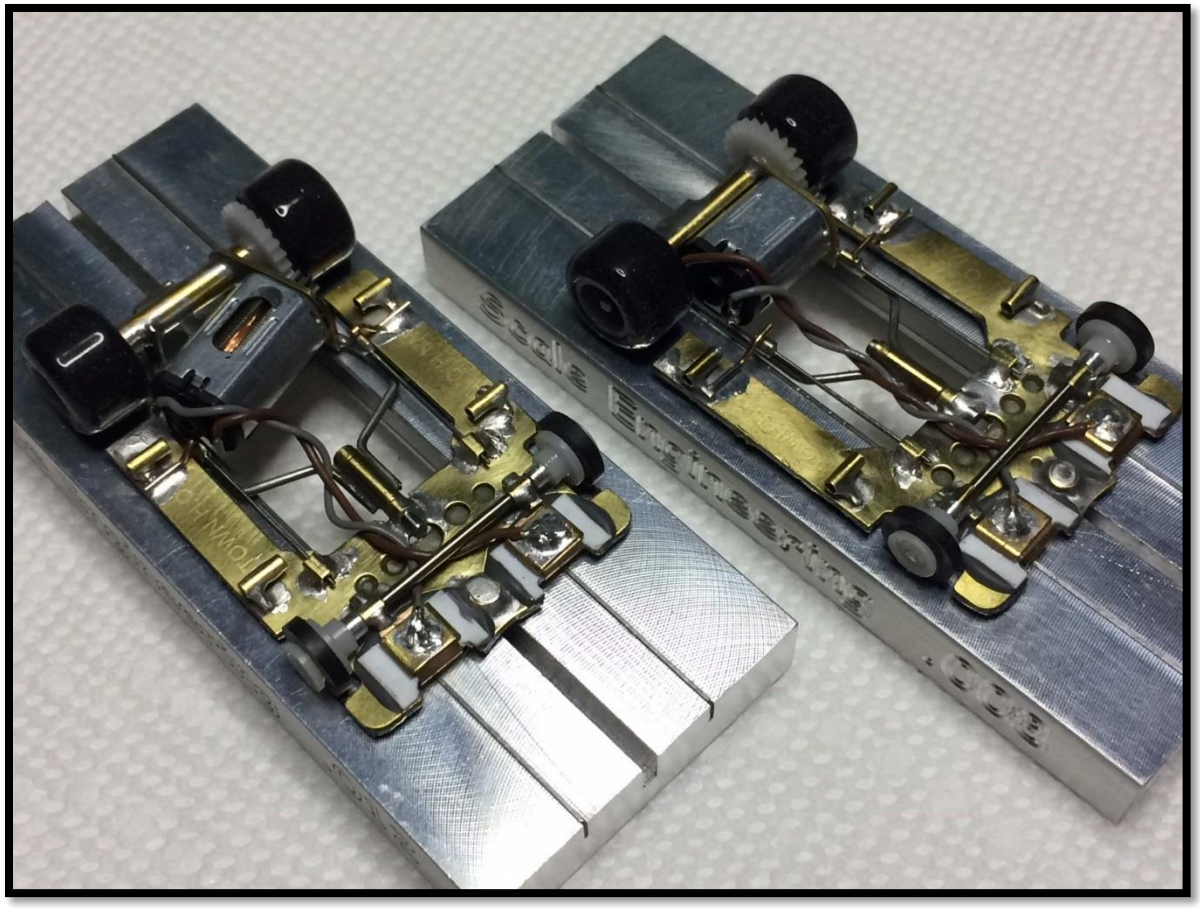
Building a Motown Panned Center-Hinged Gravity Car

By John Reimels August 7, 2017

The state of the art mini-motored gravity car has been evolving at a rapid pace, gone are the simple in-line chassis based on the original LandShark kit. Gone are the standard brass-panned AFX cars. In their wake, we're seeing very flexible, hinged chassis in the mini-motor camp and lowered AFX cars in the pancake camp. At the 2017 Nats, Joel Pennington's lowered AFX car finished first followed by three different center-hinged mini-motored cars, all based on Al Thurman's very flexible center-hinge chassis concept he debuted at the 2016 Nats. Given this evolution, I thought it might be helpful to write an article on the Motown panned, center-hinged anglewinder that I ran at the Nats, the car finished a very competitive third place. In addition to "stealing" Al's center-hinged concept, it also "steals" Joel's concept of keeping the center of gravity as low as possible. While Joel uses tungsten on the bottom of his chassis, I've taken an easier road by lining the bottom of my car with lead, which is much easier to work with. The third "stolen" item for this project is the use of Motown's brass pan originally designed for use on an AFX based car. One of the hardest parts of building a mini-motored gravity car is constructing the basic pan / nose piece. Well, Motown H.O. has taken care of that for us, their DM-1 pan is perfect for the heart of this project. I've documented building an anglewinder in this article but the steps for building an in-line and a sidewinder chassis are very similar. Since the basic pan work is identical whether you're building a sidewinder, anglewinder or in-line configured car, I thought it best to start with the pan construction first.



Basic Chassis Specifications:

Wheelbase – 1.5”

Overall Width (bare chassis) – 1.245”

Overall Width (w/ tires and body) – 1.312”

Chassis to Track Clearance – 0.030”

Rear Axle Centerline to Guide Pin Centerline – 1.70”

Rear Tire Diameter – 0.460” / Rear Jig Wheel Diameter – 0.400”

Front Tire Diameter – 0.300” / Front Jig Wheel Diameter before adding lead to pan – 0.200” / Front Jig Wheel Diameter after adding lead – 0.240”

List of parts and material required for build:

Motown HO:

DM-1 Brass Pan

K&S:

815037	1/16” Thin Wall Brass Tube	(Pin Tubes and Front Axle Bushing)
8149	1/16” Square Brass Tube	(Front Axle Stand-offs & Torsion Bar Retainer)
815047	1/32” Square Brass Bar	(Pin Tube Spacer)
8164	1/8” Brass Rod	(Guide Pin Boss)
8126	3/32” Brass Tube	(Hinge Tube and Retainers)
8127	1/8” Brass Tube	(Rear Axle Tube)
8128	5/32” Brass Tube	(Wiper Holder)
8236	0.025” x 0.5” brass strip	(Motor Bracket)
5498	0.020” Music Wire	(Torsion Bar)
5501	0.032” Music Wire	(Main Rails)
502	0.047” Music Wire	(Guide Pin)

William T Hutchison Co (The best source for truly straight drill blanks):

1.65mm M2 Drill Blank	(Hinge Shaft)
#53 M2 Drill Blank	(Rear Axle)
3/64” M2 Drill Blank	(Front Axle & Guide Pin)

RotoMetals:

1/64” Lead Sheet	(Bottom Lead)

OR

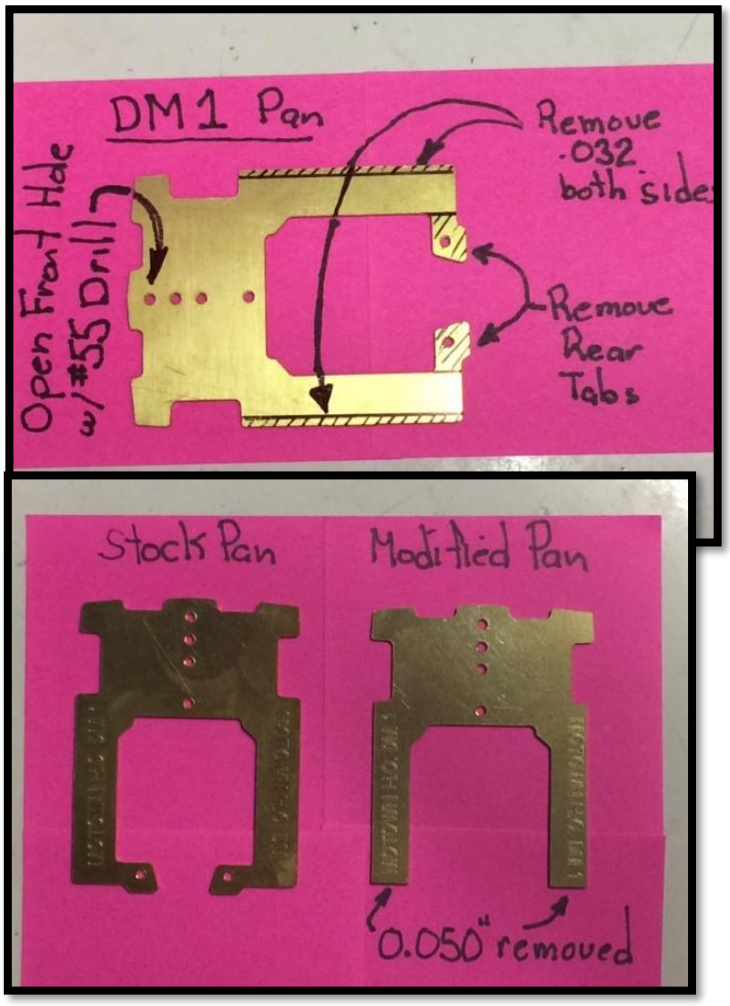
Professor Motor:

PMTR1047 0.016” Chassis Lead (Bottom Lead)

Lucky Bob’s:

Tyco Endbell Bushings (Rear Axle Bushings)
LB Motor Screws
HOST Motor
Life-Like T-Chassis 7T Pinion
Quicker Engineering Stuff (Best acquired thru Lucky Bob’s):
- 23T / 24T Spur Gear
- Front Wheel Set
- 0.460” Gravity Tires
- 0.003” Phosphor Bronze Strips (Used to make wipers)

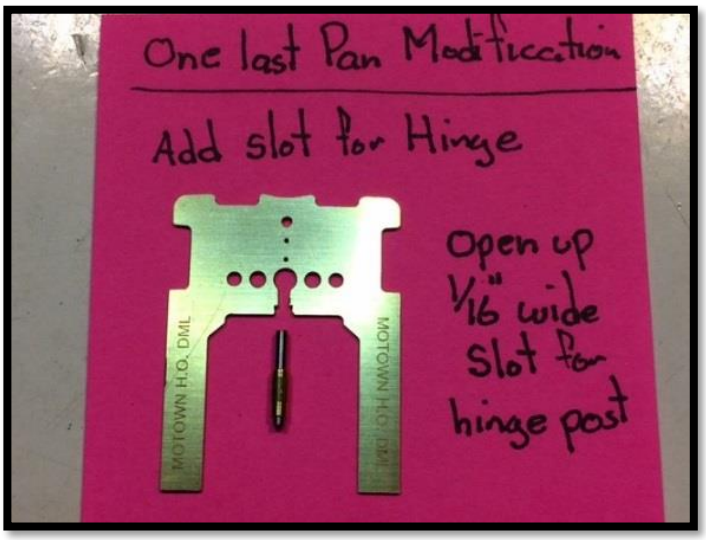
Part 1 – The Pan



Since the DM-1 pan is designed for use on an AFX chassis, the first thing is to remove the rear mounting tabs; cut them off flush with the inside edge of the side pans. The Motown Pan is also designed to take full advantage of the maximum width specification for gravity cars – 1.312”. Using the pan in this configuration requires the body pin tubes to be mounted 1/32” inboard of the edge of the pan so the mounted body and body pins can clear the tech block. The other option is to narrow the pan to 1.245” so the body can fit over the edges of the pan in a more traditional fashion. To ensure clearance with the rear tires, shorten the length of the pans by 0.050”, this prevents the rear of the pan from contacting the rear tires throughout the travel of the center hinge movement.

For mounting the guide pin there are two schools of thought; first is to use a threaded pin with a lock nut and a threaded hole in the pan so the guide pin

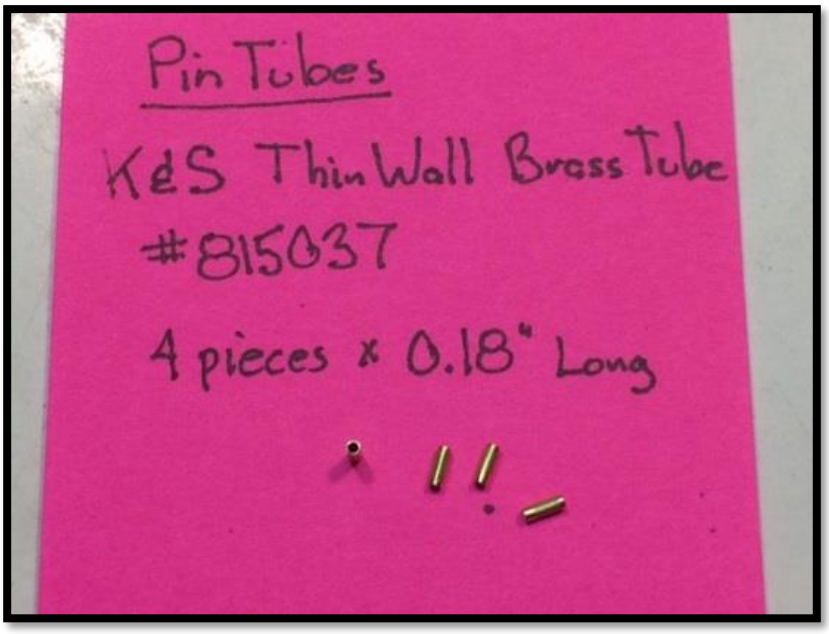
can be adjusted for depth and is easily replaceable when worn. The second option is to solder the pin in place so it will never loosen up mid-race. If going the soldering route, open the guide pin hole with a #55 drill bit. Chose the hole that has the guide pin located approximately 0.20" ahead of the front axle.



The last modification to the pan is to add a slot for the center-hinge pin; a Dremel tool and a #409 cut-off wheel will do the trick. These cut-off wheels shatter easily so wear eye protection but they do make a nice clean, narrow cut. Mark the center of the pan as shown in photo, cut a slot and then open the width to accommodate the hinge pin and brass tubing boss.

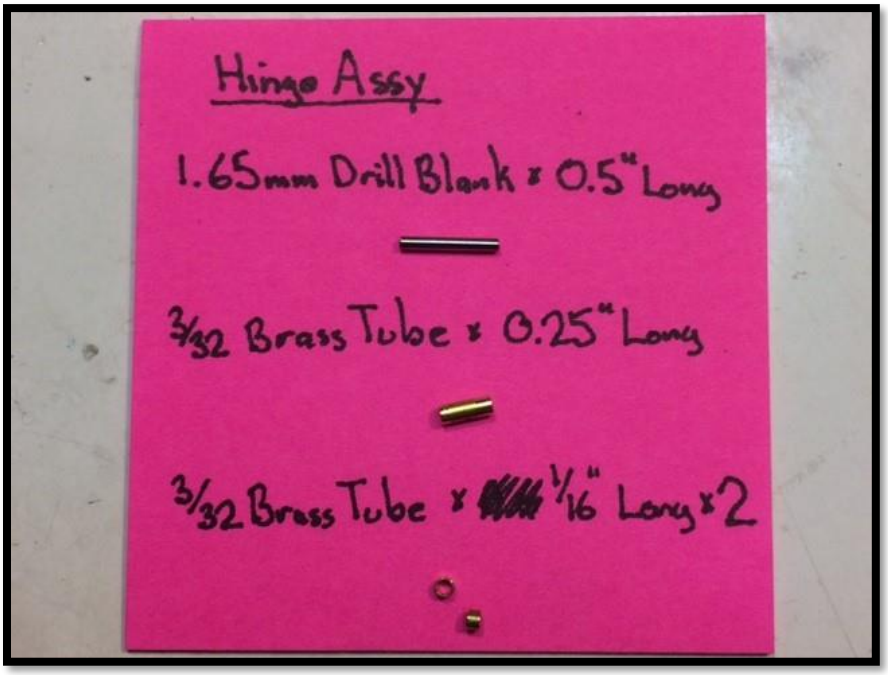
<u>UPDATE -</u> The rumors are that the great folks at Motown H.O. are going to produce a pan specifically for center-hinged, mini-motor cars eliminating the need for modification. Before purchasing a DM-1 pan for this build, check with them on the availability of the new pan.

Now that the pan is ready, next up is fabricating the pin tubes, guide pin, hinge assembly and front axle holders that will be soldered to the pan. For the pin tubes, use K&S thin walled 1/16" brass tubing (K&S #815037). While this tubing can be hard to find in local hobby shops, it can be ordered on-line. The advantage of this tubing is that standard aluminum body pins can be used without modification eliminating the need to either open the inside diameter of standard 1/16" brass tubing or finding smaller diameter body pins that will fit inside standard 1/16" tubing. The tubes should be spaced up off the pan a bit, this reduces the tendency for the body pin to rip through the body hole which is especially applicable if you're using a full width pan; for this use short pieces of K&S 1/32" square brass bar (K&S #815047); once again this is considered a specialty item and will need to be ordered on-line.



If going with a soldered in guide pin use either 0.047" piano wire or a 3/64" drill blank for the pin. Both materials are hard enough that wear will not be an issue. To make the guide pin attachment more robust, thicken the area of the pan where the pin will be soldered with either a short piece of 1/8" brass rod about 0.080" thick or alternatively, a small piece of brass sheet at least 0.032" thick. These are drilled thru with a 3/64" drill bit to accommodate the guide pin. This is soldered to the top of the pan to support the guide pin and stiffen the chassis making it more robust. At this point make the guide pin long - about 3/8" long; it will be trimmed to the proper length during the final assembly of the chassis.

Now on to the hinge assembly. Using 3/32" brass tube over a 1/16" steel pin for the hinge is too sloppy; any play in the fit between the pin and the tube is magnified at the rear of the finished chassis allowing too much movement of the rear tires. Rather than making a custom tube out of 1/8" brass rod to remove the slop from the assembly (my first two builds…), it turns out that a 1.65mm drill blank is a PERFECT fit inside K&S's standard 3/32" brass tubing eliminating the need for a custom brass tube. What a time saver! Speaking of drill blanks, I purchase mine at William T Hutchison Company. The price of the drill blanks is reasonable but the shipping costs are a bit high so purchase a few rear axles (#53 M2 Drill Blank) and a few front axles (3/64" M2 Drill Blank) at the same time as purchasing a 1.65mm M2 Drill Blank for the hinge. I've tried other suppliers but I've always been disappointed in the quality of their drill blanks, I've yet to see any run-out in the drill blanks I've purchased from Hutchison.



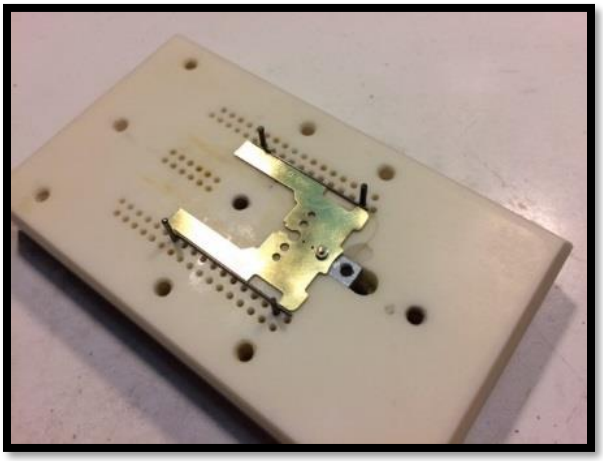
To fabricate the hinge assembly cut a piece of the 1.65mm drill blank a ½" long chamfering the ends slightly to remove the burrs. Next cut three pieces of 3/32" brass tube, one a ¼" long and two pieces each approximately 1/16" long; remove the burrs from the inside and outside edges of the tubes. The rod and one of the short pieces of tubing will be soldered to the pan, the long piece of brass tube will be soldered to the motor frame with the second piece of short tubing being used to cap the assembly together.

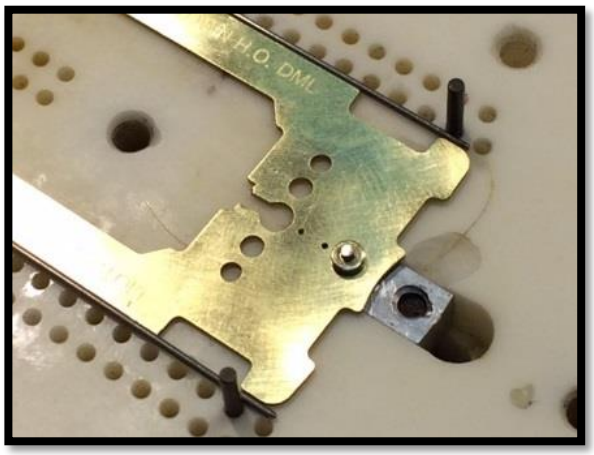
The front axle is mounted using 1/16" square brass tubing (K&S #8149) and the same 1/16" thin wall tubing that was used for the pin tubes. The square pieces of tubing are used to get the correct spacing off the pan while the thin wall tubing is used as the bearing surface for the axle - the thin wall tubing is an excellent fit for a 3/64" front axle. Cut two pieces of 1/16" square tubing approximately 1/8" long and two pieces of the round thin wall tubing the small length, 1/8" long.

Now let's get soldering!

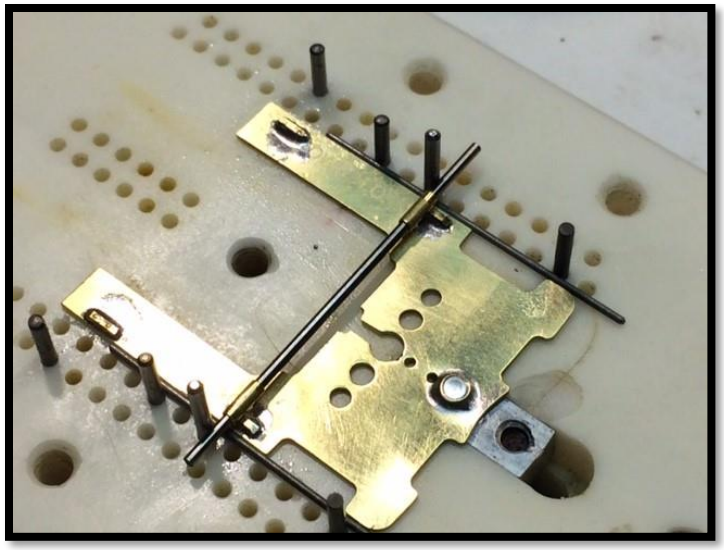
While it might be tempting to try to build a chassis without some sort of holding fixture, I don't recommend it; things get hot in a hurry and finger tips get burned no matter how quick you think you can solder. While you might not need a fancy chassis jig, you will need something to hold the parts in position while soldering. A flat piece of wood with push pins to hold the parts in place can work but if you think you'll be building more than one chassis, investing in a good chassis jig will pay off in the long run. I use a chassis jig made by RGeo Products; it has served me well over the past six years as I've made at least 20 chassis and it's still going strong. While the HO chassis jig is not listed on Rick's website (www.rgeoproducts.com) , I understand if you contact him, he's still willing to make them. While I'm on the soap box, let's discuss soldering tools. It's important to use a good, high wattage soldering iron. Solder won't flow properly until the surrounding metal gets hot enough to melt the solder. A low wattage iron won't be able to heat up brass quick enough to solder, the heat will wick away faster than the iron can heat it up. I use a Weller 45W Iron, model 1140A but they make a 50W iron that's also good, model 1175. I recommend Lucky Bob's solder flux and a good lead-based solder like Kester's 44 Rosin Core Solder, it flows well and cleans up easily.

Now back to our project, start with the guide pin. This is the hardest part to solder because of the large



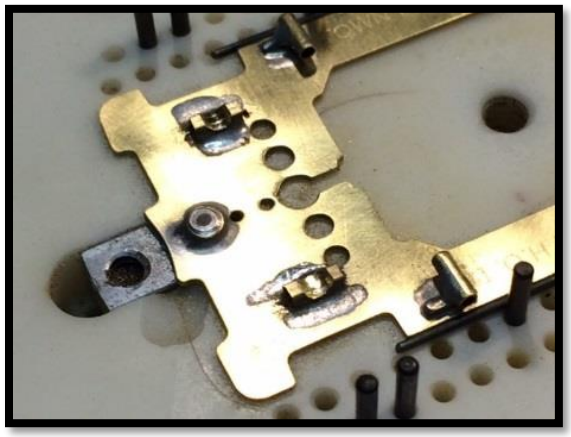


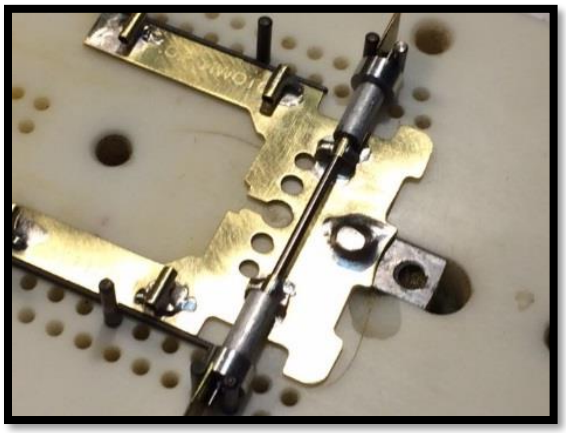
area being heated up. That's why starting here is important because other parts won't unsolder whist heating up the pan for the guide pin installation. Center the pan on the jig using spare pieces of piano wire (if the pan has been narrowed). The jig should hold the guide pin square to the chassis while soldering.

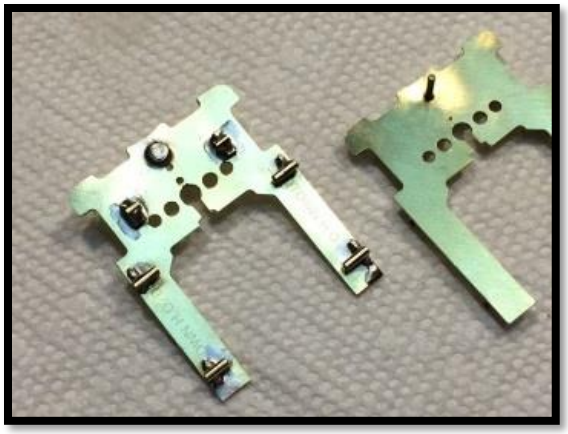


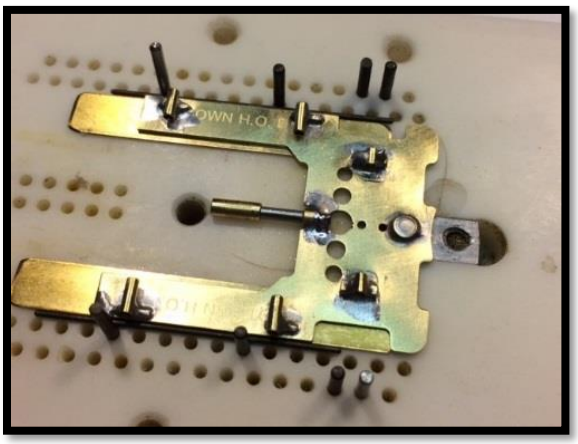
Next step is to solder short pieces of 1/32” square brass bar to the pan to space up the pin tubes properly. Then, using the chassis jig to keep things square, solder the pin tubes on top of the spacers using a piece of 3/64” piano wire to align the pin tubes.

Next up is installing the front axle standoffs. Solder the 1/16” square tubing in place to act as a saddle for the axle tubes. Then, using a round jeweler’s file, create a groove in the square tubing that will accept the axle tubing. Using 0.200” jig wheels on a 3/64” drill blank, the groove should be deep enough so the axle tubes just clear the square tubing. It’s important that the height of the axle be governed by the jig wheels, not by the tubes hitting the square tubing standoffs. Once clearance is achieved, the axle tubes can be soldered to the square tubing using the chassis jig as a guide to keep everything square. Solder will fill the gap between the axle tubes and the standoffs. If everything works out, the final chassis will require 0.300” front wheels to achieve the desired 0.030” chassis ground clearance.









The last step is to add the hinge pin. Since we're going to be adding 1/64" lead to the bottom of the chassis, we need to space the pan up by 1/64" before soldering in the hinge pin; I used scrap pieces of 1/64" brass stock for this purpose. This will allow the bottom of the hinge to sit level with the bottom of the lead covered chassis keeping the center of gravity where we want it - as low as possible. With the pan spaced up, solder the hinge pin and boss in place. The boss will provide a nice surface for the hinge tube to rotate against. During the soldering operation, use a piece of 3/32" tubing at the rear of the pin to ensure It is parallel to the bottom of the chassis.

Now you can unplug the soldering iron and clean up the chassis. I use a tooth brush and dish washer detergent for cleaning up any flux residue. I then use 3M Radical Bristle Discs (80 grit) mounted in a Dremel tool to clean up the solder joints. After a few minutes with the Dremel tool, you'll look like a soldering Pro! (Note, most pictures contained in this document are AFTER clean up…).

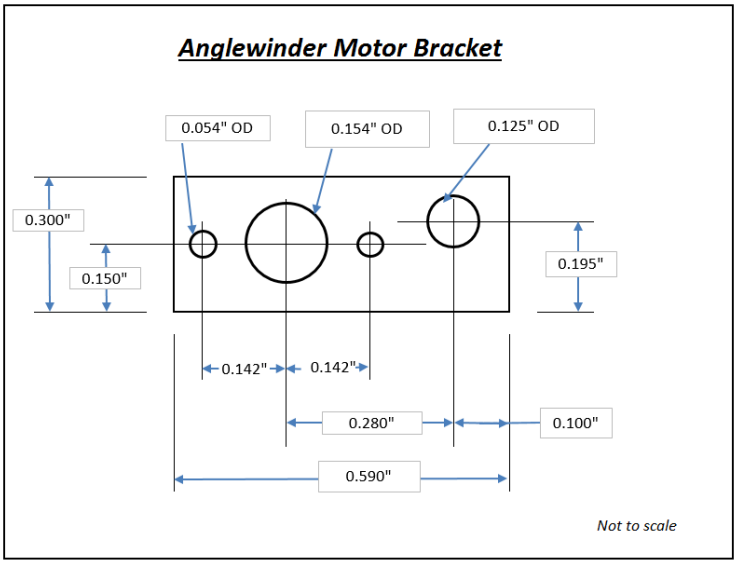
The last step in pan preparation is gluing the lead to the bottom of the chassis. I purchased a sheet of 1/64" lead from RotoMetals. Again, the shipping cost is a significant portion of the overall purchase so I ended up buying 4 sqft of lead. That's enough lead to last me forever but it did help me feel better by spreading the shipping cost over a larger purchase… If you're not contemplating building a fleet of cars, you can purchase a small piece of 1/64" thick, self-stick lead from Professor Motor eliminating the need for rubber cement. Either way, trace the outline of the pan on the lead and rough cut the lead to size. Drill a 1/16" hole in the appropriate spot to provide clearance for the guide pin. Then sneak into the kitchen and steal a rolling pin to flatten the lead as much as possible. When satisfied that the lead is flat, apply rubber cement to both the lead and to the bottom of the chassis. After letting the rubber cement sit for 15 minutes, put the two together. You have one shot at this so when rough cutting the lead, be generous in size. Once the glue has set, trim the overhang with an X-Acto knife. I found it best to carve away the excess lead using an upward motion that pulls the lead toward the chassis. Cutting

with a motion that pushes the lead away from the bottom of the chassis can cause separation of the lead from the pan.

The pan is now ready. The wiper holders and torsion bar retainers will be installed during final assembly.

Part 2 – The Anglewinder Motor Pod

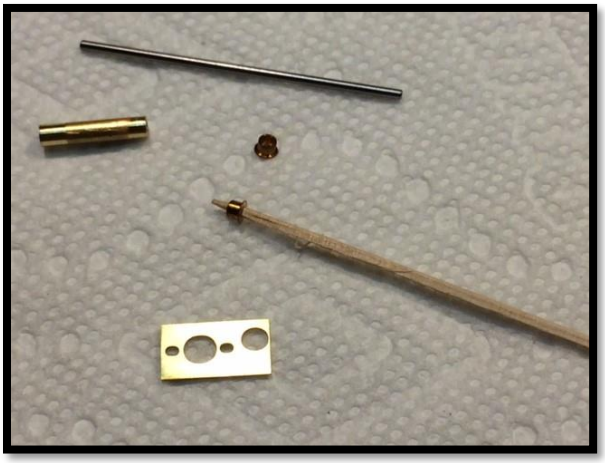
As stated earlier in this article, the completed pan can be used in many motor configurations including anglewinder, sidewinder and in-line. The most difficult to construct is the anglewinder with the simplest probably being the in-line (assuming use of Al Thurman's motor bracket). Since we're building a replica of the chassis used at the Nats, the remainder of this article will be dedicated to building an anglewinder. You'll notice there are a few shots of the sidewinder I built alongside the anglewinder, if there is interest, I can write a companion article for the sidewinder.

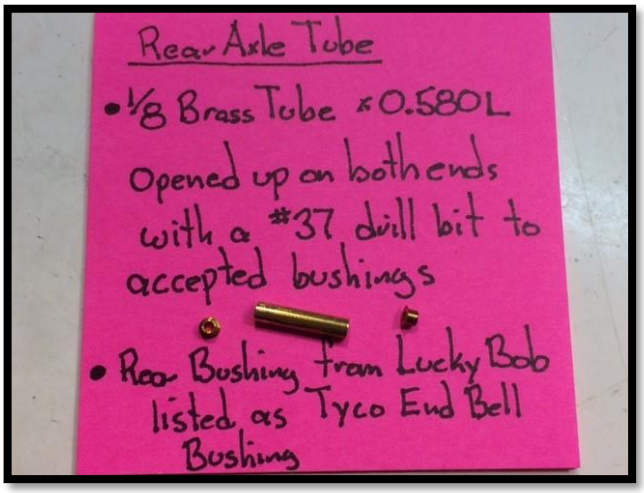


Let's start with the motor bracket. It is constructed using a 0.025" x 0.5" brass strip (K&S # 8236). Cut a piece approximately 1" long. Then layout the holes per the dimensions in the photo. Once the dimensions are lightly scribed onto the brass, use a center punch to locate the hole centers and, using a drill press, open the holes to their correct diameters. While accuracy is great, a small round jeweler's file will help correct any errors.

<u>UPDATE</u> – There are also rumors that Motown H.O. will be making the motor bracket for sale. Please contact them for availability.

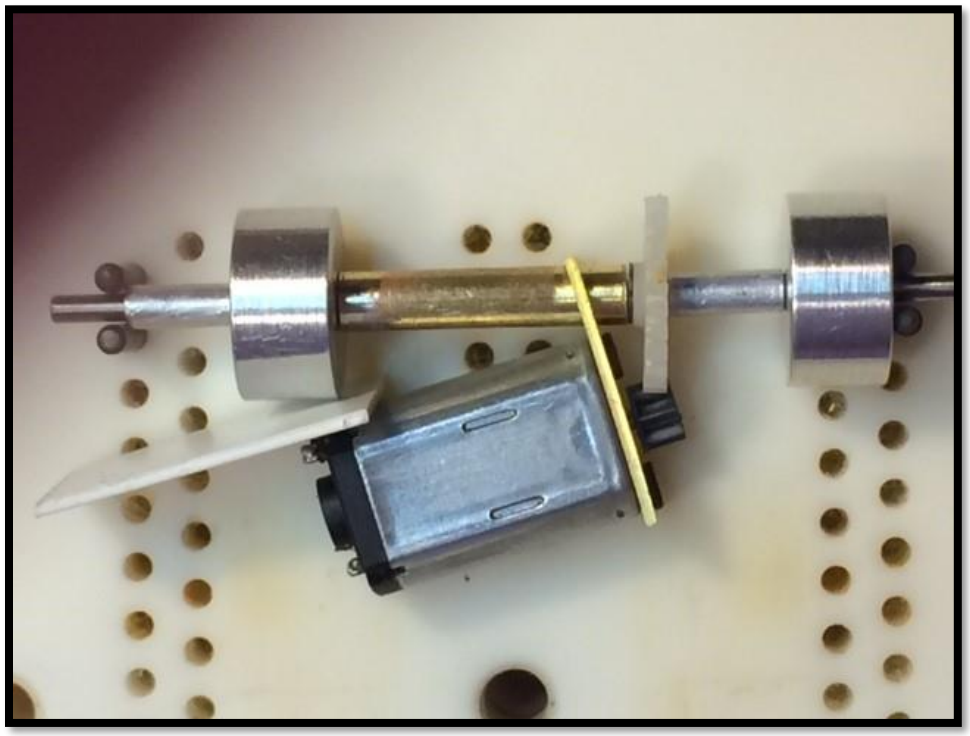
Next up is the rear axle tube. While at the Nats this past June, I noticed that Lucky Bob had a bag of



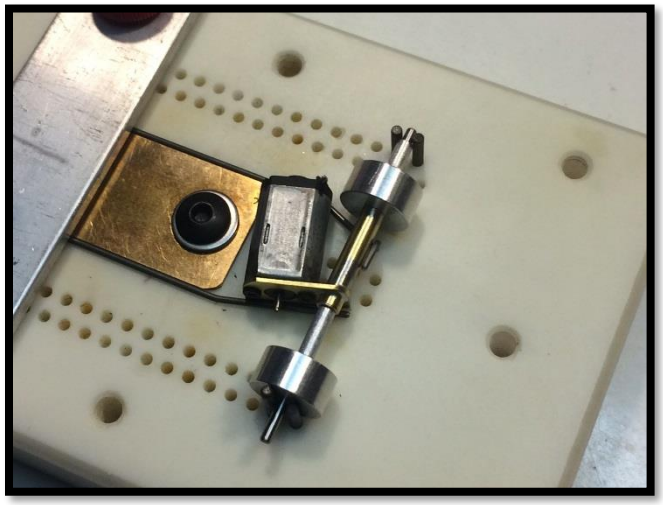


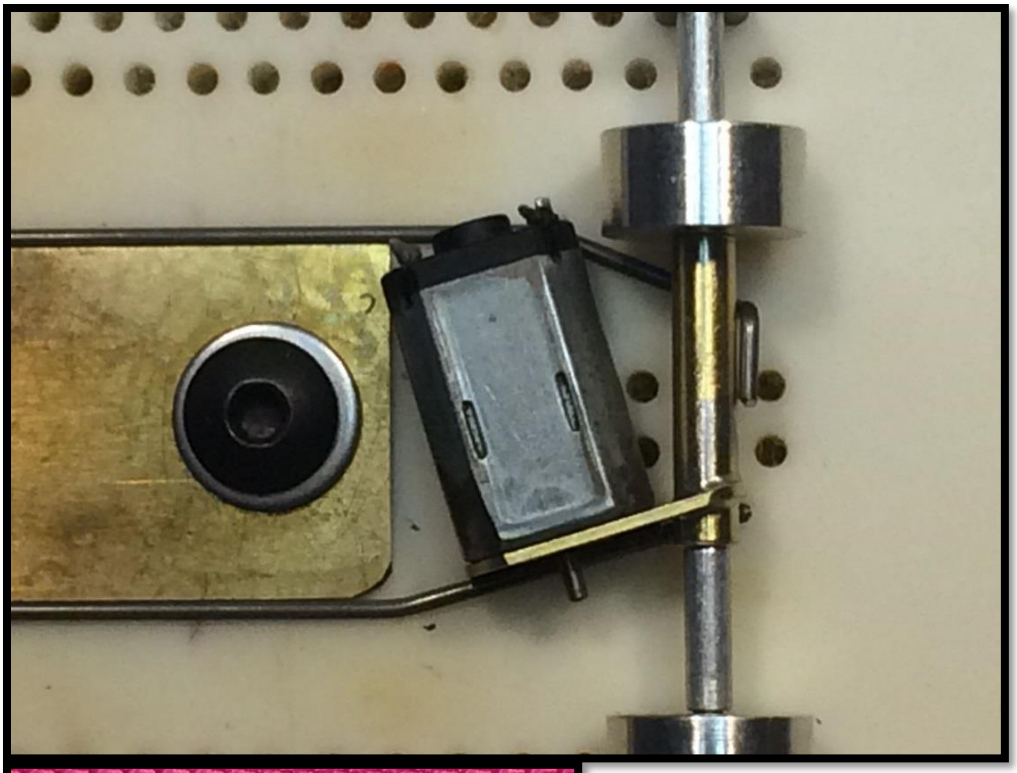
bushings made for the Tyco Endbell. These are nearly perfect for our use as axle bushings, the only task for our application is to open up the ends of the axle tube to accept the outside diameter of the bushings; the inside diameter of the bushings are a perfect fit on a #53 Drill Blank axle (0.0594"). Cut a piece of 1/8" brass tubing 0.580" long. To accommodate the bushings, open the ends of the tubing up with a #37 drill bit. To solder the bushings into the tube, clamp the tube into a vise, heat up the end of the tube with a soldering iron and tin the inside of the tube with solder. Put a drop of flux on the outside of the bushings, re-heat the tube and, holding the bushing with a toothpick, push the bushing into the end of the axle. Repeat on the other side. Check alignment of the bushings by inserting a #53 drill blank in the axle tube. If it's binding, run a #53 drill bit through the tube and bushings to open the bushings slightly. Now you should have a perfect axle tube.

To solder the tube to the motor bracket, we're going to need rear jig wheels, a chassis jig, a spur gear and a motor with the pinion installed as well as a #53 drill blank. Use 0.400" diameter jig wheels to allow adequate clearance between the gear and the track rails. To ensure the motor won't rub against the rear wheels, use a 0.030" piece of plastic to space the motor away from the jig wheel. Align the motor bracket so the edge of the pinion lines up with the edge of the spur gear. The axle hole in the motor bracket will have to be opened up to accommodate the angle the bracket makes with the tube. With everything properly aligned, solder the bracket to the axle tube. It's best to use a dummy spur gear and motor so the flux and heat doesn't ruin your "good stuff"; it's amazing how quick things heat up.



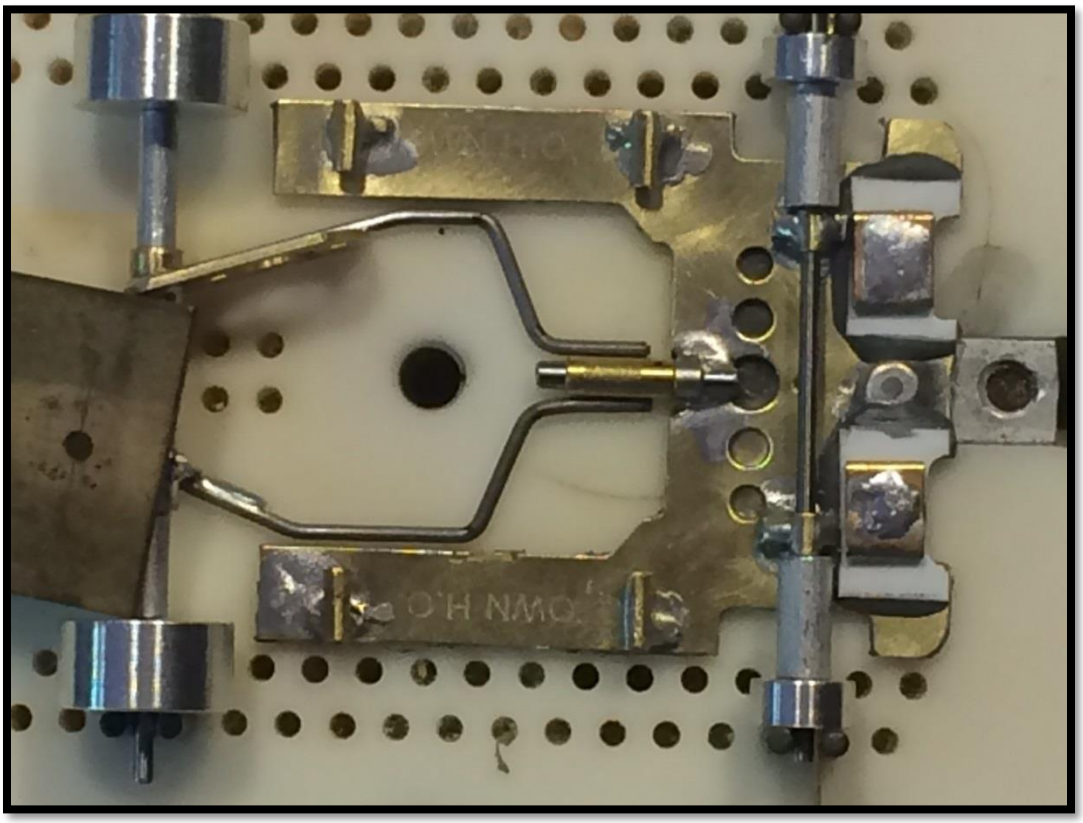
With the motor bracket assembly complete, it's time to add the main rails. Since the flex of the chassis will not be dependent on the size of the main rail, a thicker than normal rail can be used; I used 0.031" piano wire. For an anglewinder, space the main rails apart by 0.700". To ensure the main rails are parallel and properly spaced apart, use a 0.700" wide spacer centered on the chassis jig. The axle tube / motor bracket is spaced on the jig using 3/32" aluminum tubing over the #53 drill blank. The aluminum tube on the gear side needs to be 0.080" longer than the non-gear side to ensure the axle is properly spaced when the spur gear is installed (the spur gear is 0.080" thick). The rail that solders to the motor bracket is simple, only one bend is required so the rail aligns with the motor bracket and the center spacer. The other rail is a bit more



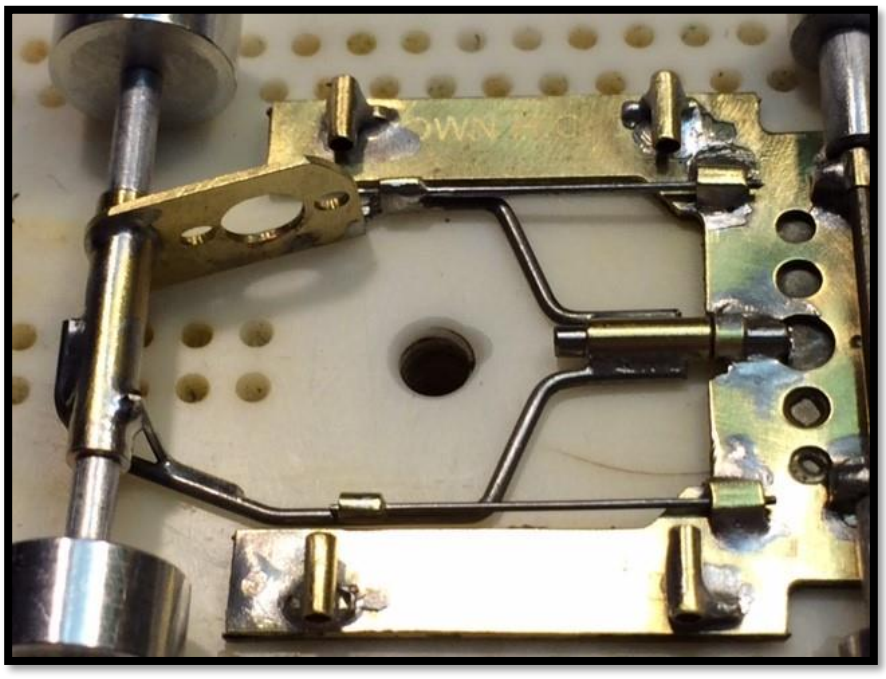


difficult. Start with the bend by the endbell of the motor. The rail must snake between the motor and the jig wheel. Remember the actual wheel will be larger than the jig wheel so to ensure clearance between the rail and the wheel, stay at least 0.030" away from the jig wheel. To create a bit more clearance, I've found it helpful to remove some plastic from the underside of the motor endbell so the rail can run under that corner of the motor. This makes the bends a little less critical. The end of the rail is then bent up to catch the rear edge of the axle tube and then it is bent so the end is parallel to the axle tube. I went through a few pieces of piano wire the first few times I tried to make this rail so don't get discouraged. Once satisfied with the rails, clamp them to the chassis jig and solder the rails to the axle tube and motor bracket accordingly.

The final step for the motor bracket assembly is to bend the rails and solder them to the center-hinge tube. Once again I find the chassis jig very useful for this task to ensure everything is aligned properly. Place the pan assembly and the motor bracket in the jig and mark where to bend the rails. The object is



to bend the rails so they are properly aligned with the center hinge tube. The hardest part of this task is keeping the rails flat against the jig. Go slow, bend a little, trial fit and bend (or unbend…) accordingly until the rails sit flat against the jig, the motor bracket is still sitting flat against the jig and the rails end up alongside the hinge tube. Ensure the hinge tube is up against the brass pin boss and solder the rails to the tube.

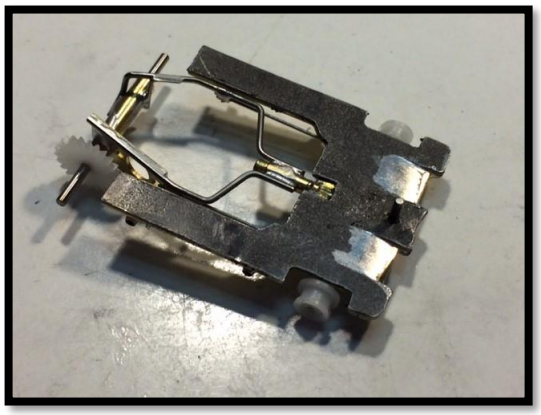


Before installing the hinge cap, we need to install the torsion springs. I use 0.020” piano wire for the torsion springs but I think I’ll go even softer in my next build and try 0.015” piano wire. The rear of the piano wire is soldered to the main rails and floats inside pieces of 1/16” square brass tubing that are soldered to the front pan. I like to keep the torsion spring parallel to the main rails so I use a short piece of 1/16” brass tubing to space up the piano wire in the back before

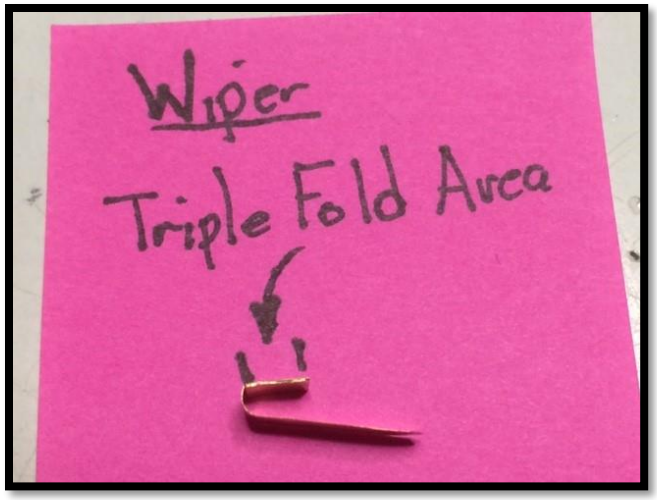
soldering to the main rail. In future builds I'm going to eliminate the brass tube holder and just make a small S bend in the torsion spring so it can be soldered directly to the main rail. The last step is to install some stops so excessive twist doesn't tweak the torsion springs. I make the stops out a 0.025" brass wire that's soldered to the pans and bent so they contact the main rails when the chassis is twisted. I bend the stops to allow about 1/16" of clearance between the stop and the main rail when the chassis is sitting flat.

Now we can finish up the chassis by installing the small brass tube over the hinge pin to tie the front and rear of the chassis together. The brave amongst us might want to solder this tube in place but I worry about soldering wicking inside the pivot tube and soldering the hinge solid. I use a small drop of Loctite 620 to hold the cap in place. There's little load on this cap and the Loctite has worked fine thus far. Now is a good time for a really good clean-up of the chassis with soap and hot water followed by a thorough burnishing with an 80 grit 3M bristle brush. Congratulations, the chassis is complete.

Part 3 – Final Assembly

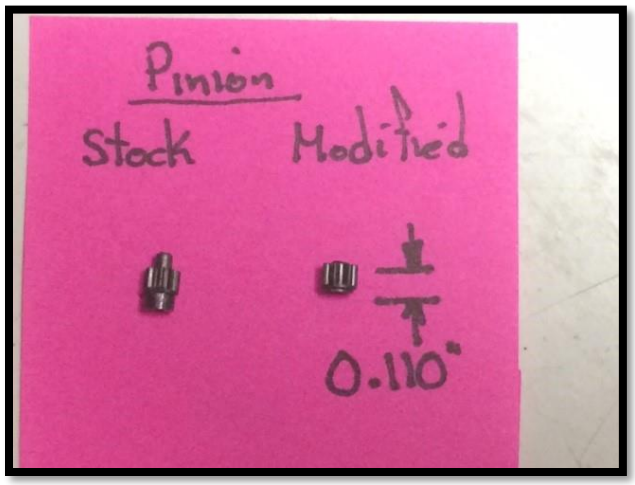


The wiper holders are made out of flattened 5/32" brass tubing. Cut two pieces of tubing approximately 0.180" long. Chamfer the inside edges of the tube to make wiper installation easier. Start to flatten the tubing in a vise; before fully compressed, insert a spacer into the tube to make clearance for the wiper. I use a 0.010" spacer which requires the wipers to be triple folded on the end of the wiper. Others use a 0.003" / 0.005" spacer eliminating the need for triple folding. The triple fold stiffens the end of the wiper aiding installation into the holder but makes the wipers more difficult to make. Once flattened, the holders are glued to the top of the pan. To insulate the holders from the pan, use a thin piece of plastic between the holder and the pan or simply rely on the glue for

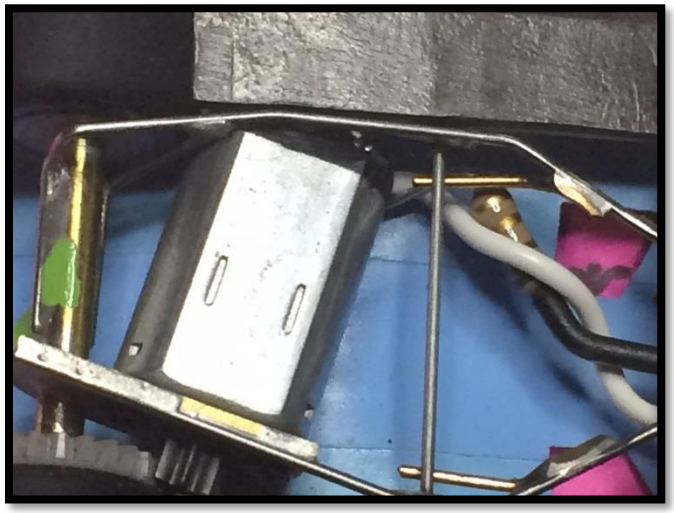


insulation. Either way, glue the holders in place using epoxy or super glue. To make wiper adjustment easier, file a taper into the lead on the bottom of the chassis as shown in the picture.

The rear axle is made from a #53 drill blank shortened to 1.22" long. Press the Quicker Engineering spur gear onto the axle, hub side of gear against the axle tube. Insert the axle into the axle tube, there should be an equal amount of axle showing on both sides – if not, reposition spur gear accordingly. Modify a Life-Like motor pinion as shown in the picture by removing the nub on the gear side and by removing most the hub on the motor side of the pinion. The overall width of the gear should be 0.110" long. Press the pinion onto the motor and using Lucky Bob motor screws, install the motor in the chassis. If the non-gear side main rail interferes with the corner of the endbell, remove the offending material from the endbell with a cut-off wheel. Reinstall the axle assembly and verify the gear mesh. If not correct, open the motor holes in the bracket so the motor can be moved to achieve a good mesh between the pinion and the spur gear. The last step before installing the motor is to solder on some motor leads; leave the wires long, they'll be cut to length before soldering them to the wiper holders. With the motor installed, the rear tires can now be pressed onto the axle.



The front axle is made from a 3/64" drill blank cut to 1.300" long. Verify the width of the front hub / axle assembly in the chassis. Add shims / shorten the hubs as required to achieve an overall width that will pass through the tech block (1.312"). The front tires will need to be ground to 0.300", that should result in a 0.030" ground clearance. If the chassis is sitting much lower than 0.030", tweaking the wipers will be difficult; much higher than 0.030" and the center of gravity will be higher than desirable.



The guide pin should be trimmed so it's 0.170" from the bottom of the chassis. This

length seems to work well on all tracks except Atlas plastic track which has a very shallow slot depth.

Route the motor leads forward twisting them together a few times then run them under the front axle. This keeps them from interfering with the body. Cut the wires to length and solder them to the top of the wiper holders. Insert a wiper into the holder when soldering the leads in place, the wiper helps wick away the heat so the glue joint remains intact.

To prevent the wipers from shorting out on the bottom of the chassis, place a piece of packing tape or Scotch Tape approximately 3/8" wide x ½" long running from the front of the chassis toward the back of the chassis.

All that's left is to install the wipers and take the car out for a spin!