CHARGE UP!

To get the most from your cells they need to be charged properly — here's how.

All Electric Radio Control Cars use fundamentally the same power source, a *Ni-cad* battery pack. This is the only source of energy available to drive the motor, and in some cases the receiver and servo's/speed controller. Universally we use sintered plate Nickel-Cadmium 'sub c' sized cells. Each cell contains a number of metal plates and a chemical electrolyte. The nominal voltage is 1.2 volts (v) and the nominal capacity is 1.2 ampere-hours (Ah). The major characteristic of this type of battery is its ability to deliver very high current (up to 60/70 amps (A)) for very short periods, and that they are rechargeable.

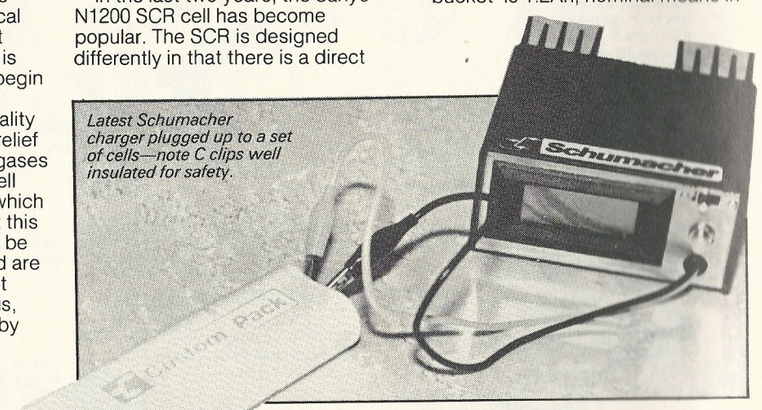
Currently, most Electric R/C car formulae use either four or six cells connected in series. This gives a nominal pack voltage of either 4.8 volts or 7.2 volts (6×1.2v or 4×1.2v). It is the voltage of the pack that determines how fast the motor will turn. The ampere-hour rating indicates the capacity of the cell, in this case 1.2A for one hour. If it were possible to increase the capacity to, say, 1.5Ah, then the cell will deliver the same voltage, but for longer.

Before racing your R/C car, it will be necessary to charge up the *Ni-cad* pack. During the charge phase, a chemical reaction takes place within the *Ni-cad*. As the charge phase nears its end, the chemical reaction creates heat. This heat builds rapidly and if the charge is not stopped, the chemical will begin to gas causing extremely high pressures within the cell. All quality cells are fitted with a pressure relief valve (vent) which permits the gases to escape, but eventually the cell will start to spit out chemicals which are both corrosive and toxic. At this point the cell is so hot it cannot be handled (and the gases emitted are highly explosive) and is in effect ruined. This dire, and dangerous, state of affairs can be avoided by using a proper charger which automatically cuts-off when the charge is complete.

Although there are a number of cell suppliers, the major manufacturer is *Sanyo*. This Japanese company makes over 30,000,000 sub c size cells every year, the majority of which are not used in model cars. There are a few different types of cells available whose plate construction and chemical electrolyte are specified to suit different applications. The *Sanyo* designation is given as N1200 followed by two or three letters. Currently three types of cell are used in R/C car racing. N1200SC have been around for about 10 years, and are by far the most popular type of cells. Whatever the label on the cells provided in a kit, or from a shop, unless it specifically says otherwise it is normally an N1200SC. Kits from *Tamiya* and *Kyosho* typically use these cells, called SC for short.

In the last two years, the *Sanyo* N1200 SCR cell has become popular. The SCR is designed differently in that there is a direct relationship between the build up of heat and the amount of 'overcharge' in the cell. These cells can deliver higher currents for the same voltage, but only marginally so. SCR's have found greater favour in indoor racing (1:12th) where the slightly extra voltage and better current delivery gives a slight advantage. In the main I find that the SCR cells give equal performance to SC cells, but actually have a longer usable life, that is they give better performance over a greater number of charges.

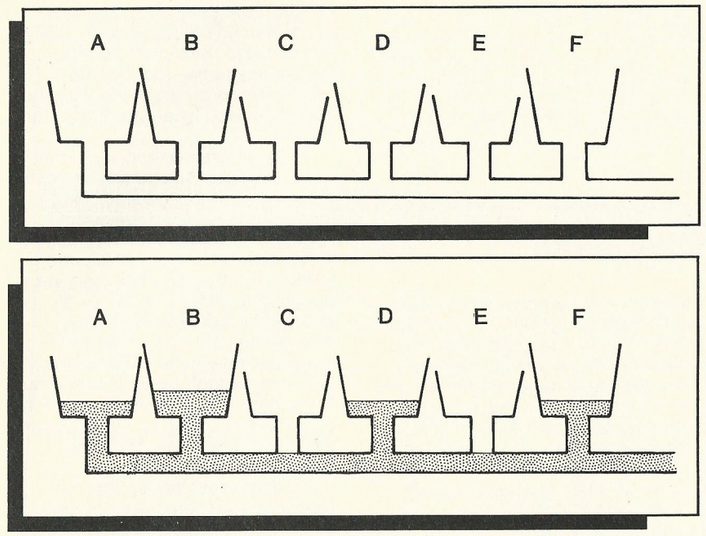
Brand new on the market is a higher capacity cell from *Sanyo*. Designated the N1700 SCE, these cells have a nominal capacity of 1.7Ah (1700) as opposed to 1.2 Ah (1200). At the time of writing little is known about SCE's, but undoubtedly many will want to try them, so we will deal with this later on.



Latest Schumacher charger plugged up to a set of cells—note C clips well insulated for safety.

How it works

For practical purposes one can regard six Ni-cads in a pack rather like six buckets of water, see diagrams, each with a hole in the bottom connected to a hose. Before someone says they are connected in parallel, not series, I know—bear with me. When charged, water is pushed in at a certain rate (X). Although the capacity of each 'bucket' is 1.2Ah, nominal means in



name only, not real or actual. In practice each cell has a slightly different capacity. When 'water' is pushed in at 'X', the smaller buckets 'C' and 'E' will fill first, and the largest bucket 'B' will fill last. This is the equivalent of buckets 'C' and 'E' being overcharged and getting hot. Once all the buckets (or cells) are full (or charged) the whole pack starts to get hot, it is then fully charged. However, bucket B still has more capacity than all the other buckets. Once water is allowed to escape from X (when the cells are discharged during racing) they all discharge at the same rate; ie, the buckets empty at the same speed. When all the 'water' has escaped from 'C' and 'E' those cells are discharged.

Buckets A, B, D, F, still have 'water', but we are now running on a four bucket (cell) system. Eventually, buckets A, D and F, empty, leaving only bucket B, a one cell pack!

This phenomena is displayed on the track by the car slowing down noticeably after $\frac{3}{4}$ or $\frac{7}{8}$ of the race, and then carrying on at a gradually reducing speed for some time. Worse still, during the time that bucket C and E have water in them, bucket B still has more 'push' due to the greater weight of water, and thus it tries to charge up the lower cells as well as putting water out at 'X'.

The point to note is that if all the buckets were of the same size, then all their energy would go into providing power at 'X'. A pack of six buckets all the same size as 'C' and 'E' will give more useable performance than a pack with one or two large buckets.

In terms of Ni-cad packs it is far better to have six *Ni-cads* all at 1.2Ah than to have four or five at 1.4Ah, and one or two at 1.2Ah.

Choosing a battery pack

Obviously it would be nice to find a pack which has limitless capacity and lasted for an infinite amount of charges, but frankly you'll have more luck trying to sell legwarmers to a snake. Go for *Ni-cads* which claim to be matched. I say claim, because in recent years people have been fooled into buying so-called matched *Ni-cads* which match only because all the labels look the same! At the risk of incurring the wrath of certain traders, I can only infer in the results of top National events that *Ni-cads* sold as matched under the *Parma, SRM-Laser, Schumacher* or *Nosram* banner are worth considering. I have no experience of the *Panasonic* (Black Knight) or *MIH* pushed cells and therefore cannot rule on them out one way or another. The problem with matched *Ni-cads* is the expense, up to £40 per pack. For the average club racer are they worth half to two times the price—no. The important thing about buying *Ni-cads* is that you should get reputable names. Those companies who sell the most get the best. For all types of R/C electric cars there is nothing wrong with SC cells from *Tamiya* or *Parma* at around £20 to £25. For experienced club racers then the extra expense of matched SCR's from *SRM-Laser* or *Schumacher* will be worthwhile. Note that all the four companies mentioned supply ready assembled packs, and it is best to let the experts do assembly. Just so there is no confusion here, I am sponsored by *SRM Racing*. You pay the money, so you choose. The performance of cells will be more affected by the way you treat them than the money you pay. Bad electrical connections, poor motor care, and improperly maintained cars with stiff drive trains play a greater part in performance than another £10–£15 spent on cells.

Battery use and care

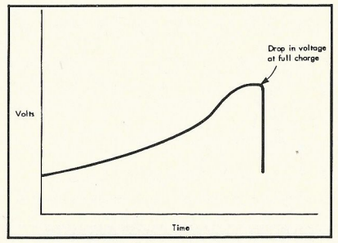
Cells from almost all the major suppliers mentioned come fitted with two leads, some even fitted with a plug. Solder the correct connectors to the leads—never crimp or tape wires to connectors, always solder. Always use a foolproof plug system to avoid connecting batteries the wrong way round. Many experienced drivers do not use plugs, but they know what they are doing. Club racers would be unwise to follow, use a plug and be safe.

There are four basic ways to charge cells. All have a common bond—a power source. Almost universally this is a 12 volt lead-acid battery like that used in modern motor cars. Make sure that the 12 volt is fully charged before a meeting, and carry it in a safe container, be that wooden box or plastic bucket. It is possible to use the 12 volt fitted to your car, but it is advisable to run the engine halfway through the meeting to keep it

charged. Never run the car engine while cells are being charged. Note also that the 12 volt lead acid battery designed for car use is not suited to deep discharge such as it gets after four or five charges of a *Ni-cad*, the life of the 12v battery will be shorter. The best 12 volts to use are those designed for use in boats or caravans which commonly have 'double separators'. These cost £80–£100, but can last for years if treated well, and certainly longer than a cheap car battery.

Never charge cells direct from a 12volt battery, or direct from a 12 volt battery charger, or (it's been tried) from the household mains. Back to the four methods. Number one is the manual method. Some kits come with charge leads, one being a resistor wire, or having a resistor fitted, the other a straight wire. Needless to say, the negative or black lead is connected from the negative (–ve) of the 12v to the –ve of the Ni-cad pack, and the positive (red) lead from the positive (+ve) of the 12v to the +ve of the *Ni-cad* pack. If the *Ni-cad* pack is connected the wrong way round then severe damage will result.

Once connected, the *Ni-cads* are on charge. It takes between 20 and 30 minutes to charge the pack. This charge is completed when the pack is slightly warm to the touch, it should never rise above handwarm. This simple method has many pitfalls, not least of which is the possibility of overcharge which will severely overheat the pack. If this happens never touch the pack. If the pack starts to pop or spit from the vents get it away from the charge leads quickly by pushing it with something—never touch it. Get the pack onto a wooden bench or the bare earth or grass and smother with an old towel. Leave for an hour.



Typical peak voltage curve

Go to the shop—buy a new one!

Number two is the timed charge. This is usually a resistor to reduce the current and a timer. Correctly connect the charger to the 12v, and to the *Ni-cads*. Set the timer for 20 minutes or so. Once the time is up the charge stops. If the cells are still cold set the timer for another 10 minutes, when the pack is hand warm stop the charge even if the timer is still going.

Number three is the 'peak detect' method. These electronic chargers connect to a 12v and to the cells. During charging the voltage in the cells rises (as it does with any method) until the pack is fully charged. This voltage is much higher than the nominal 7.2v, it can be anywhere between 8.9 and 10.0v. Once fully charged, and at the point where the pack becomes hand warm, the voltage starts to drop (see graph).

The peak detecting charger senses this drop in voltage and shuts off. Number four is the temperature sensing charger. This is again connected to a 12v and the Ni-cads, but in addition a small sensor is inserted into the pack next to the cells. When the pack is fully charged the temperature rises and at a preset temperature the charger stops. Note that the temperature sensing method makes the cells hotter than in other methods, this is OK because the cut-off point is always the same. Judging the higher temperatures manually is not recommended when using another method.

Temperature sensing works best with SCR cells, in general the peak detection method is safest with other types. Although peak detect chargers are expensive they pay for themselves in longer cell life and more consistent charging and are to be recommended. More experienced drivers use temperature sensing on all cell types but they do know what they are doing—don't be tempted if you are unsure. Peak detect chargers by *Schumacher, Intronics*, and *CS* work well, temperature sensing from *Laser* and *Nosram*.

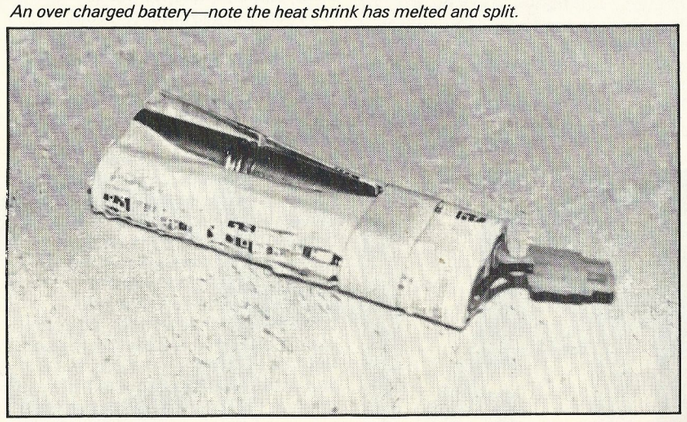
Try to charge cells so that the charge is completed during the race before your own. If not, then charge early, and switch the charger on again to reheat or repeak the cells to finish five minutes before your race. This allows time to fit the cells and get to the race start. Completing the charge close to the race start gives maximum performance from the *Ni-cad* pack. After a race the cells will be much hotter, indeed with high performance off-road motors, cells can be too hot to hold firmly in the hand. This can be regarded as acceptable, should the cells become too hot to pick up between finger and thumb then either the motor is overgeared, or look for excessive friction in the drive train. Remove the cells from the car and let them cool off.

Although *Sanyo* may frown on the 'temperature' charging methods, they are against my next piece of advice. I, and hundreds like me, use this method of storing cells and have done for years. *Sanyo* advise that cells should not be discharged below six volts, or 1.0 volts per cell.

Once cells have cooled off a little, connect them to a discharge resistor. This can be either a 50 watt, 1 ohm resistor mounted on a large heatsink, or a 60 watt car headlamp bulb. Leave connected to the resistor until the resistor is cool, or until the bulb goes out. Remove the resistor or bulb and store away. *Ni-cads* will develop a 'memory' when always discharged to a certain voltage. After a period the *Ni-cads* will refuse to perform below this voltage and their effectiveness is lessened. A full discharge prevents this occurring.

Ni-cad packs must be cold before recharging. At most club meetings it is advisable to use two packs of *Ni-cads* alternately between races. This gives each pack a chance to cool down.

An over charged battery—note the heat shrink has melted and split.



Should the need arise to solder connectors, or resolder frayed/broken connectors, proceed with care. When soldering to the cam, or negative, end of a cell, too much heat will damage the chemical electrolyte and harm the cell. Soldering to the positive, or button, end of the cell may put excessive heat on the rubber diaphragm in the venting valve. Damage here can cause the vent to malfunction making the pressure relief valve (vent) operate improperly, or not at all.

When one must solder to a cell, or pack, try to do it when the pack is already warm, preferably after discharge. Use a good soldering iron, at least 40 watts. Rub the button or cam with emergy cloth. Melt a large 'blob' of solder onto the cell. Melt solder onto the wire, and put a large 'blob' of solder on the tip of the iron. Place the iron on the cell, melt the solder and promptly put the wire in place. Hold in place for a second or two until the solder on the wire melts. Remove the iron and hold the wire in place until the solder solidifies. The secret is to put the soldering iron on the cell for the minimum time.

Advanced cell care

There are a number of things you can do to cells to make sure you always get the best from them. Here are a few which are not beyond the reach of the average club racer. Between each meeting charge up the *Ni-cad* pack to peak, and then discharge it on a 50 watt 1 ohm resistor, or 100 watt halogen headlight bulb. This is called a smooth discharge; that is a constant smooth load on the pack as opposed to the variable load the pack gets in a race. Again, discharge to flat and put away. After years of testing on a computer it is proven that packs perform best two to five days after a smooth discharge. I don't know why, I only know how!

During the discharge it is possible to monitor pack voltage against time. Using a digital voltmeter (DVM) connected to the cells, start a stepwatch immediately the pack is connected to the resistor or bulb. Note down the voltage every minute on a chart. Note the time when the pack drops below 6.0 volts. By doing this every so often, it is possible to monitor the state of your packs, and determine which is the best. In general the voltages at minute intervals are not too relevant, but the time to reach 6.0v will give a good idea of duration. The longer the time to reach 6.0v, the longer the car will maintain race speed on the circuit. The higher the intermediate voltages, the more motor speed. Like all things there is a better way, and in this case it is the *Schumacher Ni-Cad* Pack Tester (Part no 61820).

This cunning device connects to a fully charged pack. The digital

Available Cells and Specifications

NAME	MANUFACTURER	NOMINAL CAPACITY Ah	SUPPLIED WITH	PRICE	SUPPLIER	COMMENTS
6N 1200 SC	Sanyo	1.2	Tamiya plug	£18.95	Lesro Models	Standard pack
6N 1200 SCR	Sanyo	1.2	Tamiya plug	£19.95	Lesro Models	Standard pack
6N 1200 SCR Spec. selected	Sanyo	1.2		£24.50	Lesro Models	Special selected
6N 1700 SCE	Sanyo	1.7		£30.00	Lesro Models	Standard SCE pack
6N 1200 SC FM	Sanyo	1.2		£19.38	Lesro Models	Matched by Sanyo at source
6N 1200 SCR FM	Sanyo	1.2		£20.28	Lesro Models	Matched by Sanyo at source
MIH pushed SC	Sanyo	1.2		£30.00	Lesro Models	Specially cycled to increase voltage and capacity
MIH pushed SCR	Sanyo	1.2		£35.00	Lesro Models	As above
Lesro Custom SC SCR SCE	Sanyo Sanyo Sanyo	1.2 1.2 1.7		£21.97 £23.74 £32.50	Lesro Models Lesro Models Lesro Models	Hard wired for minimum voltage loss - available in stick or saddle packs
Technicad matched SC pack	Sanyo	1.2		£28.17	Lesro Models	6 cells supplied loose for assembly with braid and instructions
Technicad matched SCR pack	Sanyo	1.2		£31.55	Lesro Models	As above
Trinity Matched SC	Sanyo	1.2		£26.95	Lesro Models	As above
Trinity matched SCR	Sanyo	1.2		£28.89	Lesro Models	As above
Red Dragon Competition Cells	N/A	N/A	N/A	N/A	MG Model Products	Details of a new range of computer matched drive batteries will be announced shortly
Mardave	Saft	1.2	Tamiya plug on long lead	£14.95	Mardave	
G622 Sanyo Red SCR	Sanyo	1.2		£19.95	Schumacher	
G624 Technicad selected reds	Sanyo	1.2		£22.50	Schumacher	SCR cells
G632 CS selected reds	Sanyo	1.2		£32.50	Schumacher	SCR cells
G629 MiH pushed	Sanyo	1.2		£36.50	Schumacher	SCR cells
G621 Custom Pack	Sanyo	1.2		£22.50	Schumacher	Hand built hardwired SCR cells
G626 'Matchpack'	Sanyo	1.2		£19.95	Schumacher	Factory matched Sanyo SC cells
G634 Custom Pack	Sanyo	1.7		£32.00	Schumacher	Hand built hardwired SCE cells
G627 Yellows	Sanyo	1.2		£17.50	Schumacher	Sanyo Yellow SC cells
11249	Sanyo	1.2	Tamiya plug	£24.95	Parma	Matched Hi-output battery pack SCR
11250	Sanyo	1.2	Tamiya plug	£19.95	Parma	Matched battery pack SC
11251	Panasonic	1.2		£19.95	Parma	Matched Turbo battery pack SC
11260	Sanyo	1.2	Tamiya plug	£19.95	Parma	Matched battery pack SC 'Hump' configuration to suit Tamiya cars
4519	Sanyo	1.2		£19.95	Parma	Computer matched stick pack SC

Note: Agents Helger Racing can supply any configuration of pack on request. Supplies of SCE cells available soon.

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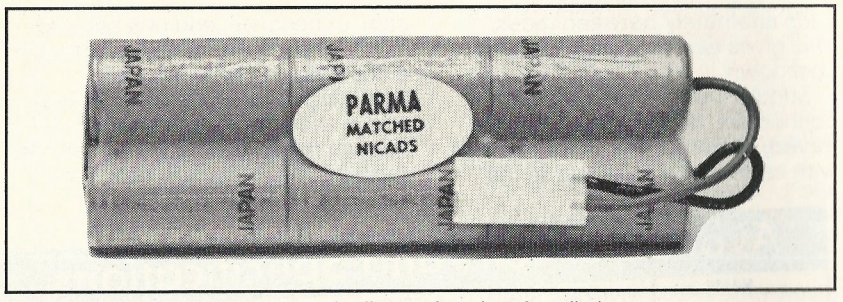


Parma produce specialised packs of cells to suit various installations.

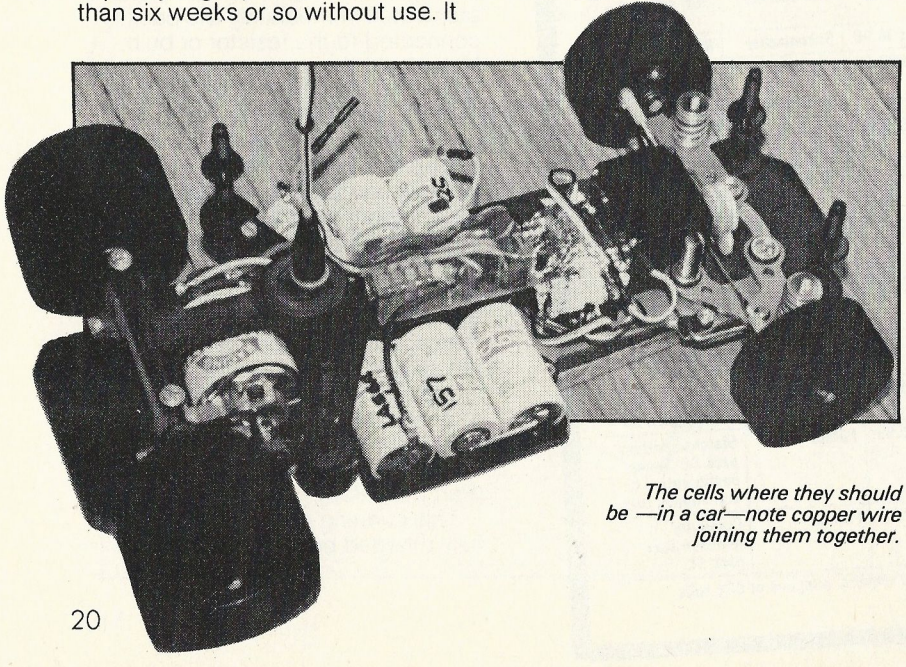
display measures the capacity of the pack and stops at a preset voltage. By reading off and noting the number on the display, one has an instant record of the pack capacity. This performs the dual task of the smooth discharge and pack monitoring in one. As time goes by, the pack gradually weakens and the number displayed on the dial gets lower. It is an instant, convenient, and safe way to monitor pack performance and know which pack is best. Be aware that the readings can vary by up to five depending on the time between charge and discharge. Try to take the pack straight off the charger and onto the *Ni-cad* Pack Tester for consistent results.

The *Schumacher Ni-Cad* Pack Tester costs £125. As a discharger tester it would be expensive, but there is another trick up its sleeve. Ni-Cad packs already raced can be connected to the discharger. This will give a reading of the capacity left in the pack. By careful analysis and practice it is possible to gauge whether the gear ratio can be lowered, and by how much. In this mode the *Ni-Cad* Pack Tester is excellent. The price may deter all but the hardened racer, so why don't a few of you club together and get one. Used one evening a week for the smooth discharge, and shared at a meeting, it would be easy for four or five people to share one. At £25–£30 each it is good value, and you can learn faster by pooling your knowledge.

Ni-Cad packs tend to lose their capacity slightly if stored for more than six weeks or so without use. It is preferable to cycle them twice through a smooth discharge in the week before the meeting to restore that capacity. *Ni-Cad* packs perform less well when used for a second time in a day. Whilst it is easy for me to say that one should use a 'fresh' pack each race, you have to buy them and that comes hard to both of us! Using at least two packs is recommended to allow time to cool between races, just be aware that the second time a pack is used in a day its capacity and performance will not be quite as good, so be prepared to raise the gear ratio slightly to ensure full race duration.

Summing up

Buy your *Ni-cad* packs from reputable high volume dealers and pay at least £20 per pack, but no more than £25 if you can't justify 'matched' packs. Solder connectors to leads, solder carefully to cells, and always use a 'foolproof' connector. Invest in a good 'peak detect' or 'temperature senser' charger and a quality 12 volt lead acid battery. Discharge cells after each race, don't charge hot cells. Try to give cells a 'smooth discharge' between each meeting.



The cells where they should be —in a car—note copper wire joining them together.

The general rules are not to overheat on charging and not to run the car if there is anything wrong with it which puts excessive load on the batteries.

Lastly a warning. *Ni-Cad* packs are *dangerous* when overheated. Never go near an overcharged pack if it is gassing or spitting. Don't touch the chemicals if they do spill out. Never connect the two leads from the *Ni-cad* pack directly together, in extreme circumstances the pack will literally explode. This is not being alarmist, treat *Ni-cads* with care. If you follow the rules *Ni-cads* are the cleanest and safest form of energy for model cars and will give long life, as much as 200 to 300 charges. Never throw *Ni-cads* away in incinerators, never put them in a fire.

SCE's—the be all or end all

Sanyo's new N1700 SCE *Ni-cads* have only just appeared on the scene. As this is written few have tried them and opinion is sharply divided. At present it appears that they give markedly improved duration at the expense of speed. On existing motors it is possible to gear down (8:1 instead of 9:1 say) to improve the speed at the expense of acceleration. On the face of it racers need to buy new motors to match the characteristics of the new cells. However, they do provide a ready means for the club racer to ensure that they will last the race, and this is to be welcomed. There are many question marks which, if you can afford it, can be answered by the purchase of two packs to test. I shall be waiting a while yet to see how things pan out. On the form I have seen so far there is little difference between very powerful motors on SCE's, and slightly less powerful motors on SC's/SCR's. The SCE's produce less voltage and have ample reserves to power a 'hot' motor, but the SC's/SCR's have more voltage to make milder motor's work faster. □