More on the Clansman 24V, 4 Amp-hour Ni-Cad Battery

By Simon Dabbs, G4GFN

This article follows on from Colin Guy's excellent article in Newsletter 27 (February 2003) on refurbishing these batteries.

A Tale of Refurbishment

About a year ago, I was fortunate enough to acquire an old 28v Storno battery unit, containing two dozen 4Ah "D"-size nickel-cadmium cells. I tested them on the bench and found them to be excellent condition, so I looked after them (see how below), hoping one day to drop across a scrap Clansman battery to refurbish. My patience paid off, for this autumn I met up with Les Thacker at Pippingford Park, and in a discussion on Clansman 351s, it emerged that he had a defunct unit, for which I am grateful.

I followed the instructions given in Colin Guy's article. As he hints, the most difficult part of the process is digging out the defunct cells from the foam "gunge" in which they are embedded. Colin warns of the dangers of damaging the diode temperature sensors, but a great deal of force is needed to dislodge the cells, and before I knew it, I had broken the lead to the sensor diode located in the centre of the pack of cells. This did not please me. However, I needn't have felt guilty. Once I dug a bit further and extracted the diode, there was very little of it left. Alkali leaking from nearby cells had all but dissolved it! Obviously, this was a little disappointing, but I figured that if I could extract the other sensor, which is buried in the foam under the output terminals, I should be able to find out what type of diode it is, and with luck, find a replacement. No such luck! You guessed it; the other diode had dissolved, too. Both diodes would have to be replaced.

What is the purpose of these two diodes? Well, the Clansman DC Charging Unit (DCCU) enables the Clansman 24V battery to be charged from a vehicle supply (there is a 28-volt type and a 14-volt type available, depending on the vehicle voltage). During charging, a yellow LED lights to indicate charging proceeding. Once charged, the yellow LED is extinguished and a green LED lights, and the charging current is removed. The DCCU senses when the battery is fully charged by making use of the principle that once a NiCad cell is fully charged, further current passing through it will be converted into heat. In the battery the "hot" diode, in the centre of the battery pack senses this heat. The second "cold" diode is located close to the outer casing of the battery (under the output terminals) to sense the ambient temperature to act as a comparator. This is very necessary, as Clansman sets are specified to operate from minus 40 deg. C to plus 50 deg. C. This system is why the lead connecting the DCCU to the battery is 4-way. One plug pin is the positive battery terminal, one is the negative, one goes to the "hot" diode anode, and one to the "cold" diode anode. The cathodes of both diodes are connected internally to the negative battery terminal.

So, what kind of diodes to use? Colin suggested I should try a matched pair of humble 1N4148 diodes, and Murray McCabe concurred, explaining that these have the correct forward voltage/temperature coefficient, of the order of minus 2mV per deg. C. The face of the casing below the two main battery terminals houses the 4-way socket for connecting to the DCCU. I did not disturb the wires that go from the back of the socket to the cells/main terminals, but I had to make new connections to my new diode sensors. This was a fairly easy soldering job, once the gunge had been scraped away. I used about 4 inches of thin 2-way flex to each diode, connecting the two cathode leads to the negative end of the cells. Initially, as a test, I put twenty of the D cells in series across the battery terminals, keeping them outside of the case and kept the diodes floating in free space. I plugged in my DCCU and switched on. No good; the green LED was flashing, indicating a fault condition. I checked all the connections and polarities and all was as it should be. I concluded that the 1N4148s were unsuitable. Then I had the idea of comparing the diode characteristics of a good Clansman battery. I measured the forward voltage and found it was about twice the 1N4148's value. So, I did the obvious thing and tried two 1N4148s in series, for each sensor (all 4 diodes from the same batch). I switched on the DCCU and the yellow LED lit, showing all was well. I then held the "hot" diode in the warmth of my hand and after a few seconds the DCCU was fooled into "thinking" that the cells were charged and the green LED lit instead of the yellow. Excellent!

I then proceeded to fit the cells into the battery case

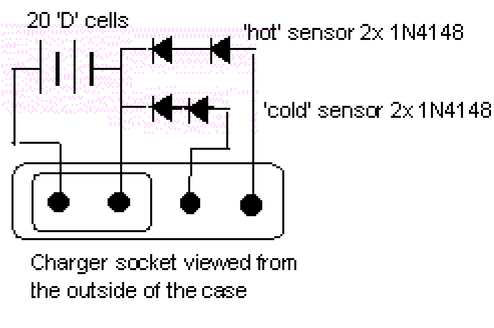

Fig. 1 Wiring of the charger socket.

properly, following Colin's article, and it was plain sailing. I applied narrow heat-shrink sleeving over each pair of diodes, to provide electrical insulation. I taped the "hot" one to a cell near the middle of the top layer (each cell was wrapped in its own thin plastic sleeve). The "cold" one was sandwiched between the aluminium case (in one of the near corners) and the fibreglass matting layer within. The idea of this is to put the cold diode in reasonable thermal contact with the casing, but having a degree of thermal isolation from the cells. One slight challenge I found was the fact that it is a very tight squeeze to get all the cells into the casing, and there isn't much vertical room for electrical insulation between the two layers of cells and between the top layer and the lid. I used polythene panels about 3mm thick, cut from a used 4-pint plastic milk bottle. A friend kindly riveted the lid back on for me, and the battery has given excellent service ever since.

Looking after Nickel-Cadmium Batteries

I have to admit to not being a great fan of Ni-Cads. Unlike lead-acid batteries (which for a 12V set seem happy to stand-by, fully charged on a constant float-charge voltage of 13.8V for ever and a day), Ni-Cads need to be charged and discharged from time to time. If this doesn't happen they can suffer from "memory effect" and won't yield all their energy on discharge. Apparently, Nickel-metal hydride (NiMH) batteries do not suffer so much from memory effect and achieve a higher specific energy density (more amp-hours per unit volume), but have the disadvantage of a higher self-

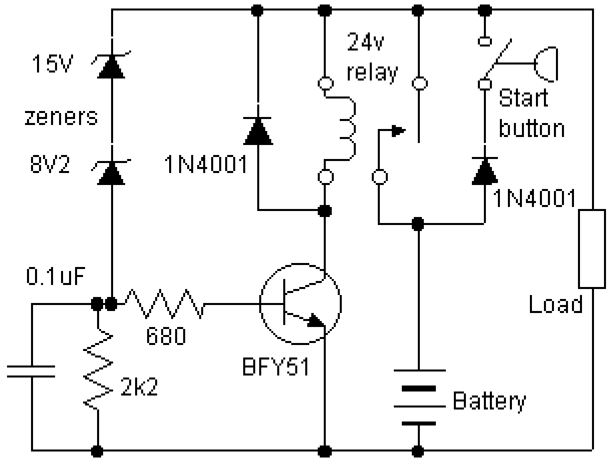

Fig. 2 Circuit of auto-stop discharge unit. "Load" in this case consists of a 24v 21w automotive lamp.

discharge rate. Incidentally, NiCad and NiMH batteries need to be charged from a constant current source. The DCCU charges at about 650mA, and towards the end of the charging process, the voltage across the battery terminals reaches about 30.5V

I like to discharge and re-charge my Ni-Cads about every 6 weeks. In the case of the Clansman 4 Ah unit, I connect a 24V, 21W automotive lamp, thereby drawing a current of about 1 amp. However, it would be disastrous to allow the battery to discharge completely, so I tend to keep an Avo connected during the discharge period, and keep checking it until the voltage gets down to about 23.5V, when I disconnect the load. This is rather tedious, not to mention the risk of forgetting all about it! So I've devised and built a simple circuit whereby the load can be connected to a charged battery and left running. Once the voltage falls to 23.8V, the load automatically disconnects.

An Auto-stop Discharge Circuit

The circuit consists of a latching relay, energised via a transistor whose base is fed by an appropriate zener diode. Once the input voltage falls below the zener voltage, the relay drops out. The diode in series with the start button provides polarity protection, and a degree of hysterisis, so that only a fairly well charged battery's discharge can be initiated.

I tend to set the discharge process going over night. The next morning, the DCCU is deployed to recharge the set. One word of warning though. When using the DCCU, you need to watch out for when the charging cycle is complete. If you miss it and delay switching it off, the hot diode in the battery pack will cool back to ambient after about 30 to 50 minutes, and the charge cycle will initiate again, which will unnecessarily heat up your cells, which can't be good for them.

References/Acknowledgements

Refurbishing a Clansman 24v 4Ah Battery, Colin Guy G4DDI, VMARS Newsletter 27, February 2003.

My thanks to Colin Guy and Murray McCabe for their help with this and other Clansman projects.