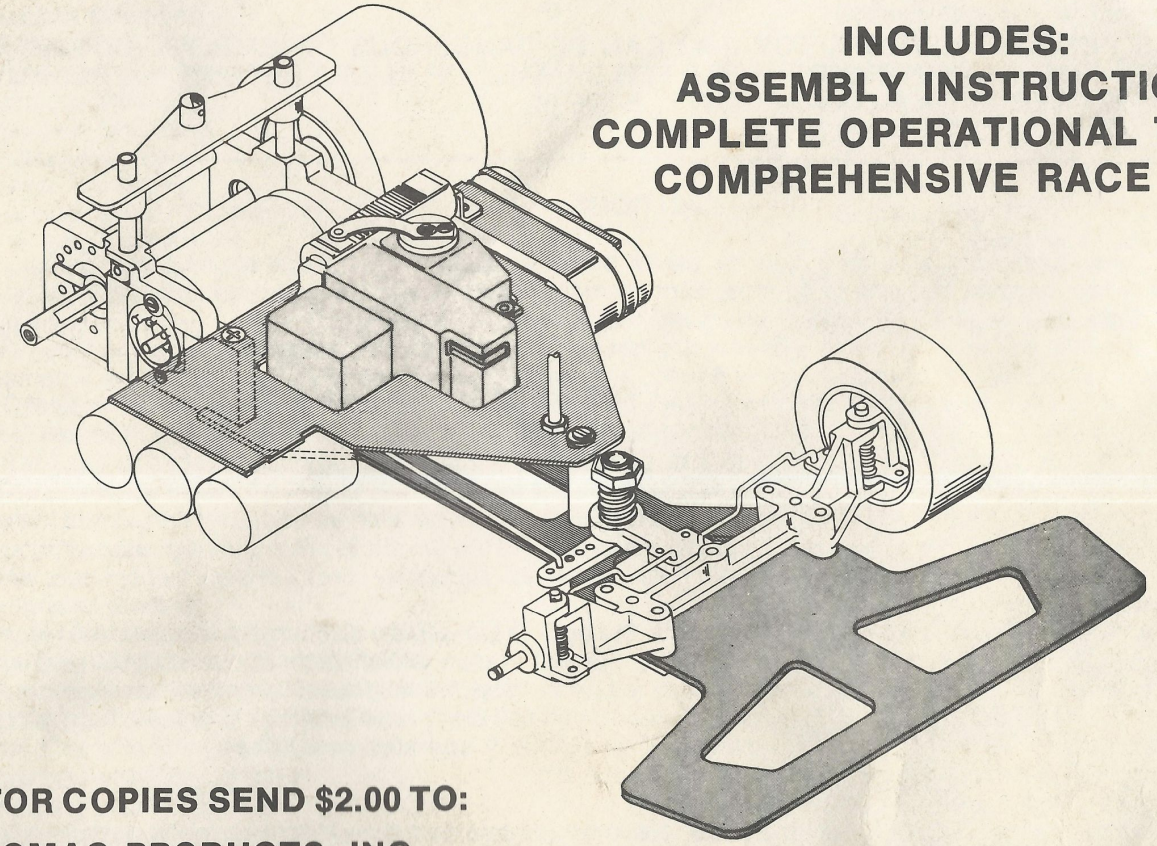
JoMac PRODUCTS INC.

LIGHTNING 2000

1981 U.S. "ROAR" NATIONALS WINNER

6 CELL MODIFIED EXPERT CLASS

INSTRUCTION MANUAL



INCLUDES:
ASSEMBLY INSTRUCTIONS
COMPLETE OPERATIONAL THEORY
COMPREHENSIVE RACE TIPS

FOR COPIES SEND $2.00 TO:

JOMAC PRODUCTS, INC.
12702 N.E. 124TH ST., KIRKLAND, WASHINGTON 98033 USA

JR160 12/1/81 Revised

INTRODUCTION

This "Lightning 2000" electric R/C car kit incorporates the highest quality parts and latest design technology available. Being complex and highly adjustable requires this drivers manual to be long, yet very complete and loaded with race tips. It is necessary for proper operation that instructions and warnings be followed completely.

If any assembly, operations, or racing questions come up or you want the latest in racing tips you may call JoMac Products, Inc., 9:00am - 5:00pm (Pacific time) weekdays for information at (206) 823-2303. When calling have your drivers manual, car, and radio handy for easy reference. JoMac has a full time staff of electronic and mechanical engineers, plus a staff of persons experienced in assembly and racing. Any suggestions for better or clearer instructions are welcome.

Certain sections of this manual apply only to basic or complete kits and not to assembled cars with or without radio. However, all sections are included to help in understanding repairs and operation.

Before doing any assembly work on your new Lightning 2000 electric kit car, take time to read through the instruction manual, familiarizing yourself with the components and general layout of the finished car. Construction of the car is relatively easy if the instructions are followed.

Although the car in the photos has a Futaba radio installed, most popular 2-channel radios will work just as well.

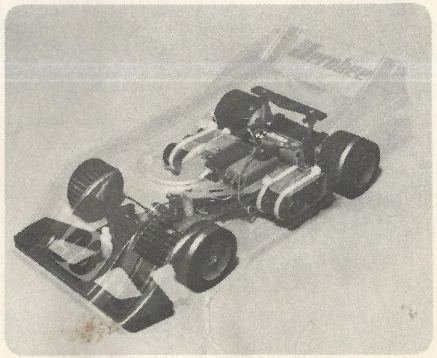
WARNING—THIS PRODUCT IS NOT A TOY AND CAN BE DANGEROUS OR EASILY DAMAGED IF IMPROPERLY USED. JOMAC IS NOT RESPONSIBLE FOR DAMAGE OR INJURY RESULTING FROM MISUSE OF THIS PRODUCT—SEE ATTACHED WARRANTY, PAGE 32.

—CAUTIONS—

- Batteries contain enough energy to start fires or cause burns if shorted out. Overcharged batteries, even when charged at the recommended fast rate of 4 amps, vent corrosive liquid or can be damaged and can blow up, cause burns, or start fires. See page 20 for battery charging instructions.
- Small amounts of water will damage radio systems. Do not run your car around water or on wet surface.
- Radio systems can be damaged if operated at over 6 volts. A 6 cell car has voltage of 7.2 volts and either a center tap or voltage dropping diode system must be used to protect the receiver. See page 13 for receiver protection.
- Battery charging systems are designed to work *only from a 12 volt DC supply.* Connecting a charge cord to AC 110 volt supply can result in fires or electric shock sufficient to cause severe injury and possible death.
- Do not stall the motor under power. If the car stops suddenly on the track, or fails to move forward when you attempt to accelerate, push the throttle control on your transmitter to the brake, or off position immediately and attend to the car. If a small rock stalls the gear, or if the car is stalled against a barrier, and the throttle is left in the on position the result can be a burned out motor or resistor (or electronic speed control unit). Be especially careful of stick transmitters with throttle stick loaded to center (half speed).
- If you run your car to the point where more than one cell in the pack is completely discharged, it is possible to lose radio control of the car before the drive motor stops completely. For this reason you should not operate your car in an area where it could be harmed, such as near a busy roadway or a pool of water. Usually radio control will be regained as soon as you pick up the car and the motor is allowed to free-run. If you still don't have control, then you unplug the motor.
- R/C cars are distractive to spectators and can cause car accidents if operated near roads.
- This car and body contain some sharp edges that can cause cuts.
- The antenna can cause eye injury if not handled properly.
- Gears on R/C cars can cause bad cuts or entangle hair. Keep fingers and hair away from gear while operating this car.
- Lexan bodies and plastic radio cases can be damaged if put in contact with petroleum based products such as gasoline, nitro methane, solvents, some oils, 10 second glues, Locktite, and ammonia. Clean only with wood alcohol.

LIGHTNING 2000 TABLE OF CONTENTS

Picture 1



SECTION I—ASSEMBLY

ASSEMBLY

The car should be asembled one group of components at a time, therefore each group of components required for a certain assembly (module) is individually bagged. The charge cord is the easiest of these assemblies to complete and will give you some practice in soldering, so we'll start there.

Assembly Tips

Tools needed for kit car #2300, #2310, #2320, & #2330, assembly:
- Soldering iron & 60/40 Rosin Core solder
- Wire strippers
- Needle nose pliers
- 3/16" slotted screw driver
- #2 phillips screw driver
- 3/32 allen wrench
- .05 allen wrench
- Ruler for wire identification
- X-acto knife

Additional tools needed for radio installation on all cars
- Cooping saw
- 1/16" drill bit and drill

Be sure to use the proper size screw driver (#2 phillips) in the chassis screws to avoid stripping out the heads. Do not force screws into plastic. If, for some reason, a screw should strip out you can use an oversize screw to replace it. Available in hardware stores.

Soldering

Most of the time spent in assembling this car will be in soldering various wires to components. The time involved is not as important as the results, as one bad solder joint can keep your car from running properly, forcing you to retrace your steps to find the defective solder job.

A good soldering iron is important for good results. An Ungar or similar 40 watt iron, equipped with a pencil tip, is recommended.

The solder recommended is 60/40 rosin core solder. The use of flux is generally not required with this solder. DO NOT use acid core solder, as corrosion will result.

When doing assembly work, be sure to *pre-tin* all solder joints. This applies to both pieces to be joined, for instance both the plug and the wire to be soldered to the plug should be pre-tinned by heating and applying solder to each before actual soldering is attempted.

When soldering, be sure to apply heat to the pieces being joined, not just the solder. Hot solder dripped onto the pieces being assembled will generally just result in a coating of solder on the pieces rather than an effective, both mechanically and electrically, bond. Proper solder joints are shiny and indicate the proper application of heat. Dull looking solder joints indicate a lack of adequate heat or flux and should always be suspect. If in doubt, resolder before going to the next assembly.

If you do not have any previous experience in soldering, be sure to thoroughly read and understand the instructions supplied with your soldering iron and then practice on scrap pieces of wire before starting assembly of this car.

PREASSEMBLY SECTION

SIX CELL BATTERY PACK

Assembly required on all kits — not included on Base Kit #2300 and 2310.

Caution: These batteries are of a very sophisticated nature and if exposed to too much heat by shorting or overcharging, may burst or give off toxic material and cause heat which can cause burns or a fire.

Referring to the picture and wiring diagram locate and identify all components. First solder the three wires to the Deans 5 pin connector, taking *CAREFUL NOTE* of the alignment mark on the connector. Also note that the red wire is soldered to two pins, the wire and the solder forming a bridge between these two pins. Apply heat shrink tubing.

Very carefully arrange the batteries into two groups of three cells with the positive and negative ends arranged per the wiring diagram. To ease the awkwardness of soldering the batteries together, it is suggested that they be glued to each other with Hot Stuff, a small amount of epoxy, hot melt glue, etc.

When soldering the wires to the batteries, the solder tabs should be bent up away from the batteries before soldering and bent back down flat when soldering is completed. The batteries themselves can act as heat sinks making good solder joints difficult if the tabs are left flat on the ends of the batteries while soldering.

Solder the four short jumper wires in their respective positions, then solder the three leads from the 5 pin plug to the batteries again referring to the wiring diagram and *DOUBLE-CHECKING* all positioning of wires *BEFORE* soldering. A mistake here can short out a battery, rendering it useless.

Be very careful with the battery pack, as it is possible to accidently touch one of the 3 cell packs to the other causing battery damage. As soon as possible neatly wrap the packs in electrical tape, or dip in plastic dip or similar insulation being sure to insulate all wiring.

BATTERY PACK DETAIL
(with 4 cell tap)

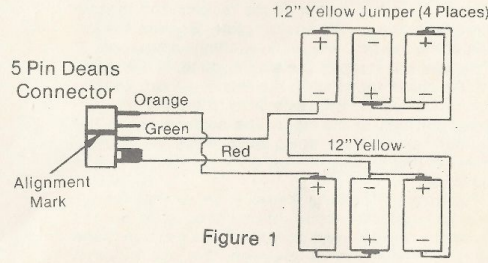
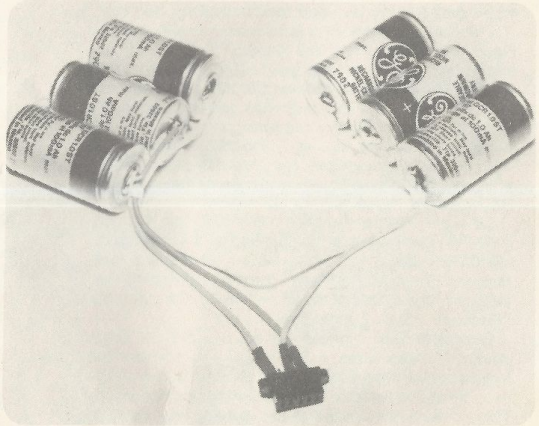


Figure 1



Picture 2

RESISTOR MODULE

Note: Depending on the model, "Lightning" cars come either with an assembled resistor module or with no resistor at all. These instructions are provided to aid in assembly of your own module and to help understand the operation of an assembled unit.

Before starting assembly of this module it is suggested that a trial layout of the resistor and throttle servo be made on the shaker plate. Be sure the flat side of the resistor, where the windings are exposed, is parallel to the top of the shaker plate. In one position the solder tabs face to the rear of the car, and the brake position on the resistor is to the left, the full speed position to the right. The solder tabs on the resistor can be bent down to facilitate installation, however this should not be done until soldering is complete.

For proper throttling action, a servo that rotates counter clockwise when the control stick on the transmitter is advanced from the brake position to the full power position is required. To use a servo rotating clockwise, the resistor must be turned around.

A servo with either clockwise or counter-clockwise rotation may be used for controlling steering.

The first assembly step is to solder all wires to the Dean 5 pin plug, *TAKING CAREFUL NOTE* of the alignment marks on the plug. (See diagram and photo). The 6" thin red wire and 6" thin black wire are taps that provide 4 cell (4.8 volt) power to drive the receiver. This comlicates the wiring slightly but eliminates the need for use of a separate battery pack which is just extra weight and also difficult to mount properly. If you plan to use separate batteries for the RX these two wires will not be needed.

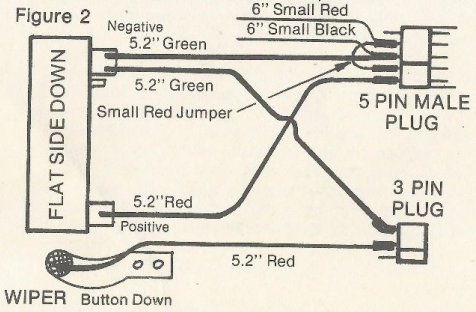
On some resistor modules (like #578) this 4.8 volt receiver power tap is accomplished by a 4 cell tap of the battery pack. In others (like #579) this 4.8 volt receiver tap is accomplished by diode dropping the voltage of the 6 cells of the battery pack. See page 13 "Receiver Power Connection."

Complete this module by soldering both large diameter green wires to left tab or resistor and the large diameter red wire to the right tab. Note that the flat side of the resistor is down during this assembly. The red wire is soldered to the resistor wiper arm at the contact end of the arm. The free ends of red and green wires will be soldered directly to the motor leads or plugged in using a three pin Deans connector. Note: it may be necessary to add the .1 MF capacitor (provided) across the motor positive (red) and negative (black) lead. This capacitor helps to prevent radio interference caused by the motor brushes arcing. This capacitor may be added on either side, the resistor male plug or the motor female plug. The motor plugs are wired with negative lead (green or black) going to the center pin and the positive lead (red) going to the outside pin nearest the alignment mark.

Double-check all soldering and wiring. Refer to picture of completed resistor module, taking careful note of the wiring.

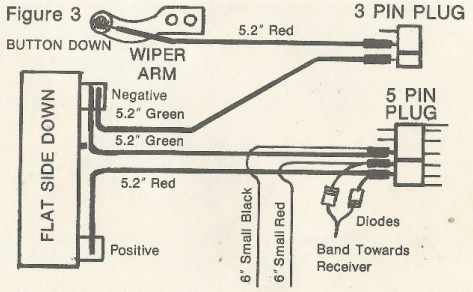
RESISTOR MODULE DETAIL
(WITH 4 CELL TAP)

Figure 2



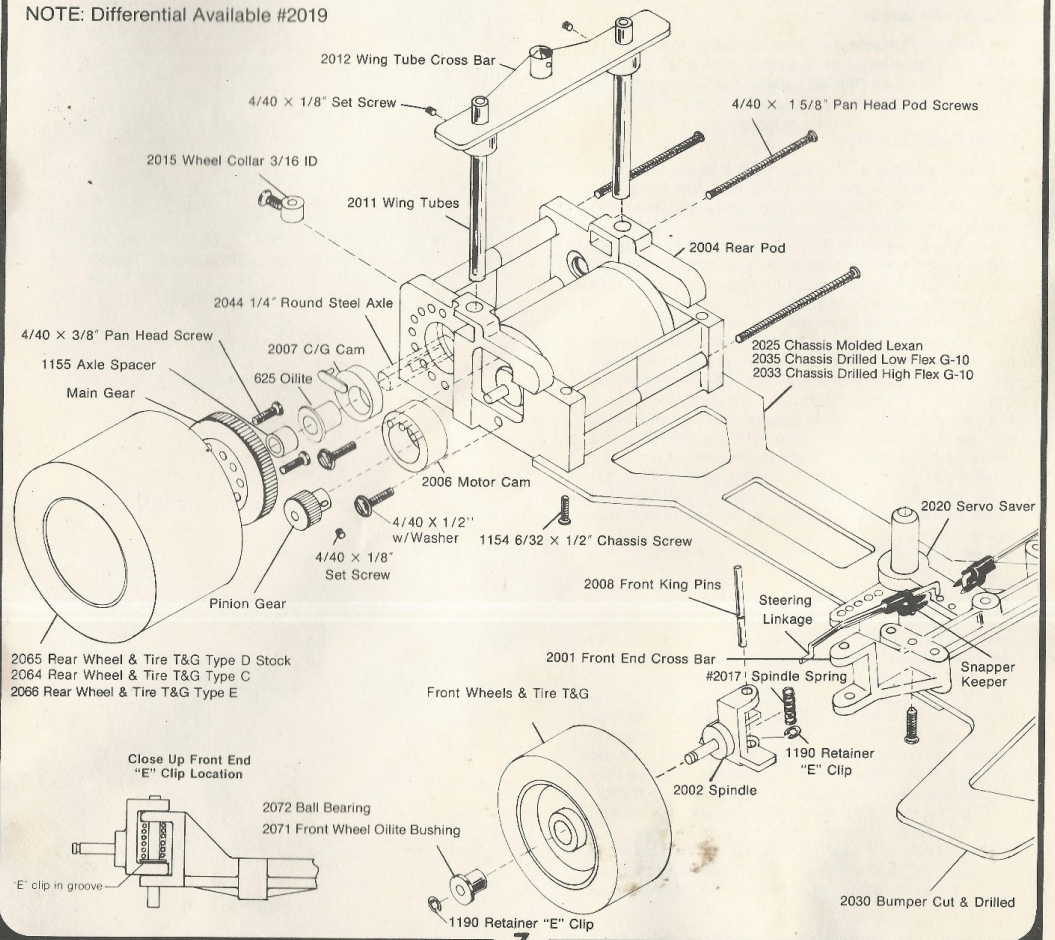
DIODE DROP TO 4.8 VOLT, LIKE JOMAC #579

Figure 3



Electric 2000 Chassis Assembly Exploded View Chassis Drawing

NOTE: Differential Available #2019



ASSEMBLY INSTRUCTIONS

Chassis Assembly

Assemble chassis per the following instructions and the exploded view drawing. Use a #2 phillips screwdriver on all phillips screws, taking care not to strip out their heads. See exploded view, page 7.

Front End Assembly

Note that there is 5° castor built into the front end assembly. Mount the front end with the "A-arms" tilting back. The bumper mounts under the front end between the front end and chassis.

There are seven (7) 6/32 × 1/2 countersunk bolts provided for front end assembly, all are not necessary, but use at least two (2) on each side, one (1) in front, and one (1) in the rear hole.

The spindles are held onto the front end with kingpins. Install the kingpin with the groove down, pushing down through the top arm of the spindle, then through the top arm of the A-arm until the end sticks out about 3/8". Next, slide the spring onto the kingpin and continue pushing the pin through the lower spindle arm and lower A-arm until the groove in the pin is flush with the top of the lower spindle arm. The position of the "E" clip is under the spring, over the lower arm of the spindle. The kingpin travels up and down with the spindle, therefore, it must move freely in the A-arm.

See racing tips for front end adjustments.

Rear Pod

The rear pod assembly should be bolted together with the three 4-40 × 1 5/8" screws before mounting the chassis and shaker plate. The pod is attached to the shaker plate and chassis with 6/32 × 1/2" countersunk screws, two through the chassis on the bottom and two through the shaker plate on the top.

In order to install and remove the motor easily, the inside top forward edge of the pod sides can be rounded with a file or knife. Otherwise, the two rear pod screws must be loosened to remove the motor.

The motor cam is installed from the outside and held in place with two 4/40 × 1/2 screws with washers under the heads. Both screws must be loose to adjust gear mesh. Adjust mesh by rotating cam using a small screwdriver between two of the small nubs.

The wing tubes fit loosely into the wing tube holes and are secured in place with the 3/16" collars. The wing cross bar is slid down over the wing tubes and held in place with the 4-40 × 1/8 set screws. (Note: use the special #4-40 × 3/8 self tap screw in holes first to tap threads, then install set screws.)

Linkages

In the kit you will find two 2" links and one 4" link with "Z" bends on each end. Use the long link to go from servo to servo saver. Cut the link in the middle and connect as shown in figure 6 with 1/8" wheel collar included to allow for adjustment.

Use the other two for tie rods. Bend as shown in figure 5 to clear front end and to adjust tow-in. Insert "Z" bends into spindle arm first, then push 90° bend end into servo saver arm and install keepers.

STEERING LINKAGE TEMPLATE

Figure 4

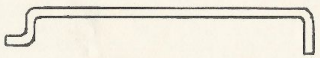


Figure 5

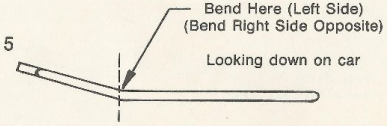
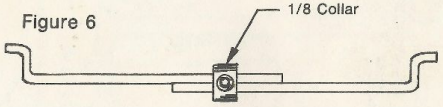
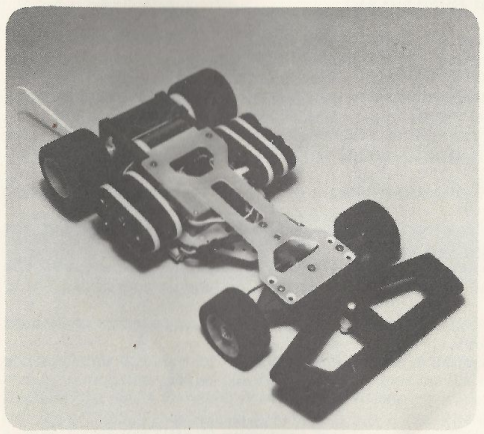
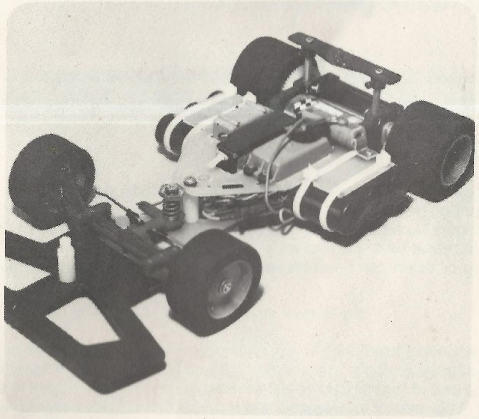


Figure 6





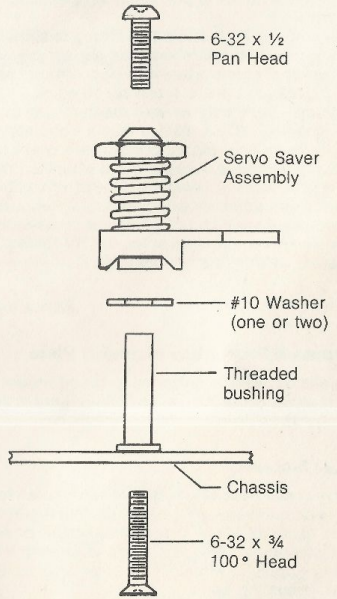
Picture 3



Picture 4

Figure 7

SERVO SAVER



NOTE: Lexan chassis does not use the threaded bushing or 6/32 x 3/4 100° head screw.

CHOOSING A RADIO

The Lightning 2000 car is designed to adapt to most radio systems with minimal work. The radio can be installed with either the left or right servo doing steering and the other servo operating the resistor. It can also be used with JoMac Electronic Speed Control. The radio can be set up with servos that operate in either rotation and of any size.

An ideal radio system is one that: costs the least, is the most reliable, never has interference, is the fastest, the strongest, and is the smallest and lightest. There is no such radio, but try to pick one that has these features.

Speed. The faster it is, the better. Only with a fast servo can you react fast enough to catch a car in a spin or drive around traffic. The faster a servo is the less you'll have to think ahead to compensate for servo lag. A fast servo has a transit time of .3 second for 90°.

Torque is not as important in 1/12 electric racing as in 1/8 scale cars. A torque of 20 inch ounces is sufficient to steer the car.

Servo Gear Train should be strong to allow for impacts of the steering into walls and other cars. A servo saver provides some protection and should be set as soft as possible to prevent damage.

Size is not as important as *weight.* The lighter the servo the better. However, ROAR Rules require a 6 cell car to weigh 31 oz. (878.82 gm.) and a 4 cell car to weigh 29 oz. (822.12 gm.). A JoMac "Lightning 2000" car can be built stock close to these minimum weights with medium servos.

Reliability. R/C car radios take a tremendous beating, much more than airplane radios. Look for receivers and servos with through hole plated boards to prevent loose components.

Design Features. A radio with a wheel for steering is much easier to drive and adapt to even for a person who is used to flying with sticks. An easy to use and adjustable steering trim is important. The throttle should be easy and comfortable to operate and adjustable or trimmable. Range is not as important as selectivity as cars aren't driven far away, but race cars are subjected to a lot of high power cross-modulation. Transmitter power of 500 milliwatts is good for racing. Changeable crystals are almost a must feature for racing, therefore, 27 MHZ radios work well. Radios on 27 MHZ are not as much a problem as in airplanes because they are on the ground.

Radio Installation—See Figure 8, page 11

Purpose & Proper Use of Shaker Plate

A shaker plate is designed to tripod mount all radio components and batteries securely, but allow unrestricted flex of the chassis. No portion of any component mounted on the shaker plate should touch the chassis when the shaker plate is sitting flat or flexed in either direction.

Servo Mounting

It may be necessary to cut the servo notch forward on the shaker plate to allow for larger servos. This can easily be done with a cooping saw, jig saw, or file. Insert servo and mark mounting holes with a pencil. Drill 1/16 mounting holes & mount servo using #2 × 1/4 sheet metal screws or nuts and bolts. It may be necessary to space the throttle servo up to allow a 1/16 clearance from the chassis to prevent interference with chassis flex. It is also advisable to get the steering servo as low as possible (within 1/16") to the chassis. Spacing servo up or down can be done using washers or spacers under the servo mounting ears.

Resistor Mounting

Mount the wired throttle resistor in position. The resistor mounting brackets are connected at the center and must be broken apart before use. Note that the brackets are angled slightly in order that the top surface of the resistor ends up level with shaker plate. You'll have to try both brackets on one end of the resistor to get the correct orientation. Screw the brackets to the tray using the #2 self-tapping screws provided. The resistor should end up about 3/16× to 1/4× away from the servo case.

SHAKER PLATE - .060 thick epoxy board

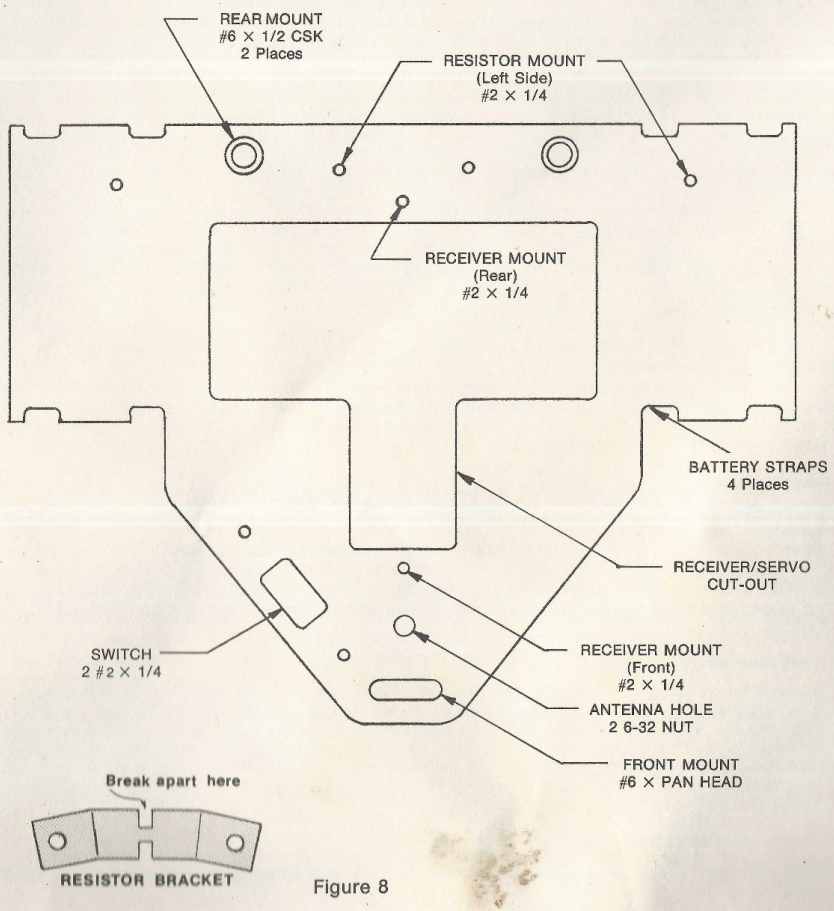


Figure 8

Wiper Arm Mounting

The hole in the shaker plate, for throttle servo, is made for a micro servo and with a small amount of trimming, will fit small servos. For others, you will have to cut out the hole acordingly. When doing this, try to keep the servo wheel fairly near the center of the speed control and you will get a more evn pattern on your wiper arm. Use spacers if necessary under servo mounts on small servos to get the top of srvo wheel slightly higher than the top of the speed control. Lay the wiper arm on the servo wheel. Bend it up or down as necessary to get good contact on the speed resistor, so there will be a minimum of arcing or sparking and the speed control will last longer. Bring your receiver close to the car and plug in servos, etc. Throttle—refer to car picture for mounting of wiper arm on servo. The best way we have found using JoMac Mach 3, Futaba 2F, or Kraft 2AW or similar units is to use the screw that holds the wheel to the servo for one of the holes in the wiper. Attach wiper in this fashion, make bends in the wiper to make good contact on speed control resistor. Turn on transmitter then receiver and move throttle on transmitter to full speed. Then, while holding it there, turn off receiver. This will keep throttle servo in full speed position. Adjust wiper arm to full speed end of speed resistor. Now find or drill another hole in servo wheel or arm that will line up with second hole in wiper arm and use a small screw and washer to attach it. Make sure screws are tight so wiper arm will stay in correct position. Turn receiver back on and set transmitter so wiper arm returns to brake position, but does not come past it. On some radios this can be adjusted with a throttle trip or stop and on others you will have to make a stop. Move the throttle back and forth a few times to make sure the wiper goes all the way onto the brake band and the full speed band. If it does not readjust until it does. This is very important. If the servo operates in the opposite direction needed for the resistor, when mounted normally as shown, you may reverse the resistor.

Antenna Mounting

The nylon antenna tube is mounted by using two 6/32 nuts. Drive one nut on approximately 3/8 of an inch then place the antenna tube in the shaker plate hole and secure the tube with the other 6/32 nut.

The receiver antenna wire should be threaded through the tube after removing kinks by pulling the wire through your fingers. The receiver antenna may be shortened but this will affect total range which will probably still be sufficient. Do not cross, bunch up, knot, wrap or loop your excess antenna wire as this will affect range. The extra antenna wire may be weaved in holes drilled in the shaker plate.

Receiver Mounting

The receiver should be mounted so it doesn't touch the chassis and should clear the chassis by 1/16" so it doesn't affect chassis flex.

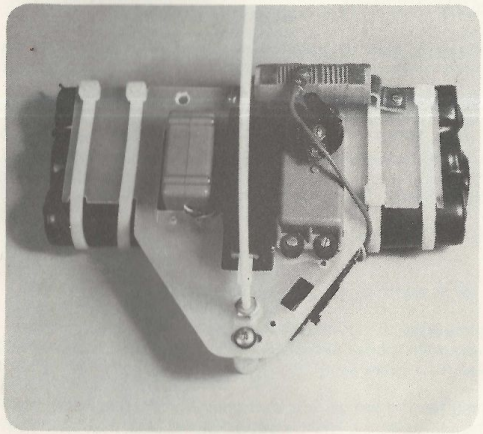
Mount the receiver by using double sided servo tape mounted to the servo sides or with bracket glued to the receiver end and screwed to the shaker plate. The bracket method is preferred because it allows you to remove either the receiver or servos individually. Receiver mounting brackets can be made from scrap Lexan or aluminum and glued to the case using 10 second glue like Zap, Bondini, Eastman 910, or silicone glue—all are available from hobby shops or hardware stores.

Battery Mounting

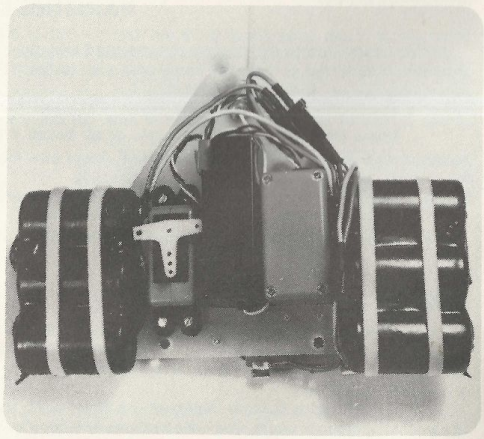
Mount batteries using the 10" straps provided. To prevent batteries from sliding out sideways on impact and to act as insulators, batteries are dipped at the factory on all assembled cars. Individuals may dip their own cells using a liquid air dry vinyl dip used on tool handles available at hardware stores. Dip adds 1/2 oz. to the weight of the car and may be left off if weight is critical. If the dip is not used, the batteries should be secured to the shaker plate using double sided servo tape to keep the cells from slipping sideways off the shaker plate. (CAUTION: Nicad batteries contain enough power to cause burns and start fires if shorted during handling or storage. Shorting batteries also can cause battery damage or imbalance.) Batteries may also be taped to the shaker plate.

SWITCH MOUNTING

If desired, mount your off-on switch through the shaker plate on the front side. The holes cut there fit some switches, but you may have to make changes.



Picture 5



Picture 6

RECEIVER POWER CONNECTION WARNING

Radio systems can be damaged if operated at over 6 volts. A 6 cell car has voltage of 7.2 volts and either a center tap or voltage dropping diode system must be used to protect the receiver.

You will need to provide 4.8 to 6.0 volt power to operate your receiver. You can add an additional 4 cell pack to power your receiver, but this adds weight and is illegal for racing. Power can be taken from the sub c 4 cell or 6 cell Nicad pack operating the car. 4 Cell power can be taken directly from the battery connector. A series switch can be added to allow you to conveniently turn off your receiver if you desire.

There are two ways to achieve the required lower voltage on 6 cell packs. The first way is to connect one or two voltage dropping diodes in series (band towards receiver) with your 6 cell pack and your receiver. This causes about 1.5 volts to be lost (.75 per diode) and the voltage is correct for your receiver. Care must be taken not to short out this receiver power or the diodes will be damaged. A prewired resistor harness #579 is available with diodes.

The second method to get 4 cell power for your receiver is to make a 4 cell tap connection.

Figure 1 shows the wiring of the JoMac 6 cell pack (#860) which has the 4 cell tap connection. All of JoMac speed controls are designed to get 4 cell power this way including the wired resistor assemblies (#578). One advantage of this system is that you simply plug the pack in backwards and your car is ready for 4 cell racing. The disadvantage to getting receiver power this way is that current for the receiver is taken from 4 cells only and causes a slight imbalance in your pack. But in reality, this imbalance is insignificant. See battery balance, page 19.

PAINTING LEXAN BODIES

JoMac Lexan bodies are designed to be good looking, aerodynamic, light, and the most durable available. All styles are available prepainted or clear for those who wish to paint their own. Proper painting of a body is not easy and may require some practice on scrap lexan pieces.

Tools needed for painting:

Spray paint gun with fine nozzle or air brush if not using spray cans.
Masking tape (3M recommended).

X-acto knife or other scalpel type knife.

Paint & thinner (see recommended brands).

400 grit sand paper.

Preparing Bodies

Do not trim wheel wells or put holes in the body prior to painting as paint may drip through onto the outside clear finish.

Clean the body if dirty or greasy from handling with dishwasher detergent. It is also advisable to sand with very fine 400 grit sandpaper to rough up the areas to be painted. This makes for a better bond between the paint & body. Do not sand the windshield areas.

To add stripes and designs mask off the body using masking tape cut on glass to design, and applied to the inside of the body. Do not cut the tape on the body as the body will crack along scribe lines. It may be easier to lay the tape on the body, mark with a pencil where to cut, peel the tape up, lay on a surface, cut, then reapply the tape.

Paints

Proper paints for lexan are sometimes hard to find and in order to stick properly some types must attack, or etch, the surface. If applied too thick some paint will weaken the body and cause stress cracks. Paint must be sprayed on very lightly and as dry (least thinner) as possible. Do not attempt to brush paint on.

Recommended Paints

PARMA® — available through hobby shops specializing in R/C car products. It is not available in spray cans so thinner and spray equipment must be used.

MOST VINYL UPHOLSTERY PAINTS — available in auto parts stores will work and can be purchased in spray cans, but test before use, as paints vary considerably.

RUST OLEUM® PAINT — available in hardware stores, is available in spray cans. This is runny paint and needs to be put on very lightly.

AUTOMOTIVE ACRYLIC LACQUERS — like Dupont or Nasson thinned with Dupont® 3613-S or Nasson® 481-03 thinner will stick directly, but spray on lightly and as dry as possible or it will etch and weaken the body. This paint is what is used by most experienced painters and manufacturers. These types are not available in spray cans, therefore, must be used with spray equipment.

ALL OTHER ENAMELS AND REGULAR LACQUERS — paints will not stick to the body surface unless a base coat that will stick is applied. Such primers are Krylon® #1302, Crystal Clear Acrylic or Speedy Dry Rust Oleum® Clear #2500. Do not attempt to mix lacquers with enamels, Dope & epoxies. When in doubt, don't.

Overspray or runs may be cleaned using wood (denatured) alcohol immediately after painting, before the paint cures. Do not use thinners directly on the body.

Bodies are painted on the inside so that the paint cannot be scratched and the clear lexan adds depth to the paint. When painting from the inside all masking must be done in reverse — window first, then stripes or trim.

Detailing the Body

After painting the body, the body may be detailed using a Sharpie® marking pen designed for permanent marking on most surfaces. Available at grocery & stationery stores,this pen can be used to highlight detail lines. Mistakes can be cleaned up using wood alcohol.

JoMac makes two different set of mylar decals, large #1149 and small #1148. These come complete with number, backgrounds, and sponsors.

Drivers can be painted, after sanding, with artists acrylic water base paint. These paints dry flat and can be trimmed with ball point or felt tipped pens.

Contact paper, glitter foil, or "trim" monocote can by used for stripes and designs on the outside of the body.

Trimming the Body

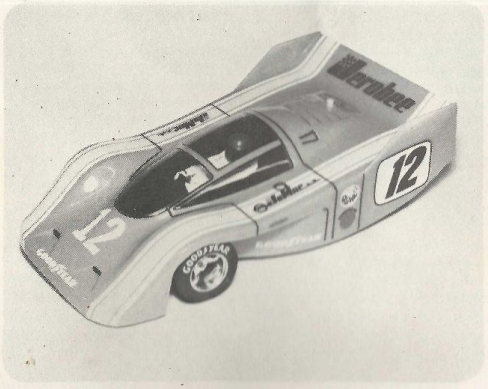
Cutting out a body can be done using tin snips or by scoring a line with a sharp scalpel knife and bending back, breaking the body along the line.

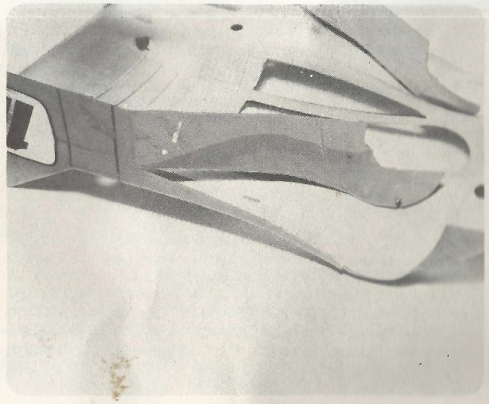
Holes for the front and rear body post and wing tubes should be drilled slightly oversized to allow for chassis flex.

The antenna hole should be large enough to allow for easy access — about 1/4".

SCHKEE BODY RACING TIPS

The Schkee Lola Can Am body is by far the best Can Am body available and certainly the most popular. The real car ran with the rear fender area close which cuts drag. The back of the front wheel well can be cut as shown which scoops air from inside the body and forces it out, increasing the negative pressure and down force inside the body. Even with this added down force the body has the same weight and drag as a conventional set up less a wing because you are only channeling the air in a constructive manner much like "ground affects" of real cars. It is always best to mount any body as close to the ground as possible. Note the side flaps are connected to the body with small screws and then the side wall is trimmed to clear the front end.





SECTION II—OPERATION INSTRUCTION & THEORY

POWERING YOUR ELECTRIC R/C CAR

Motors

Motors used on 1/12 scale electric cars are of the 05 type. These motors are available in a few different models. There are stock motors that are the lowest cost, yet perform very well. There are blue printed motors that have better balance quality which means they run smoother and will obtain higher RPM. Rewound motors are made with slightly thicker wire (22 gauge) which causes them to draw more current and, therefore, will have more power. There are also motors available that have ball bearings to reduce friction and are double wound with fewer turns (28 turns) to give super performance. The different models are available because of different organized racing classes and because of the different performance requirements of the R/C car owner.

National and most local organized races use ROAR (a national organization) rules to govern their races. There are basically two classes of racing; stock and modified. You should check with your local race club to determine which motor you should run in your car.

These motors typically operate on 5 - 8 volts D.C. in the form of battery power. They draw as much as 25 - 30 amps during stall and slow speed - high acceleration conditions, so good battery qualities and good wiring (18 gauge minimum) is required for good performance.

If you find after wiring your car that the motor runs backwards, simply reverse the motor leads.

Select from JoMac model numbers #520 - 542 for a motor and model numbers 551-563 for motor replacement parts.

It should be noted that the high performance model motors draw more current and, therefore, the running time on a charge will be reduced.

Motor Break-In

Motors, whether stock or modified, do not reach peak performance until their bearings are aligned and brushes seated.

Motors must be broken-in (run-in) to align the bearings and wear in motor brushes. During normal operation this takes up to four (4) hours.

The ideal method with the best results is to run the motor at two volts for about 12 hours. At higher voltages the motor will overheat (hot to touch) and it is necessary to stop the motor for cooling.

Motor bearings may be oiled, but only once in awhile and very lightly to avoid getting oil on the commutator. If a commutator gets dirty it can be cleaned with an eraser or alcohol after disassembling.

Motor Cleaning

Motors are semi sealed, but the commutator still requires occasional cleaning for maximum performance. The easiest way is to use spray contact cleaner (one without lubricant) available for cleaning electrical contacts and TV tuners. This is sprayed through the motor mounting screw holes using the plastic extension tube that comes with the cleaner.

The best method is to disassemble the motor and clean the commutator with a pencil eraser.

Motor Disassembly

If your motor has a knurled shaft you can remove them by using a fine file while the motor is running. This will allow the armature to be removed from the can without disturbing the bearing. To remove the endbell the tabs must be bent up. After a couple disassemblies the end tabs will break, in which case the endbell can be held in place using tape or small screws. When disassembling the motor keep track of all the small motor washers and where they go.

BATTERIES—GENERAL

Dry cells can be used to power your car, but are not legal for racing and, due to the bulk and expense of replacing dry cells, the only practical batteries to use are the rechargeable nickle-cadmium (Nicad) type. 1/12 scale cars use 1.2 amp hour sub C size batteries. There are also various types of sub C nicads available. There is the type that requires 15-16 hours to recharge at a charge rate of .1 amp (100 ma) and there is the so-called quick-charge nicad that needs 5 hours to recharge at a rate of .3 amp (300 ma). Finally, there is the fast-charge sub C nicad that can be recharged in only 15 minutes at a charge rate of 4 amps. The fast charge is, by far, the most popular. This means you can run your car after only 15 minutes of charge time if you desire. There are also some fast charge batteries that cannot withstand the severe requirements of 1/12 scale R/C car use, so it is recommended that you purchase your fast charge batteries only from a recognized 1/12 scale manufacturer.

There are two types of battery arrangements used in 1/12 scale cars: the 4 cell series connected pack and the 6 cell series connected pack. The 4 cell pack is used for indoor racing primarily, and the 6 cell is used primarily for outdoor asphalt parking lot type racing. The 6 cell pack will give you much more performance than the 4 cell pack, but the 6 cell pack will not give you as much running time as the 4 cell pack because of the increased current demand. A 4 cell pack output will be about 5 volts and a 6 cell output will be about 7.5 volts.

JoMac has batteries available in several forms. JoMac #810 GE & #811 Sanyo are single sub C cells. The #830 GE & #831 Sanyo are 3 cell sub C nicad sticks. The JoMac #840 GE is a wired 4 cell pack with a 5 pin Deans connector. The #860 GE & #861 Sanyo are 6 cell wired packs with a 5 pin Deans connector that has a 4 cell tap connection for receiver power. A 6 cell GE wired pack is also available with a 3 pin AMP connector, #80.

Refer to the battery charging section for charging instructions and precautions.

BATTERY CHARACTERISTICS

G.E. (General Electric) Nicad cells are available in several types, each with a different capacity and resistance. The G.E. type chosen for R/C car use have an average capacity of 1.1 Amp Hour and an average resistance of 11 milli ohms. They are highly reliable when used properly and take abuse from overcharing much better than any other type. G.E. Sub C's may be slow charged at 100 milli amps and fast charged at 4 amps.

Sanyo Nicads, like G.E., come in several types. The type provided are yellow wrapped and have a very low internal resistance of about 9 milli ohms and, therefore, under load put out slightly more voltage than the G.E. type, allowing the car to go about 1-2 MPH faster. Sanyo cells have an average capacity of 1.2 amp hour which is 10% more than the fast charge G.E. type. Sanyo batteries do not take abuse as well as G.E. type and degrade from normal use much faster, therefore, are not recommended for beginner, amateur or sport use. Sanyo batteries can be slow charged at 100 milliamps and may be fast charged at 2 amps (4 amps charge rate is possible, but not recommended as it degrades the cells quickly).

All Nicad batteries, especially Sanyo type, last longer and provide more capacity if slow charged only. We recognize this is not practical in most instances, therefore, you must invest in a good fast charger. JoMac makes several types as explained in text.

The fast charge Nickel-Cadmium (Nicad) batteries used in 1/12 scale electric cars are capable of being recharged approximately 300 times before they start to show signs of age and can deliver 50 amps of current quite easily when demanded. Fast charge batteries can be charged in just 15 minutes and deliver their energy at an almost constant level until the very end.

Since motors draw more current under accelerating and slow speed conditions typical of road course racing, you will find that a charge on a pack will last longer in oval type racing even though the speeds are higher.

Capacity rating of 4 and 6 cell packs are the same as the individual cell as discussed above because the cells are series connected and, therefore, the current that is delivered to the motor goes through all of the cells equally. The only difference is that the terminal voltage has been increased.

As the 4 or 6 cell pack is being discharged, the lower capacity cell of the pack will become completely discharged first and its individual voltage will drop off causing the pack voltage to drop off by this same amount. By further discharging the battery pack, a second cell will become completely discharged and the pack voltage will drop off slightly more, and so it will continue. At first sign of the first cell dropping off, further discharge should be stopped because of a reverse charge situation that happens. As a charged pack is being discharged and the first cell of the pack is completely discharged, its terminal voltage goes to zero. Because all the cells are series connected, the current is the same in all the cells and any further pack discharging will cause this discharge cell to begin to charge in reverse. This reverse charging will permanently damage batteries and must be avoided. In conclusion, only run your car until the first sign of the pack being completely discharged. It would be a rare situation that all the cells of a pack would become discharged at the same time, and therefore, no reverse charging would occur.

These batteries should never be allowed to get hot because permanent damage can occur. Excessive discharge rates in the order of 15 amps and greater continuously cause the batteries to become too warm. The higher discharge rates can only be done intermittently. Warm batteries also drop their output voltage during discharge which results in a slower car.

Battery Characteristics-Continued

The capacity rating of Nicads can be used to assist and understand battery charging as well. Charging time is governed by the following equation:

$$\text{Charging Time (hours)} = \frac{\text{Battery Capacity (ah)}}{\text{Charging Current}}$$

For example, a completely discharged 1.0 ah battery that is being charged at 4 amps will require 1/4 (1.0 ah/4 amps) hour or 15 minutes to completely charge the pack. This should only be used as a guide and not a hard fact. It whould be noted that the current used in the equation is a constant current of 4 amps and not a current that is changing during charge. This same battery that is completely discharged can be fully charged at a rate of 2 amps for a time of 30 minutes, for example. These batteries must *not* be charged at a current greater than 4 to 5 amps or permanent damage could occur. Any charge rate above .15 amps (150 ma) must be time limited or permanent damage will occur. A battery that has a high discharge capacity will also have a high charging capacity.

The biggest enemy of the Nicad is high temperature and must be avoided if at all possible. Typically, the most damage to Nicads is done during fast charging. So, a good understanding of charging is important.

CHARGING NICAD HEAT CHARACTERISTICS

As a Nicad is being charged, the current that passes through the cell causes a chemical conversion to take place and, in this way, energy is stored. But, due to the limited capacity of batteries, eventually no more chemical conversion can take place and this energy going into the cell, by passing current through it, must go somewhere. This energy, after the battery has been completely charged, is given off in the form of heat; damaging heat. While *overcharging* with 4 amps, the power being dissipated in a 6 cell pack is 40 watts. This is enough heat to melt plastic car parts. The presure inside the cell can reach 500 PSI and can burst the cell, particularly if the built in relief valve fails to work. When the pressure relief valve releases pressure, battery electrolyte can be lost, which will reduce the charging capacity of the battery. So, overcharging and the high temperature, particularly due to fast charging, must be avoided to prevent battery damage, explosion and even fires. When fast charging, at the first sign that batteries are getting warm (check all of them), stop charging immediately.

CHARGING NICAD VOLTAGE CHARACTERISTICS

Another indication of charge condition of a nicad pack is the voltage of the pack while fast charging. When first starting to fast charge (at a constant 4 amps) a discharged 6 cell pack, the voltage could be as low as 6 volts but it will begin to rise immediately. As the charging continues, this voltage will slowly rise until the pack is completely charged (approx. 15 min.). Near this point the voltage will reach a peak, then begin to drop slightly. This peak voltage (also called Delta Peak) will be in the order of 10.2 volts (under 4 amp charge) for 6 cell and will vary from pack to pack and, as a result of different volt meters, slightly different charging currents and battery variations.

The time when this peak voltage is observed will correspond to the time the pack will begin to warm up and charging should stop immediately. The amount of charge time to reach this peak starting with a completely dead pack may vary from 12 minutes to as much as 20 minutes. The time depends on your pack capacity.

Observing this peak voltage using a charger with a panel voltmeter will be difficult to see, but can be done. The ideal way to monitor this pack voltage is to use a digital voltmeter that has a digit readout accuracy of 1/100 of a volt (10.21 volts, for example).

During any part of the 4 amp fast charge cycle, if the voltage was observed and then the charge current was stopped, the pack voltage would drop immediately. This drop in voltage is due to the battery pack internal resistance. But, what it means is that if you are going to determine charge condition by this voltage monitoring, the current must be constant or at least consistent and at the fast charge rate of 2-4 amps for Sub C.

To become familiar with the voltage of the pack in relationship to the charge on a pack, you must first only fast charge completely discharged packs (approx. 12-20 minutes) until the pack voltage is observed and/or the pack begins to get warm. But, after you are familiar with this relationship you can charge packs that have an unknown amount of charge by monitoring its pack voltage. You will find after starting to fast charge a partially charged pack, that it will take about 30 seconds or so for the voltage to raise to the normal charge-voltage relationship.

So, to charge a partially charged pack, just look for this familiar peak voltage.

Warning — Charging using the peak voltage (Delta peak) method only works with a balanced pack and can be damaging to an unbalanced pack. Example:

Charging Nicad Voltage Characteristics-Continued

If one cell is 50% charged and the other cells are 25% charged when charging begins then the overall voltage of the pack will continue to rise even though one cell may be going into overcharge.

Note: 1. Sanyo batteries have a lower resistance than G.E. type and, therefore, have a lower voltage reading.
2. Voltage varies with resistance, hot batteries have higher resistance.

BALANCING PACKS BY SLOW CHARGING

A balanced pack is one that has all the cells of the pack charged to an equal amount. The cells of the pack could be all discharged, all charged to 1/2 capacity, or all completely charged. The fact is, they are all equally charged and this is necessary to have a pack that has a very high voltage output during use until the end when all the cells drop off, due to discharged, as close to the same time as possible.

Packs may be unbalanced for several reasons. If a pack has been allowed to go into overcharge, one or two cells may have gotten hotter than the rest and they could have vented and lost some of their charge, therefore, have less charge than the rest. A part of the pack could have been shorted temporarily and an unbalance of charge would be present. When a new pack is wired, the cells are not balanced. If a cell must be replaced, for any reason, this cell will more than likely not have the same charge.

There are two basic situations that are damaging to Nicads. One situation is that if a Nicad is allowed to go into overcharge, the excess heat will damage the cell. The other is when a cell is being discharged. If the cell voltage is allowed to go negative, the cell will be reverse charged, and this will damage the cell. This reverse charging is possible when discharging, for example, 6 series connected cells, because when one cell of the pack becomes discharged, the remaining cells will continue to discharge causing a reverse charging current in the discharged cell.

If a 6 cell pack has cells that have different amounts of charge and discharging the pack is stopped because a cell is beginning to reverse charge, the remaining cells still have charge that you cannot use to power your car. On the other hand, when you fast charge your unbalanced pack, you must stop when the first cell begins to get warm, and consequently, all the cells do not get charged. The solution to this problem is to slow charge the pack. Slow charging a pack is done by choosing a charging current that, if left charging continuously, will not cause the cells to get warm enough to be damaged. For Sub C cells, this current is 100 mil amp (.1 amp). So, to balance a pack, simply charge the pack at 100ma for 16 hours. Slow charging should be done as frequently as possible to keep your pack in good balance.

CHARGING WITH A CHARGE CORD

The charge cord has been developed to provide a very low cost battery charger. Charge cords are designed for use with 4 cell packs or 6 cell packs, but not both. They are constructed with a calibrated amount of resistance to adjust the current to 4 amps when used with an automobile 12 volt battery. They do not have an automatic shut-off timer, so extreme caution must be used to limit the charge to 15 minutes for a completely dead pack. It is recommended that a mechanical bell timer be used to remind you of elapsed charging time, and frequent monitoring of battery temperature is recommended. JoMac has a model #594 charge cord to be used with a 4 cell pack, and a model #596 to be used with a 6 cell pack. They have 5 pin plugs to mate with JoMac battery packs. JoMac also has a low cost slow charge adaptor (#590) to be used with either charge cord for balancing the pack. Fast charge only balanced packs. See slow charging section.

CHARGING WITH THE RESISTANCE TYPE CHARGER

The resistance type charger is a boxed type of charger that has a current meter which shows charging current and also has a 0-15 minute fast charge shut-off feature. They usually are provided with a switch to select 4 cell or 6 cell to adjust the current to 4 amps for these packs. Some have discharge circuits to discharge packs and most have a slow charge feature that slow charges the pack after the fast charge has terminated (timer off). They are made to be used with 12 volt automotive battery.

Because the voltage of Nicad packs changes as they are being charged, the charging current varies with this type of charger. If a completely discharged pack is being charged, the starting current is usually around 5 amps, and after the pack has reached full charge (about 12-20 minutes), the current is usually down to about 3 amps. Therefore, the average current is about 4 amps. If the 12 volt automotive battery has consistent output and you have charged your pack a few times, you will notice that every time you charge your pack the current will be about the same. This information will allow you to safely charge a partially charged pack, providing that you monitor the current meter for this known charged current that you have determined. To slow charge your pack, simply connect the charger to the 12 volt automobile battery and your pack, but do not turn the timer on. Slow charge for 16 hours. JoMac has a model #804 Resistance Charger that is to be used with a 12 volt automotive battery and has the current meter, 15 minute timer, 6 cell-4 cell switch, and has the slow charge feature with an LED lamp to indicate slow charge. Fast charge only balance packs. See slow charge section.

CHARGING WITH THE CONSTANT CURRENT CHARGER

The constant current charger is similar to the resistance type charger, but is has some improved features. The constant current charger has an electronic circuit to provide a constant charging current that is selectable. They will usually have a voltmeter to monitor the pack voltage before, during, and after the charge. They also have a mechanical 0-15 minute timer which allows you to select the fast charge time, and some have a slow charge feature.

The advantage of the constant current charger is that any number of series connected cells from 1-8 can be charged with no variation in the selected current. This makes the charger very versatile. A voltmeter monitors the pack voltage so abnormal voltages, due to bad cells, can be spotted easily.

Since the current is constant, and a 0-15 minute timer is provided, exacting amount of charge can be delivered to battery packs. For example, a 1.0 ah of charge can be delivered to a pack by setting the charger to 4 amps with a time of 15 minutes.

Since the constant current charger delivers a constant current and a voltmeter, rather than an amp meter, is provided, a pack can be charged by using the voltage method of determining full charge. See section on Charging Nicad Voltage.

CHARACTERISTICS

JoMac has model #801 & #803 Constant Current Charger that are designed to fast charge and slow charge a number of cells from 1-8, either AA of Sub C size Nicads. It has a voltage meter or LED readout for monitoring pack voltage and has a 0-15 minute timer and switches to slow charge when the fast charge timer has elapsed. A LED lamp is also provided to indicate normal operation. Power for the charger can come from a 12 volt automotive battery or a 4 amp or greater capacity automotive battery charger. It delivers 4 amps for fast charge and 100MA for slow charge to a Sub C Nicad pack. It delivers 2A for fast charge and 50MA for slow charge to an AA Nicad pack.

SPECIAL RACING TIPS ON BATTERIES AND CHARGING FOR MAXIMUM PERFORMANCE UNDER RACE CONDITIONS

For maximum speed use batteries with the lowest resistance (Sanyo Yellow).

For maximum running time use batteries with the most capacity (G.E. has 1.4 amp cells available).

The capacity and resistance of batteries vary even in cells of the same type and batch therefore, sorting is advantageous.

Cells need to be "Cycled" for maximum capacity and lowest resistance. Cycling is done by charging full, balancing, and discharging cells. Maximum battery performance is achieved after cycling a pack about 8 times. Don't expect good battery performance from a new pack or one that has been stored for several weeks.

Cells degrade with many cycles. The faster they are charged the faster they degrade. As cells degrade their resistance increases and capacity shortens.

Slow charging is the safest way to charge batteries and prevent degrading.

Maximum capacity is achieved from a balanced slow charged pack that has been "cycled" and "pumped" with 2 amps for 30 seconds prior to the race. This adds about 1% more capacity.

SPEED CONTROLLERS

Electronic Type Speed Controls

The electronic type speed control performs the same function as the resistance type, but does it electronically. It has no moving parts and is simple to use. There are three basic electrical connections to make, to the receiver, battery pack, and motor. Electronic speed controls are made to plug into your receiver just like a servo (usually channel 2). Sometimes connectors have to be changed to adapt to your system, however, power for your receiver and steering servo usually comes from the electronic speed control which, in turn, comes from the 4 cell or 6 cell sub c Nicad pack. The proper receiver voltage is obtained by the cell tap method, the 2 diode method, or is sometimes done electronically in the speed control.

Electronic speed controls provide you with a more proportional speed control and better slow speed control. Brake is accomplished by shorting out the motor electronically.

When you are running your car at half speed the electronic speed control pulses the current full on and then full off in the amount necessary to move the car half speed. This pulsing causes less energy to be lost in the form of heat than in the case of the resistance type controller. The disadvantage of electronic speed controls is an inherent voltage loss of about .3 volts at normal racing conditions which in reality is quite insignificant (4% for 6 cell operation).

One big advantage of electronic speed controls is their instant response (less than 1/60 second). The servo resistance type speed control has an inherent delay due to the servo response time. See racing tips.

Resistor Speed Controls

There are two basic types of speed controllers. The first is a resistance type.

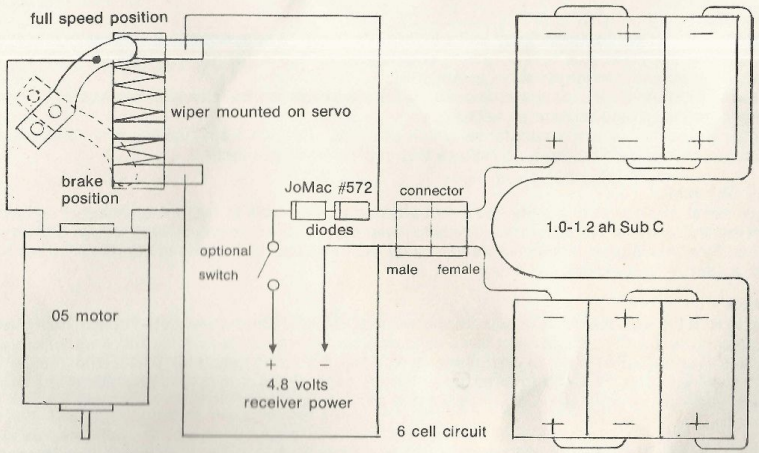
A power resistor is used in conjunction with a standard servo which is usually connected to channel two of your receiver. A wiper arm is mounted on the servo output arm and it is allowed to rub on the top surface of the power resistor winding. As the servo and the wiper arm is moved, the resistance between the motor and your battery pack is varied from the maximum (1-2 ohm) to zero resistance; thus controlling the speed of your car. (See figure (picture 5) & figure (10).

It can be seen in figure 10 that when the servo moves the wiper to the full speed position, the motor leads are connected directly to the battery leads without any resistance. Therefore, maximum acceleration and speed will be realized.

As the servo moves the wiper away from the full speed position on the resistor, more resistance is added in series with the battery and motor. Consequently, the motor will slow down. As the wiper continues to move it reaches and stops on the brake pad. The circuit now shows that power has been removed from the motor, but the motor leads are shorted. This shorting causes the braking action to occur. It is observed that only maximum braking occurs in the brake position with this type of resistor and circuit arrangement.

By looking at figure 10 you will notice the resistor has a resistance winding connected to the brake end as well as the power end. This circuit arrangement allows a variable amount of braking to occur as well as a variable amount of acceleration and speed. JoMac part #576 is a resistor of this type as used in "Lightning 2000" kits. It has a 1 ohm power resistance with a brake winding. Part #579 is a 1 ohm resistor in assembled form. It comes completely wired with 5 pin male Deans power connections and 3 pin female Deans motor connections. These resistors will work with 4 cell or 6 cell systems.

Figure 10 BASIC RESISTOR SPEED CONTROLS



All wires should be 18 gauge except receiver power wires.

SECTION III—RACING TIPS

LIGHTNING 2000 DIFFERENTIAL

Differentials prevent the traction of the rear tires from fighting the turning ability of the front tires allowing better steering. They also help prevent the car from spinning out due to slippage and have the effect of masking (hiding) the affects of castor, flex, tweak, and weight transfer.

Differentials are recommended for beginners, especially on slippery surfaces, as they make a car work better without a perfect car set up. However, they tend to use up some power. In an all out race on a good traction surface, with a properly set up car and a good driver, a straight axle car is faster.

Assembly

The differential can be assembled on or off the car. In order to tighten the Allen Cap Screw the stationary wheel (the one opposite the differential) must be attached to the axle at the flat spot provided. Assemble the differential from left to right as shown in the drawing. Use plenty of vaseline or other heavy body grease on ball rollers, thrust bearing and between the axle and free wheel.

NOTE: the hardened drive washers have one ground face, this side should go against the balls.

Cautions

*Do not overtighten the Allen Cap Screw or you may dislocate the thrust hub, which is pressed on. When tightening the axle assembly to lock up the differential action — see "Locking the Axle".

*Do not burr the axle with pliers or vise as the bearing will no longer slip over the axle smoothly. If a burr should occur, clean up with a fine file and polish with crocus cloth.

Adjusting Gear Slip

By tightening the Allen Cap Screw the gear will slip less. By loosening the Allen Cap Screw the pressure on the ball rollers is less, allowing the main gear to slip, taming engine torque. This is desirable on slippery surfaces. Normally the setting stays fairly constant through an average run.

WARNING: Excessive long term slippage will cause the drive washers and balls to wear more quickly. Inspect the drive washers for "wear grooves" and replace as necessary.

The Allen Cap Screw has a nyloc substance which prevents vibration from loosening it during operation. After repeated adjustment it may be necessary to replace this cap screw or use loctite.

Car Set Up For Differential

Normally the lowest rear center of gravity and a stiff chassis are desirable to prevent spinning or unloading of the inside rear wheel on hard corners. The differential tends to lower or mask the effects of tweak, castor and chassis flex, but all still affect handling to a degree. It is desirable to lock up the free wheel of the axle to adjust car tweak before freeing the differential action — (see locking the axle).

Locking The Axle

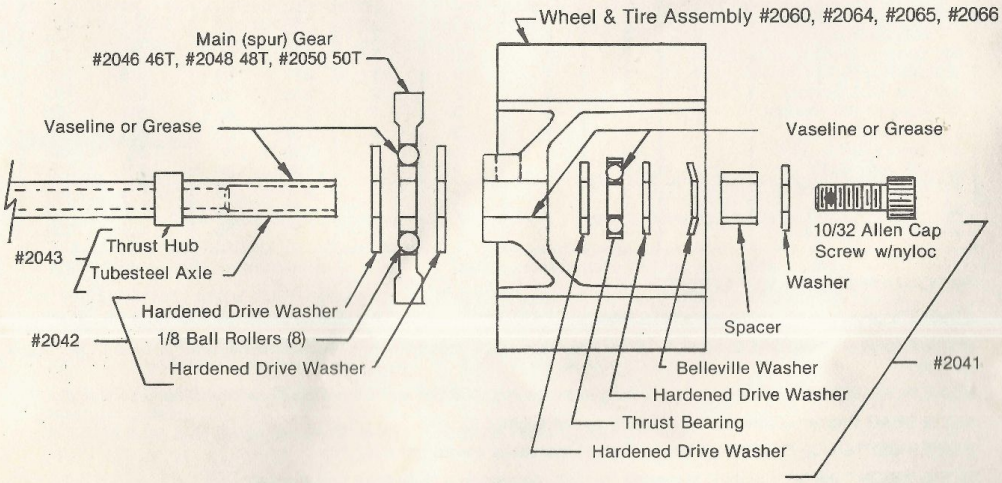
It is possible to lock the free wheel to the axle using the set screw in the free wheel hub. You can lock the axle with the gear set tight, in which case, the car will react like a solid axle car, where castor and flex will work for or against the car handling. The axle may be locked with the gear preset to slip (see adjusting gear slip). This makes the car handle like a straight axle car with a torque converter to tame motor torque. Locking the axle is desirable sometimes on very high or very low traction surfaces, depending on driving style and car set up.

Lubrication

It is recommended that the balls, thrust washers, and free wheel hub be lubricated regularly with vaseline or other heavy bodied grease.

Differential Break-In

During initial operation the differential may be stiff and go out of adjustment easily. After some usage the balls and washers will have seated and the differential will become smooth and hold it's setting.



LEXAN CHASSIS #2025 & #2026

The properties of Lexan are ideally suited to electric R/C Car use. The #2025 injection molded chassis can be used on the Lightning 2000 series cars and is only 4 grams heavier than our standard #2033 low weight high flex G-10 chassis, yet is over four times more impact-resistant and much lower in cost. The #2026 light-weight Lexan chassis is 10 grams lighter than #2025, yet is 95% as stiff and strong. The most interesting feature of the Lexan chassis is that when you hit the wall it doesn't take a temporary set like G-10 fiberglass or graphite. When the car is put back on the track, after an impact, it is straight and doesn't need any time to settle out. Lexan's only weakness is caused by contamination from petroleum-based products such as gasoline, WD-40, nitro-methane, solvents, some oils, Locktite, ammonia and especially 10-second glues.

BODIES

Relative Affects of Bodies

Body Affects Chart	Stability	Down Force Front	Down Force Rear	Wind Drag	Height of C.G.	Painted Weight Oz.	Painted Weight Gram	Battery Area Width Inch	Battery Area Width mm
306 Shadow (Formula)	3	2	3	3	1	1.27	36	6¼	159
307 Alfa (Sports)	2	5	5	4	2	1.91	54	6¼	159
308 Corvette (G.T.)	3	3	3	2	3	2.12	60	5½	140
309 VW Bug (G.T.)	1	1	1	5	5	2.22	63	5½	140
310 Lola T282 (Sports)	4	3	4	2	2	2.08	59	6½	165
311 Porsche 917 (Sports)	5	4	5	3	2	2.12	60	6½	165
314 Schkee (Sports)	5	4	5	2	2	1.87	53	6½	165
315 Toyota (G.T.)	2	4	3	3	4	2.19	62	5⅞	149
316 HB Vette (G.T.)	2	3	2	2	3	1.98	56	5¾	146
318 Ford GT40 (Sports)		3	2	3	3	205	58	6½	165
320 Lightning (Indy)	3	3	3	2	2	1.48	42	6¼	159
321 BMW M-1 (G.T.)	2	3	3	2	4	1.99	56	6¼	159

EXPLANATION OF BODY AFFECTS

STABILITY (higher number) increases stability.

MORE FRONT DOWN FORCE (higher number) increases high speed steering. Increased oversteer at speed. Decreases stability.

MORE REAR DOWN FORCE (higher number) increase rear traction and increases understeer. Increase stability.

MORE DRAG (higher number) slows the top speed slightly.

HIGHER CENTER OF GRAVITY (higher number) increases weight transfer.

MORE WEIGHT (higher number) increases traction, decreases acceleration and braking.

REAR WING, depending on the angle, can add one to two relative points rear down force. Also increases drag .5 to 1 relative points. Adds weight of ¾ oz. (21.3 grams).

WIDTH. Lightning cars require a width of 6¼" (159mm) for batteries. Jerobee chassis cars require a width of 5⅞ inches for batteries. Other brands, or layouts, using 3 cell stick batteries require between 5 to 6¼" (127 & 159mm).

Wing Adjustment

The wing angle, height, and location are all important to the rear downforce. For more rear downforce, increased stability and decreased oversteer at high speeds mount the wing farther back or add more angle up to 30%. Raising the wing gets it into cleaner air, but also affects the weight transfer.

To move the wing forward or back, rebend the wing wire so that the bend will be closer or farther from the top of the wing tube.

TIRE COMPOUNDS & CHARACTERISTICS

Tire Tips

It is possible to ad a slight traction increase to tires by adding shallow (1/8") multiple slits around the tire surface. If the slits are too deep it will increase tire bounce and deterioration. Add slits by spinning the tires under power and using a scalpel knife — use extreme caution as the knife may grab or slip out of control causing injury.

Clean tires have much better traction. Tires may be cleaned using alcohol.

Tire rubber tends to dry out with age and may be rejuvanized using WD40 Spray, which is mostly solvent, or another solvent on the tire surface. Do not soak the tires as this will cause the glue to soften. Apply by rolling the tires in a puddle of WD40 or other solvent, let stand 1 minute, and clean.

Front Tire Compounds

TYPE A FOAM SPONGE FIRM—Medium traction, medium wear for asphalt tracks stock compound on all Lightning 2000 cars.
#2074 Tires on 2000 Series Wheels 9" Wide — #2094 Front Donuts 1" Wide (Old #616)

TYPE F FOAM SPONGE HARD—Minimum traction for low wear on slippery tracks.
#2075 Tires on 2000 Series Wheels 9" Wide — #1095 Front Donuts 1" Wide (Old #620)

TYPE D FOAM SPONGE SOFT—Maximum traction, high wear, for most rug and high bite asphalt tracks.
#2076 Tires on 2000 Series Wheels 9" Wide — #2096 Front Donuts 1"Wide

TYPE C FOAM SPONGE SOFT—High traction (more than A less than D) high wear for use on rug and asphalt tracks
#2077 Tires on 2000 Series Wheels 9" Wide — #2097 Front Donuts 1"Wide

TYPE A/D FOAM SPONGE COMBINATION—Half & Half A & D type rubber, stable on straight yet high traction in fast tight corners.
#2078 Tires on 2000 Series Wheels 9" Wide — #2098 Front Donuts 1" Wide

Rear Tire Compounds

TYPE C FOAM SPONGE MEDIUM—Highest bounce, medium to high traction, best on dirty, dusty asphalt surfaces.
#607 Hex Wheels & Tires — #2064 2000 Series Wheels & Tires
#609 Tire Donuts Only

TYPE D FOAM SPONGE MEDIUM—1 1/2" wide, medium bounce, highest traction on clean asphalt surfaces.
#608 Hex Wheels & Tires — #2065 2000 Series Wheels & Tires
#610 Tire Donut Only

SILICONE COATED TIRES—Best traction on smooth, dust free surfaces, coat with G.E. clear silicone use a coarse tread bolt for applying tread while spinning tire on axle in drill.

INNERTUBE CAPPED TIRES—Best traction on concrete/sand/paint surfaces. Use 2" diameter bike innertube turned inside out and glued with 10 sec. glue or contact cement. Overlap tube over edges of tires.

GEARING

Gear Mesh

It is important to have the smoothest gear ratio in order to transmit motor power into maximum speed. Some gears may have a small amount of flash which can be cleaned up with a small file or X-acto knife. Gears can be adjusted up to a total of three (3) teeth using the motor cam. Larger changes require changing the pinion or main gear. Keep in mind, when adjusting the rear axle cams, the gear mesh changes. It is possible to decrease gear drag by sanding the sides of the gear face while the motor is spinning the rear wheels. This decreases the gear contact area, but also decreases gear strength.

GEAR RATIO CHART

	8	9	10	11	12	13	14	15	16
44	5.50	4.89	4.40	4.00	3.67	3.38	3.14	2.93	2.75
45	5.63	5.00	4.50	4.09	3.75	3.46	3.21	3.00	2.81
46	5.75	5.11	4.60	4.18	3.83	3.54	3.29	3.07	2.88
47	5.88	5.22	4.70	4.27	3.92	3.62	3.36	3.13	2.94
48	6.00	5.33	4.80	4.36	4.00	3.69	3.43	3.20	3.00
49	6.13	5.44	4.90	4.45	4.08	3.77	3.50	3.27	3.06
50	6.25	5.56	5.00	4.55	4.17	3.85	3.57	3.33	3.13
51	6.38	5.67	5.10	4.64	4.25	3.92	3.64	3.40	3.19
52	6.50	5.78	5.20	4.73	4.33	4.00	3.71	3.47	3.25
53	6.63	5.89	5.30	4.82	4.42	4.08	3.79	3.53	3.31
54	6.75	6.00	5.40	4.91	4.50	.415	3.86	3.60	3.38
55	6.88	6.11	5.50	5.00	4.58	4.23	3.93	3.67	3.44
56	7.00	6.22	5.60	5.09	4.67	4.31	4.00	3.73	3.50
57	7.13	6.33	5.70	5.18	4.75	4.38	4.07	3.80	3.56
58	7.25	6.44	5.80	5.27	4.83	4.46	4.14	3.87	3.63

The average all around best gear ratio with a stock motor on regular tracks for 4 cell race cars is 3.75 to 1 and for 6 cell cars 3.90 to 1. For more top speed, but reduced acceleration, decrease the ratio. For more acceleration and slower speed increase the gear ratio. Note the lower the gear ratio the higher the battery drain. Tire size also affects the ratio.

NOTE: These ideal ratios are based on a race lasting 8 minutes. For shorter races you may decrease closer to (1 to 1) the ratio.

Items effecting the gear ratio are as follows:

TRACK—Long loose tracks with over 100' straights and few tight corners decrease ratio by .25 to .50. Short tight tracks of 75' or less increase the ratio by .25 to .50.

AERODYNAMIC DRAG. Higher wind drag bodies require a lower gear ratio. See body information on page 24 and lower the ratio by .10 for each point over 3.

WEIGHT. The higher the car weight the lower the ratio in order to achieve the best acceleration to top speed ratio. Lower the ratio by .10 for each ounce over 31 oz. for 6 cell and 29 oz. for 4 cell.

ELECTRONIC SPEED CONTROLLER. Electronic speed controllers tend to provide a little less bottom end torque, therefore, the ratio should be lower by .25 on the average for 20 amp speed control units and .50 on 10 amp units.

MOTOR VARIANCE. Motors, even of the same construction, all vary in torque and RPM. Some motors, even stock ones, have timing built in that cause them to run faster in one direction than the other. Two motors using the same gear ratio may run at different speeds.

Items Affecting Gear Ratios—Continued

MOTOR WINDS

Different motors are wound with wire of varying size and number of turns which affect the ideal gear ratio. Motors with less than 35 turns tend to run faster RPM with less torque requiring a higher gear ratio. Motors with larger than 23 gauge (60 MM) single wind wire increase torque and require a lower gear ratio. Double and triple gauge wires are figured differently.

JoMac makes different complete modified motors and rewound & modified armatures that will increase car speed when properly used. The slower motors may run faster with a different ratio and only testing will determine your motor characteristics. Always test motors after they are broken in as RPM and torque will vary and the motor brushes seat.

As motor timing is advanced motor RPM increases and torque decreases requiring a higher ratio.

CHASSIS GLOSSARY OF TERMS & CHASSIS ADJUSTMENT FEATURES

TWEAK — The uneven weight distribution on the rear tires. If a chassis is "tweaked" it will tend to turn tighter (under power) in the direction of the rear tire with the least weight (or front tire with the most weight). At coast tweak has no affect on turning. Under brake it has the reverse affect of power on. Tweak is not desirable unless you want a car to turn better under power one way or another.

CASTER — Tilting back the spindle kingpins 2 - 7% has the effect of tweaking the chassis by rotating one front tire down while rotating the other up slightly during a turn. This effect maintains the straightaway stability while adding oversteer under power.

FLEX — Is the amount of lateral twist a chassis/frame is capable of. The more flex a chassis has the tighter it will turn under power due to the "weight transfer".

WEIGHT TRANSFER — Is the loading of weight on one rear tire or the other in a corner due to the effect of centrifugal force on the higher chassis/frame weight and has similar effects as castor on chassis handling.

TRACK — Is the width of the front or rear wheels. Track width affects the weight transfer and castor effects on chassis handling.

CAMBER — Is the perpendicular angle of the front wheels. By adjusting camber you can adjust the front tire contact patch with the ground.

ADJUSTING CHASSIS — 2000 SERIES

CHASSIS "TWEAK" — Tweak can be caused by a pair of tires of different diameter. a twisted chassis, the body not allowing the chassis to flex. If the car pulls to the right under power, space up the right front wheel which allows more pressure on the right rear tire. This can be adjusted by the addition of washers or "c" clips on the king pin over the top of the A-arm under the upper spindle arm or by adding washers under the right side of the front end.

CHASSIS "FLEX" — May be increased by cutting coils off each spindle spring, by thinning or cutting out or drill holes in the center of the chassis/frame, or by loosening the front shaker bolt. To stiffen chassis, tighten the shaker plate bolt or stiffen the spindle spring with spacers. NOTE: the more "flex" a chassis has the less a "tweak" will be apparent. The less "flex" the more a slight "tweak" will be noticeable.

CASTER—The "Lightning 2000" car comes with 5% caster built in. More or less caster can be added by placing washers under the front or rear end of the front end mounting blocks. Caster is one of the most used car adjustments.

WEIGHT TRANSER — Can be adjusted by raising or lowering the rear center of gravity (c.g.) with axle cams. Too much weight transfer can cause corner hop and tire bounce. Not enough weight transfer will cause the car to understeer. When using a differential, it is best to lower the rear c.g. as this will keep the differential from free wheeling by lifting the inside rear tire.

CAMBER — You can go from full tire patch to part patch depending on the camber angle, and vary that contact patch with the amount of steering angle. To adjust for camber, warp the front end by loosening the outside front end mounting bolts and tighten the center bolt that goes through the middle of the front end. Then, retighten the outside mounting bolts until snug. For positive camber, loosen the outside bolts and stack washers at the center bolt between the front end and the chassis plate. Insert the middle bolt, but tighten the outside mounting bolts first, warping the outside of the front end down. The castor angle affects the tire patch. Most adjustments are made from neutral to positive (warping the outside up).

GENERAL RACE TIPS

RESISTOR SPEED CONTROLLERS

Lower OHM resistors give faster high speed response, but don't run at slower speeds. Higher OHM resistors give better slow speed response, but slower high speed response.

In order to get maximum speed and smoothest response you must keep resistors clean and making good electrical contact with the wiper button. To clean the resistor use very fine emery cloth. It is available to round off the edges of the wiper button.

When driving with a resistor speed control you must anticipate braking and acceleration similar to a gas engine car. It takes a while to get used to this "timing." Shortening the wiper arm throw or using fast servos decrease the anticipation/-timing/control delay.

Brake band resistors may be reversed using the shorter brake band as the power band and the power band as the brake band allowing faster servo response.

Resistor Bypass

In order to get the best contact on a resistor's high speed band most racers are adding a "Resistor Bypass" which is simply made from a wiper arm and button. This bypass acts to pinch the wiper contact button tight to the resistor high speed band providing better contact. The bypass is wired to the high speed band to provide a double contact. Depending on wiper tension and how clean th resistor is, the bypass can lower resistance from 8 to 20 miliohms, which in an 8-minute race can make a difference of 15 to 40 feet.

Wires & Connectors

Resistance is accumulative, meaning a little here and a little there all add up. Resistance is present in all wires and non-soldered connection. Heavier wire has less resistance than lighter weights. We recommend using at least 18 gauge high temperature wire on all battery, motor, and controller connections. Lighter wire is sufficient for radio connections. Use as short a wire as possible. Keep plugs and resistor clean. JoMac plugs are gold plated for low resistance and to prevent corrosion. For top performance use no plugs. Solder all connections and use silver-plated 16 gauge wire. Number 573-S.

Weight

Weight of an R/C race car is critical on high traction surfaces as it directly affects acceleration and braking. There are minimum weight requirements in most classes. Different components such as bodies, wings, tires and radio vary in weight from type to type. There are some weight saving accessories available—see the order form.

Weight can be taken off some parts in all but production classes. Example: Though a bumper is required it may be cut down in front; steel screws may be substituted with aluminum ones; excess rear axle length may be cut off; the chassis may be cut down though this affects the flex and strength.

EFFECTS OF BALL BEARINGS ON CAR PERFORMANCE

REAR BALL BEARINGS #624—Add 1 - 3% forward speed and 3 - 6% cornering speed and prevent axle misalignment. Oil occasionally with lightweight oil like "3 in 1" or "WD40".

FRONT BALL BEARINGS—Add .5 - 1.5% forward speed and 3 - 6% corner speed. Ball bearing fronts also increase oversteer by 5% by reducing drag. JoMac #621 Thin Wheels & ball bearings fit #1050 and #605 tires. #2070 replace the oilite bushings in stock "Lightning 2000" front wheels.

RADIO TROUBLE SHOOTING

Trouble	Probable Cause	Remedy
Radio control does not operate at all.	Weak or dead batteries.	Replace or charge batteries.
	Radio rx diodes open or shorted.	Replace.
	Batteries wired incorrectly or making poor contact.	Check to see that batteries are installed correctly.
	Broken wires or leads. Bad solder joint.	Replace or resolder.
	Switch or plugs dirty.	Clean with contact cleaner.
	Defective radio component.	Send to service station.
	Antenna damaged or not fully extended.	Check antenna for breaks or loose connections.
Operating range limited.	Transmitter battery low.	Recharge or replace.
	Receiver antenna bunched up.	Unknot or uncrl antenna.
	Radio interference.	Operate radio control away from large steel structures, fluorescent lights, change crystals.
Servo slow, not working, or intermittent.	Excess oil in gear.	Clean with alcohol.
	Dirty servo potentiometer.	Clean with contact cleaner or replace.
	Dead, dirty, or worn servo motor.	Replace.
	Stripped gears.	Replace.
	Loose or bad components.	Send to service station.
Servo locked to one side.	Broken wire in or to servo.	Replace or resolder.
Radio intermittent, works sometimes, but not always.	Dirty switch, plugs, or crystal socket.	Clean with contact cleaner.
	interference from other transmitter operating too close.	Change crystals. Separate transmitters by 8 ft.
	Radio interference.	Operate radio control away from large steel structures, mercury vapor lights, citizens bands transmitters, and automobile ignitions systems.
	Loose components or wires.	Send to service station.
	Out of tune.	Send to service station.
	Antenna in transmitter or receiver not extended or damaged.	Extend antennas. Check connection.
	Water in radio or servo.	Open and dry out then clean with alcohol.
	Radio swamped by too much signal or cross modulation of transmitters.	Shorten the receiver antenna.
	Radio interference from motor.	Break in motor brushes. Add or check capacitor .01 MF between positive and negative motor lead. Ground motor case to negative motor lead.

MOTOR & HANDLING TROUBLE SHOOTING

Trouble	Probable Cause	Remedy
Car won't run except on full throttle	Burned out resistor bands, poor wiper contact.	Replace. Realign.
Car doesn't go straight at neutral steering.	Transmitter out of trim.	Adjust trim knob or lever on tx.
	Transmitter wheel slipped on pot shaft.	Take off wheel and recalibrate.
	Steering linkage out of adjustment.	Readjust.
	Tie rods bent.	Straighten.
	Front wheel frozen on axle.	Take wheel off and oil.
	Body rubbing front tire.	Trim body.
	Rear tires not the same diameter.	True to same diameter.
	Chassis tweaked.	Adjust with washers.
Car understeers at high speed only. Do the opposite for high speed oversteer.	Servo saver unloading.	Tighten servo saver spring.
	Front wheels binding.	Use ball bearing front wheels. Oil wheel.
	Too much rear down force.	Cut down rear air dam. Change bodies.
	Not enough weight transfer.	Loosen spindle spring. Add more caster. Raise rear center of gravity.
Car understeers at low speed only. Do the opposite for low speed oversteer.	Too much rear traction.	Use thinner rear tires. Use differential.
	Not enough front traction.	Use softer front tires.
	Not enough weight transfer.	Add more caster, increase chassis flex, raise center of gravity.
Car won't accept charge.	Wire broken.	Replace and resolder.
	Charger defective.	Check with volt meter and replace.
	Source voltage too low.	Charge source battery.
	Bad connectors.	Replace and resolder.
Batteries overheat. NOTE: Batteries do get warm from use—this is normal.	Overcharged.	Let cool, run down, slow charge. (16 hrs.)
	Imbalance of capacity.	Slow charge. (16 hrs.)
	Excessive current drain.	Check motor for possible short. Should draw 1 amp only at free wheel.
Car will not run at all. Radio works.	Broken wire in resistor module.	Replace and resolder.
	Bad solder joint in resistor module.	Resolder using rosin paste flux.
	Rock in gear.	Clean.
	Unplugged or bad plugs.	Check and repair or replace.
	Resistor not making contact.	Realign.

Car runs, but slower than usual.	An insufficient charge.	Recharge.
	A dead cell in pack.	Replace or slow charge.
	Batteries overheated.	Let cool and slow charge. (16 hrs.)
	Bad solder joint.	Resolder using rosin paste flux.
	Binding gears.	Adjust gear mesh.
	Binding rear axle.	Align bearing or axle spacers.
	Body rubbing on tires.	Trim body.
	Reversed cell in battery pack.	Replace.
Batteries/car doesn't run very long.	Bad cell in battery pack.	Replace.
	Batteries not balanced.	Balance with slow charge.
	Shorted motor armature.	Check amp draw. Should be 1 amp. Replace.
	Binding axle.	Align bearings. Oil with 3 & 1 oil only.
	Batteries overheated.	Let cool and slow charge. (16 hrs.)

"GENERAL SERVICE POLICY"

Though we prefer units to be sent to the factory for service, for your convenience, JoMac has set up a nationwide network of local service stations. Factory authorized service stations will make necessary repairs and restore the equipment to the original factory specifications and configurations. Service stations endeavor to rank lowest cost and functional reliability ahead of appearance defects and will, therefore, not replace parts which have a reasonable life expectancy. "Special" or "custom" modifications will be removed when, in the judgment of the Service,Station, they adversely affect the functional reliability or final cost. Repair charges are figured on a time and parts basis, with a minimum charge of $5.00. The maximum per hour rate for non-warranty labor will be $15.00. The cost of parts will be no higher than the suggested list price as set by JoMac. Units will be returned COD for all charges and return freight. Return items for service only to JoMac or its authorized warranty "A" Service Station.

Questions or comments regarding products or warranty service should be referred to: Customer Service Dept., JoMac Products, Inc., 12702 NE 124th St., Kirkland, WA 98033 (206) 823-2303.

SERVICE RETURN PROCEDURE FOR WARRANTY AND NON-WARRANTY REPAIRS

1. All items must be returned prepaid to either JoMac Products or one of JoMac's warranty "A" Service Stations.
2. Return all items including transmitter, receiver, crystals, and batteries as the problem may relate to these items.
3. Pack carefully using plenty of packing material as JoMac and service stations are not responsible for damage in transit.
4. Attach a tag to the unit or box stating all parts broken or defective, the symptoms of any problems, etc., and the name, address, city, state, zip code, and phone number of the person to whom the unit should be returned.

All units will be returned COD for repairs and return freight unless prepaid. Repairs covered by warranty will not be charged providing a "Service Authorization Card" (sent on receipt of warranty registration card included in radio only), or proof of purchase date (receipt), is enclosed.

"JOMAC LIMITED WARRANTY POLICY"

Items manufactured by JoMac Products are warranteed (except as noted) against defects in materials or workmanship present at the time of shipment from the factory or that occur within the warranty period. The warranty period starts from the date of purchase and extends for six (6) months on radio systems and 30 days on engines, batteries, modular speed controllers, battery chargers, motors, and plastic parts. Glow heads, pull cables, tires, main gears, and radio crystals are not warranted as these parts have a normal wear rate or can easily be damaged by misuse. Specific exclusion of this warranty are misuse or accidental damage caused by:

1) Water or fuel in radio systems, speed controls, chargers or motors—Do not operate this equipment in the rain or on a damp or wet track.
2) Reverse or high voltage damage to radios, speed control, or chargers—use only recommended voltage and be careful when hooking systems up to be sure the correct polarity is used.
3) Over-charging or shorting of batteries. NOTE: Special instruction for care of batteries.
4) Damage cause to Lexan chassis due to petroleum distillants. Avoid oils, gas, nytromethane, or lacquer thinners—clean with only woodgrain alcohol.
5) Speed control damage caused by using shorted or stalled motors—if the heat sink on the speed control gets hot or the car runs slow and gets short runs on full charges the motor may be shorted.

Under the terms of this warranty JoMac agrees at its, or its Service Stations discretion to correct factory originated deficiencies by either repairing or replacing defective parts. Damage resulting from crash, accident, misuse, or modification by affixing unauthorized accessories is not covered by this warranty. Tampering with the radio or service performed by unauthorized agencies renders this warranty invalid.

FOR WARRANTY REPAIRS DO NOT RETURN TO PLACE OF PURCHASE AS OVER THE COUNTER RETURNS, REFUND, OR EXCHANGES CANNOT BE GRANTED.

Warranty service can be performed only when the unit is returned, by the consumer, to JoMac or one of JoMac's warranty "A" Service Stations. The unit must be returned freight prepaid in accordance with procedures listed and with a "Service Authorization Card" on complete cars with radio or radio unit. The "Service Authorization Card" for radio units will be mailed to the customer immediately on receipt of the "Warranty Registration Card" and proof of purchase date (sales slip or equivalent). The "Warranty Registration Card" must be sent to JoMac within 10 days of purchase. Without a current "Service Authorization Card" service stations cannot perform warranty service. Other items only need proof of purchase date.

This warranty does not cover the costs of freight or insurance. Enclose $4.00 for return freight when sending a unit in for service. If not enclosed the unit will be returned COD for this post plus COD fees and an additional $2.00 handling charge. These charges do not apply to units returned in person.

Repairs beyond the scope of this warranty, or service that is received without a current "Service Authorization Card" will be completed and returned in accordance with our "General Service Policy". (Listed on the back of this card.)

No liability is assumed for any property damage or personal injury resulting from the use or misuse of this equipment. This warranty is in lieu of all others expressed or implied.

JEROBEE "A" SERVICE CENTERS ARE AUTHORIZED TO DO
ALL MECHANICAL AND RADIO REPAIRS, INCLUDING FACTORY WARRANTY WORK.