

# Nickel Cadmium Care

Simple modifications to an inexpensive commercial NiCd charger will ensure long life for your batteries.

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**B**attery powered equipment offers the great convenience of go-anywhere portability — at a price, batteries being much more expensive than the same energy from AC. I use the word battery loosely, in the modern sense, to mean either a battery or a single cell.

Strictly, a battery (of cells) is an arrangement of two or more cells connected in series so as to provide a higher voltage, such as a 9V zinc-carbon (6 cell) battery used in a portable radio.

## Secondary Batteries

Compared with primary (use and throw away) batteries such as zinc-carbon, zinc chloride, alkaline manganese, lithium or oxide types, secondary (rechargeable) batteries can save their cost many times over. However, in practise the hoped-for economies sometimes do not materialize.

To digress for a moment, it's interesting to note that the term "NiCad" is a trademark owned by SAFT America of Georgia. The original patent was filed in 1961 by Gould, Inc., and sold to SAFT in 1982. Therefore, we'll use the spelling "NiCd" throughout.

You may find that the NiCd cells powering a Walkman type personal stereo

player, for example, seem to last no time at all before needing recharging, so it's less trouble to revert to ordinary primary cells. In such a case, the problem often lies not with the cells but with their maintenance and conditions of use.

A professional NiCd battery pack, as used with a military radio transceiver, for example, will have been assembled from individual cells chosen all to have exactly the same amp-hour capacity, so that in use they all become discharged at the same time. Likewise, when recharged they will all have become fully charged at the end of the rated charge time. Consumer equipment, on the other hand, is often powered not from a NiCd battery as such, but rather a collection of NiCd cells which, even if all bought at the same time, have only nominally the same capacity.

Worse still, a typical NiCd battery charger cannot be relied upon to deliver exactly the same number of ampere-hours of charge to each and every cell when they are recharged. The result is that the weakest cell may become discharged before the others and then be subject to reverse charging from the remaining cells. If, furthermore, it receives less recharging than the others, it may become

discharged progressively sooner on each charge-discharge cycle.

The exception is the true battery, such as the NiCd 9V (actually 8.4 volts), where of course the cells are permanently connected in series inside the battery. (This battery, usually of mass plate construction and therefore not suitable for fast charging, actually contains seven cells, since a NiCd cell only produces 1.2V, unlike a zinc-carbon cell.)

## Use and Maintenance

Careful use and maintenance can prevent the problem of early exhaustion of one cell. If you have a lab bench stabilized power supply with a continuously adjustable current limit, this can be used to charge all NiCd cells in a piece of equipment in series, thus guaranteeing that they all receive the same total charge. It is often not even necessary to remove them from the radio/cassette or whatever.

Just remove the battery cover and poke the bared end of the positive lead down between the positive battery contact and the battery, and similarly for the negative lead. Set the power supply current limit to minimum and the output voltage to maximum. Switch the supply on and

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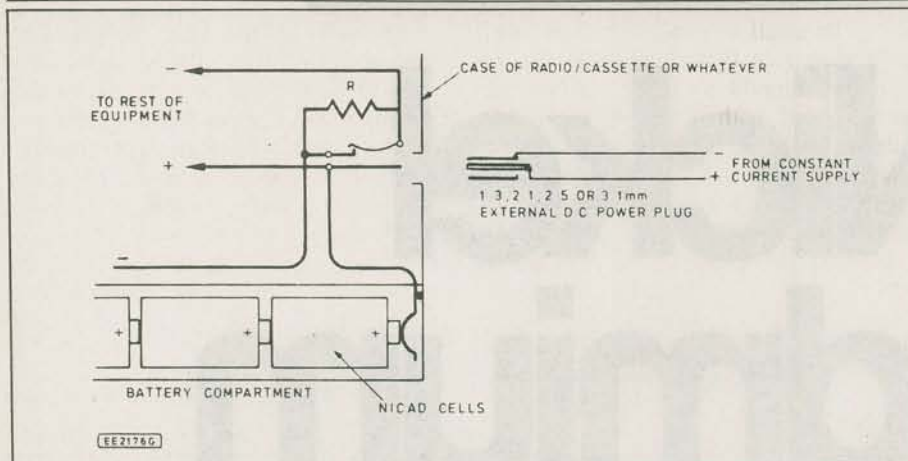


Fig. 1. Charging cells in the equipment. Centre pole positive is shown; check the polarity on the unit.

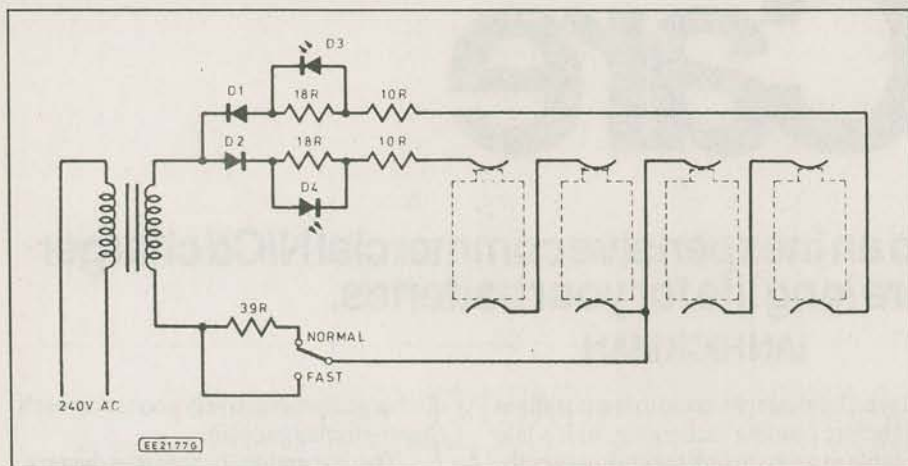


Fig. 2. Circuit of the commercial charger.

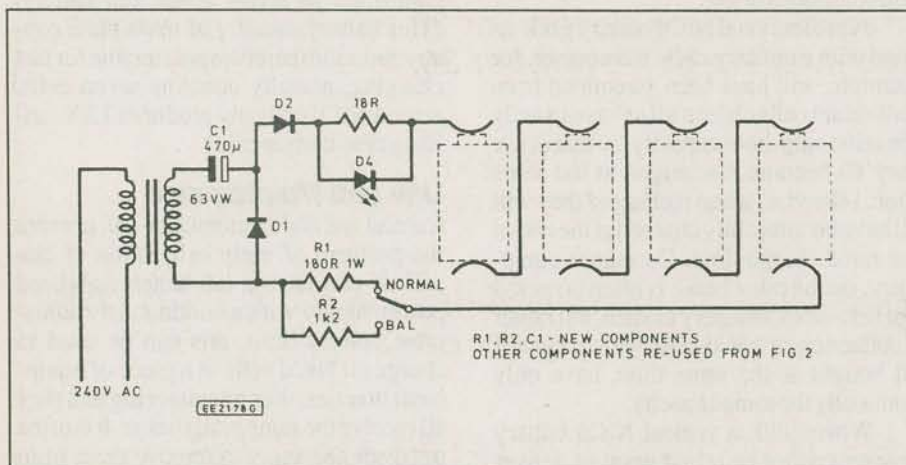


Fig. 3. The modified charger circuit.

advance the current limit control to the recommended charging current, e.g. 45mA for AA size cells.

If you never run the equipment from an external DC supply then an even more

convenient scheme is possible. Just rewire the external DC input socket so that inserting the plug does not disconnect the battery. Now, the current limited supply can be simply injected via the socket. A

wise precaution is to include a resistor, to limit the charging current to a safe value in the This can simply be wired across the socket's break-contact, which is designed to disconnect the equipment from the internal battery when an external power plug is inserted, see Fig. 1. For a medium sized radio/cassette using 6 C cells, a 22 ohm 1/2 watt resistor is suitable.

## Simple Charger

I recently purchased, a mains operated NiCd battery charger designed to charge two or four AA cells; Fig 2 shows the circuit diagram of the charger as purchased and, as you can see, it offers a choice of standard or fast charge rates. The circuit is entirely typical of various makes of charger from the far east.

Two of the cells are charged on one half cycle of the mains and the other two on the alternate half cycle. The charging current is thus discontinuous or dirty DC, which is actually reckoned to be better for the purpose than smooth DC. It also explains how the LEDs light — 50mA of smooth DC would not produce the necessary 1.8V (or thereabouts) voltage drop across 18 ohms.

On normal charge, the 39 ohm resistor and the total transformer winding resistance referred to the secondary are common to both charging circuits. Assuming the voltage drops across the rectifier diodes, the 10 ohm resistors and the LEDs are equal, then the charging current will be equal — assuming the voltage drops across the cells in each circuit are also equal.

The charging current on normal proved to be about 63mA in each circuit, distinctly above the recommended value of 45 or 50mA, depending on the make of NiCd AA cell. On fast charge, the current was over 150mA and, without the equalizing effect of the 39 ohm resistor common to both charging circuits, the balance was poorer — all resistors were 5% tolerance.

Note that fast charge **should only be used** if you are certain that **ALL** the cells are **FULLY** discharged, and the recommended charging time **should NEVER be exceeded**, as overcharging at the fast rate is even more damaging to cells than overcharging at normal rate.

## Modified Charger

Unfortunately my personal radio/stereo cassette uses three AA cells, which left me with a problem. Two of the cells could be charged in one circuit, and the third cell in the other, using a dummy

battery to complete the circuit. However, the charging currents would not be identical, due to the drop across two cells in one circuit against only one in the other.

I considered charging the dummy battery from a straight-through connection, to two silicon diodes in series, to simulate the volt drop across a NiCd, but exact equality of the charging current could still not have been guaranteed. The only way to ensure this is to charge all the cells, be it two, three or four, in series. It was therefore decided to modify the charger circuit.

The circuit of the modified charger is shown in Fig. 3. If all the cells are to be charged from the same current, then a higher back voltage must be overcome and a higher charging voltage is necessary. This was obtained from the same transformer by using a half wave voltage doubler circuit, involving the addition of C1. No smoothing capacitor was used, giving a dirty DC charging current as before. For safety, a generously rated 63V electrolytic was used. R1 was chosen to give a charging current of 45mA with four cells on charge, the current being slightly higher with three or two, but not excessive even with one.

The small increase in current when charging less than four cells can be avoided entirely by using dummy batteries fitted with diodes as mentioned above. In the interest of kindness to batteries, the fast charge facility was dropped entirely — this also ensured that the transformer was running well within its VA rating in the modified circuit. The alternative switch position was retained, however, and redesignated BAL, with an additional 1k2 series resistor. The reason for this will appear in a moment.

### Discharge

Another very useful gadget was invented to assist in maintaining my NiCd cells in good condition. It consists of a battery holder designed to accept four D cells side by side, modified so that each cell position has a 1.25V 0.25A flashlight bulb (of the integral lens variety used in miniature flashlights) wired in parallel.

In addition to D cells, the holder will also accept C and AA cells, with the aid of some packing pieces, consisting of one inch lengths of wooden lath wrapped in foil. When the set of NiCds ceased to operate my personal stereo, I tried the

three cells in the bulb gadget. Sure enough, one cell was flat, while the other two lit their bulbs for ages. When they finally expired, I put them in the Fig. 3 charger, safe in the knowledge that they were all in exactly the same state of discharge. Following the normal 14 hours charge they operated the personal stereo for much longer than previously, and have continued to do so through many charging cycles.

### Overcharging

Overcharging NiCds, even at the normal charge rate is not recommended, but they will withstand overcharging at a lower rate — say 20 percent of the normal rate or 10mA for AA cells — without coming to any harm. So every so often, following a normal charge, I switch to the Bal (balance) position and leave the cells on charge for another 12 hours. This balancing charge ensures that even if one of the cells is a bit on the low side, it finally reaches the fully charged state, ready for the next discharge cycle.

Given this sort of care, your NiCds will last and last, giving you the 500-plus charging cycles promised by the manufacturer.