T-Jet Tuning

Introduction

Aurora introduced the Thunderjet car in 1963 and stopped production in 1972. By 1966 35 million T-Jets had been sold. The total production may have been close to 50 million cars. When Aurora went out of business REH bought their entire inventory and has been selling NOS rolling chassis ever since.

This article is intended for beginning and intermediate T-Jet racers, advanced racers are not as likely to find much here that is new.

If you plan on racing your cars be sure to consult the rules before you make any modifications or substitute parts. If you have any questions about the rules it is best to inquire directly with the club official that handles rules issues.

T-Jet Classes

For people that race there are several classes that are based on T-Jets. Box stock cars are one such class. As the name implies few or no changes are allowed. Sometimes silicone tires and/or aftermarket wheels are allowed. ECHORR and HOCOC Indy cars are based on the Hot Rod version of the T-Jet chassis. The next step up would be ECHORR Nostalgia class cars, those can have weighted front ends plus a few other modifications. Probably the most popular class that is based on the T-Jet chassis is the Fray or T-Jet SS class. In the Northeast HOCOC runs several novel classes, one is the Grand National class for cars with mid '60s through mid '70s NASCAR style bodies, the rules for those are more liberal than the ones for Fray style cars. Another popular HOCOC class is the Jalopies, which use Indy rules.

See the Reference section for links to rules.

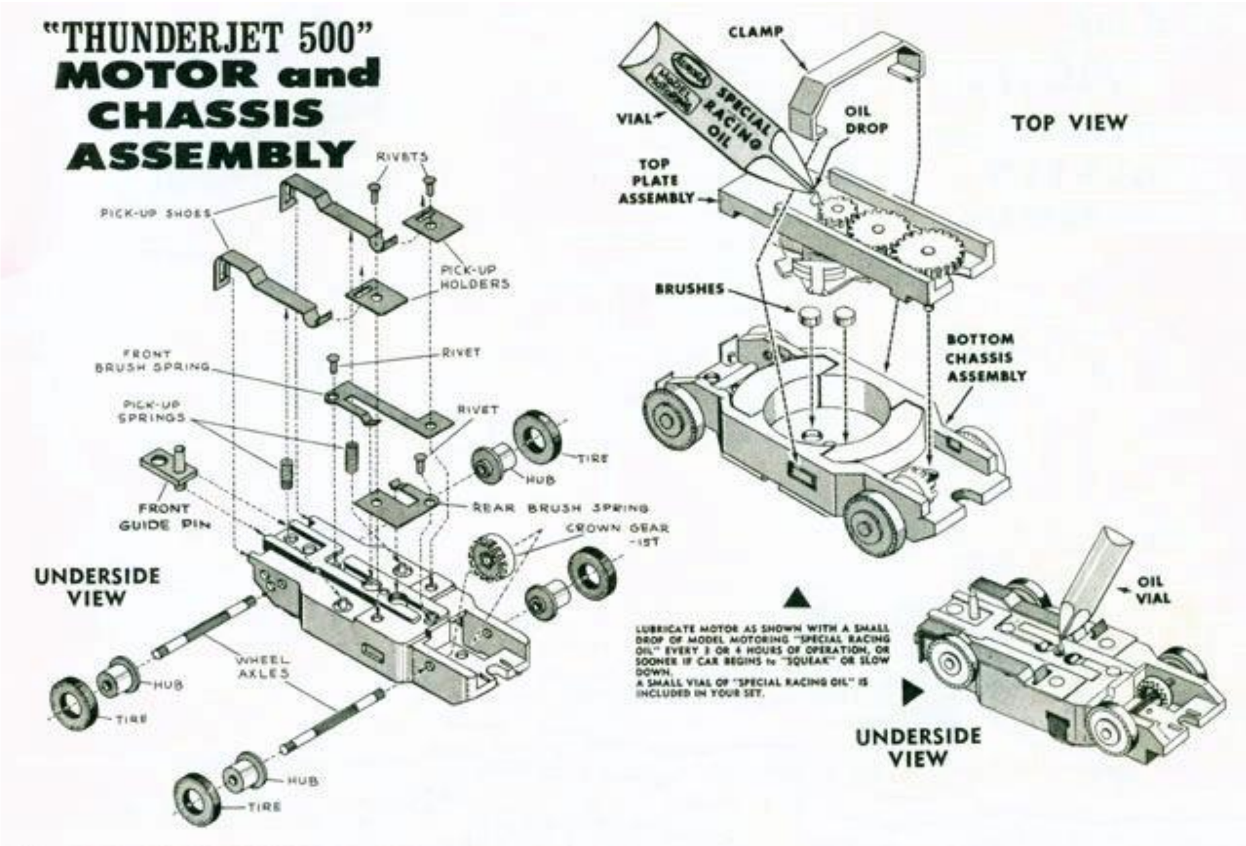
Box Stock

Indy

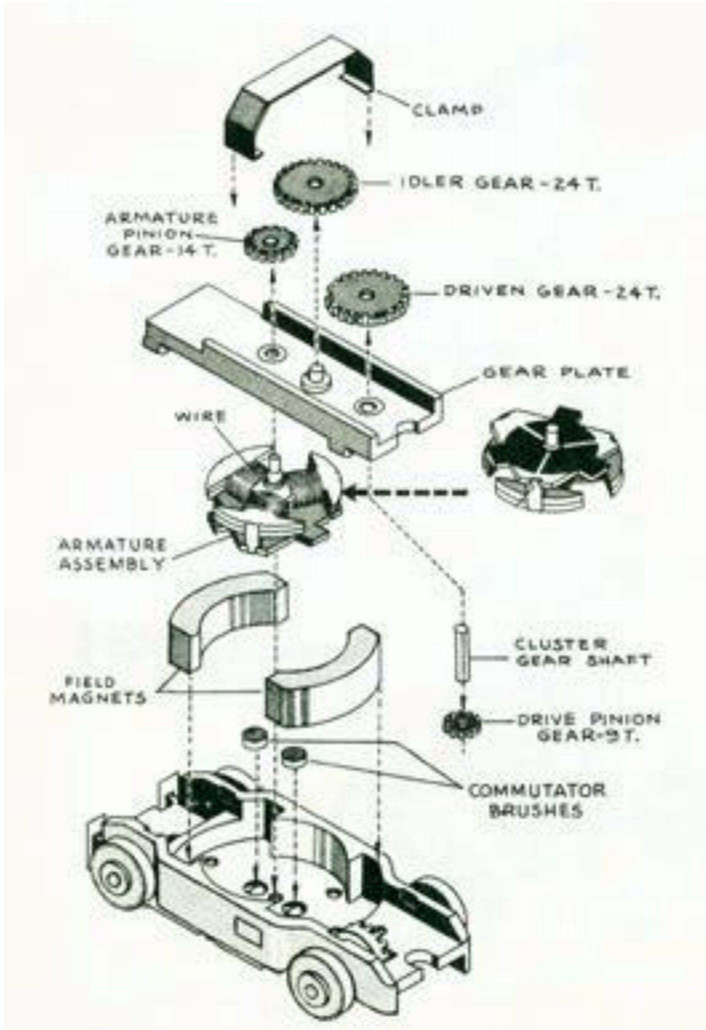
Nostalgia

Fray/T-Jet SS

Thunderjet chassis exploded view



Note the places that require oil

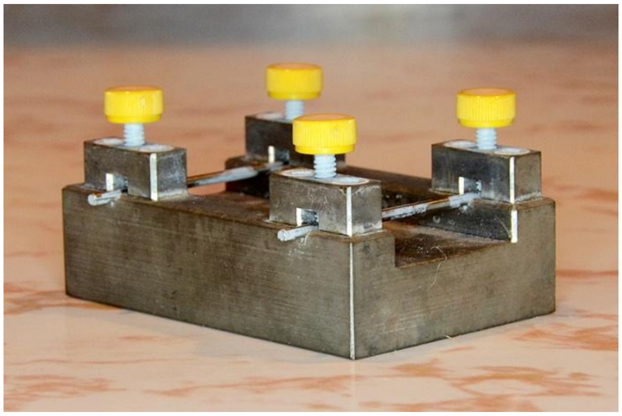


A note on T-Jet Parts: Originally Aurora sold replacement parts in blister packs, today, for the most part, those are long gone. The OEM Aurora parts available now come from disassembled rolling chassis, reproduction or stock replacements parts are available as well.

Chassis

Here I am referring to just the base or bottom chassis. Many of the chassis that are sold today were made at the end of the production run when the tooling was just about shot. If you look at a chassis or gear plate you will see some numbers on it. The molds used to make the chassis did a number of them at once, the numbers indicate which section of the mold the chassis or gear plate came from. Some people have found that certain numbers tend to work better than others. The late production chassis often have defects that earlier examples did not, for that reason some people scour tag sales and ebay for older parts. Fortunately many of the possible defects can be corrected.

First you should make sure that all four wheels touch the track, once in a while you may come across a warped chassis. You can use a tech gauge to do the check, if you use a track section it may not be perfectly flat. The chassis can be straightened using a boiling fixture. The bare chassis is placed in the fixture and 0.0635 inch drill blanks are inserted through the fixture and axle holes. The chassis and fixture are placed in boiling water for about 30 minutes. The chassis and fixture should be left in the water and allowed to cool slowly. The boiling treatment can also soften the chassis a little, which in some cases might improve handling, especially on a sectional track.



Boiling fixture

Peening a gear plate

It is common for the axle holes to be too big, the hole in the chassis that the end of the cluster gear shaft fits into may be also be too big. When the axle holes are too large the axle will move around causing a vibration that wastes power and degrades handling.
In the right hand illustration above an RT-HO ball tipped screw is being used to peen the armature hole in a gear plate. The same technique can be used to close up the chassis axle holes. An anvil consisting of a hex head machine screw with a notch ground in it is used to back up the chassis. Once the holes have been closed up they must be checked with a 0.0635 inch drill blank. First insert the drill blank into the hole on one side, it should not be so tight that the drill blank will not turn freely, if it is too tight you can wiggle the blank around to open up the hole a little. Next do the same on the opposite side. The final check is to push the blank through from one side to see how the holes line up. If the holes are not aligned you can fix that easily, for example if the drill blank points to a spot that is below the axle hole you can carefully twist the drill blank upward to correct the problem. The procedure must be performed from both sides of the chassis. When you are done insert the drill blank through both axle holes, it should move freely with no play.
Another method is sometimes used to fix loose axle holes, I call it the Superglue trick. Start with a chassis that has the axles, wheels and tires in place. Flush any oil out with contact cleaner and allow that to dry. Put a small drop of Superglue on the end of a toothpick or other small sharp object and use that to transfer the Superglue to the spot where the axle passes through the chassis on the inside, do that for the other side of the chassis as well. Do not apply glue between the wheel and chassis. Let the glue set for a minute or so, then roll the wheels on a flat surface for about five minutes. After another 30 minutes it is safe to oil the axle holes and run the car.

The pickup shoe holders and brush springs are part of the base chassis, the springs will be discussed along with the brushes. In general you need to be sure that all of the electrical parts are shiny and free of corrosion. Sometimes the rivets that hold the shoe holders in place are loose so that they can rotate and make poor contact with the pickup shoes and/or the brush springs. If the holders have rotated you can twist them so that they make equal contact with the hooked ends of the pickup shoes. A punch may be used to tighten up the rivets. Metal polish can be used to shine the copper parts of a T-Jet chassis. The tops of the holders that contact the shoes are more difficult to reach, those may be cleaned with 1500 grit sandpaper that has been folded over several times.

Gear Plates

Like the chassis the gear plate can have holes that are too big and peening the holes will fix that. The idler gear post can sometimes be too small. Some people fish through their spare parts looking for an idler gear that has a slightly smaller than normal hole. See the next section for more information on that subject. The post can be expanded by using a dedicated tool, or a punch could be used. I do not recommend using a punch because you would be likely to make the post too big in which case the gear plate would be ruined.

I have encountered a few gear plates with the idler gear post in the wrong place. The mesh between the armature pinion and the idler gear could be too tight while the mesh between the idler and the driven gear was too loose. Possibly the opposite situation might occur. There is no cure for that problem. A gear plate with that defect would have to be discarded or saved for use in a shelf queen.

Another possible problem can happen when the gear plate does not line up with the base chassis. The misalignment could cause the armature to be out of plumb resulting in a poor mesh between the pinion and idler gears and the contact between the commutator and motor brushes being less than optimal. This condition can be difficult to diagnose, I know of at least one person that made a jig to test for this problem. As far as I know nobody sells such a jig and you would need a milling machine to make your own.

I have also found a gear plate that had the cluster gear shaft hole in the wrong place causing a poor mesh between the drive pinion and the crown gear. The traditional fix for the problem is to keep switching gear plates until you find one that works best. It is probably a good idea to obtain spare gear plates from several different sources, that would increase your chances of getting a better match. Possibly the tabs on the gear plate that fit into the chassis could be modified by filing them on one side and pinching the opposite side, thus changing the location of the gear plate with respect to the base chassis. I have never seen a set of rules that allows that procedure however.

Note that with some classes it is legal to remove part of the gear plate rails to allow the car's body to be lowered.

Top Gears

Compared to modern inline HO cars T-Jets have a lot of gears, those can have mesh and alignment problems that will seriously degrade performance. A stock T-Jet has a 14 tooth armature pinion gear, a 24 tooth idler gear, a 24 tooth driven gear and a 9 tooth drive pinion. The only gear that can be changed to affect the gear ratio is the drive pinion. Other drive pinions are available, but with some classes the stock 9 tooth pinion must be used. See the chart below for the possible gear ratios.

Drive Pinion	Final Gear Ratio
9	**2.67:1**
10	**2.40:1**
11	**2.18:1**
12	**2.00:1**
14	**1.71:1**

Stock T-Jet gears were made by drawing brass bar stock through a die, slicing up the bar to get the individual gears and either drilling or punching the holes. OEM gears are still available and Wizzard sells stock replacement gears that appear to be made the same way. Today aftermarket CNC gears are available and as you would expect they are just about perfect while stock type gears may not be. Poorly meshing gears can rob a lot of power, if they are noisy it is a good bet that the gears need attention.

Before you start to work on the gears themselves make sure that there are no problems with the gear plate that they will be installed in.

In order to work on the gears you will at the least need a pinion gear puller. The gears can be removed or installed by brute force methods, but if you are going to work on T-Jets a lot you should consider buying at least some of the specialized tools that I will mention later in this section.

For a start, when I am working with stock gears, I like to polish them up. Probably polishing the gears does not enhance their performance, but at least you can spot them at a glance. First I work the top and bottom surfaces of the gears on 400 grit sandpaper to remove any tool marks, then I use a Dremel with some metal polish on a buffing wheel to give them a mirror like shine.

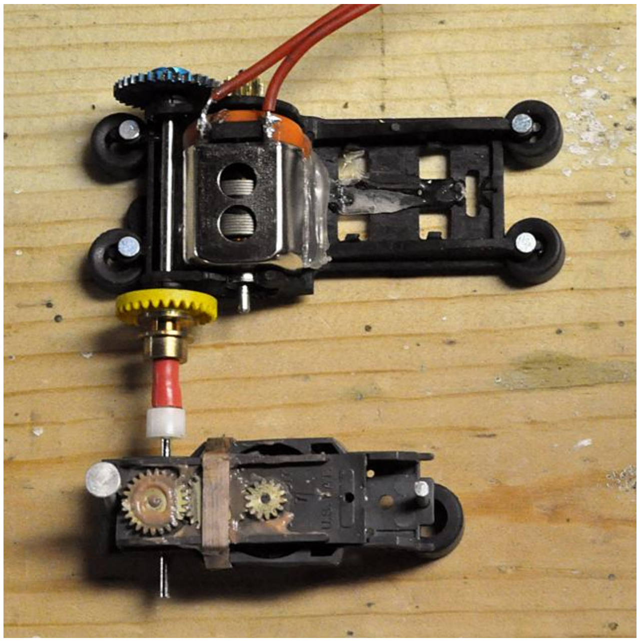
If you need to install a pinion gear you can do that by placing it on a hard flat surface. Turn the armature and gear plate upside down, center the armature shaft on the hole in the gear and gently tap on the other end of the armature shaft with a small hammer. I prefer to use a gear press to do this operation, it is not likely that the armature shaft will get bent or the gear will be distorted. See the Tool section for more information on gear presses.

Doing the driven gear and drive pinion is a bit more tricky. First it is best to make sure that the cluster gear shaft is straight. You can do that by rolling it on a perfectly flat surface like the underside of a tech block. Advanced builders often use an aftermarket cluster gear shaft that is made from a drill blank. First the cluster gear shaft must be pressed through the drive pinion. The hammer and flat surface procedure will work, but is complicated by the fact that the lower end if the cluster gear shaft will have to fit into the hole in the base chassis and the whole works will have to turn freely once it is assembled on the gear plate. There needs to be some place for the end of the shaft to go once it clears the gear. You could put some metal spacers between your flat surface and the gear, but it is easier to drill a hole in some brass flat stock that is 0.175 inches thick. I used to open up the jaws of a vise a little and put the gear across the gap. While holding the shaft so it is perpendicular and centered on the gear you can tap it in place with a hammer. This is a case where using a gear press is clearly the superior method, if you do not hold the cluster gear shaft perpendicular you could bend it. The last gear to go on is the driven gear, that can be installed the same way that the armature pinion is. The cluster gear shaft has to be kept perpendicular during this operation or it might ending up with some runout.

Once everything is installed there should be a little up and down play. If the cluster gear assembly ends up being too tight a pinion puller can be use to loosen things up a little. It is best if the bottom of the drive pinion does not touch the chassis.

The last gear to go in is the idler gear, it should not be a sloppy fit on the idler gear post. As was mentioned earlier the post can be expanded, but it is also possible to close up the hole in the idler gear a little using a gear press with a ball tipped screw, such as the one that is used for peening chassis holes, in place of the regular screw. You could also put the idler gear on a hard flat surface, put a 0.25 inch ball bearing on the hole and give that a few taps with a hammer.

With the top gears all in place the gears can be lapped. CNC gears should not need lapping however. Any thick metal polish, or even tooth paste can be used to lap gears. A favorite product for lapping gears is Simichrome, which is a paste. Regular thin metal polish will sling off and not be as effective. I use automotive buffing compound that has been mixed with liquid metal polish to thin it a bit. With the top plate in a complete chassis the motor can be powered up to get the gears turning and the polish can be applied to the gears. If the gears are turning too fast the polish will get slung off before the lapping is complete. If you run the motor too slowly it will tend to stall, so you might end up having to hang around to restart it repeatedly. To beat that problem I built the rig shown below using a motor from a 1/32nd car. It can be powered up with a 1.5 volt battery.



Gear lapping rig

With the mixture that I use 5-10 minutes of lapping in each direction is enough. Using Simichrome or toothpaste it might take longer. Once the gears are lapped the polish should be removed. I scrub with an old toothbrush then put the top plate assembly in a sonic bath with a little dishwashing liquid in the water for 5-10 minutes. Flushing with spray contact cleaner will also remove most of the polish. After cleaning a small amount of oil should be applied under the armature pinion, on the idler gear post and on the cluster gear shaft where it passes through the gear plate.

With the armature/gear plate installed in the car you can rotate a rear wheel and feel for a smooth mesh. If the gears are meshing properly they will make little or no noise when you run the car on the track. The top gears last a very long time with the exception of the drive pinion, which may need to be replaced from time to time. The hole in the idler gear is also subject to some wear. If you have to remove a pressed on gear do not re-use it unless you close up the hole. The gear may seem to be OK, but it is likely to spin on you later on.

Crown Gears

The crown gear has 15 teeth, a stock T-Jet gear is intended to mesh with a 9 tooth drive pinion. For other drive pinions it is necessary to remove material from the gear hub on the side that is opposite from the teeth or to use a different crown gear that already has a shorter hub. A/FX crown gears are made to mesh with a 14 tooth drive pinion and there are also aftermarket crown gears with shorter hubs. If the rules allow it a spacer can be used on the toothed side to keep the gear from bottoming out. It might also be necessary to put a spacer on the opposite side to keep the gears meshed properly. Aftermarket CNC gears are made of various plastics, they should all be a bit less likely to be damaged than a stock or A/FX crown gear. Always inspect crown gears carefully, the tiniest nick in just one tooth is enough to degrade performance.

Pickup Shoes and Springs

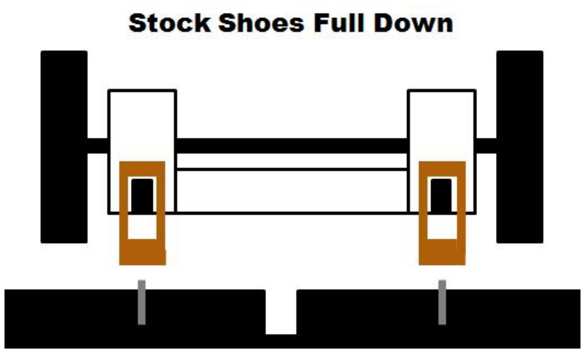
Properly adjusted pickup shoes and springs are critical to the performance of the car. Besides the stock Aurora shoes there are also stock replacement shoes from REH and aftermarket shoes from BSRT, Dash, Slottech and Wizzard. Some makes have ski style shoes along with the regular stepped style and Wizzard shoes are much wider than usual. Most rules only allow plain copper shoes, but silver and nickel plated shoes are available.

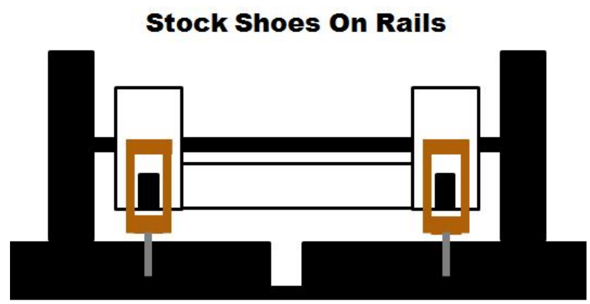
The vertical front end of the shoe has a window in it and an extension on the front of the base chassis sticks through that to hold the front of the shoe in place while allowing some up and down motion. Below the window is a 90 degree bend and with stock shoes that is followed by a 3/8ths inch long flat section called the step. After the step are two bends and a straight section ending in a hook that fits through the pickup holder that is part of the base chassis. The hook makes both the mechanical and electrical connection. Some aftermarket shoes have a somewhat longer step and ski shoes have a much longer step.

The shoe springs are located under the shoes at the hook end and fit into depressions in the base chassis.

The stock springs and shoes work well as they come with a box stock car. Fray style cars are lowered so that both the shoes and springs may have to be modified.

The first illustration shows a stock car lifted off of the track so that the shoes are in the full down position. Notice that the shoes can hang down quite a lot. The second illustration shows the car on the track with the shoes on the rails. Looking at the front of the car the shoes should be flat on the rails, not twisted one way of the other. The window opening must be such that the shoes are not bottomed out on the shoe hangers. If the shoes are bottomed out a slightly higher than normal track joint will cause the car to de-slot. In that case the bottom of the window would have to be enlarged with a small square file. I use one that has had the teeth ground off on two opposite sides. There should also be at least a little clearance above the hanger, if there is no clearance at all the car will lose power if there is a spot on the track where the rail height is less than normal.

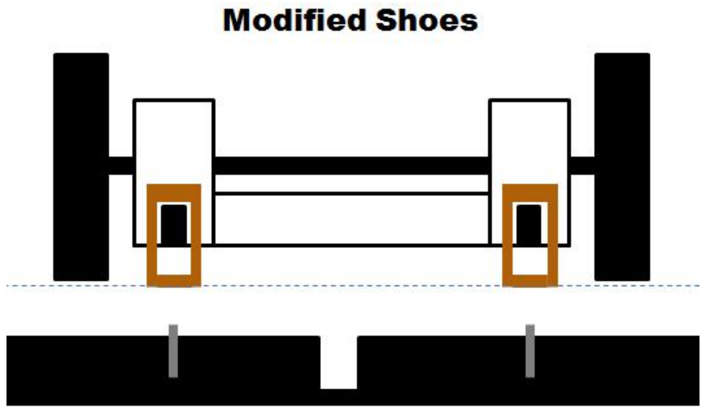




Looking from the side the step portion of the shoes should ride perfectly flat on the rails. That adjustment is critical and takes a little fiddling to get right. If you put the car on a spare track section you can hold it up to the light to see how the shoes are sitting. You need to use a track section that has a fairly uniform rail height and matches the track that you expect to run on. If you use a Dremel to remove the plastic next to the rails for a couple of inches you will be able to turn the car and track section upside down and get a better look at the contact area. It is not unusual for the step area to be a little concave or convex, you would want to fix that first. If the defect is not too great you may be able to level things by sanding on some 400 grit paper on a flat surface, otherwise the step will have to be bent to straighten it.

Once the step itself is flat it will have to be adjusted to ride flat on the rails. Increasing or decreasing the angle of second bend after the step is the way to do it. Once the shoes seem to be properly adjusted the ultimate test is to run the car and observe the mark the rails will make on the shoes. It is a little faster to put some Magic Marker on the steps, then put the car on the track and push it a few feet. It is not unusual for a little more tweaking to be necessary.

If it is legal to do so it is a good idea to limit the shoe travel in the downward direction. If you look at the following illustration you will see that the shoes do not drop down as much as normal, they are just barely lower than the tires.

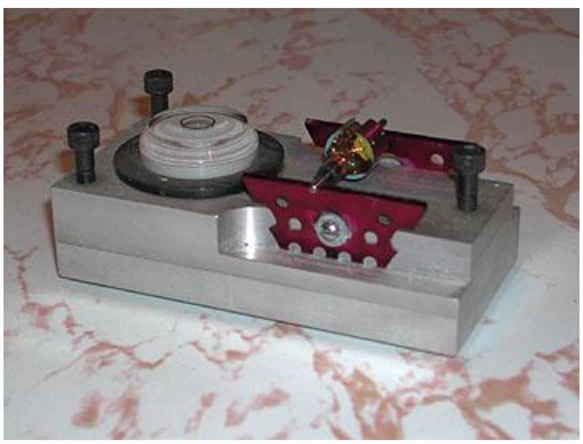


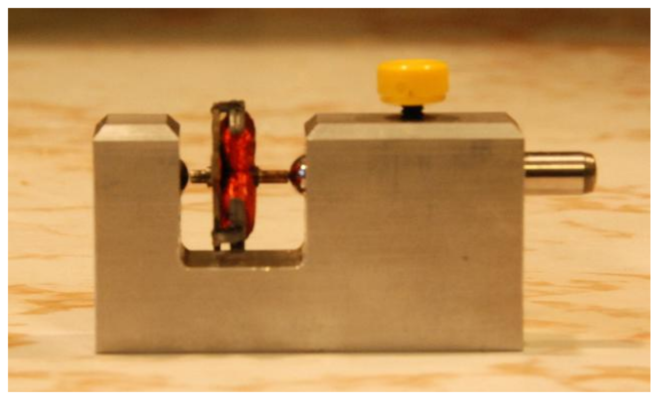
With the shoes adjusted that way when the front end starts to lift the shoes will lose contact with the rails and the car will lose power, usually before the guide pin comes out of the slot. If the shoes can't drop down far enough you could lose power on places around the track where the rail height is less than normal and if the race is long enough for the shoes to wear you would get a power loss as well.
There are several ways to limit shoe travel, I prefer to decrease the height of the window at the top by folding the end of shoe forward and down. A less obvious way of limiting the shoe travel is to open up the bend at the hook end of the shoe just past the holder.
I have encountered a situation where the width of the window caused a problem. One track that I was running on must have had a slightly unusual rail spacing because once in a while the shoes would get jammed in between the rails. Using Wizzard shoes which are wider and also have narrow windows fixed that problem.
Compared to modern high down force inline cars T-Jets have rather light shoe springs. In the absence of significant magnetic down force high tension springs would tend to lift the front of the car and cause de-slots.
It is not a bad idea to turn down the lights and run your car around the track. If you see a lot of sparking the shoes may not be flat or the shoe springs have too little tension. If more tension is needed there will probably be burn marks on the shoes. If the shoe spring tension is too great the car will want to do wheel stands, in that case a coil could be clipped off or a weaker spring could be substituted. It is a good idea to experiment a little with springs, aftermarket springs are available from Dr. Oogan, Slottech and Wizzard. In the case of cars that have been lowered it is possible that the springs are fully compressed before the shoes are in the full up position and that could cause the car to de-slot more easily when it crosses a joint. Once again a coil can be removed or a shorter aftermarket spring can be used. If more tension is needed the springs can be stretched of stiffer ones can be used.
If the shoes have deep grooves worn in them they can be sanded flat, stock shoes can be sanded many times, aftermarket shoes tend to be a lot thinner.
Besides the step area the hook that contacts the chassis shoe holder should be clean and shiny. Always check to be sure that the pickup shoes move freely up and down and do not want to hang up. With some bodies there is likely to be an interference problem.

Armatures

The armature is a critical component of the car, it is like the heart in a human body.
A list of the various armatures that were used in T-Jet car can be found in the reference section.
Unfortunately the armatures that are sold today can have many defects compared to the ones that were sold in the mid '60s. Some of the possible defects can be remediated, others might render the armature useless for racing.
A number of people do sell worked up armatures, some of them are listed in the Links section.
The first thing to do is to measure the resistance of the armature. Digital meters are best for doing the measurement and a reading is needed for all three poles. The common classes of T-Jets that are raced require armatures that are 16 ohms or greater. All three poles should have the same resistance ±0.1 ohm. You probably should set aside any armature that has a greater variation between the poles. In theory if enough track power is available an armature with a lower ohm value should be better than one with a higher value, however in practice that is not always the case.
An armature could possibly have a bent shaft, since the shaft is so short that defect is difficult to see by eye. If a person had a precision lathe he could chuck up the armature using a collet and check for run out using a dial gauge. The chuck of a drill pres would have too much wobble to do a test of this sort There are tuners that straighten bent armature shafts, I have never tried to do that.
Take a look at the commutator, it should be centered on the motor shaft. If the commutator is not centered the armature is more likely to be out of balance. Sometimes the three commutator segments are not equal, I recommend tossing armatures with that defect. There are several other possible defects in the commutator. Some commutators are tilted and the resulting run out will degrade performance because it causes brush bounce and arcing. A similar test to the one that is used to check for a bent armature can be used to check the commutator. Scale Engineering sells a commutator run out gauge. Besides being tilted the commutator might also be warped and a run out gauge would find that as well. A cheap, but fairly effective run out gauge can be made using a spare chassis. First one of the brush springs would have to be removed, then a 1/16th inch hole would be drilled through the bottom of the chassis about 3/16ths of an inch from the center of the axle hole. The armature shaft hole in the chassis should be closed up for a snug fit. The armature/gear plate assembly is installed on the base chassis and held in place with a retainer clip. A length of 1/16th diameter styrene rod is inserted into the hole, It should be sanded so that it is nearly flush with the bottom of the chassis. The hole may have to be enlarged slightly so that the rod is a slip fit. Holding the chassis upside down and turning the wheels will cause an up and down motion in the rod that should be easy to spot if the commutator is tilted or warped.
A close examination of the marks on the commutator that are made by the motor brushes is often a good indication of a warped commutator because those marks will not be uniform.
The commutator is simply a piece of printed circuit board that has been etched to make the segments, so the copper conductors are rather thin. Commutator facing tools are available that can remove a minor defect in the commutator. Such a tool is simply a

brass cylinder with an indent in the center of the top surface for the armature shaft to fit into. A fine sandpaper disc with a hole in the center is stuck to the end of the tool and rotated against the commutator to remove the high spots. Just a quick pass of the tool is also another way to detect a warped commutator. The facing tool is not the thing to use with a tilted commutator in many cases. Fixing a tilted commutator is possible, I have never attempted to do that. Squeezing the holding tab on the high side might work if it did not result in the commutator being warped or actually breaking. I suppose that it would be safer to pry out the holding tabs, reposition the commutator and glue the commutator to the tabs.
Some armatures actually have the stacks off center. The ends of the stacks can be ground so that the tips are all the same distance from the center of the armature shaft. The removal of too much material would result in some loss of power, so it might be best to set aside an armature with this defect.
Balance is always an issue with slot car armatures. Pancake cars are especially prone to balance problems because they are relatively large in diameter. In some cases it is not legal to balance the armature, but you can always check it. There are several types of balancer that can be used at home. The one on the left was actually made for 1/24th scale motors, one for pancake armatures would have to put the razor blades closer together. Note that there is a bubble gauge and adjusting screws for leveling the device.





The balancer on the right is the magnetic type. The shaft to the right is adjustable in order to accommodate different armature lengths. Both types are referred to as static balancers. The heavy side is determined based on where the armature stops after it has been rotated. People that do a lot of armatures to sell use a dynamic balancer which can find the heavy pole while the armature is still in motion and is supposed to be more accurate, I have never seen one of those in action.
In order to use either type the poles must be marked. With the first type of balancer the armature is placed at one end of the razor blades and given a gentle push to get it rolling. It might be better to blow through a straw than to poke it with something. Obviously a light touch is needed or the armature will fall off the other end. When the armature comes to rest make a note of the pole that is pointing down, that would possibly be the heaviest one. Sometimes the heavy spot will fall between two poles, in that case mark down both of them. I like to repeat the test ten times, then I tally up the hits for each pole. The heaviest pole will have the most hits and the lightest the least

hits. The magnetic balancer works the same way, the opening must be adjusted so that the armature spins smoothly without wobbling and the straw method of starting the spin is mandatory. With the magnetic balancer a badly out of whack armature will cause the whole works to walk across the table. An armature that has a bent shaft will also act like it is out of balance.

In my experience if an armature is really bad it might not be worth trying to balance it. There are two possible ways to balance an armature and some people like to use a combination of those. With the first method a small amount of material is removed by grinding or notching the heavy pole(s) and the armature is retested with more material being removed as needed. If the armature is too far out of balance the second method is preferred, in that case a dab of epoxy is applied to the light pole (s). Some people start with the epoxy and then fine tune by removing material. It is best to minimize the amount of metal that is removed, any significant loss of the stacks will result in less power. If a lot of material is removed the car will have more top speed on a long straight, but it will be lacking in punch off the corners.

When I am done working up an armature I like to polish up the commutator to a mirror finish. With the armature Installed on a gear plate I use a Dremel and a buffing wheel with some metal polish. Touching the wheel to the com will cause it to spin. I lightly touch my finger to the ends of the stacks to put a little drag on the armature. I wipe off the polish when I am done buffing and flush off the surface of the commutator with spray contact cleaner.

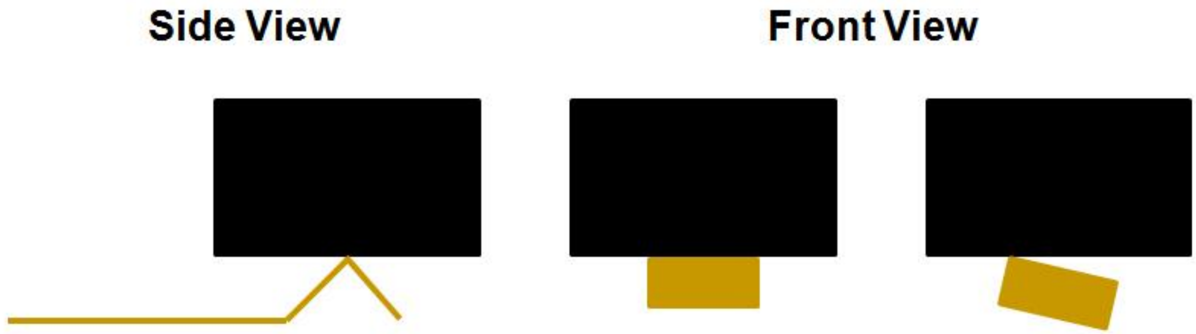
The ultimate test of an armature is to put it in the car and see what it does. You have the option of sorting through dozens of armatures to find a few that are good. You can buy worked up armatures from a builder with a good reputation or you can try some of the tricks that I have mentioned.

Motor Brushes and Springs

Stock Aurora motor brushes are not of very good quality and you will get better performance by replacing them with modern carbon/copper composite motor brushes such as the ones from Slottech, Tunderbrushes or Wizzard. Carbon/silver motor brushes are also available, but those are not legal for any of the classes that I have discussed.

Motor brushes tend to rotate somewhat as the armature turns and it is common practice to stop that by making a slight score mark or X on the bottom of each brush. Usually making an actual groove is forbidden and in box stock cars even scoring the brushes may not be legal. Motor brushes do wear out slowly and they need to be replaced when about a third of the original thickness is gone. Often oil will get on the brushes, since that tends to degrade performance the brushes would need to be cleaned. Usually I just spray them with contact cleaner, then wipe them on 1500 grit sand paper or even just plain paper. Some people put the brushes on the hot tip of a soldering iron to burn off the oil.

Obviously the brush spring tension is important. You should inspect the springs to be sure that they are not bent or twisted so that only one corner is touching the bottom of the motor brush. The contact point should also be centered when viewed from the front or side. The V should not be flattened out.



Often used chassis have badly bent springs and it is difficult to fix that. You might be better off putting aside a chassis with mangled springs.

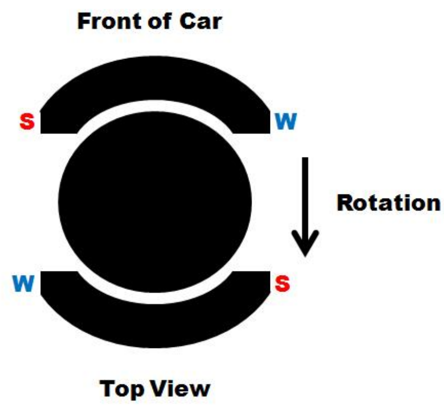
The spring tension may need to be adjusted and that can be a little tricky. I run the motor with a power supply at about 9 volts and very gently press on the bottom of each spring half way between the rivet and the start of the V using the tip of a toothpick. If the motor speeds up the tension will have to be increased by pressing on the underside of the spring at the rivet end. That adjustment must be done with the armature/gear plate assembly out of the car. If the test causes the motor to slow down the tension may already be about right or it may actually be too great. When you get used to working on these cars you can see if the tension is correct just by removing the armature/gear plate assembly and seeing how far the tops of the brushes are above the chassis floor. That should be about 0.05 inches. I don't know of any easy way of testing for too much spring tension short of actually running the car. The amp draw would possibly be a good indication, I will have to investigate that. A brute force method will work. With the armature/gear plate assembly removed you can carefully push down on the brushes so that when they are released they are a bit lower than they were originally. Re assemble the car and repeat the toothpick test. If the motor speeds up the original tension was probably OK., if not you could be good to go or possibly you would need to move the springs down a little more.

Magnets

All of the classes of cars mentioned in this article use ceramic magnets, which tend to maintain their strength over a long period of time, even when they are stored in less than ideal conditions. Over the years Aurora used magnets with different color codes, those can be found listed in the Reference section. In general the magnets got stronger on average as time went by, but examples of each type can vary significantly in strength.

Magnetic strength or flux density is measured in gauss, the strength of the Earth's magnetic field is 0.3 to 0.6 gauss at the surface. The weakest T-Jet magnets measure a little over 400 gauss and the strongest ones that I have found measured around 650 gauss. Aftermarket Johnny Lightning/Auto World and Dash magnets range from about 800 to 950 gauss with the Dash magnets turning in more consistently high values. The king of the ceramic magnets are the ones that Aurora made for the Super II car, I have measured examples that were 1100 gauss. Of the stock T-Jet magnets the orange/green ones seem to be the strongest.

There are several ways to measure magnets, probably the best way is to use a magnetometer (gauss meter). A considerably less expensive device is sometimes referred to as a magnet matcher, those measure the relative strength of magnets without giving an actual gauss reading. See the reference section for building a magnet matcher.
Measuring magnets is tricky because they do not have a uniform field, simply moving the probe a little can make a significant difference in your reading. When I am testing magnets I look at the center of the side that faces the armature and fish around for the highest value, next I check the ends of the magnet and mark the stronger end.



Magnet orientation

The strength of a car's magnets has several effects on the performance of the car. The stronger the magnets are the more power the car will have, however that effect is not linear, doubling the strength of the magnets will not come close to doubling the power. It seems like a particular armature will work best with a certain magnetic strength and it is well known to advanced tuners that magnets that are too strong will actually decrease the top speed of a car. A second effect of strong magnets is more braking, some cars with very strong magnets will tend to stop very quickly, even when dynamic brakes are not used. Finally the magnets will affect handling to some extent because they do provide a measure of magnetic down force.
As I hinted at earlier magnets are often stronger at one end than the other. If you look at the right hand diagram above you will see that you can get more power if the armature rotation is towards the stronger (**S**) ends of the magnets and away from the weaker (**W**) ends. In order to orient the magnets you may have to turn them upside down. Orienting the magnets in this way may decrease braking slightly.
It is important to use pairs of magnets that are equal in strength, otherwise power will be wasted trying to drag the armature to one side.
Sometimes the magnets can be loose in the chassis magnet pockets, it that case you should shim them for a snug fit. Any non-ferrous material can be used to shim the magnets. I just put one or two layers of masking tape on the backs of the magnets.
The magnets that you have may not be at full strength. Some people have a re-magnetizer, usually called a zapper, so they can zap all of their magnets before they use them. A particular magnet can only be so strong, some magnets will be stronger after they are zapped, others will not. Zappers tend to be expensive and hard to come

by, they were much more common back in the early '60s when some motors used Alnico magnets that could easily loose strength due to heat, mechanical shock, improper storage and even dynamic braking. Today there are outfits that will zap your magnets for a dollar or two a pair and often will take gauss readings of them for an additional fee.

Rear Axles

Stock Aurora T-Jet axes are of good quality, they are splined at the ends where the wheels go on and in the middle where the crown gear is. A stock axle is about 7/8ths of an inch in length. Hot Rod axles are longer, but may not be used on box stock cars. Other than on box stock cars aftermarket axles are often used. A 0.0630 axle is needed, often I have used Tomy rear axles because they are the right diameter and they are splined in the middle so that a stock crown gear will not slip. Many suppliers offer replacement axles. 1.3125 inches would be the longest axle that you can use because that is the widest legal chassis width. An aftermarket axle would be expected to be straight. A thorough builder would test that by rolling the axle on a flat surface.

Front Ends

For box stock cars you are stuck with stock front axles and the small chromed wheels. In some cases an aftermarket wheel that is the same size as a stock wheel is allowed. Indy and HOCOC style Jalopy cars can use longer axles and Hot Rod/Dune Buggy/Truck style wheels as well as similar sized aftermarket wheels. Nostalgia cars have a maximum width of 1.125 inch and brass front ends, such as the ones sold by JW's HO Speed Parts, for that class are normally used. The extra weight of a brass front end makes the car more stable in the corners. Fray/T-Jet SS cars also use brass front ends. The cars tend to have more grip than Nostalgia cars and they have more power as well, so a somewhat heavier brass front end may be needed to prevent wheel stands. Usually the wheels have extended nibs on the chassis side which serve as spacers. The front end sold by RT-HO is unique in that the wheels are light weight narrow plastic affairs and separate brass weights that are below the axle centerline are used as spacers.

The weighted front ends are usually held together with tiny plastic retainers and some of those can split causing the wheels to fall off during a race. The retainers should be inspected and split ones should be replaced or CAREFULLY glued in place with Superglue.

The front end should be adjusted so there is just a couple of thousandths of an inch of side play. The wheels should turn smoothly.

Rear Wheels and Tires

Aurora used two sizes of rear wheels and tires. Regular cars had 0.188 diameter chromed wheels and 0.40 inch diameter tires that are about 0.07 inches wide. Hot Rods had 0.250 inch diameter wheels with 0.50 inch diameter tires that are 0.16 inches wide.

Box Stock classes usually use the smaller wheels and tires. In most cases the stock rubber tires can be replaced with slip-on silicone tires. Because the replacement tires will often tend to come off the stock wheels double flanged rear wheels may be allowed as well. Generally the aftermarket tires would be somewhat smaller in diameter than the original tires.

Nostalgia type cars use aftermarket double flanged wheels and slip-on silicone tires that are about 0.12 inches wide and have a 0.350 inch minimum diameter.

Fray and T-Jet SS cars usually use silicone coated sponge tires that come glued to machined Nylon or Delrin wheels. Tires/wheels of that sort come in incremental sizes, usually 0.002 inches apart. silicone on sponge tires are expensive, they may be as much as $12 a pair.

The alternative to the silicone on sponge tires has been machined plastic wheels with slip-on silicone tires. The slip-on tires are much less expensive, they sell for around $1.50 to about $3.50 a pair. Slip-on tires are also available in incremental sizes.

In addition to silicone tires urethane slip-on tires are available, however I have not heard of anyone using them in competition.

Up until 2012 0.188 inch diameter wheels were the standard diameter. Once it was discovered that slip on tires can have more grip if they are mounted on 0.170 inch diameter wheels those wheels quickly became widely available from a number of makers. Traditionally silicone on sponge tires have had better grip than slip-on tires and possibly have been more forgiving on regular sectional track. The introduction of the smaller diameter wheels and some new silicone formulations has narrowed or even eliminated the difference in performance. A few groups have now switched to using slip-on tires exclusively or run special classes for them.

Which tires should you use? My best answer is that you will have to experiment. You won't go too far wrong if you use the same tires as the people that win the most races in your area do.

Here are a few factors to consider. Harder tires have less rolling resistance, so you get more top speed, but they may have less grip, so cornering speeds may fall off. Most people consider low lap times to be the best indicator of tire performance, but a tire that delivers consistent performance with less offs is usually better in the long run. Some tires have terrific grip when they are clean but quickly lose grip as the laps go by. Other tires can go an entire race with hardly any increase in lap times.

Tire diameter has two effects on performance, first off tire diameter is part of a car's gear ratio, so some people prefer to use bigger diameter tires on tracks with long straights. The diameter of the tires also affects the car's ride height, the closer you can get the car's magnets to the rails the more magnetic down force you will have. Higher down force can lower straight line speeds, but generally it pays off in lower lap times and more consistent handling.

There is sometimes a rule that limits the minimum tire diameter that you can use, otherwise you will be limited by the fact that at some point the crown gear will start to hit the rails when the back of the car begins to slide out. With silicone on sponge tires in order to try different sizes you need to pull off the wheels and press on different ones. With slip-on tires you just change the tires themselves.

When installing slip-on tires be sure they are straight on the wheels, before you run the car you can roll the tires on a flat surface while putting a little downward pressure on the car to seat the tires.
You should be aware that the diameter of silicone on sponge tires will change with changes in temperature and humidity, possibly big changes in atmospheric pressure can have an effect as well. The marked diameter will in most cases only be approximate, you should measure the diameter of the tires before you put them on the car if you like to cut things close. Be sure to inspect the silicone coating, in some cases it might start to peel off.

Guide Pins

The guide pin is what actually steers the car around the track, so selecting and installing them is important.
The original Aurora guide pins were very good, they hardly ever broke and they lasted a long time. Now OEM Aurora guide pins are scarce, but there are many reproduction and aftermarket pins. Sadly some of those are not very good, they either wear out very quickly or they break off easily. A broken guide pin can ruin your whole day if it happens during a race!
Different tracks can have different slot depths, so a longer or shorter guide pin may be used. I tend to set my guide pin depth for the shallowest slots. After installing a new pin I put the car on a spare track section and see how the pin looks. I use a Dremel with a cutoff wheel to trim the guide pin to the correct depth.
Fray/T-Jet SS cars are lowered, which can cause a clearance issue with the front body screw, you can drill a depression in the guide pin tab or buy pins that already have one.
Many racers prefer to glue in the guide pin, I used to use contact cement for that but I found that the guide pin could come loose. I now us Superglue, but it must be used sparingly or it is difficult to replace the guide pin. I put a drop of Superglue on a screwdriver blade and use that to transfer the Superglue to the chassis. If that is done properly the guide pin will not come loose, but it will not be difficult to pry it off when it is time for a new pin. If the pin resists removal touching the bottom of it with a hot soldering iron will get the Superglue hot enough to de-bond.
Before a race take a look at the guide pin and replace it if it has flats worn on the sides and also make sure that it has not gotten bent. That last check may also have to be done between heats if you car has crashed a time or two.

Bodies

The body is not just there to make the car look good, especially with Fray/T-Jet SS cars it is an important factor in how your car will handle.
Most of the time you want the body to be as light as possible. Some resin bodies can be a little heavy and certain racers have been known to spend a considerable amount of time hogging them out to reduce the weight. Sometimes a little weight down low is advantageous, however it is usually forbidden to use a body that has too much material at the rocker panels. Bodies that are low and wide tend to give the best results, a little extra weight in the nose may not hurt. Leaving the body screws loose so that the body

is free to move a little can often enhance handling, especially on sectional track. Be sure that the body never touches the tires, that can cause erratic handling.
You will have to use body screws with a flattened head or flat head conical machine screws if the chassis is lower than stock. Always check to be sure that the front body screw does not touch the track and be extra careful if you run on a track with elevation changes.

Handling Issues

Some of the things that affect handling, such as pickup shoe tension, chassis height and tire grip have already been discussed. You should remember that anything that can cause a vibration can upset the car. Vibrations from loose armatures gears and axles, out of balance armatures, bent axles, poorly meshing gears and out of round tires and wheels can all cause problems. Leaving the body screws loose can help to damp out vibrations.
The amount of noise that a car makes can tell you a lot. If you run on regular sectional track the noise that the pickup shoes make when the cars cross the joints tend to mask more subtle noises. If a car is noisy there has to be something that can be improved.
Sometimes it is hard for the novice, or even the experienced racer for that matter, to tell whether a car's poor performance is due to handling issues or just the lack of power. A better handling car can get a good run going coming off of a corner that makes it look like it is faster in a straight line. If you are starting to get passed after you are half way down a long straight you probably need more power.
The type of track that you run on can affect the way that you set up your cars. There are three types of HO tracks. First there is common set type sectional track, then there is aftermarket sectional track, such as MaxTrax and WizTrackz and finally there are continuous rail tracks like Bucktracks, Brad's Tracks and TKO.
Regular sectional track has a lot of joints, some of those might be mismatched. The rail height may be different from section to section and the track surface can be warped. Aftermarket sectional tracks have far fewer joints to cause problems and the joints are easier to match up because of the way that they join together. Continuous rail tracks usually only have the few joints that are necessary to make it possible to break the track down for shipping.
If a car handles well on sectional track it should also work well on a smoother type of track, but the opposite is not always true.

General Maintenance

Your cars need to be kept clean, inspect the axles for hair and lint that can get wrapped around them and cause extra drag. Remove the armature/gear plate assembly and wipe out the chassis floor. If oil has gotten on the motor brushes or the commutator it must be removed. The exploded view at the beginning of this article shows the two places that must be oiled, the hole for the lower end of the armature shaft is the really critical spot. Failure to oil that spot will result in the dreaded T-Jet squeak of death that causes your car to slow to a crawl. Do not over oil that spot, excess oil will get on the motor brushes and slow the car. The axles can be oiled where they pass through the

chassis along with the cluster gear shaft. A little oil on the idler gear post will not hurt. In all cases apply oil sparingly. If you get too much oil on the top gears the car will run a little slower than usual until it slings off.
For the most part T-Jets do not need grease, it can get between the gear teeth, attract dirt and cause extra drag.

Tools   Items that I consider to be essential are marked in red.

Armature balancer As far as I know nobody sells a razor blade style balancer, but a jeweler's poise would work. I was not able to find one of those for sale but they may be better known by another name. RT-HO used to sell a magnetic balancer, VRP still sells them.

Balance Electronic balances have become quite inexpensive lately, if you run any classes that have a minimum weight it is nice to have one. If you use resin bodies those can be heavy, with a balance you can track how you are doing as you remove excess material.

Boiling jig This was mentioned in the article, the only one that I know of is sold by RT-HO.

Calipers In the past regular vernier or dial gauge calipers would be used, today electronic calipers with a digital display have become inexpensive. Avoid plastic calipers, they can flex too much and will not be as accurate as metal ones. Be sure to get calipers that read three decimal places, some calipers display down to a half ten thousandth of an inch and those are better. Use minimum pressure when you close the jaws of a caliper.

Commutator facing tool A number of makers offer these tools, they are described in the text of the article. If the commutator is too far out of whack you will wear right through the copper before the commutator is flat.

Commutator run out gauge Scale Engineering makes the only run out gauge that I know of. If you have access to a precision lathe you would only need a dial gauge to check a commutator and places like Harbor Freight have inexpensive ones.

Dremel I suppose that "rotary tool" would have been the right term to use, but Dremel is the best known maker and cheap imitations may not hold up well. If you expect to use the tool for long periods of time a plug-in model might be better, but if you want something to bring to the races a battery powered model is more convenient and of those the ones with a lithium ion battery are really the way to go. Rotary tools are great for grinding and polishing. The cut-off wheel is the thing to use to shorten up an axle. You can use a wire brush or polishing bob to shine your pickup shoes during a race and small grinding wheels are good for lightening up a thick resin body. The sanding drums are good for body work as well, especially for rounding off or enlarging wheel openings. **Always wear safety glasses, or better yet goggles, when using a rotary tool!**

Drill blanks/pin gauges These are useful for testing axle, cluster shaft and armature shaft holes. 0.0635 inches in diameter is a good size for that purpose. Many outfits that cater to T-jets have the right diameter and length drill blanks, or you can get them from an industrial supply house, like McMaster-Carr.

Dynamometer At the end of the day, after you have worked on your car for hours, you have to put the car on the track and see how it runs, so one might ask why you would need a dynamometer. A dynamometer can be helpful because it will eliminate a number of variables that tend to mask the things that are related directly to motor performance.

A dyno will tell you what motor speed and amp draw you will get for a particular applied voltage. Some dynos can also apply a load on the motor and that is more useful because it will tell you more about how much relative power the motor puts out. Some motors can really rev up, but the car might still be slow to get off the corners, just measuring the motor speed does not tell the whole story. If you do not have a track handy to test your cars a dynamometer would certainly be useful.

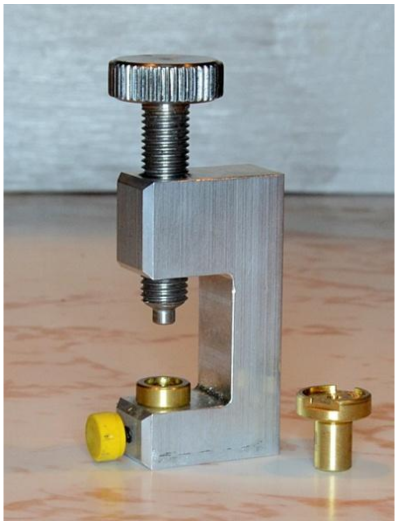
Files A set of miniature files will have many uses. I found some nice ones at Harbor Freight.

Forceps Most people would call these tweezers, you really need a pair to handle motor brushes. I have some stainless steel forceps that I got from a scientific equipment supply place. Tweezers from the cosmetics section of a drug store or supermarket will do as well.

Idler post expanding tool The only supplier of these that I know of is RT-HO. The complete top plate assembly is placed in the tool.

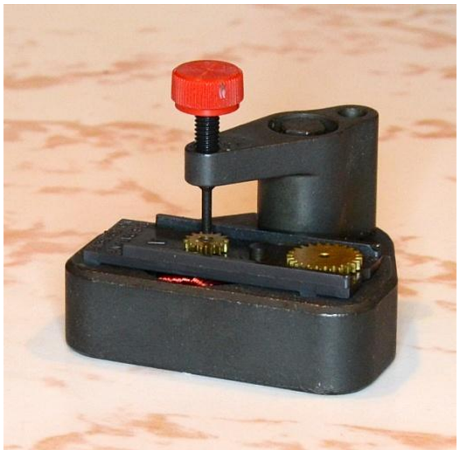
Gear hole closure tool This is the same as the gear press shown below, except that a different screw is used. The tool makes it easier to re-use gears.

Gear press Different diameter gears require different anvils. The anvils have adjustable stops to keep the gears from being pressed on too far.



Gear puller You have to get one of these, they are mostly used to pull armature pinions.

Gear removal tool for top plate gears The arm flips so the tool can be used both for armature pinions and driven gears. These do not work as well with pinion gears if the gear plate rails have been trimmed, but this is the easiest way to remove driven gears.



Magnetometer See the article for a picture. The HO Slot Car Racing site has a newer version for sale.

Multimeter Digital ones are best, look for one that reads tenths of an ohm.

Pliers The needle nosed variety will probably be the most useful, especially for adjusting pickup shoes.

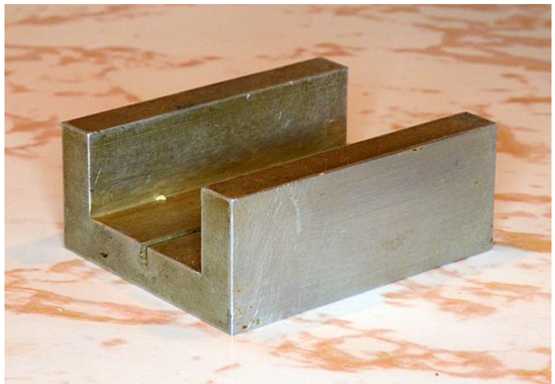
Re-Magnetizer These can be difficult to come by new, they do turn up for sale from time to time.

Screw drivers Reasonably priced high quality screw drivers are made by Wera and Wiha. A regular blade needs to be 1/8th of an inch wide and a 2mm width can be useful as well. Do not use a screw driver to pry off wheels and gears! For body screws use a 4mm Phillips driver, a 2mm driver might come in handy as well.

Shoe bending tool Scale Engineering sells an adjustable pickup shoe bending tool.

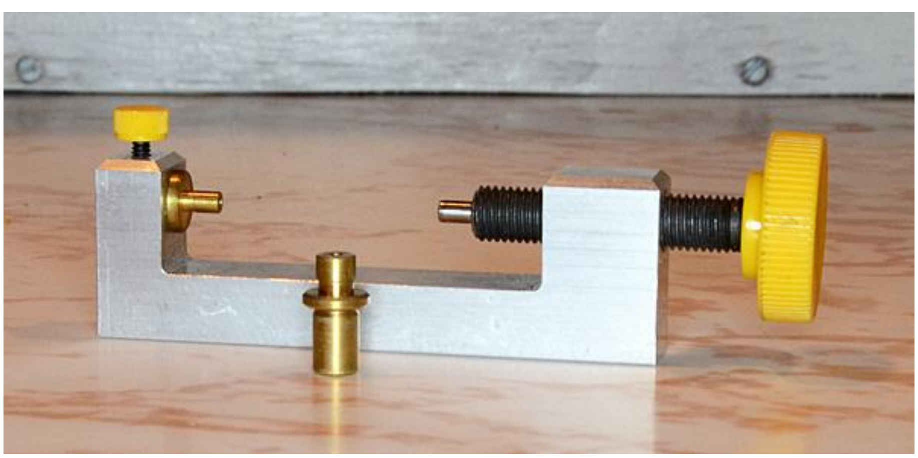
Spring tension tool VRP sells a tool for measuring pickup shoe tension.

Tech block Everyone needs one of these. These are mostly used to be sure a car is the correct width. Narrower blocks are made for Nostalgia type cars. Note the groove for the car's guide pin. The bottom of the block can be used as a flat surface.

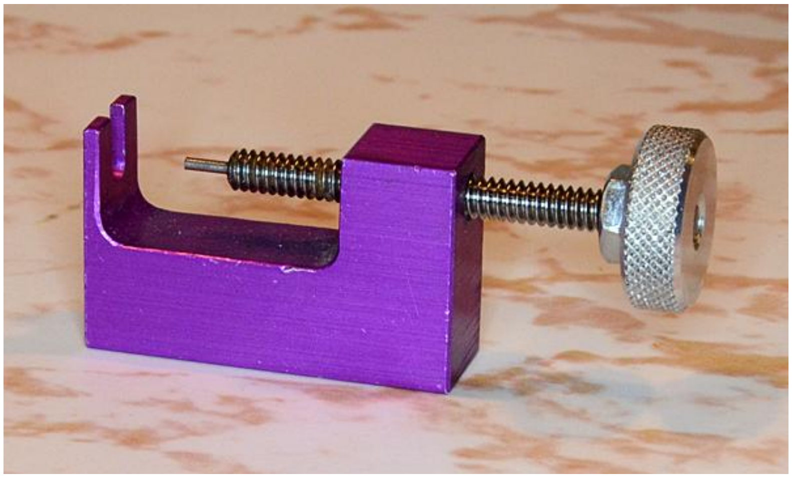


Tire Gauge In my opinion a tire gauge is the best way to measure tire diameters. This gauge is made of stainless steel. A caliper can also be used, but they are not ideal for measuring things that can be compressed.

Wheel press The anvil is made to fit inside of the wheel and different sizes are available.



Wheel puller



Ultrasonic cleaner These are great for cleaning armature/top plate assemblies after you have lapped the gears. Ultrasound can remove dirt from places that you can't reach with a brush. Fill the tank with water and add a few drops of dishwashing liquid.

Vise It is nice to have a fairly large bench vise, they can be used to press on gears and wheels in a pinch and the flat spot on the fixed part makes a good anvil. A lot of people have a small vise with a suction base that they take to races.

X-acto knife These have an aluminum handle that take different styles of blades. I like the #1 style.

Oil, grease, contact cleaners

Using the right oil is extremely important. Over the fifty plus years that I have been running T-Jets I have tried many types of oil and often been disappointed with the results. Back in the '60s the best thing to use was the famous Aurora red oil. Today I

use Superlube, it can often be found in hardware stores, but Slot Car Corner buys it in bulk and sells it in 20ml squeeze bottles with a needle tip. The latest bottles have a self retaining cap. If you over oil the top gears the car will run a little slow for a few laps.
Grease is seldom needed on T-Jets. A very small amount of grease on the top and crown gears might be helpful, but it is also likely to cause lint, etc. to get stuck between the teeth.
Contact cleaner is good for flushing crud off the chassis and the armature commutator. Be sure to use a cleaner that is plastic safe and leaves no residue. A few cleaners may contain a small amount of oil and those should be avoided.

Links (Note: The links are clickable)

Parts and Tools

Balls Out Racing http://ballsoutho.webs.com/apps/webstore/

Dash Motorsports http://www.dash-motorsports.com/index.html
bodies, pickup shoes, magnets **Note: A complete reproduction T-Jet car is in the works!**

DC HO Motors http://www.dchomotors.com/
armatures

Dynamic Armatures http://www.dynamicarmatures.com/
armatures

HO Slot Car Racing http://www.hoslotcarracing.com/index.html
Magnetometer (look under magnets), reference material

JAG Hobbies http://www.jaghobbies.com/ho_slot_cars/slot_cars.htm
OEM T-Jet parts, Johnny Lightning/Auto World parts, bodies

JW's HO Speed Parts http://jwhospeedparts.com/
Wheels, tires, gears, axles, spacers, screws, guide pins, front ends

Lucky Bob's http://www.lucky-bobs-slot-cars.com/
tools

RT-HO http://rt-ho.com/
Tools, gears, front ends

Scale Auto/BSRT http://www.scaleauto.com/bsrt/tj_parts.htm
pickup shoes, shoe springs, guide pins, tires

Scale Engineering http://www.scaleengineering.com/
Commutator run out gauge, pickup shoe bender

Slot Car Corner http://www.slotcarcorner.com/Super-Tires-H-O-c203/
tires and wheels, oil

Slottech http://www.slottech.net/home
motor brushes, pickup shoes

Super Tires http://supertires.com/index.htm
tires and wheels, look for the Pro Series tires

Tom Hiester's HO Raceway http://www.xp77.com/hiester/
parts, tools, tires, oil

VRP http://www.vrpslotracing.com/
Dynos, magnet testers

Wizzard http://www.wizzardho.com/Main.htm
Top gears, motor brushes, pickup shoes, shoe springs, front ends, tires and wheels

Zoomin Motorsports http://zoominmotorsports.com/
wheels, tires, axles

Resin and Injection Molded Bodies

9 Finger Hobbies http://9fingerhobbies.weebly.com/
Resin bodies

BRP http://www.bat-jet.com/cat1.html
resin bodies

GoGo http://www.gohoracing.com/index.html
resin bodies

Greg's Garage http://www.gregsgarage.itgo.com/
resin bodies

MEV Originals http://www.tjets.com/
resin bodies

+R Models http://rmodelshoslot.jimdo.com/
resin bodies, decals

Resin Dude Bodies http://www.resindude.com/
resin bodies

Road Race Replicas http://www.ho-slotcars.com/
resin bodies, decals, Nu-Rora bodies

Superjet http://superjetslotcars.com/body64.html
resin bodies

Reference Material

Chassis IDs http://www.modelmotorist.com/web-content/idchass.jsp

T-Jet Armatures http://www.slotmonsters.com/slot-car-thunderjet-500-pancake-motor-armatures.ashx

Magnets http://slotmonsters.com/slot-car-pancake-motor-magnets.ashx

Gauss meter http://www.coolmagnetman.com/magmeter.htm

ECHORR Rules, etc. http://www.echorr.com/

HOCOC Rules
https://docs.google.com/file/d/0BzLR42NthGeCbGhZREZrd2RrM28/edit?usp=drive_web

https://docs.google.com/file/d/0BzLR42NthGeCRE50VzNPTXd5dUU/edit?usp=sharing

https://docs.google.com/file/d/0BzLR42NthGeCN1FHLVMxSExERU0/edit?usp=sharing

Fray Rules, etc. http://thefrayinferndale.com/fray-2012-schedule/