Signal Training Bulletin

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

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B-8 Charging Nickel-Iron and Nickel-Cadmium Battery

Definition: (a) Charging: The process of putting electrical energy into a battery.

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

(c) Battery: A group of cells, electrically connected.

(d) Rectifier: A device which converts alternating current into unidirectional current by virtue of a characteristic permitting appreciable flow of current in one direction only.

Symbol: None

Description: As the definition implies, a storage cell is charged by applying dc to its terminals. The direct current must be passed through the cell in the opposite direction to that in which the current flows when the cell is discharging. The source of direct current is normally a rectifier which receives its power from an ac source and converts it to dc.

Purpose and Application: Storage battery with rectifier is used as a source of dc power at locations where ac is available. It is used for track circuits, signal lighting, relay circuits, highway crossing protection or for any railway signal equipment or circuit that requires direct current. Charging is simply a means of keeping the battery in operating condition.

General Information: (a) **Initial Charge**—All batteries lose some of their charge during shipment or when standing idle. The battery should be given an initial or freshening charge to make sure that it is fully charged.

Nickel-cadmium and nickel-iron batteries should be initially charged at higher than normal rate until the voltage of the lowest cell has become constant.

At the end of the initial or freshening charge, specific gravity, voltage, temperature, charging rate and electrolyte level of all cells should be checked and recorded for future reference.

(b) **Trickle Charge**—In signal applications, trickle charge refers to the charging current required to compensate for internal losses only.

A trickle charge is used to keep spare batteries fully charged and ready for immediate use.

(c) **Floating Charge**—The floating charge must supply sufficient current to operate the signal system components and also supply sufficient current to the battery to maintain terminal voltage. In floating service, charging rates should initially be set higher than necessary and gradually reduced from week to week until consecutive voltage readings of individual cells at normal solution temperatures of from 15.5C (60F) to 21C (70F) consistently remain between 1.5 and 1.6 volts per cell for nickel-iron and between 1.42 and 1.50 volts per cell for nickel-cadmium.

The rectifier output should be adjusted, as necessary, until the correct floating voltage is obtained. The state of charge of an alkaline battery cannot be determined as readily as with other types. During discharge, the composition of the electrolyte remains unchanged and it merely acts as an agent for the oxygen. The specific gravity does not change appreciably during discharge or recharge, and a specific gravity reading, therefore, has no significance. The only practical means is to read the voltage of a pilot cell under a momentary high rate of discharge. A device known as a test fork is available for this purpose. The following tables indicate voltages of fully charged cells at solution temperatures shown:

SOLUTION TEMPERATURE	VOLTAGE PER CELL	
	Nickel-Iron	Nickel-Cadmium
26.67C (80F)	1.48	1.45
21.11C (70F)	1.50	1.47
15.55C (60F)	1.52	1.49
10.00C (50F)	1.55	1.51
4.44C (40F)	1.58	1.53
—1.11C (30F)	1.60	1.55
—6.67C (20F)	1.61	1.57
—12.22C (10F)	1.62	1.59
—17.78C (0F)	1.63	1.61

Detailed Operation—Floating Charge: Since it is the most widely used of the various types of battery charging, the float system will be described in detail. All battery charging systems are not connected exactly as shown in Figure 1. However, in all cases where a "floating system" is used, the rectifier must supply enough current to:

(a) Supply the steady connected load (relay or signal load).

(b) Return to the battery the amount taken out during intermittent discharge from the battery.

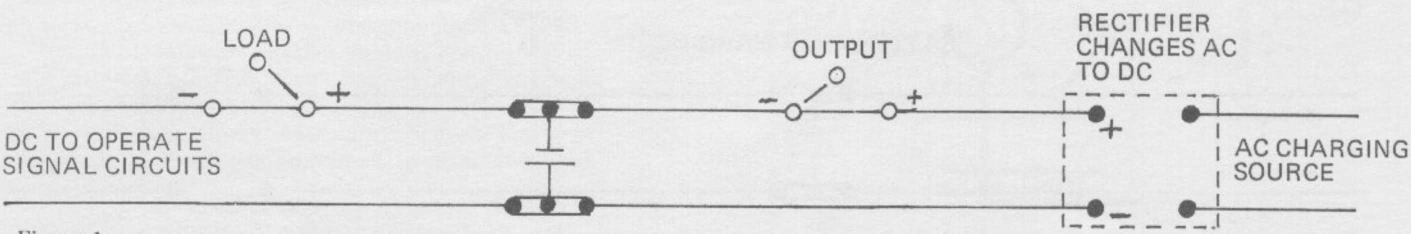

Figure 1

(c) Make up for local action or internal loss in the battery.

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 illustrate the current paths for three different operating conditions.

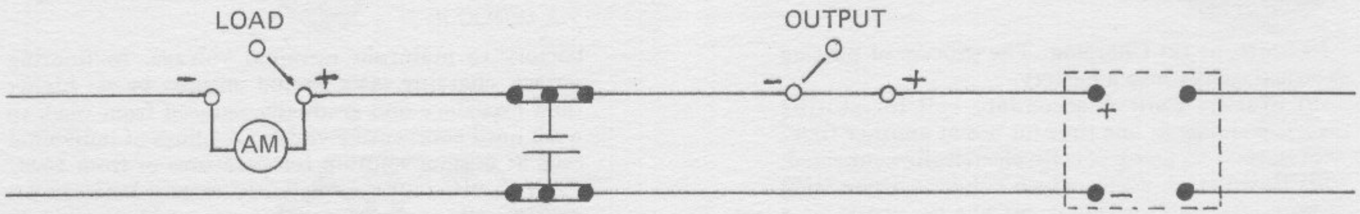

Figure 2 – Test to determine amount of current being supplied to operate the circuit load. Note: Open test link to obtain current reading.

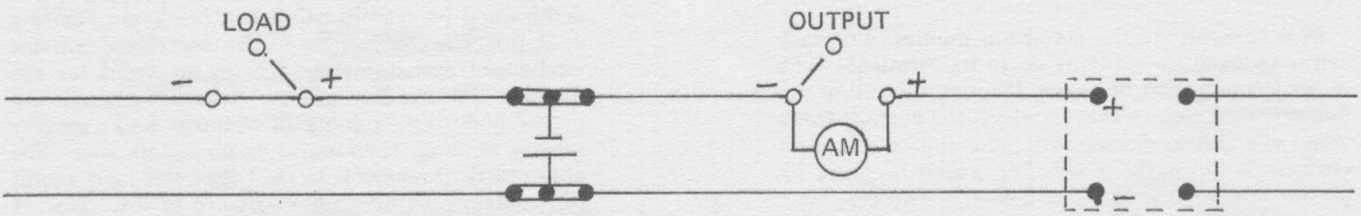

Figure 3 – Test to determine total rectifier output. This is the sum of the currents which supply the load and charge the battery. Note: Open test link to obtain current reading.

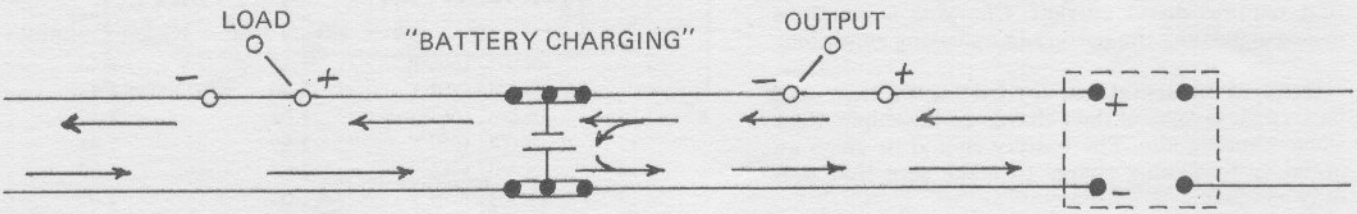

Figure 4 – Conditions normal. Battery receiving charge and circuit drawing a normal current load.

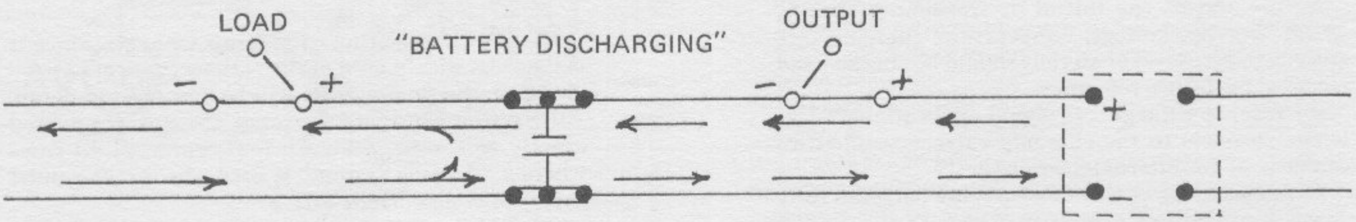

Figure 5 – Circuit under heavy load. Current flows from rectifier and also from battery.

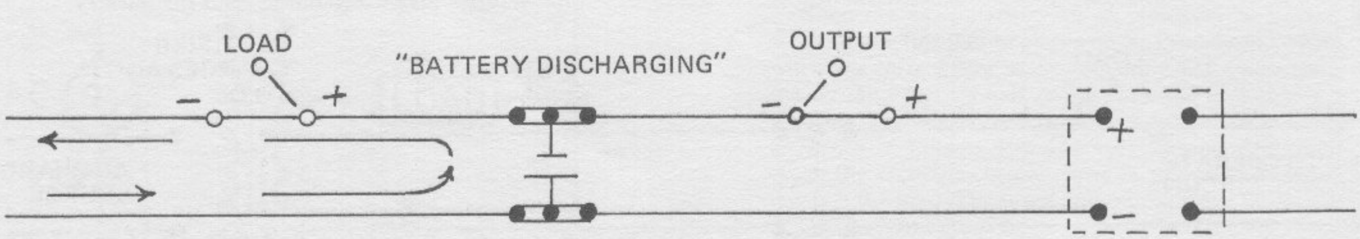

Figure 6 – AC power interruption. Current flows from battery to operate circuit. No current flows from rectifier until charging power is restored.