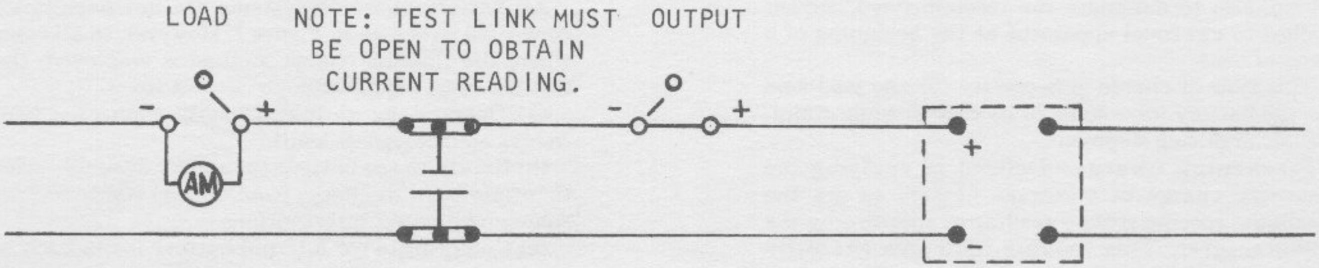

Figure 2: To determine amount of current being supplied to operate the circuit load, test as shown.

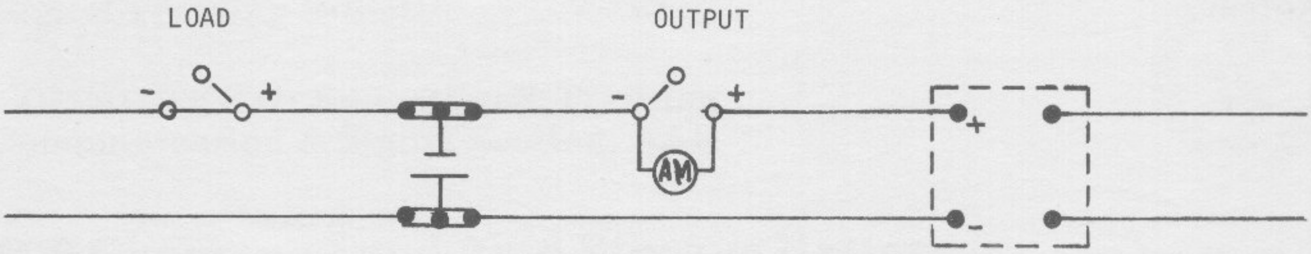

Figure 3: To determine total rectifier output, test as shown. Total rectifier output is the sum of the currents which supply the load and charge the battery.
Note: Test link must be open to obtain current reading.

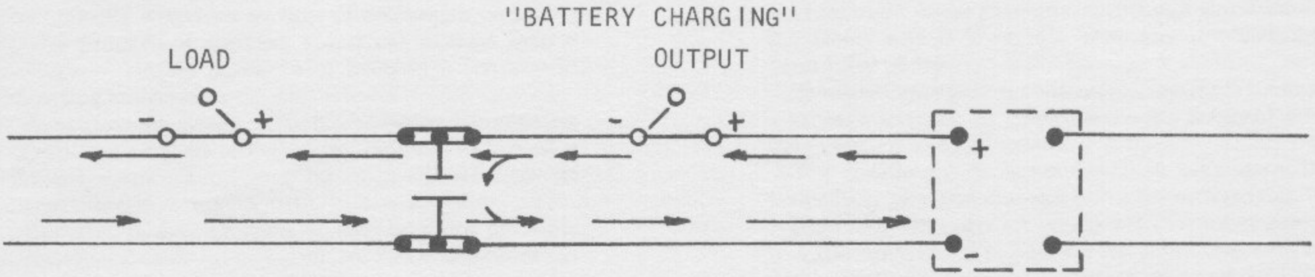

Figure 4 shows current paths for operating condition listed. Conditions normal. Battery receiving charge and circuit drawing a normal current load.

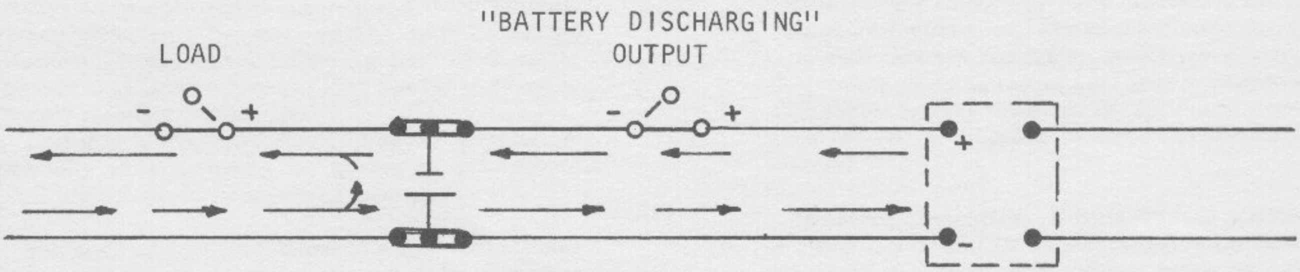

Figure 5 shows current paths for operating condition listed. Circuit under heavy load. Current flows from rectifiers and also from battery.

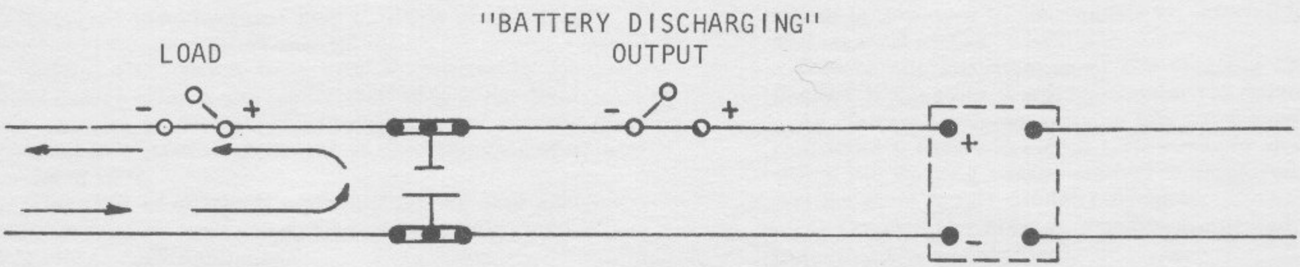

Figure 6 shows current paths for operating condition listed. AC power interruption. Current flows from battery to operate circuit. No current flows from rectifier until charging power restored.