10

NiCad Battery Charger

Ordinary dry cell batteries can be rather expensive for long term use in equipment which has a fairly high current consumption, such as portable cassette recorders and electronic flashguns, and there is also the bother of frequently having to replace exhausted batteries. Nickel cadmium (NiCad) cells have a rather high initial cost, but they are

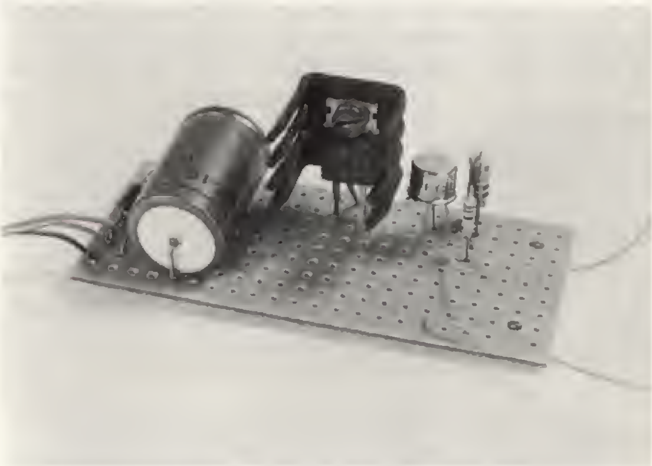

Figure 10.1

NiCad battery charger

rechargeable and have an extremely long lifespan. This makes them economically quite attractive in the long term, especially if one builds one's own charger unit at low cost.

The charger described here is designed for charging up to about six AA size NiCad cells (these are equivalent to HP7 cells in size). However, it can easily be modified to charge other sizes of battery, as will be explained more fully later on.

NiCad cells have a rather low internal resistance which is an advantage in that it enables them to supply quite high currents, but is a disadvantage in that it slightly complicates the recharging of these cells. Due to the low cell impedance the charger needs to have only a slightly higher output voltage than the cells in order to produce a very high charge current. Usually NiCad cells must not be charged at high currents as this would result in a greatly reduced life. AA size cells have a recommended charge current of about 50mA and require a charge time of about 15 hours in order to recharge a cell that has become completely discharged. The precise figures actually vary slightly from one cell manufacturer to another, but are not really critical.

The circuit

The complete circuit diagram of the NiCad Battery Charger is provided in Fig. 10.2. The mains supply is connected direct to the primary of mains isolation and step down transformer T1, and no on/off switch

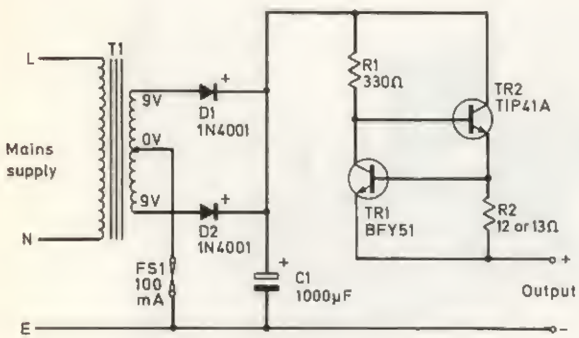

Figure 10.2

Battery charger circuit

is used as the unit will presumably be disconnected from the mains when it is not in use. The output from the secondary of T1 is fullwave rectified by D1 and D2 and the resultant rough d.c. is smoothed to some degree by C1.

A current limiter circuit of quite conventional design is connected in series with the output and ensures that the output current is approximately the required level. The current limiter employs TR1, TR2, R1 and R2, and it works in the following manner.

TR2 is used in the emitter follower mode and is biased hard on by R1. With a battery connected across the output a fairly high output current therefore attempts to flow from the charger. This current develops a voltage across R2 as this component is connected in series with the output, but the voltage across this component will rise only to about 0.65V. When this voltage is reached, TR1 is turned on and it taps off some of the base current of TR2 down to the negative supply rail through the load.

Even if a short circuit is placed on the output, the voltage across R2 will not exceed more than about 0.65V as the base of TR2 would be virtually short circuited to earth through TR1, and the output voltage would be little more than zero.

From Ohm's law it is easy to see that the output current is equal to 0.65V divided by R2 in ohms. A 13Ω resistor in the R2 position gives the required current of 50mA (in theory anyway), and the more readily available value of 12Ω gives a theoretical current of just over 54mA, which should also be perfectly suitable in practice. Of course, due to component tolerances etc. the actual output current of a circuit built to this design may be as much as several per cent different to the calculated output current, but this is of no real consequence as the charge currents of NiCad cells are not highly critical.

Fuse FS1 protects the charger and NiCad cells against passing an excessive output current if the current limit circuit should fail for any reason.

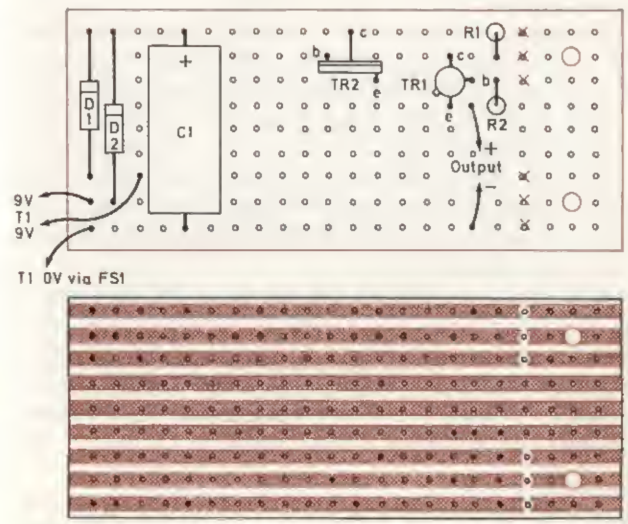

Figure 10.3

0.15 in strip board layout

Construction

A suitable 0.15in matrix stripboard layout for the unit is shown in Fig. 10.3. This accommodates all the components except T1 and FS1. The latter is mounted in a chassis fixing fuse holder which is bolted to the bottom of the case. T1 is also bolted to the base of the case. The output sockets, which may be wander types, are mounted on the front panel of the case and a hole for the mains lead must be made in the rear of the case. This hole should be fitted with a grommet to protect the lead if a metal or hard plastics case is used.

The point to point wiring is then completed before the component panel is finally mounted at the bottom of the cabinet. The mains earth lead connects to the negative output socket, and if a metal case is used this must also be earthed.

Using the charger

Battery clip leads to fit AA type cells are not available, but suitable battery holders are. These holders are available for various numbers of cells, and they are fitted with a battery clip of the same type and size used on PP3 and PP6 batteries. By mounting the cells in such a holder it is therefore possible to make the connection between the charger and the cells using a PP3 type battery connector having its leadout wires terminated in wander plugs.

If a holder for the appropriate number of cells is not available either unused positions in the holder can be bypassed using a shorting lead, or a couple of holders may be connected in series, whichever the situation dictates. Make absolutely certain that the charger is connected to the cells with the correct polarity (positive to positive and negative to negative). Also make sure that the cells are not forgotten and accidentally charged for much longer than is necessary, since the charger will continue to force current into the cells once they have become fully charged, and this is best avoided.

It is an easy matter to modify the unit to provide a different charge current, and the principal change is to the value of R2. The theoretical value of this component is equal to 0.65 divided by the required charge current in amperes, and this gives the answer in ohms. The theoretical value will not always coincide with a preferred value, and it is then necessary to choose the preferred value which is closest to the calculated one.

A few other points must be kept in mind if the unit is being used to provide a charge current of much more than about 50mA, or is being used to charge a large number of cells. T1 must have a rating which enables it to provide at least the required charge current, and it must

be capable of producing a loaded voltage which is two or three volts more than that of the fully charged cells in series (when charging more than one cell they are always connected in series and not in parallel). The rating of FS1 must be suitably increased for charge currents of more than 100mA.

If the unit is used to charge fairly large cells such as the C (HP11) or D (HP2) types, the higher charge currents required will result in increased dissipation in TR2. This will probably necessitate the fitting of a small commercial bolt-on type heatsink, and the component panel has been designed to accommodate such a heatsink. If the transformer supplies a loaded voltage which is considerably higher than the total cell voltage it may even be necessary to mount TR2 away from the component panel on a more substantial heatsink in order to prevent this device from overheating.

Components list for the Ni-Cad battery charger

Resistors (both ½W, 5%)	
R1	330Ω
R2	12 or 13Ω (see text)
Capacitor	
C1	1000μF, 16V
Semiconductors	
TR1	BFY51
TR2	TIP41A
D1	1N4001
D2	1N4001
Fuse	
FS1	100mA, 20mm fuse
Transformer	
T1	Standard mains primary, 9 – 0 – 9V at 100mA secondary (see text)
Miscellaneous	
Case	
0.15in pitch stripboard panel	
Heatsink for TR2	
Chassis mounting 20mm fuseholder	
Output sockets and connecting leads	
Mains lead, plug, wire, solder, etc.	