LION
The King of Batteries
Technical Bulletin

SERIES / PARALLEL BATTERY MATCHING

*this month's owl is **Scott McCafkey** at East Penn. He gives battery matching information regarding his recreational vehicle to South Dakota's **Walt Lanning.***

Dear Wise Old Owl: My questions are on battery replacement. If I am replacing my 6volt batteries, I have heard that it is important to match the 6-volt batteries. What does that mean, and how is it accomplished? I am using four, 6-volt batteries hooked in series/parallel as they go into the inverter. What is equalizing existing batteries, and how is it accomplished? Is this part of the charging system or what?

Scott McCafkey responds:

Battery Matching (four 6-volt batteries in a 12-volt system):

If you are replacing all four batteries together, and all four replacements are the same type, have the same date code and have similar voltages at installation, you have matching batteries. No problems.

What you want to avoid is connecting batteries with different states of charge (ampere-hour deficits) and/or different capacities in series. (Having the batteries at different temperatures due to uneven heating in the application produces similar issues.)

In the left diagram below, A is in series with C. B is in series with D. The current through Battery A is always exactly equal to the current through Battery C. The current through Battery B is always exactly equal to the current through Battery D.

If the pack is discharged, and C is replaced with a new (charged) battery, Battery C will be overcharged as Battery A is brought up toward full charge. Battery A won't reach full charge because Battery C will inhibit its charge completion. If the charger is large, the current through B and D may exceed recommended levels since the current through A and C will be low. The capacity of the string (A and C) will be limited to just a little over the capacity of Battery A. Battery A may also be damaged during discharge to a normal cutoff voltage (10.5V). Battery A's discharge should be ended at 5.25V, but if Battery C is still at 6.00 volts, the discharge will continue until Battery A's voltage falls to perhaps 4.50V.

In the right diagram, A and B act together as one battery with a capacity of A+B and a charge deficit of A+B. C and D act together as a second battery. If the pack is discharged, and Battery C is replaced with a charged battery, similar issues will arise. A+B will together behave as A does alone in the left diagram and C+D will behave together as C does alone in the left diagram. Battery D's current may be excessive, but only in the first cycle.

To keep a pack balanced, wire as per the left diagram, and replace batteries only in pairs (or all four). Put the replacements together in the same string (Positions A and C or B and D). If this causes you to move one of the remaining batteries to a new position, make sure the voltage of the other battery in that string matches. If not, you must charge each battery individually.

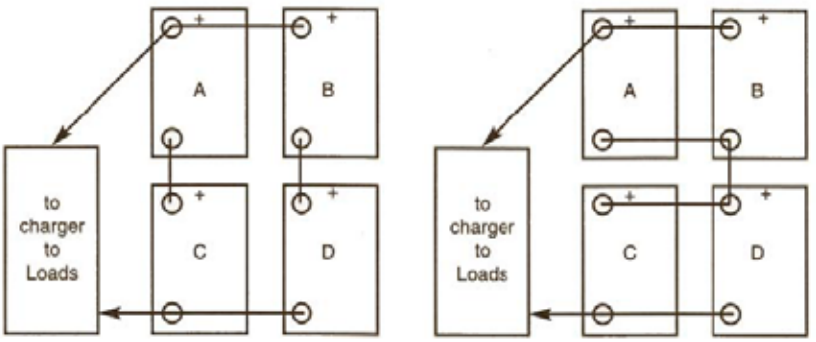
If you plan to replace one at a time, wire as per the right diagram, and monitor the voltages at the end of discharge (while under load) and end of charge (while charging) for the first cycle. Throw an additional load on any batteries that are too high and/or throw some charge into any batteries that are too low.

Slight imbalances are not a problem and are self-correcting by the charging system. A normal recharge delivers 5

percent to 30 percent overcharge depending on the requirement for the type of battery. (You didn't mention if you use gel, AGM or wet batteries). Some wet batteries benefit from an occasional intentional overcharge called "equalization." Some chargers automate this process.

Obviously, you can't mix gel, AGM and wet batteries in the same system. You could run into problems mixing nearly equivalent batteries from different manufacturers. Some batteries are compatible in some configurations, but the safest bet is to use all the same types from the same manufacturer.

Source:
The Battery Man Magazine; June 2005



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