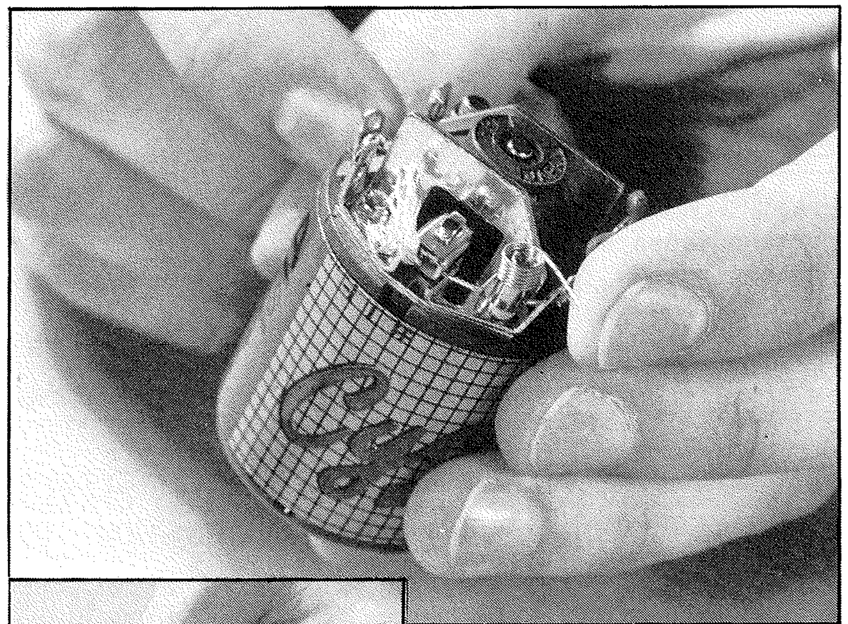
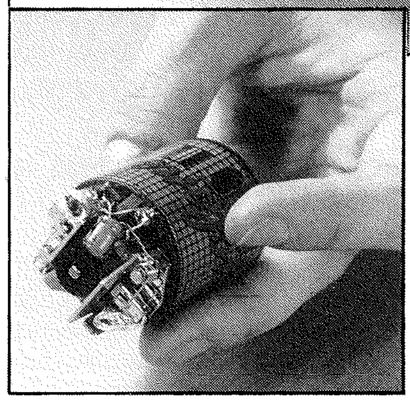
Speed Secrets

Pete Winton tells the facts on how to look after and run your motors . . .



Removing brush springs.



Motor with capacitors correctly fitted.

Motors for electric car racing. This is probably the most difficult subject to write about because the buyer has too much choice. Many people have attempted to provide information on motors, some good, some bad. Yet still there are more people who do the wrong things with motors than do right things. Buyers equate fast lap times with fast motors, and this is a fundamental mistake. This articles on motors will make you better informed, but is designed to save you money. We shall disucss the basics of motors, and the reasons for not buying more and more in that elusive search for more laps per race.

DC (direct current) electric motors work on the principle of magnetism, and electro-magnetism. A permanent magnet has two poles, called north and south. The earth itself has the properties of a magnet, which is why compasses always point to the North Pole, and hence each end of a magnet is called a pole, and they are labelled north and south.

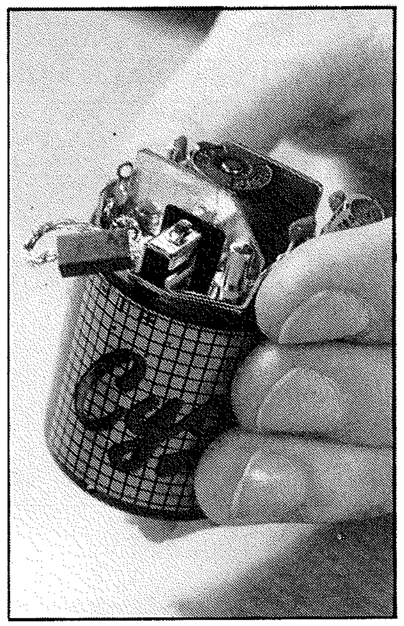
One of the properties of magnets is that they attract ferrous metals (containing iron), and other magnets. Place two magnets together and they will attract each other. The north pole attracts a south pole, and vice versa. More importantly for our use, like poles (eg a south and a south) repel. It is this phenomenon which we use in an electric motor to create rotary motion.

Electro-magnetism is slightly different. When an electric current is passed through a wire, it creates a magnetic field. The wire itself (usually copper) is not magnetic, but if wire is wrapped around an iron rod, the rod is magnetised. This principle is used in Solenoids (for example central locking on cars) and relays.

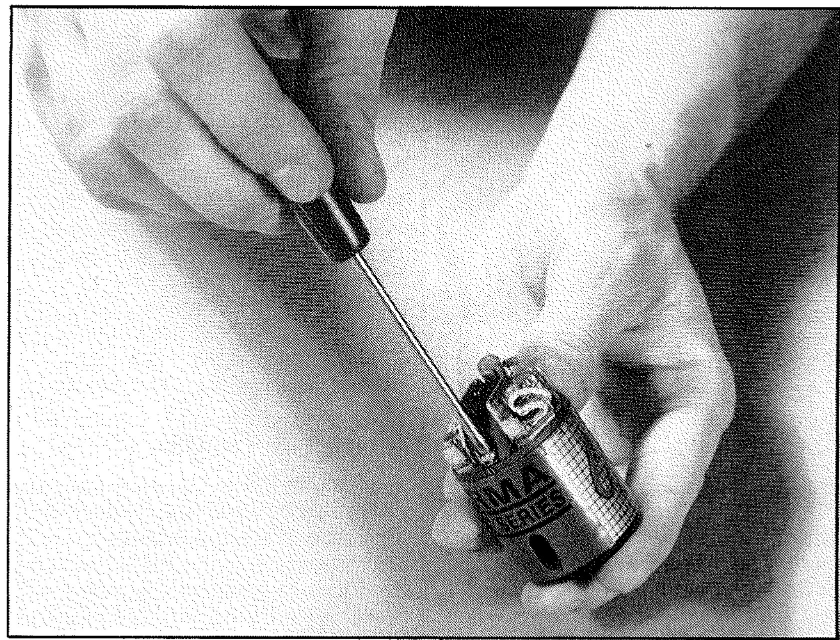
Our dc electric motors have two permanent magnets and three electro magnets. The permanent magnets are inside the can, and the electromagnets are on the armature. When current is passed through the armature, it energises the electro magnets. By controlling this process, we can energise the armature to be a south pole. This is next to a south pole permanent magnet so they repel each other. Since the only movement possible is rotary, the armature moves around, away from the permanent magnet.

The commutator on the end of the armature is so designed to reverse the flow of electricity through the copper wire. As the armature rotates, it is re-energised as a north pole. Now it is sitting next to the north pole permanent magnet, it is repelled again, and rotates. This process is continual, resulting in rotary motion.

That is a very simple explanation, give you a guide to the process in action. However, it contains two key points which must never be forgotten. Firstly, the strength of the permanet magnets is a factor in motor performance, and secondly the amount of current passing through the armature is variable, thus varying the motor speed.

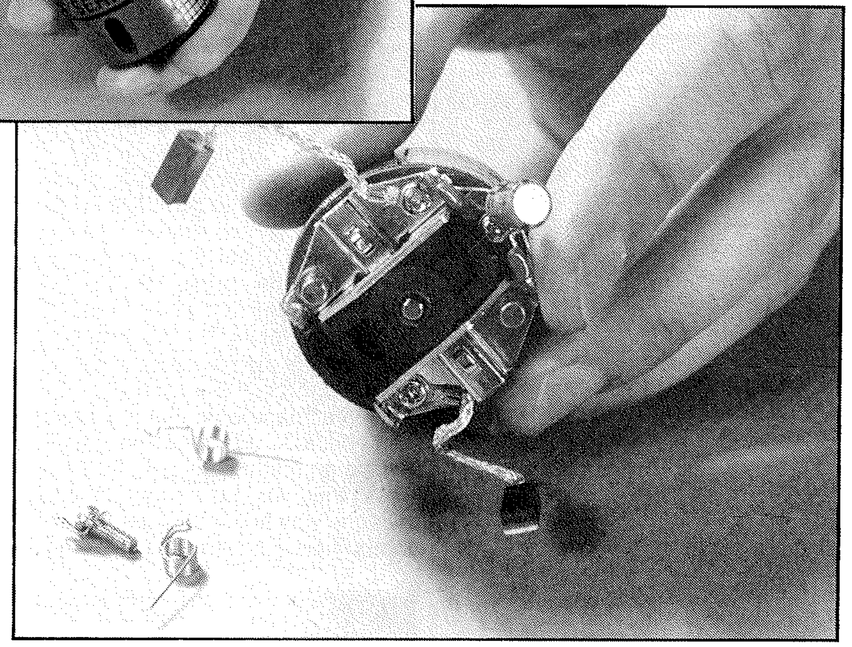


Brushes removed from the guides.



Removing endbell placement screws.

The theoretical side of electrical current passing through the armature is of most interest. The current (measured in amps) that passes through the armature varies the strength of the electro-magnet field created. The stronger the electro magnetic field, the stronger the performance of the motor. The more current that can be passed through the motor, the greater its performance.



Springs off-brushes out and screws removed.

Current Time

The amount of current that can be passed is directly related to the resistance of the copper wire wound around the armature. The more wire there is, the more resistance, the lower the current, the lower the motor performance. However, another factor is the diameter of the wire. The smaller the wire diameter, the more the resistance there is, the lower the motor performance.

Without delving into complicated theory, these physical properties are seen by the motor buyer in two ways. High strength permanent magnets are now in use under the name 'wet magnets'. This has changed the characteristics of our motors from high revolutions per minute (revs) or high speed, to low revs and higher torque. We shall discuss the impact of this later.

However, the normal way of expressing the specification of a motor is by the number of turns of wire on each segment (or stack) of the armature.

The less the number of turns, the less resistance in the armature and the greater the amount of current that can be passed. As we said, more current generally means more performance. A 27 turn motor will not have as much performance on a test bed as a 19 turn motor. The statement of the number of turns is in effect a statement of the motors' anticipated performance. The diameter of wire used is the other factor mentioned, so we can say that in theory, a 19 turn motor using wire 0.75mm diameter will have more performance than a motor of 19 turns using wire 0.6mm in diameter. Larger wire diameters allow more current to be passed, and this improves performance.

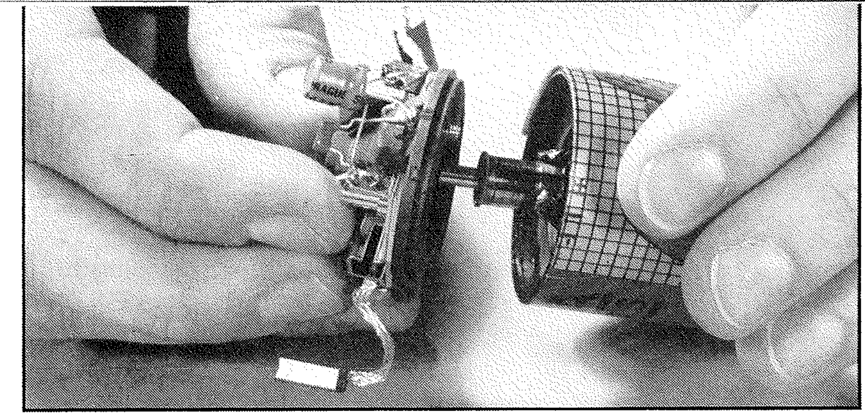
Performance?

Whilst our general measure of likely motor performance is expressed by the number of turns on each stack of the armature, it ignores several other factors which affect the final outcome. It is however, the best and simplest for our needs. We can use it to determine relative factors like acceleration, top speed, and current consumption. The motor buyer needs to understand that more performance is possible with a 19 turn motor than a 27 turn motor, and that is all. We shall deal with the terms single wind, double wind, triple quad and quin at a later time, for now file away the following fact: less turns means more current consumption and higher motor performance.

We shall now think about motor selection. To illustrate much of what follows, here is one of my favourite motor racing stories: Back in the late seventies, David Hobbs was driving a BMW 2002 turbo in the American IMSA series. He was part of the BMW Junior Team, and they recruited the late, great, Ronnie Peterson to guest drive in a race at Watkins Glen. Admittedly overawed by the presence of the outstanding Lotus Formula 1 driver, Hobbs invited Peterson to take the whole practice session himself to set the car up to his liking. Peterson declined, saying that Hobbs had to deal with the car for the rest of the series, and he would be happy to drive with whatever set-up Hobbs determined for the track.

Hobbs worked hard, and thought he had done well to qualify high in his class. Peterson calmly walked over to the car for his run, and within a few laps was recording times 3 second a lap faster than Hobbs. I don't recall the outcome of the race, but Hobbs' comment was 'He's a genius'. The moral of the story is it not what you drive, it's the way you drive it.

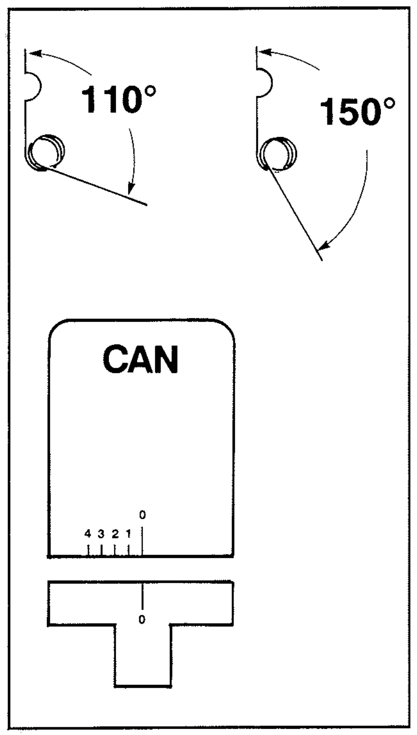
The only way you or I will ever make



Carefully removing endbell — keep an eye on washers.

faster lap times is by better driving skill. No amount of horsepower will make the car faster around the circuit if the driver cannot use that power to good effect. The way you drive, and the set-up of your car, are one hundred times more important than the power of your motors.

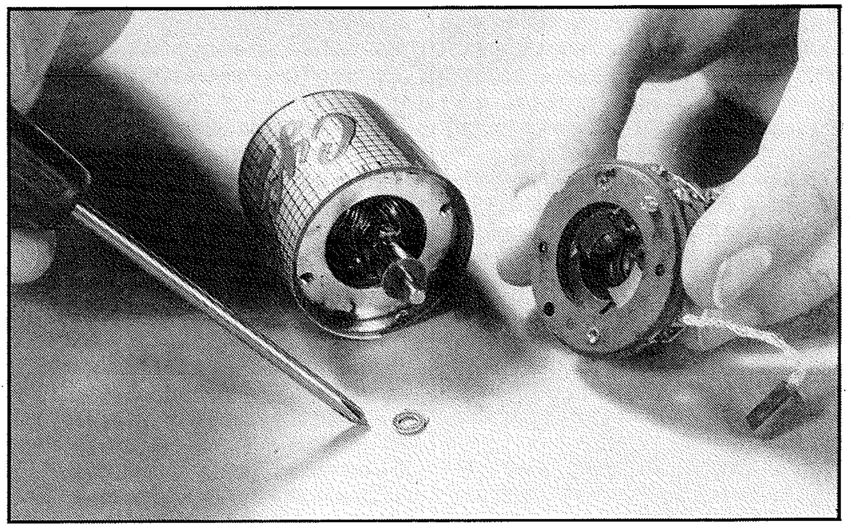
A high performance motor will always make a car more difficult to drive. Performance motors increase wear on the transmission, cells and tyres. Driving style must change. Every car will have either more horsepower than grip, or more grip than horsepower. Driving cars with more horsepower than grip means early braking, late turn-in to the corner, and delicate application of the throttle. These cars are at their worst on short tracks with lots of corners since their cornering speed is low. Cars which have more grip than horsepower mean late braking, early turn-in and immediate throttle opening. These cars are at their best on short tracks with lots of corners since their cornering speeds are high. If you can raise the amount of grip your car generates in a turn your lap times will be faster using the same motor.



Speed More Speed!

Many drivers buy high-performance motors because they think speed down the straight is important. If all you want is to be the fastest thing on four wheels in a straight line don't let me stop you buying every motor your heart desires. However, most of us seem to want to complete more laps, which means driving faster for the duration of the race, not just on one part of the course. Having bought a super-fast motor to zap down the straight, drivers then wonder why the car spins when accelerating out of a corner!

It seems improbable that this article can conclude without some specific advice on motor selection. Before we get to that, you must grasp the basic reasons why some cars are better than others (chassis, design, tyres



Spacing washers — keep track of where they came from.

etc) and some drivers will always be faster than you are (more skill, better preparation etc). Everyone should have a choice of motors in their box if they want seriously to compete at Regional and National level. On no account should the rest of us buy those same motors and expect to achieve the same lap times.

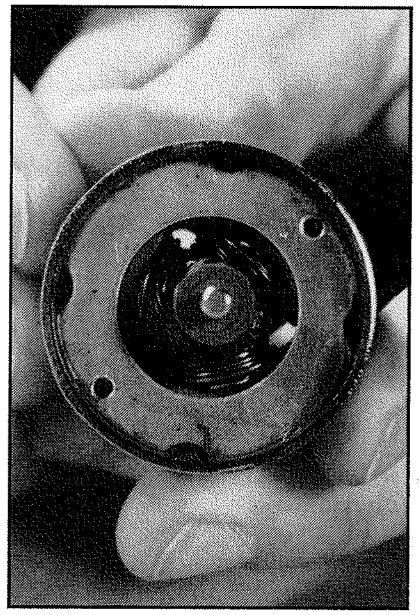
Motor selection must be based on your ability to control the car you are driving. Motors of 19 or 21 turns are idea for the average club driver, providing a balance between speed and ease of driving. Motors with more turns could be too slow to maximise your driving ability, and motors with less turns will surely tax your skill and patience. Many clubs still run using 27 turn motors (the BRCA standard motor) and have thriving memberships. Like Mr Hobbs and Mr Peterson, your driving skill is far greater in determining lap times; improving your skill costs nothing, motors are £45 a time!

Rules & Regs

The British Radio Car Association sets rules by which the National Championships are organised. Some years ago, the BRCA decided to introduce a class to be raced at Nationals in which the type of motor used would be the same for everyone. The idea was to concentrate on the depth of a driver's skill, not the depth of his pocket. The BRCA introduced a motor specification for 12-C and 10-OR, and called it standard class. Standard class motors have a set specification. For 10-OR it is no less than 27 turns of 23 gauge wire (wire sizes are measured in 'gauges', which relates to their diameter) and for 12-C it is 35 turns of 23 gauge. In both cases only single winds are allowed (more on this next month), and only plain bearings may be used.

A standard motor is one of the above specifications depending on which class you race. BRCA standard motors also have a price limit, about £15. Many clubs still use standard motors at all their meetings, and they are an excellent way to teaching that driver skill is more important than motor power. Races at Regional level (10-CR) still use standard motors in most regions. Races at National and International level use modified motors. Again, the BRCA have rules for these. Primarily they state that modified motors must have a maximum price (about £45), must be approved by the BRCA Committee, and must be commercially available. 12-C rules additionally say that modifieds must use the same components (armature blank, can, and endbell) as standard motors, but ballraces, rewinds, different bushes, etc, are allowed.

A standard motor is one of the two types described above, and a modified motor is therefore anything else! As far as we are concerned,



Motor plate as when removed.

modified motors are of better quality and when properly maintained, will last longer. Despite the price differential, modified motor will last four or five times longer because it can be opened for cleaning and rebuilding. Unless your club run to standard class rules, a modified is cheaper in the long term.

What is basic motor care? It has taken ten years for these suggestions to be complied, and they work. They are cheap, simple and effective. How you implement them is your decision — but you get my drift!

Basic motor care means do nothing — really. If your motor has been correctly set-up, and carefully used, there is nothing to do between rebuilds. We will deal with set-up and rebuilds later on. However, checks must be made to ensure everything is in order, and standard motors will benefit from regular cleaning. Stripping motors between every run and cleaning all the parts is normally a waste of time, and detracts from performance.

Standards first.

Between each race, a standard motor should have the commutator and the brushes cleaned. Unhook the brush spring from the top of the brush holder and swing it anti-clockwise until the short arm clears the slot in the brush holder. Lift the spring off the spring post. (All brush springs are removed this way).

Clean Machine

Get hold of the copper braid (the sluint) which is attached to the brush, carefully pull the brush out of the holder. Soak a cotton bud (for those important little places!) in motor cleaner, push it down the holder, and hold it in contact with the commutator. Rotate the armature back and forth several times.

Remove the cotton bud and inspect the end. If it is very black, repeat the exercise with a fresh bud soaked in motor cleaner. The cotton bud will never be completely clean, but as long as the commutator reveals its copper colour, all is well. Using the side of the cotton bud, wipe across the face of the brush, again repeating this until the brush leaves only a little black mark on the cotton bud. Replace the brush and repeat for the other side. (Use a new cotton bud, or an unused edge of the same bud everyime. Don't use a dirty bud). Replace the springs.

Standard motors should have their bearing oiled before every race. Place a very tiny drop of oil on each bearing and rotate the shaft several times. That's it — no more, no less.

Modified motors used in dusty or wet conditions shold be cleaned the same way, but don't oil the bearings. This attracts dust and dirt and will cause increased wear. Only oil ball bearings after cleaning at home.

Modifieds used indoors, or outside on 'clean' tracks, should be inspected after every run. Remove the brushes and look at them. They should be clean, probably shiney, and smooth. There may be little chips at the edges, don't worry. The commutator should be mainly a clean copper colour, with some black marks near the edges of each slot. Check for severe brush damage, and for any score marks in the brush or commutator. If the brushes are badly scored, it is time for a rebuild.

Modified motors should be completely dismantled at home after each meeting. Using a cloth and a small paintbrush, remove all dirt and debris from the can, end bell, and armature. Take care not to touch the commutator at any time, and always put the motor back exactly as it came apart, including the correct rotary position of the end bell. This latter point is most important, and will be dealt with in more detail later.

Once reassembled, place a tiny drop of oil in each bearing.

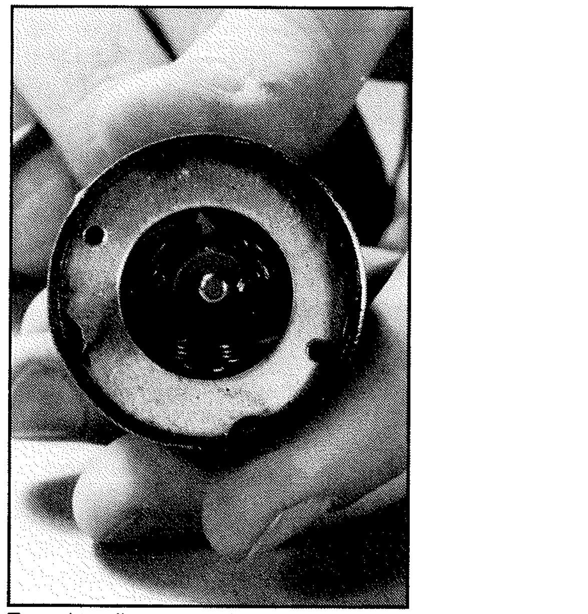
The reason for cleaning standard motor brushes and commutators, but not modifieds, is the brush material. Standard motor brushes are soft, and easily pick up dust and dirt which is rubbed into the commutator. Also, being soft, the carbon in the brush is more easily liberated, and burns (it's the sparks you see coming from a motor whilst it is running) allowing the residue, which is hard, to get into the brushes and so the same damage as the dirt. This is also the reason for cleaning modifieds in dusty or wet conditions — to remove the dirt and prevent excess damage.

Round Up

So, to sum up basic motor care, clean standards after every run with a cotton bud, and modifieds used in wet or dusty conditions. Dismantle modifieds to remove dirt and debris from all parts afer every meeting, and oil the bearings very sparingly afterwards. Oil standard motor bearings very sparingly before each run. Keep doing this until the brushes are one third worn, or until the brushes are scored for any reason. On standards, replace the brushes once this point is reached. Note that the brush on the positive side of the motor wears faster — no, I don't know why either. Always replace brushes in pairs, never one at a time. On modifieds the motor should be rebuilt if the brushes are ⅓ worn, chipped or scored, never simply replace the brushes.

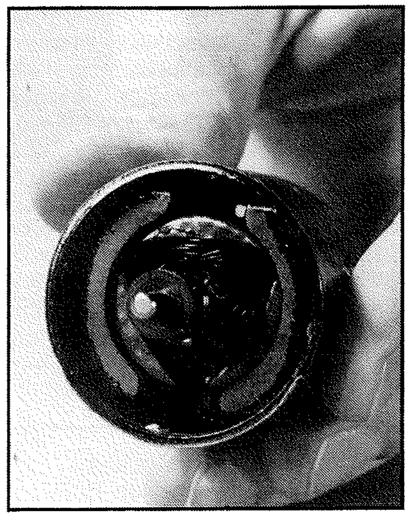
Now for the list of nevers when it comes to motor care.

NEVER immerse a motor in any liquid whether running or not.



Turned to allow removal.

NEVER touch the commutator. If this happens accidently, use the motor cleaner — soaked cotton bud on the commutator before using the motor again.
NEVER over-oil the bearings, either with too much oil, or by oiling too often.
NEVER put a sharp knife anywhere near a commutator.
NEVER use a motor if you suspect anything is wrong with it.
NEVER squirt motor cleaner into a motor, whether running or stationary.
Improving your driving is the key to fast lap times. This is impossible unless the car runs consistently heat after heat. Only by proper care of motors can tht consistency be achieved. Look after them, and they will look after you.
Motor Selection — This is the most difficult thing to write down so that everyone makes the right choice. The more one knows about motors, the more difficult it becomes to give precise advice. If there were only two motors on the market, it would be easy — there are dozens. We hope this attempt helps.



Motor plate removed with armature showing.

Which Motor?

The first place to start is with your car. If you own a car with an all plastic gearbox, or with a piece of plastic to mount the motor against, then do not buy a Modified motor. Modifieds generate too much heat and too much power for plastic gearboxes and motor mounts, they will cause much expensive damage. A BRCA standard class motor (27 turns) will be more powerful than the majority of motors supplied with these kits, and if the smallest pinion gear is supplied with the kit is fitted to the motor, you will usually get better performance.

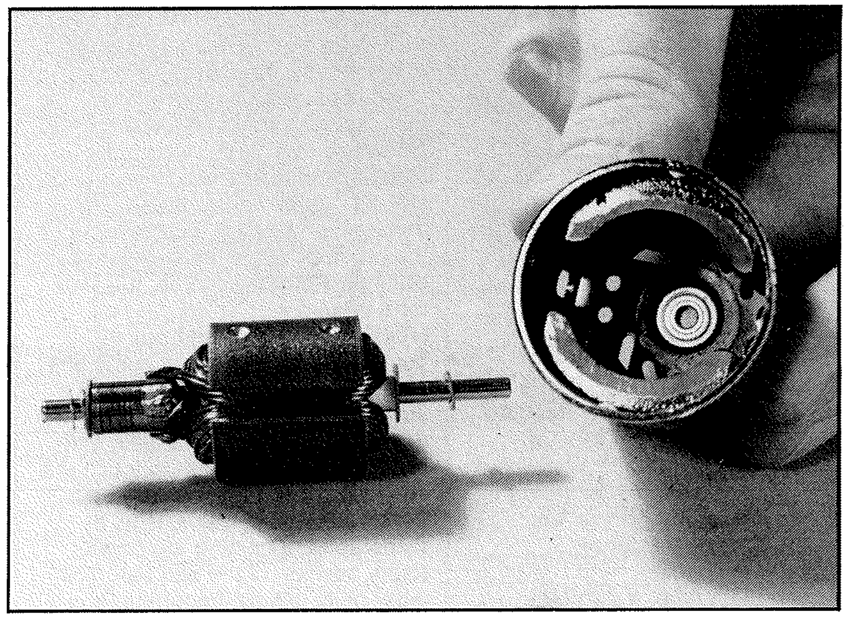
Those of you with cars which have belt drive, metal/nylon/tutnol gears, and most importantly, a metal motor mount, may consider using Modified motors. Before so doing, the car must be in good condition, and must be fitted with ballraces in all the driven axles and gearbox. These bearings must be free moving and clean, and the whole drivetrain must be free moving and correctly adjusted. If there are any faults in the gearboxes or drivetrain, excess friction or binding in the suspension or wheel bearings, then fitting a modified motor will cause major damage. Any of these faults will cause excess current drain, high motor temperatures, and can potentially damage every item in the car; cells, speed controller, and motor. If you are in any doubt, stick to standard motors.

Good Condition?

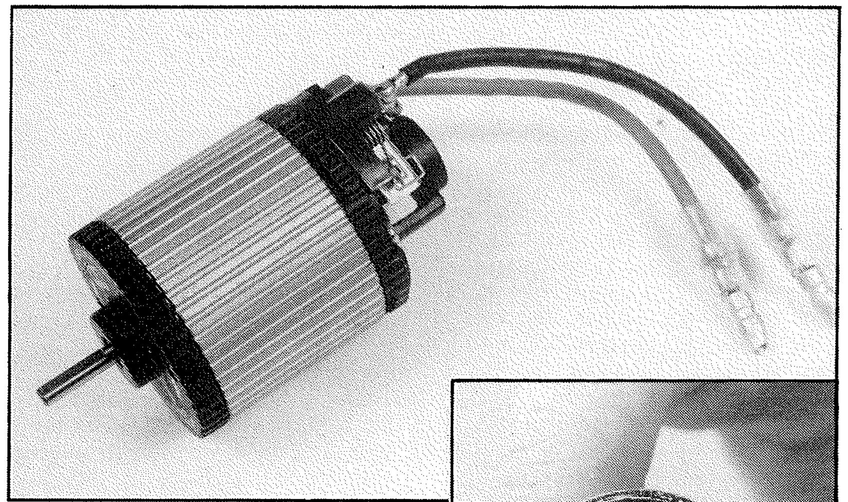
You have the right car, it is in good condition, you want a modified motor — which one? Now is the time to talk single, double, triple, quad or quin. This refers to the number of wires which are on the stack. A single wind uses one wire wrapped around each pole of the stack. A double wind has two wires side by side wraped around each pole, a triple three, a quad four, a quin five. The idea is to increase the amount of wire on the pole whilst keeping the diameter small and easy to wrap around the stack. It also changes the character of the motor. Thus a 19 double has two wires wound together 19 times around each pole (stack) of the armature.
Single winds are noted for their power at high revs. Double have more torque and smoother power delivery. Triples are more like singles, but do have slightly better torque at low revs. If you know enough to pick a quad or quin, you don't really need me to tell you why

Now is the time to talk single, double, triple, quad or quin

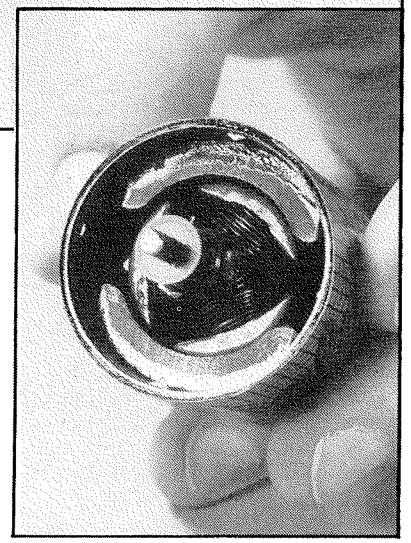
they work. New buyers should stick to doubles and triples. Singles can be difficult to tame, and quads and quins are rather like GT stripes on a car — nice talking point, but what are they there for? I have always preferred a double wind, it suits my driving and they are most flexible motors. Not for nothing are they the most popular.
So, how many turns. Back to you and your car. 2WD cars require less power since the have less grip. 4WD cars can cope with more power. As a rule of thumb, never less than 17 turns for a 4WD, or 19 turns for a 2WD. Ideally, if this is your first Modified, choose a 21 turn double for 2WD, and a 19 turn double for 4WD. When it comes to the make of motor then look to your local model shop. Associated/Reedy, Kyosho, Losi, Perma, Twister and Trinity are all good. They are all about the same price, so buy one the shop can recommend. Don't overlook the budget price modifieds from Demon, Tornado (TMS), or Schumacher. Whilst they are more mass produced, they are very good value.
The other point to note is the so-called 'wet-magnet' motor. This refers to the way in which the magnets are made. The 'wet' process produces a magnet with a stronger field (or force), which increases the torque of the motor slightly, and reduces its maximum revs. Please don't concern yourself with this aspect too much, it is mostly biology. However, if you use SCE (1700mAh) cells, then you will find the 'wet-magnet' motor easier to set-up. When using SC and SCR (1200mAh) cells, then the possession of a 'wet-magnet' motor is less important. Stick to the number of turns (19, 21 etc) and the type of wind (double, triple etc) as your selection criteria, not the magnet type.



Remove arm — note washer that usually remains in can.



Tamiya dynatech can is ribbed for cooling.



Note fibre washer which remains on armature.

Get The Right Gear

Don't leave the shop just yet. You must buy the single most important item used to the best motor performance, the gears. Your car will normally have two which are interchangeable, a large one call the spur, and a small called the pinion. The spur is attached to the gearbox, and the pinion to the motor. It is absolutely vital that you have the correct gears fitted to the car to suit the motor you have just bought — and I mean vital.
The gearing required is dependent on many factors. The quality of your batteries, the type of track, the type of speed controller, the condition of the motor, the amount of grip available, and, not least, your driving style. It is impossible to give an exact ratio for every motor, but the broad area's should be indicated so that most confusion is removed.
Motors must be run in before being used in anger. This gives the brushes a chance to bed in. When new the brushes have only a small contact area which reduces the current passed and thus the performance. Whilst there are many ways of running in a motor, here is one which works, and which everyone can use. Fit the motor in the car on your selected ratio. Using a freshly charged pack of cells, drive the car gently until the cells are flat. Accelerate gently, never use the brakes, and never use reverse. Use as much speed as possible, but don't put any strain on the car by driving over bumpy ground, muddy ground, or up hills. A local park or car park is ideal.
After this first run, make the usual checks and clean the motor as advised earlier. During the first two races try to avoid the use of brakes and reverse. After that, everything should be okay. Now you should try and find the right gear ratio for best performance.
The right gear ratio for a motor is almost never the one which uses all the battery power in one race. This is especially trying when using SCE (1770mAh) cells. The right gear ratio is one which allows the motor to accelerate the car quickly and cleanly out of a corner, and which get the car moving at its highest speed about ¼ to ⅓ of the way down the straight. Once the race is over, the motor will be hot, but it should never be too hot to touch, occasionally perhaps too hot to grasp in the hand. The cooler the motor is at the end of the race, the better its performance will be, and will continue to be.
You will know when the right ratio has been found. The car will be lively and responsive, it will be reasonably quick on the straight, and you will probabl find it easy to drive. Before ever saying the car is too slow, take a look at the lap times. The best times will come only when the car feels slow to drive, and you appear to have ample time during cornering. Remember, it is the total laps you score in a race that count, not how fast you are down the straight.
Once you have found a ratio that works for a motor/car combination, don't fiddle with it. You may have to gear up (9.5:1 to 9.0:1 say) for a 'long' track, or down (9.5:1 to 10.0:1) for a short track, to maintain the correct balance of acceleration and speed. Remember, it is the speed between corners which counts. If you can accelerate faster and brake later. You can cover the distance between corners faster than your rivals. Speed around a corner is down to chassis set-up and grip available, not the motor. A motor only really counts in a straight line, so gear yours to get the maximum acceleration between corners that you can, and not the highest speed down the main straight. The main straight is normally less than 20% of the track, so gear for the 80%.
If you find that the car never lasts the race, but the motor performs well and is cool at the end of the race, then you may need better cells. However, once again, look at the lap times before spending your money. Don't forget that every accident you have means more unnecessary acceleration to get back in the race, and more capacity required from the cells. Drive with fewer accidents and you will magically find your cells last longer, and your lap times improve. As we keep saying, driving skill is one hundred times more important than fast motors.
Modified motors must be rebuilt regularly to maintain their condition and performance. This involves retrueing the commutator and fitting new brushes as a minimum for fairly new motors. As time goes on, new bearing may be required. Modified motors will last until there is no metal (copper) left on the commutator!

Hot Stuff

As motors get hot, the metals and plastics used in their construction move. The heat distorts the plastic base of the commutator, and the friction of the brushes wears the copper face of the commutator. The commutator distorts and goes either oval, barrel shaped, or both! This mishapen commutator causes the brushes to bounce on and off its surface as the armature goes round. Clearly when the brushes are

Wet Magnets — do I need a towel??

Whether a magnet is described as wet or dry refers to the method of manufacture. Wet magnets are usually stronger, more resistant to damage from other magnetic fields, heat and impacts. Just because a motor is described as wet magnets is no guarantee of quality, the quality of the motor is still its construction, and the winds used.

The use of wet magnets is quite new, and it is important to understand that a dry magnet motor will draw less current than a wet magnet motor. Since the power of a motor in Watts is equal to the volts fed to the motor multilied by the current (amps) it draws from the cells (Watts = Volts × Amps), one can see that to obtain more power, one needs more volts. Dry magnet motors are therefore best suited to the SCR and SC cells, which deliver slightly higher voltage during discharge. Wet magnet motors draw a higher current due to the need to overcome the higher force of the wet magnets. Therefore, wet magnet motors derive their power from the amps side of the equation and are most suited to the SCE cells. In fact, wet magnet motors are less powerful than dry magnet motors on the whole. They seem faster on the track because they have much more torque, and can sustain a higher top speed due to the gear ratio used with that higher torque.

Take for example the Sierra XR 4×4, and the Peugeot 405 Mi16 4×4. The XR develops 150bhp, and the 405 160bhp. Therefore the 405 is quicker, right? Wrong. The XR develops 170lbsft of torque, and the 405 only 130lbsft. Torque is the ability of a motor to get weight on the move, and power is the ability to sustain high speed against the forces of friction and air resistance. Knowing that lot, you will be unsurprised to hear that the XR reaches 60mph over 1.5 seconds quicker than the Peugeot, that it is quicker through the gears in every situation, and that it loses out on top speed by a slim 5mph. All along, it is only the torque, or muscle of the XR which wins it the battle, not the power output which is less than the 405.

Think of the wet magnet motor as the XR, and the dry magnet motor as the 405, and you get the idea. That is why you see some drivers using 11 and 12 doubles at the top events. This is probably no more effective than the old 13 and 14 doubles in dry magnet form. Never try to emulate these guys by buying such motors, they are a drain on your pocket, your nerves, and your patience. However, if your dry magnet motors are in the 19 to 21 turn range then you will need wet magnet motors from 17 to 19 turns to get equivalent speed from your car on the track. If you use a wet magnet motor with SC and SCR cells, then to get the right speed from the car, it may drain the battery before the end of the race (the speed comes from more amps, and less volts). If you use a dry magnet motor with SCE cells, then you will again be slow since the motor cannot draw all the current available from the higher capacity cells, but it denied the high voltages it needs to develop its power.

Wet magnet motors are not better than dry magnet motors, they are just different. Knowing why should help you to get the best from your choice.

Gear Ratios

Whilst this article concentrates on the care and use of motors, the single most important thing in obtaining the best performance from a motor is the gear ratio. The best tuned and built motor will be either useless, or destroyed, if it is mated to the wrong gear ratio. Surprisingly, the use of motors in the 12th-Circuit and 10th-Circuit is not nearly as critical on gear ratios, as it is in 10th-Off Road.

The Circuit cars are very light, and the tracks always give a similar amount of grip. The correct ratio is therefore the one which gives the best speed along the straights, and lasts the race distance. Too low a gear ratio will give plenty of run time, and make the car slow. Too high a ratio, the car will not last the race distance. The risk of damaging the motor on too low a ratio is much less. Also, the correct ratio for the motor is quite easy to find, you simply ask someone at the track.

Almost all the people racing Circuit cars have a good knowledge of gear ratios, and word soon spreads! Also, the gear ratio is frequently altered to take account of tyre wear. Those using Circuit cars should take note of our motor tips, but will find this section of less relevance.

The greatest potential for getting a gear ratio wrong is in 10th-Off Road. Far too many people assume that the correct ratio is the one which exhausts all the battery energy in a five minute race. Nothing could be further from the truth. 10th-Off Road cars are much heavier than Circuit cars, and have to cope with many different types of track. It is very easy to gear the motor too high, and thus overheat it causing severe damage. Remember the point about how the motor behaves under load. If the motor cannot reach and sustain its maximum speed easily, it will draw more and more energy from the cells which is dissipated in the form of heat, not speed.

Whenever one buys a new motor, the most important thing to buy is the correct gears for the car it will be used with.

10th-Off Road cars have a gearbox which reduces the speed of the motor to the axle. The ratio of this gearbox is essential in ratio calculations. The following are a list of cars and their internal ratios.

ProCat/TOPCAT/Cougar	2.428:1
PB Mustang/Maxima	2.208:1
Ultima	2.642:1
Associated RC10	1.85:1

These ratios are used in the calculation of the total gear ratio from the motor to the rear wheels. The following is a suggested point for motors, almost irrespective of their number of turns. These ratios will err on the side of caution, but are given for wet magnet motors using SCE cells:

Motor	2WD	4WD	Ratio
19 double	8.5:1	9.0:1	High
18 double	9.0:1	9.5:1	↑
17 double	9.75:1	10.5:1	|
15 double	10.0:1	10.75:1	|
14 double	10.5:1	11.25:1	↓
13 double	11.5:1	12.5:1	Low

Please, this is not a universal list for all occasions, it is a guide when buying your motors to ensure you get the right gears for the job. Those buying, say, a 19 double (equivalent to a 21 double dry magnet motor) to fit on their RC10, will need to find out which gears are required. Using the 48DP type, with a 90 tooth spur gear fitted, and aiming for the 85:1 ratio suggested, will need to fit a 19 tooth pinion, the following formula applies to calculating the gear ratio:

$$\frac{\text{Spur gear (no. of teeth)}}{\text{Pinion gear (no. of teeth)}} \times \text{internal ratio} = \text{overall ratio.}$$

For the example above, the formula is: 90 ÷ 19 × 1.85 = 8.76

This is slightly lower than we need, but the 20 tooth pinion would give a ratio of 8.32:1, which may be too high, and we should always err on the safe side. If money is not too tight, then the exact ratio can almost be obtained by using an 88 tooth spur with a 19 tooth pinion which gives us 8.58, very close indeed. The right gear ratio for the good club driver is not too precise, depending on track conditions, driver style, and gears available. As a guide, you may find yourself one whole ratio away from the above suggestions (for the 8.5 ratio you could be 7.5 or 9.5) but that still does not make you wrong. However, when the car is performing at its best, you will normally find it does not use the full capacity for SCE cells, although it may well do so on SC or SCR cells. Whatever ratio you choose, you will know you have it right if you are consistently quick out of the corners, and about the same speed as everyone else on the straight.

Before ever looking to the motor, sort out the best tyres and suspension setup for the track. Only when the car feels slow (it is easy to drive), has the time come to look for a faster motor in the box. Gear ratios are all a matter of feel, not of fact. Always err on the side of caution. We hate to say it again, but remember Mr Hobbs and Mr Peterson — driving skill is 100 times more important than motor power. And often, that means using a lower powered motor so that you can control the car more easily and find the right line through the corners lap after lap.

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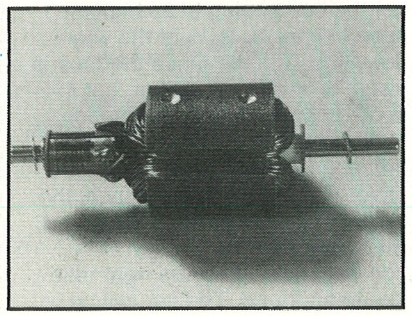
bounced off the commutator and lose contact, no current is passed. The same thing happens to standard class motors, but these cannot be dismantled for rebuilding (and BRCA rules do not allow this anyway). Modified motors must be rebuilt when either the commutator gets badly scored, or the brushes get ⅓ worn. As a rule of thumb this is normally between 10 and 20 races depending on use; 5 min races or 8 min, indoors or outdoors, quality of maintenance. Who should rebuild motors? An expert. There are perhaps three people in the country I trust, one is Parma (Helger Racing), the other is MG Model Products, and the third is me. You need about £500 of proper equipment and a lot of machining expertise. Please consider your choice of rebuilder carefully. Whatever you do, have your motor rebuilt regularly. This should always be a commutator retrue and fitment of new brushes, you should ask for bearings to be checked to the rebuilder. If one is obviously noisy or worn, get it replaced. A rebuild should cost about £5-£7, extra for bearings. Ignore rebuilds at your peril.

We have looked at motor selection, and recommended 21 and 19 turn double winds for general use. We have indicated gear ratios, and covered proper running-in procedures for new motors. Lastly, we looked at gear ratio selection. The ratio selected must be that which maximises acceleration and braking between the corners, sometimes at the expense of straight line speed. This ratio is independent of the capacity of your batteries; and is adjustable slightly to suit long fast tracks or short slow tracks. Always remember that the speed of your car through the corners is down to its grip and handling, the motor is only important in a straight line.



Arm showing balancing weight removal and spacer washer.

Tips For The Top

We now move on to advanced tips on motor set-up. The most important part of motor set-up concerns timing, and spring pressure.

You will notice that the endbell on a modified motor is not only removable, it can be rotated. An endbell can be fixed in almost any rotary position relative to the magnets. Altering this position changes the point at which electricity (current) is passed into a pole of the armature relative to its position in the magnetic field of the permanent magnets, very similar to ignition timing on road cars. In practice this alters the maximum speed at which the motor will run when it has no load (free running out of the car) but it has another useful by-product we shall discuss later.

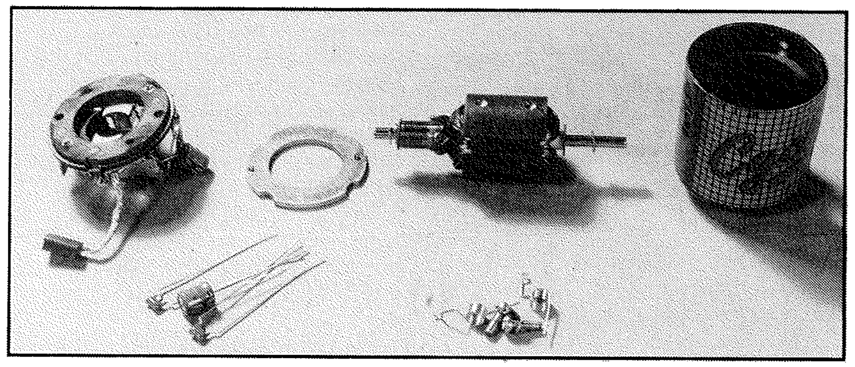
To see this in action, remove a motor from a car and connect it to a set of charged cells. Loosen the two endbell screws slightly and turn the endbell clockwise about 20 degrees whilst the motor is running. The motor speed will increase — if not you have turned it the wrong way or have connected it up the wrong way! Always mark the position of the endbell before trying this, and return the motor to this mark when finished.

The motor speed will increase — if not you have turned it the wrong way

Brush-spring pressure also affects performance. The pressure can be altered by bending the long arm of the spring. Only bend a spring arm once, constant bending to change the pressure weakens the spring and it will not be effective. Two sets of springs are ideal, one set bent to a 110 degrees angle, one set to about 150 degrees. The amount of pressure affects the current that can be passed into the motor. More spring pressure means more current passed. Springs are cheap, so have one set (a pair), bent to each of the angles given, available in your pit box. Each set will fit almost any motor. Make sure each pair has exactly the same angles, and store them as a pair. Never mix different springs on the same motor.

Armed with our two pairs of brush-springs and the ability to alter the rotary position of the endbell, we can set about trying to tune the motor to suit your needs. There are a number of rules as usual. Firstly, unless you are very knowledgeable about motors (and your own motors in particular) no adjustments can usefully be made with the motor free running out of the car. With respect to one rival magazine, anyone who tells you to tune motors by using the amount of current drawn off-load is wasting your time and theirs. DC electric motors have two properties

which are useful, but which mean that the amount of current the motor draws off-load is virtually irrelevant. A DC electric motor produces maximum torque (turning force, the ability to get weight moving) at its lowest speed. As the motor speed increases (measured in revolutions per minute; rpm) the torque falls off. As the rpm increases the 'power' developed by the motor increases, and is seen as the motor's ability to reach, and sustain, high rpm.
Secondly, the interaction of the field from the permanent magnets with that of the electro magnets (the armature poles) means that a motor will retard under load. Put simply, the more you load up a motor the more current it draws, the hotter it gets and the less able it is to reach high rpm — to develop its power.
Both these characteristics have one thing in common — load. It does not take a Newton, Fareday, or Einstein to see that current measured off-load is telling us nothing.

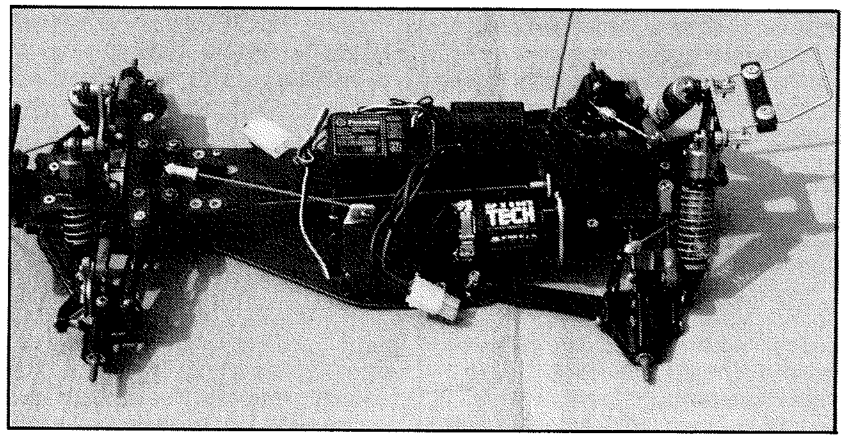

The parts that make up the motor.

Brush Strokes

The use of brush springs to vary motor performance is relatively simple. Increased spring pressure allows more current to be passed through the motor which increases its torque. However, the increased pressure and higher currents do limit the rpm at top speed slightly, and the increased current consumption will drain more energy from the batteries in a shorter time. The opposite is true of lower spring pressure, torque output is less, current consumption less, top speed rpm slightly higher.
Short, twisty tracks are home for higher brush-spring pressures. Where tight bends require low cornering speeds we need maximum acceleration to get to the next bend in the shortest time, and top speed on a short straight is much less important. Long, open tracks require less acceleration due to higher cornering speeds, so lower spring pressure will give more duration and slightly higher top speed. The difference between the two is subtle, and to a casual by-stander there may be none. To an alert driver, the change of spring pressure may be noticeable, to the less attentive it may not feel any different at all. We are not dealing with a chalk and cheese difference in motor performance because of spring pressure changes, but it is a useful weapon.
Motor timing in set-ups is a little more complicated. We have not yet suggested that the motor timing be altered at all from its factory setting. Each reassembly after cleaning should have resulted in the endbell being replaced in exactly the same position as it was when purchased. You may have a label which gives the correct position, or have scribed a line on the can and endbell to help correct re-alignment. Whichever you have, now scribe, or mark, a line 3-4mm in a anticlockwise direction (viewed from the endbell) along the can. You should now have two lines, one indicating the factory setting, one just marked. Do not move the endbell further than the limit of these lines.
The line we have just scribed or marked is totally arbitrary. Without expensive equipment it is impossible to tell if this is the limit of possible advance or not. However, how the motor performs, and what the brushes and commutator look like, will determine how close we are to the limit. Alteration in timing will only help in turning a motor to its best for a track. No amount of change will turn a docile motor into a tyre-shredding monster.
We mentioned that a DC electric motor retards under load. The more load you apply the more difficult it is for the motor to achieve a prompt acceleration because it cannot reduce the load, and stays retarded, it takes more time to speed up and reduce the load — vicious circle. In the extreme this is characterised by a car which pulls labouriously out of a corner, and then suddenly accelerates as if in possession of a turbo-charger or after-burner. The motor is over loaded, and its characteristics of low torque and high rpm mean it will have almost a 'step' in its acceleration. This afflicts singles mostly, but such a motor is almost always overgeared (should be 9.5:1 instead of 9.0:1 say). If this extreme is reached, no amount of timing advance will help, you have the wrong motor for the track or the wrong gearing.

Time For A Change

This characteristic is always there to some extent, so you can see that an increase in timing (advance) will help to counteract the retard under load, and give more acceleration out of a corner. Timing advance is achieved by loosening the two endbell screws and turning the endbell clockwise towards the second mark we made earlier. Use timing advance to gain more acceleration out of a corner (you may also get some increase in top speed) but be aware that this will take more current out of the batteries in the same time period.
More timing applies to shorter, twistier tracks, and less timing (back toward the factory setting) is better on long open circuits.
Excess timing advance is readily indentifiable. The trailing edges of the brushes become pitted and chipped, and the commutator becomes black over a significant area. Even correct timing will result in a small chipped and pitted edge


Dynatech motor installed in an egress.

to the brush, and a black area close to the slots in commutator. Providing the brush is smooth and the commutator clean over most of their area, you are on the right track.
Remember also that the signs of over-advance may appear even when the motor is set on our arbitrary mark; move back toward the factory setting if this happens.
The whole thing is a balancing act between current consumed and acceleration gained. There is no magic formula which gives a perfect result everytime. Experience will show that there is a timing position which works almost everywhere, and most setting up then concentrates on finding the correct gear ratio.
Brush spring pressure is also fairly easy, and can be used last as a fine tuning measure to get the best acceleration for the track.
Keen club drivers who know how to look after motors and make adjustments to them are our target now. We are going to delve into how different motors can be used to get the best lap times on given tracks, and on tricks to help suit a motor to a track.
Having arrived at a new track (which is the worst case) with all your equipment, how can you select a motor to suit the conditions? The first point to make is that having a choice of more than four motors is going to make the problem worse. Although we all see the top international drivers with dozens of motors in their boxes, take it from me that very few of them select a motor correctly. When it comes to top events (World Champs — Euro Champs) they rely on someone else to tell them! If they don't know, how can we tip the odds in our favour?

In Your Box

Firstly, don't posses more than four motors, and I mean modifieds.
Secondly, these motors should be in the range of 16 turns to 21 turns, the type (double, triple, etc) is up to you.
Thirdly, they must all be in good condition, and you should know exactly (or have a record to show) the gear ratio used with each motor on a track you know. Gathering this information takes time. Experiments with timing and spring pressure must result in a set-up for a particular motor which guarantees a known performance. That know performance must be connected to a suitable gear ratio. Eventually every motor you have will be of a known performance and have a known gear ratio.
We have reached the secret of motor selection, and I am quite willing to share it with you because however hard you try, only a few of you will make it work. Knowing what you know about your motors means selecting one for practice, or the first heat, putting into the car on your known gear ratio, and then driving it for a race. During this time you should be able to determine if it is the right motor for the track. Anyone who simply tells you 'this is my fastest motor' has not found the secret. Those who say 'my 16 double (or whatever) works today' has found the secret.
I have a venerable 17 double which is almost always used for practice on an unknown track. Once driven, it is usually possible to go straight to the best motor in my box for that day. Since I only have a choice of four, it limits the margin for error.
Many of you have heard of Mike Reedy, the American whose name is half of the Associated/Reedy motor products. Mike spends as much time getting to know his drivers, as he does deciding on the right motor for a track. Any Reedy driver has first to prove that his car is set up for the circuit before being issued with serious horsepower. As well as using practice to decide on a motor, use it to decide on any chassis improvements.

The whole thing is a balancing act between current consumed and acceleration gained

Here we digress slightly to make the most important point on motor choice for a race. Speed and acceleration in a straight line are about motor power. Speed in a corner is not. Anyone who watched Nigel Mansell take his 'under-powered' Ferrari to victory in Hungary last year will have noticed the Ayrton Senna was mega-quick on the straight, but slower in the turns. Despite a rumoured 50bhp advantage Senna's McClaren could not corner as fast as the Ferrari.
This meant Mansell could brake later, and accelerate earlier, around the turns. Speed between corners depends on how fast you exit a turn, and the more grip and handling advantage you have, the higher your speed out of the turn. Clearly a huge power advantage will tell in the end, but the easier its is to negotiate the turns, the higher your speed will be into the next 'straight'.
In electric car racing, cornering is a split second series of actions, or reactions, to a series of events. The position of the car on the road, braking, turning, accelerating, and the final position of the car as it exits the bend. If the track is technically difficult, one only adds to the probelm by using a powerful motor which needs care under acceleration, and early braking. Since corners make up the majority of our tracks, it is vial to use a motor which can easily be controlled. Having the car set-up to maximise grip and handling gives extra speed around the track without resorting to the motor box.
Mike Reedy is rightly concerned that his drivers have the proper car set-up before using more power. The most powerful motor in the box is useless if the car has poor grip and traction.
The important questions to answer during practice are whether you can improve the handling and grip, and whether more (or less) power will help speed through the turns. Above all, you must be certain that you are fully confident in the car when changes have been made. Too many drivers fail to make the most of changes because they leave the start line uncertain what will happen in the first lap. When you select a motor you must be 99% certain of the outcome, otherwise the change is not worth it. Always concentrate your energies on the set-up of the car first.

Chassis set-up

I often find drivers struggling to get their car to handle, and on occasions advice given has improved matters. Almost without exception that advice relates to chassis set-up. Very rarely does the problem concern the motor used, and when it does it is usually because the motor is too powerful.
Setting motors is a rather delicate and time-consuming business requiring care and thought. Remember that in the main we are looking for clean and prompt acceleration, not the highest top speed. Run the motor in properly when new, and then find the right gear ratio to suit your driving style and cells. Then, and only then, experiment with motor timing to see if there is any worth-while performance improvement. For different tracks, change brush-springs to suit acceleration/top speed requirements.
It is impossible to make radical changes to performance by mild changes in motor timing. Aim to know your motors so well that you can look at a track, pick a motor, pick a gear ratio, and last a five minute race with ease. Never skimp on rebuilds or maintenance, never overgear a motor, and never guy a new motor until you are making only one or two minor mistakes per race. A motor which costs £45 and gives you half-a-second a lap advantage is useless if you make mistakes which cost ten seconds per race. Your driving skill is one hundred times more important than your motor — remember David Hobbs and Ronnie Petersen.
That's about as far as we go for the average reader. If it all seems too little and too simple there is a reason for that — it is.

Demon

Demon Products, PO Box 12, Aldershot, Hants.

Demon motors are not badge engineered but produced to a high specification with an exclusive design of endbell. Motors are offered with "ceramic, wet or cobalt" magnets. Demon offer three options of magnet strength. All "adjustable" motors are precision balanced by Demon in the UK. Full spares and rebuild service available. Magnetising of magnets, com truing and balancing available for Demon motors.
Standard 27 × 1 BRCA stock motor. 30 deg timing 17 × 1 Fixed timing. Fast for 4WD 20 × 1 fixed timing. Fast for 2WD.
Modified 13 × 1 14 × 1 15 × 1 16 × 1 17 × 1 18 × 1 19 × 1 20 × 1 21 × 1.
10 × 2 also in 3 11 × 2 also in × 3 also in 4 12 × 2 also in × 3 also in × 13 × 2 also in × 3
also in × 4 14 × 2 also in × 3
also in × 4 15 × 2 also in × 3
also in × 4 16 × 2 also in × 3
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also in × 4 20 × 2 also in × 3
also in × 4 21 × 2 also in × 3
also in × 4 22 × 2 also in × 3
also in × 4 23 × 4 24 × 4

Kyosho

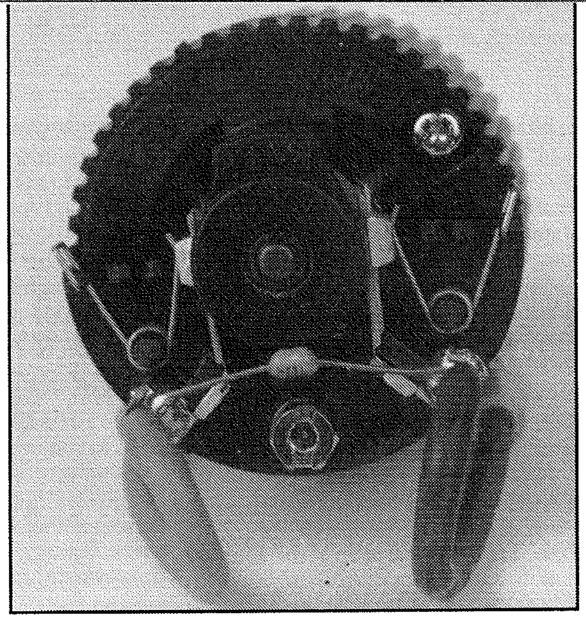
The range of Kyosho motors is large. Some incorporate metal endbells for improved heat dissipation. Kyosho motors carry the designation common in Japan, namely the number of the motor gives an indication of running time in seconds and hence the sort of performance that can be expected. The shorter the run time, the heavier the current consumption the greater the power. It does not follow however that 480 can be guaranteed to run for 480 seconds, it depends on track, driver and of course car and battery.
Lemans 480 Gold 480 S 360 PT 360 ST 240 S 600 E H 240 WS SPA 240 WS 480 WT.

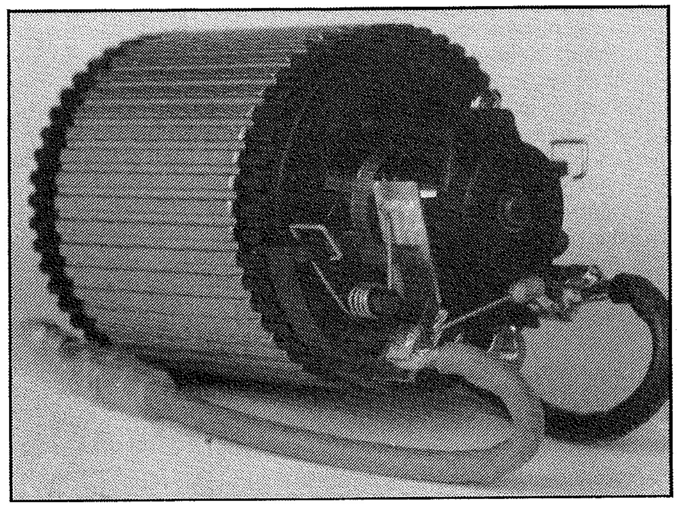
Yokomo

CML. Many companyies buy in Yokomo motors for reworking. These motors have long been the basis from which many variations stem.
Esprit Lightening. Just about any wind can be obtained, but the motors usually reappear with other labels on.

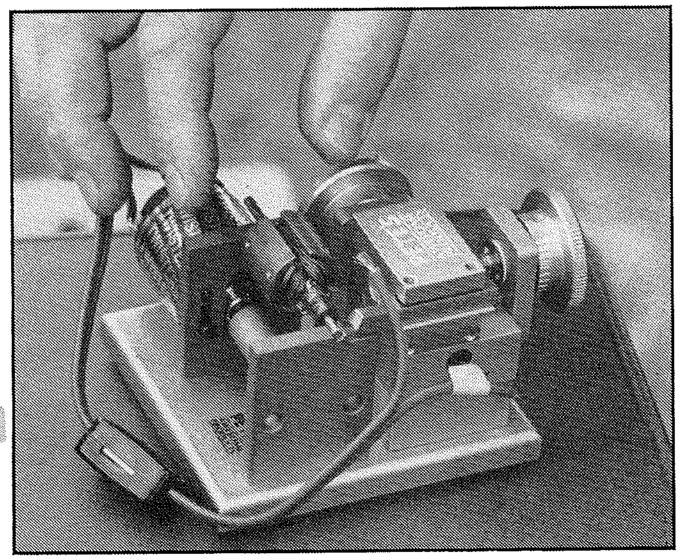
Motor Choice

A helpful list of available motors, winds, and applications





Tamiya Dynatech motor with cooling fan and ribbed can.



Reedy

Considered by many to be the archetype wizard of motor construction and reworks. International success follows Mike Reedy around the World like iron filings to a magnet. The motors start life as Yokomo products but then all is changed. Reedy incorporates exclusive features in his motor reworking program such as cord wrapping around the armature windings to ensure there is no winding movement at high speed. Little information on actual winds from Reedy lists.
Ultra series 21 Silver dot 17 Red dot Pink dot 19 Gold dot 14 Gold star 12 Blue dot 13 Green dot 16 Yellow dot 20 Silver dot 19 Brown dot 27 advanced timing 35 fixed timing Esprit series 17 fixed timing 20 fixed timing 19 × 2 15 23 13 × 2.

Trinity

Trinity offer a fine range of winds and have become extremely popular during the last few years. These Japanese pass through the Trinity US plant on their way to the UK.
Clodbuster 17 RG2012.
17 RC2013 reverse rotation
17 RC2010 19 RC2006
16 RC2030
9 RC1700 Nuclear assault fastest motor
10 RC1701 Big Daddy 2 min run 11 RC1702 Top Fuel drag motor 12 RC1703 Godzilla Oval track motor 13 RC1704 King Kong needs good cells. For 4WD cars 14 RC1705 Maximum Overdrive. Oval track motor. 15 RC1706 Behemouth. Based on World Championship motor. 16 RC1707 Gargantua. Good for on and off road. 17 RC 1708 Magic Speed Joel Johnson Signature. 18 RC1709 Heavy Metal Thunder. 19 RC1710 Tyrannosarus Rex. RC1711 Killer Force Stock motor. 27 RC2020 Reverse monster stock. Suitable for Clodbuster and Hyperdrive systems.
Hand wound armatures from 9 to 20 doubles; 13 to 17 triples and 14 to 16 quad.

Twister

Pete's Awsome Products, 50 Whitby Court, Parkhurst Road, Holloway, London N7 0SU.

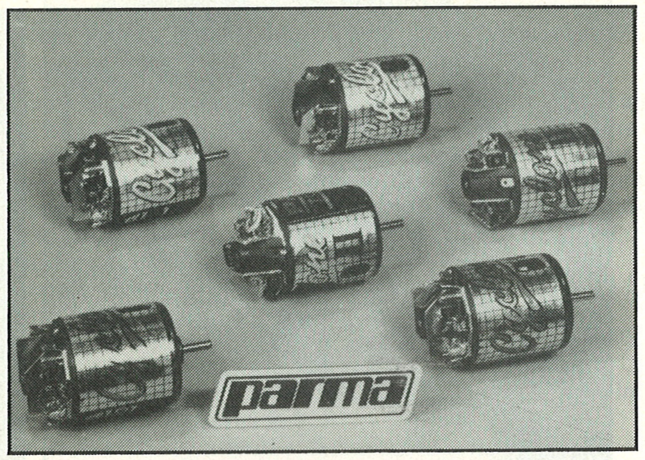
Twister motors have been available from a number of sources over the years. Now a new growing company has taken on the distribution of the motors. Pete's Awsome Products.
19 × 2 Kris Moore special. Championship winner. 19 × 4 Monster truck, easy driving and long run times 17 × 3 Stadium special 2WD cars and trucks. 16 × 3 Dirt Merchant 4WD or high traction circuits 2WD 14 × 2 SCE Special Takes advantage of high capacity SCE 14 × 3 Erik's Express, very fast 44,000 RPM 13 × 1 Cyclone 48,000 RPM on road cars 14 × 1 Titan Championship winner, best in heavier cars 12 × 2 Fast Eddie's Ride Masses of torque 15 × 2 Hurricane Sprint cars 17 × 2 Terminator very flexible 21 × 2 Tornado Tremendous torque and good run time 15 × 3 Formula 10 A 1/10 on road car motor, budget price 19 × 4 Formula 12 1/12 motor 12 × 2 Typhoon Drag, 2/4WD 50,000 RPM hold drag speed record at 74 MPH 11 × 2 Annihilator Hottest motor in the range. 50,000 RPM 13 × 3 Carolina Mountain Mt. Fast dirt motor 14 × 3 Clydesdale Monster truck motor 14 × 3 reverse Clydesdale 13 × 3 Black Max suitable for 6 or 7 cells 14 × 3 Street Racer 27 standard Ultra stock 2WD Cleaned and dyno checked 27 standard Ulta stock 4WD as above 27 standard P.R. Superpro Hotest stock motor 17 standard Pocket Rocket bushes (34,000 RPM) entry level motor 20 standard Pocket Rocket bushes (as above) 15 × 2 Pocket Rocket ball races, adjustable timing 19 × 2 Pocket Rocket ball races, adjustable timing, long life and reliable.

Parma

Parma motors have a high specification and come in good range of winds. They feature hand winds, balanced and epoxied armatures. Parma UK also offer a rebuilding service for all makes and types of motor via their dealer network.
21 × 2 1/12 on carpet motor 20 × 3 1/12 but OK for tarmac 19 × 4 Good all round and monster truck motor 17 × 3 Excellent flat

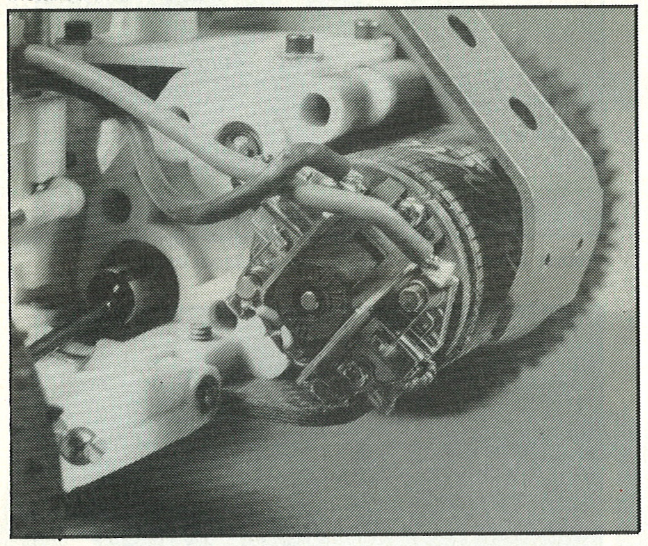
Probably the most successful range of motors ever from the American Reedy company.

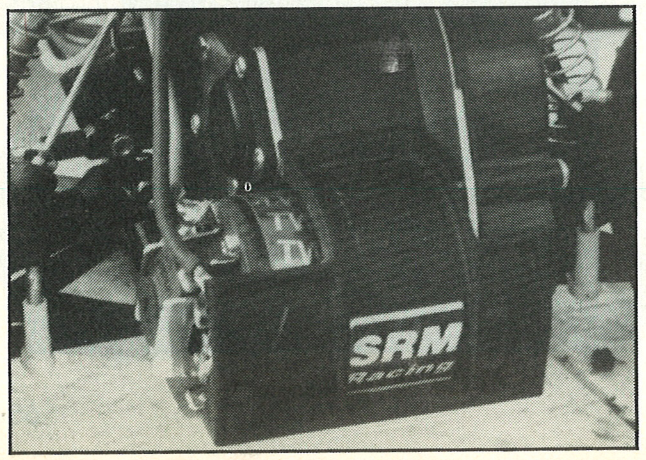
Above: German LRP motors now available in the UK.



Parma's range of Cyclone II motors.

Lesro's range of alternative brushes. Below: Twister motor installed in an RC10.





truck motor 2 or 4WD 16 × 1 Good short track buggy motor 14 × 2 Very fast for 2WD and some 4WD 12 × 3 Smooth and quick for longer tracks 13 × 1 Lots of punch on bendy tracks 8 × 1 Drag racer 30 × 1 Truck and pulling tractors 27 × 1 BRCA stock 25 × 1 Stock type, low price 17 × 1 Ultra stock, non adjustable 18 × 2 Good all rounder, adjustable timing, 2 or 4WD 16 × 2 Good for 2 or 4WD. Lower pinion required 17 × 2 Fully ballraced with adjustable timing. Suitable top to middle range cars 15 × 2 Ball raced and adjustable. Excellent for the more experienced 13 × 2 Very hot, needs a lot of experience to make the best of the performance.

T.M.S.

TMS Ltd, Deanfield Mills, Asquith, Morey, Leeds.

TMS motor brandname is Mikado. They feature good ventilation, wet magnets and dynamically balanced.
13 × 2 14 × 2 15 × 2 19 × 2 21 × 2 14 × 3 16 × 3.

MG

Unit K, Ynysmaerdy Ind Est, Llantrisant, Mid Glam.

MG continue to have many race successes with their brand of motors. They offer full rebuild service of motors (any make) including magnetising, truing and balancing.
Magnum 15 × 2 16 × 2 17 × 2 18 × 2 19 × 2 15 × 3 16 × 3 17 × 3 15 × 4 16 × 4.
Super Magnum/eliminator. Ceramic shaft large heatsink. 10 × 2 11 × 2 12 × 2 13 × 2 14 × 2 11 × 3 12 × 3 13 × 3.
Red dot plus fixed timing ballraced/balanced wet mag. 18 × 1 19 × 1 20 × 1 27 × 1 15 × 2 18 × 3 red dot 18 × 1 20 × 1.
Orange dot. BRCA standard motor wet mags. 27 × 1.

Schumacher

Schumacher have a limited range of motors in addition to Reedy motors that are also offered.
Ultra Stock Pink Power Red Heat Gold Rush Quick Silver 14 × 2 Gold Nova, good bottom and punch.

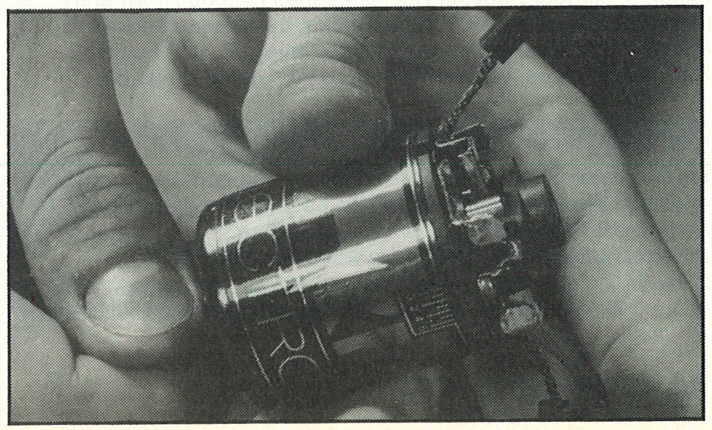
Tamiya

Co-operate with two of the major motor manufacturers in the Far East to produce motors exclusive for Tamiya. Mabuchi, the world's largest producer of small DC motors manufacture two performance motors for Tamiya.
Technigold Techniplus Dynatech 01R Dynatech 02H.

Tanaplan

A relativey new low priced motor on the market showing some excellent race results. Motors have ballraces, diamond trued commutator and with wet magnets.
13 × 2 14 × 2 15 × 2 18 × 2 16 × 3 17 × 3 Handwound motors available in just about any wind you fancy, but at about double the cost.

The LRP Pink SE comes complete with pre-soldered capacitors.



Phil Greeno

Phil Greeno has been entering all types RC racing for many years, his shop in North London has become something of a Mecca for RC enthusiasts in the area. He recently joined the ever growing band of motor distributors with his own brand of good value for money motors for 1/10 on and off road.
Lightning 27 × 1 Fixed timing 14 × 2 15 × 2 17 × 2 19 × 2.

LRP

These German produced motors are used by Jamie Booth with some considerable success in his race winning Tamiya cars. Now marketed by Jamie Booth as he moves from the track to the commercial side of the RC world. Pink E Blue SE.

Revolution

CML Distribution, 1648 Bristol Road South, Redhal, Birmingham B45 9TZ.

USA produced motors with a good range of winds and performance options.
Dry magnets 21 × 2 19 × 2 17 × 3 15 × 2 14 × 2 11 × 4 11 × 3.
Wet magnets 18 × 3 16 × 2 13 × 3 12 × 1 17 × 2 19 × 2. 27 stock motor.

Kawada

Small Japanese company, makers of a 1/12 car MX-1 17 turn MX-1 15 turn.

Speedworks

Buggymaster Endurance motor.

Checkpoint

16 × 2 18 × 2.

Paragon

Holcomac Marketing Ltd, Britannic House, 17A George Street, Stroud, Glos GL5 3DP.

USA produced motor, available in the UK in a limited range of winds.
27 × 1 Stock motor Modified range Eclipse 13 × 3 15 × 2 19 × 2.

STS

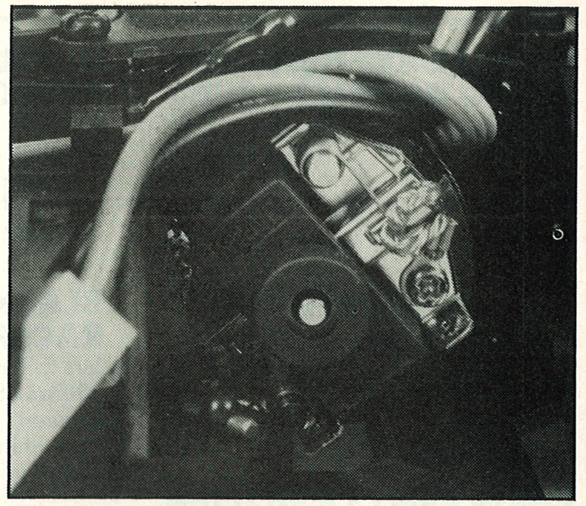
Wasp Products Ltd, 13 Morningside Road, Worcester Park, Surrey KT4 8LQ.

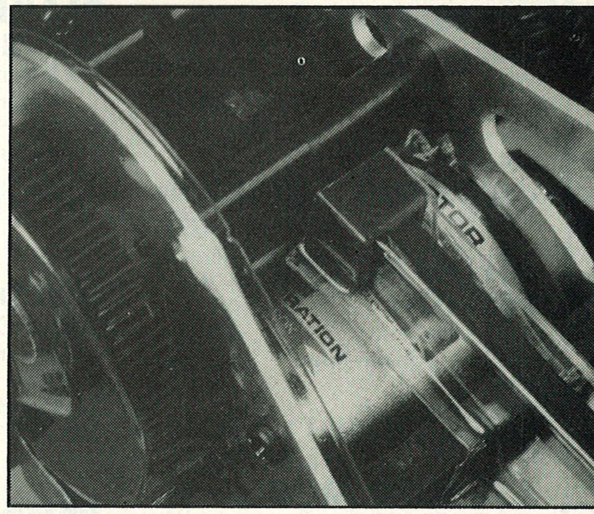
Motors from the USA. Modified motors 19 × 1 20 × 1 21 × 1 13 × 2 14 × 2 15 × 2 16 × 2 17 × 2 11 × 3 12 × 3 Standard 27 turn. Other winds to order.

Laser Lite

Wasp Products Ltd, 13 Morningside Road, Worcester Park, Surrey KT4 8LQ.

USA produced quality motors from a company with an expanding protfolio.
Modified motors 19 × 1 20 × 1 21 × 1 13 × 2 14 × 2 15 × 2 16 × 2 17 × 2 11 × 3 12 × 3 Standard 27 turn.





Kyosho's stock 540 motor in their Optima Mid. Below: com truer in action.