"ZAP" NEW LIFE INTO DEAD Ni-Cd BATTERIES

That dead cell may not be completely gone. A properly applied high current can often clear a fault, making the cell useful again.

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THE NICKEL-CADMIUM cell is a paradox. Capable of being charged many hundreds to many thousands of times, it occasionally fails long before its claimed life cycle comes to an end. Most people simply replace a cell that has failed with a new cell. Considering that most Ni-Cd cell failures are reversible, this is a waste of money.

In this article, we will discuss the most common reason for early Ni-Cd cell failure and how the great majority of all failures can be reversed. The procedure described here will restore just about any dead Ni-Cd cell to provide its entire claimed useful life.

Why Cells Fail. In general, most devices powered by Ni-Cd cells employ more than a single cell. As the battery of cells is discharged and recharged, the time available between recharges reduces. Almost invariably, this is due to the weakening of a single cell in the battery.

To understand the cause of such a failure—one cell "dead" while the others are still good—refer to Fig. 1, a schematic of a typical Ni-Cd power supply for small battery-powered devices. Without the charging source connected to the circuit, the 200-ohm load "sees" 5 volts and draws 25 mA from the battery of cells. Since each cell must pass the entire 25 mA and each cell's potential is 1.25 volts, Ohm's Law tells us that each cell sees the equivalent load of 50 ohms. Ideally, the four cells deliver identical performance and, hence, share the load equally.

In practice, no four cells in a battery

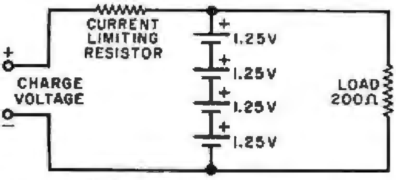

Fig. 1. Schematic of a typical NiCd supply for a small load.

ever exhibit exactly the same output voltage. Assume that one cell is delivering only 1.20 volts, while the other cells are delivering their rated 1.25 volts. Now, the 200-ohm load sees 4.95 volts and draws 24.75 mA. Since all four cells must pass the entire 24.75 mA, each of the strong cells at 1.25 volts sees an equivalent load of 50.5 ohms. This means that the weak cell sees only 48.5 ohms. While this does not seem to be too unequal a distribution, note that the weak cell is working into the heaviest load and, as a result, will discharge more rapidly than the other cells in the battery. Similarly, when the cells are recharged for only a short period of time, the weak cell, which has been working the hardest, is also the one that receives the least charging power.

This unequal loading and recharging is of little consequence in normal operation. The inequality is small for any given charge or discharge cycle, due to the relatively flat output voltage Ni-Cd cells exhibit over most of their range. And a good charge tends to equalize any energy differences between cells. However, during heavy usage, one is tempted to "quick charge" the battery just enough to restore service. A combination of shallow charges and deeper-than-normal discharges tends to exaggerate the energy difference between a weak cell and the other cells in the battery system. Operated continually in this manner, the weak cell inevitably reaches its "knee," the point at which its voltage decreases sharply, long before the other cells reach the same point.

At the knee, the picture changes dramatically. Suddenly, the weakest cell sees an increasingly heavy load, which causes its voltage to drop even faster. This avalanche continues until the cell is completely discharged, even as the other cells continue to force current to flow. The inevitable result is that the weak cell begins to charge in reverse, which eventually causes an internal short.

Once an internal short develops, recharging the cell at the normal rate is futile. The short simply bypasses current around the cell's active materials. (Even though the cell is apparently dead, most of its plate material is still intact.) If the small amount of material that forms the short could be removed, the cell would be restored to virtually its original capacity once again.

Clearing the Short. Using the circuit shown in Fig. 2, the internal short can be burned away in a few seconds. In operation, energy stored in the capacitor is rapidly discharged through the dead cell to produce the high current necessary to clear the short. Current is then limited by the resistor to a safe charge rate for a small A cell.

Several applications of discharge current are usually necessary to clear a cell. During the "zapping" (restoration) process, it is a good idea to connect a voltmeter across the cell to monitor results. Momentarily close the normally open pushbutton switch several times to successively zap the cell, allowing sufficient time for the capacitor to charge up between zaps, until the voltage begins to rise. Then, with the toggle switch closed, watch as the potential across the cell climbs to 1.25 volts. If the potential

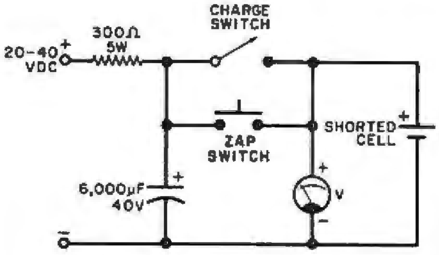

Fig. 2. Shorted cell is cleared by energy stored in capacitor.

stops before full voltage is reached, some residual short still remains and another series of zaps is in order. If you observe no effect whatsoever after several zaps and shorting out the cell and taking an ohmmeter measurement indicates a dead short, the cell is beyond redemption and should be replaced.

Once full cell potential is achieved, remove the charging current and monitor battery voltage. If the cell retains its charge, it can be returned to charge and eventually restored to service. But if the cell slowly discharges with no appreciable load, the residual slight short should be cleared. To do this, short circuit the cell for a few minutes to discharge it, zap again, and recharge it to full capacity.

Not all Ni-Cd cells can be restored by the method described here, but most can. After restoration, a cell's life expectancy will be roughly the same as that of the other cells taken from the same service application. ◇