Cells and batteries

Several incidents have been reported to the Sub-committee over the last year or two which have involved cells and batteries. These incidents fall into two types, those in which a battery holder has been destroyed and those in which a cell has "exploded".

There are three types of cell in common use:

1. The zinc/ammonium chloride/carbon cell or "dry" Leclanché cell;
2. The zinc/alkaline/carbon cell or "alkaline manganese" cell; and
3. The nickel/cadmium rechargeable cell or "NiCad".

All of these have undergone significant developments in recent years so that there are different versions of each type with the same physical dimensions, but having different internal resistances, different capacities and, for the first type, different rates of depolarisation.

When a current is passing through a cell, gases are nearly always produced as a result of the electrochemical reactions involved. If these gases are not re-absorbed or vented to the atmosphere, the pressure inside the cell increases.

The situation is further complicated by the fact that there are several different systems used for naming the cell sizes. The size used in most Worcester Circuit Boards will be referred to as size "D" in this note.
The incidents in which a battery holder has been damaged by over-heating have usually involved NiCad cells or size D and a capacity of 4 A h. Such cells have a very low internal resistance, about 0.01 ohm, and it is quite possible to draw 40 A if the external resistance is low enough. Assuming that this is an accidental short circuit, the external resistance (0.02 ohm) is probably just the contact resistance between the cell and the connections in its holder. The power developed at these contacts is then 32 W and it is not surprising if they become hot.
It is also possible to buy NiCads of size D which have a capacity of only 1.2 A h and an internal resistance of about 0.04 ohm. The current which would flow in the same situation as before is now about 20 A and the power dissipated in the contacts is reduced to 11 W. Consequently, although these cells will need recharging more frequently, misuse is unlikely to destroy the holders for over-heating.

Moreover, because the larger capacity cells can themselves be heated by the heavy discharge current, the cases must have a vent to release the gas to the atmosphere. The smaller capacity design does not become so hot and does not require a vent. The electrolyte is strongly alkaline and some may be expelled through the vent where there is one. From this point of view too, the smaller capacities are to be preferred in schools but on no account should they be charged at a current greater than that recommended on the case.

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Some kits for teaching electrical circuits use the smaller "C" size cells. There are two types of NiCad available and the one of smaller capacity is the safer.

The "explosions" have occurred when NiCads have been charged too rapidly or when currents have been forced through non-chargeable cells. One way in which this has happened is when a battery has been set up of different cells: say three alkaline manganese cells and one ammonium chloride cell. The alkaline cells last longer than the odd one and continue to pass current round the circuit. The gases generated in the flat cell cause a build-up of pressure which causes it to burst.
The lesson to be learnt from this sample: always change all the cells in a battery at the same time for new ones of the same type.

Note: Since this was written, new battery technologies have become commonplace such as lithium and NiMH types. See the 2016 edition of Topics 17, Electricity, on the ASE website.

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