LIONCHIEF CONTROLLER CRADLES

By Charles E. Kinzer

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INTRODUCTION

A project to build a "Children's Layout" for the San Luis Obispo Railroad Museum involved making "Controller Cradles". More were made for another children's layout at a local Exploration Discovery Center. Lionel LionChief was selected for both projects as having the simplist controller scheme for visitors to use with little or no help.

However, LionChief uses hand-held wireless controllers. A "Controller Cradle" was designed that has the following features:

- Prevent any chance the controller can be separated from the layout
- Allows using a power supply to eliminate the need for batteries
- Adds mechanical limits to throttle rotation. Not so much for speed reduction, but so the controller's internal stops won't be used. Some online comments indicated the internal stops could be easily broken. (Other methods can be used to reduce speed, such as putting some diodes in series with the DC voltage from the LionChief Wall Pack power supply.)
- Does not need to be turned on and off with its own switch. Turned on and off with power to the power supply.

These controller cradles are rather involved to make but were meant to look attractive in a museum setting.

Also, the design considered the tools at hand. This design can certainly be modified or used as just an idea for perhaps a better solution. And various steps could certainly be done differently. Maybe something could be 3D printed?

The design also has consideration for using a Universal remote with means to prevent visitors pressing the Engine Selection buttons. If that doesn't matter, you can forgo making the center capture bars and also forgo making the slots for them.

The design uses a Deutsch 2-pin connector, or you can use a connector of your choice. Or you could just solder wires and not use a connector. But it is easier to replace a controller if connectors are used.

Also, the drawings show an "Under Layout Support Plate" that was used for mounting the controllers on rigid Styrofoam. If mounting on a solid surface, such as plywood, this part is not needed.

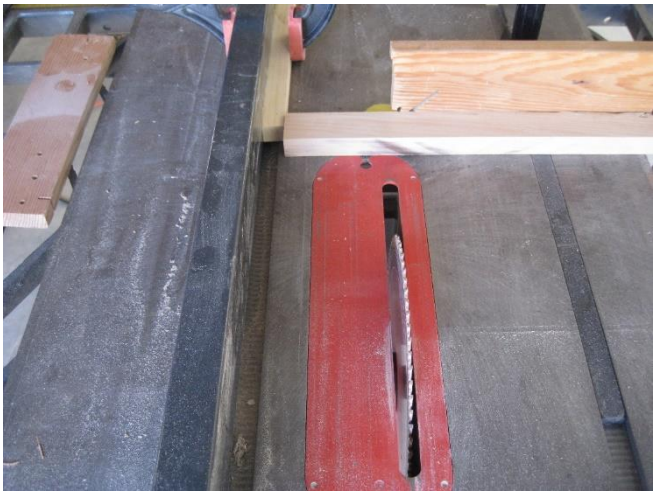
Finally, the metal bars are called "capture bars" but only the bottom bar does any capturing. The top of the controller is actually captured by small triangular wood pieces allowing a little space between the top and middle bars and the controller surface.

MAKING THE CONTROLLER CRADLES

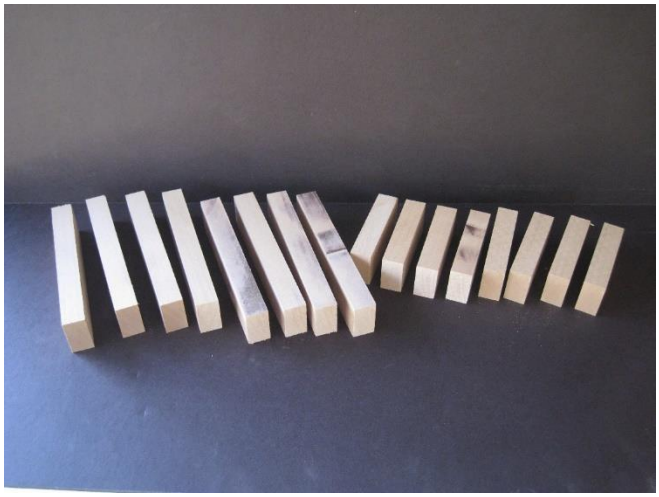
The steps below show making a batch of four cradles and six sets of captures bars.

Refer to the three drawings near the end of this document

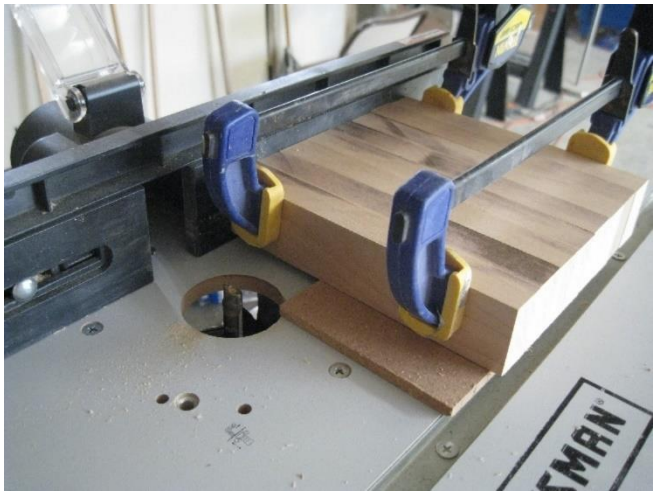
NOTE: Some machine guards removed for more clarity in photos. ALWAYS WORK SAFELY.



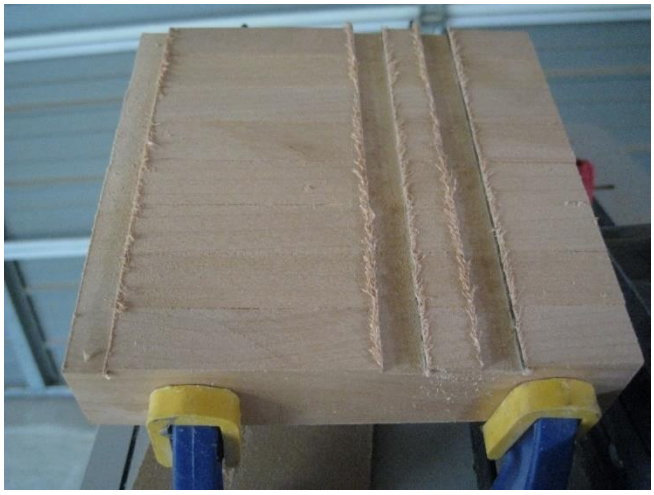
After planing to thickness and ripping to width, cut side, top, and bottom pieces to length.



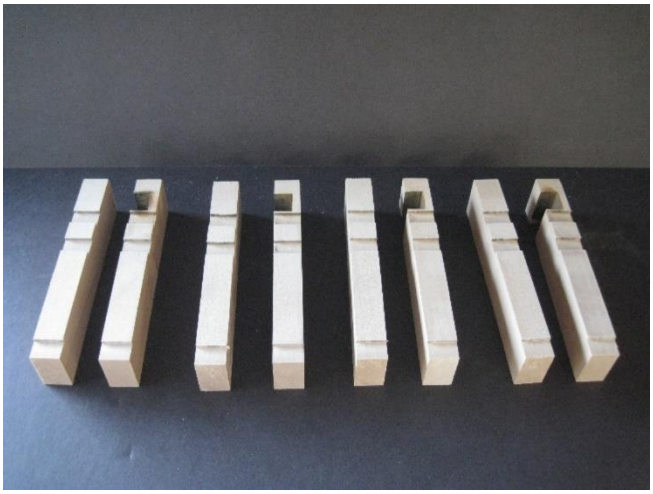
Sides, tops, and bottoms for four cradles.



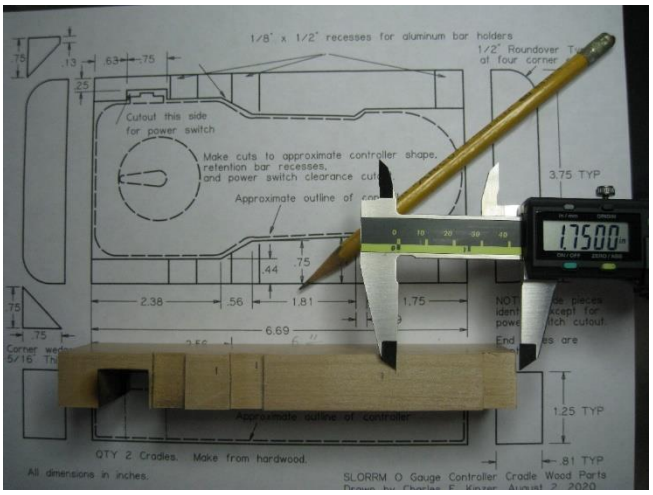
Clamp side pieces together and route 1/2” notches located per drawing.



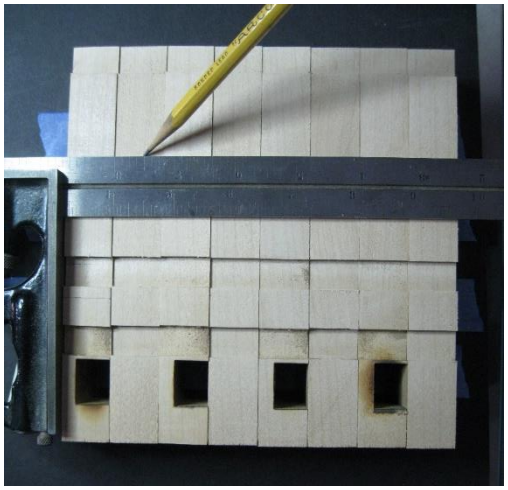
1/2” notches routed into top edges of all side pieces.



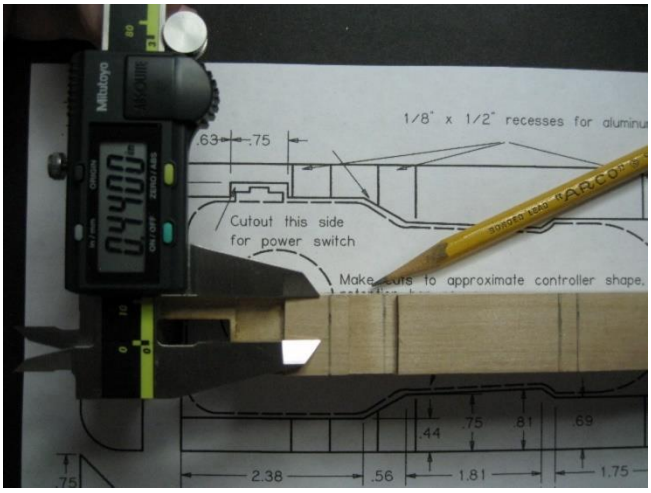
Also route 3/4” notches in half the side pieces per drawing (clearance for controller power switch).



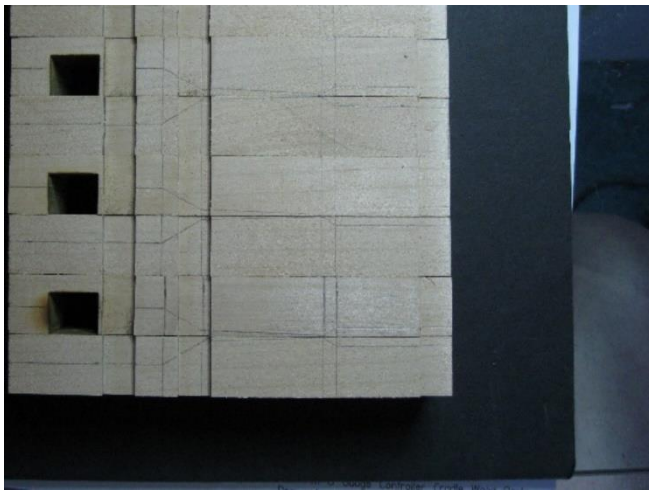
Lay out dimensions along length of a side piece for cutting to fit controller shape.



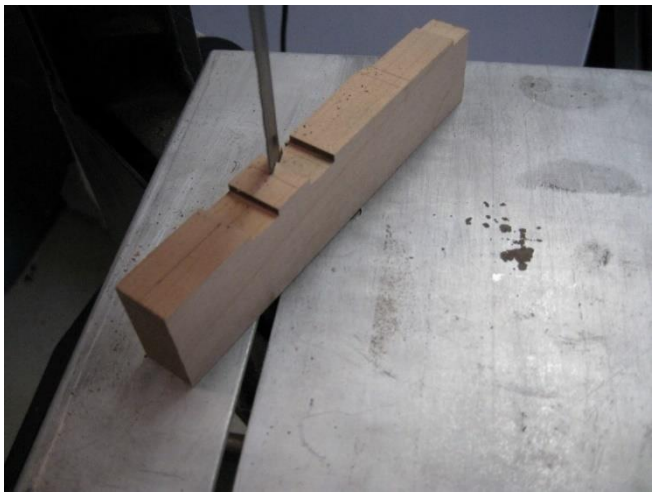
Draw the dimensions from the one marked piece across all the pieces using a square.



Lay out dimensions from edge of piece on each piece.

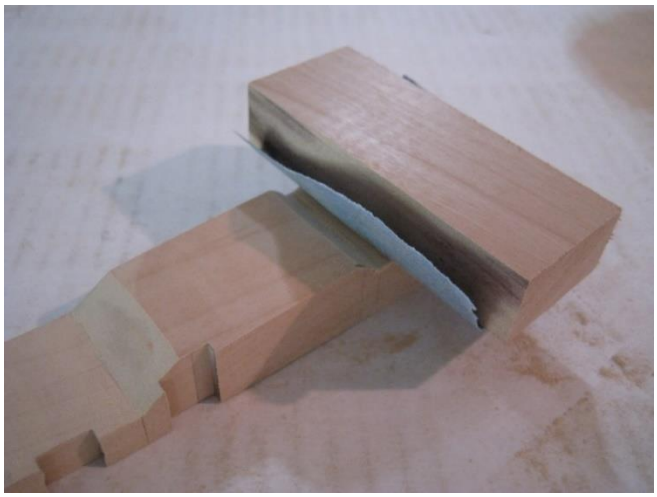


From the dimensions marked, draw lines to represent where the cuts will be made.



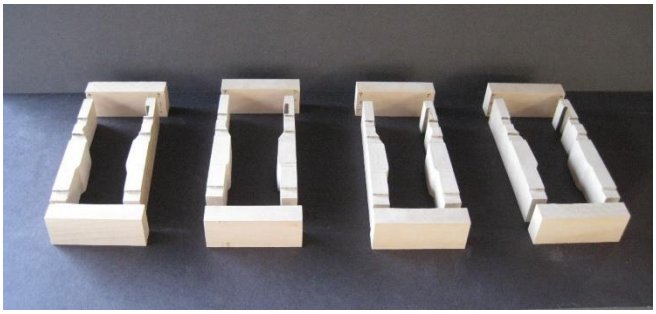
Cut side pieces on a bandsaw along marked lines which will match controller shape.

Some of the bandsaw cut edge can be sanded on a belt sander to smooth it.



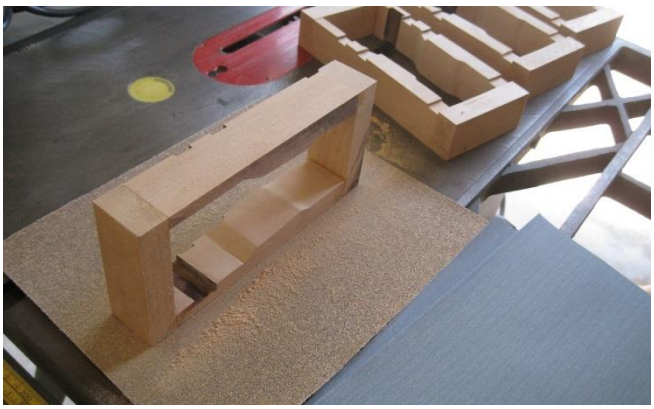
Other areas can be hand sanded. It doesn't have to be perfect as most of the inside surface will be hidden by the controller body.

Clamp each set of parts together temporarily and make sure a controller fits without binding AND can be removed by tilting up the bottom of the controller. Correct any binding problems. Also, mark the pieces in areas that won't show to keep them together as a matched set.

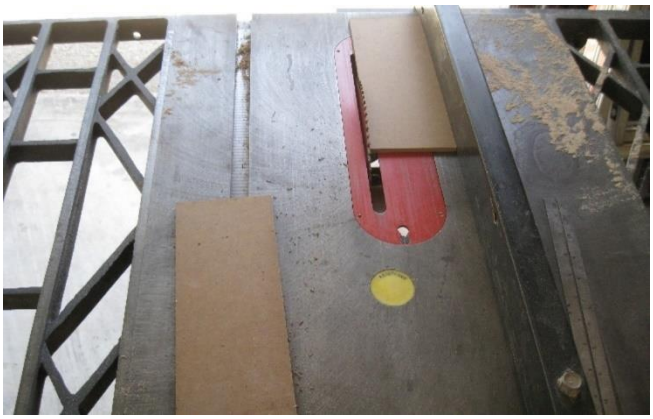


The parts so far with all sawing now completed.

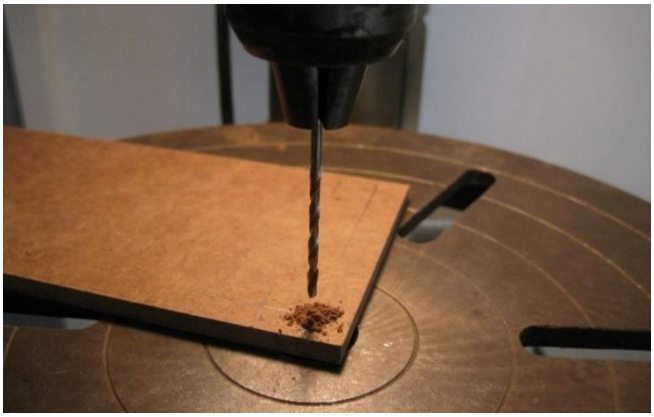
Glue the tops and bottoms to the side pieces. (Each clamp is holding two sets of parts in this example.)



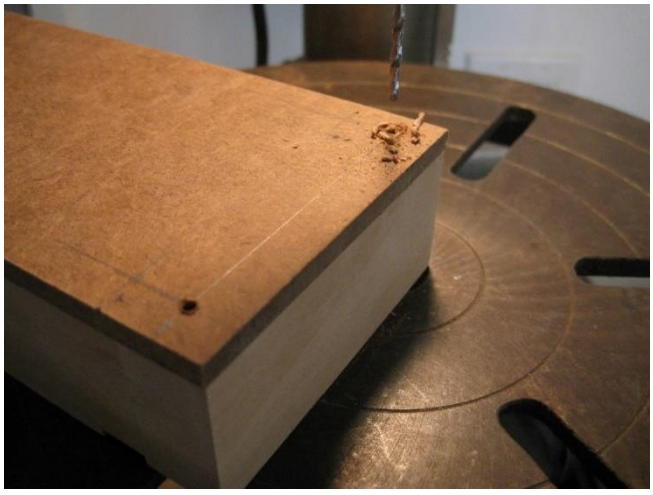
Sand on a flat surface with 180, 220, then 320 grit to make sure sides and the ends of the top and bottom pieces are smooth with the sides.



To avoid much layout work, make a template from Masonite for the mounting hole locations. This template can be used later to locate mounting holes on the layout surface.



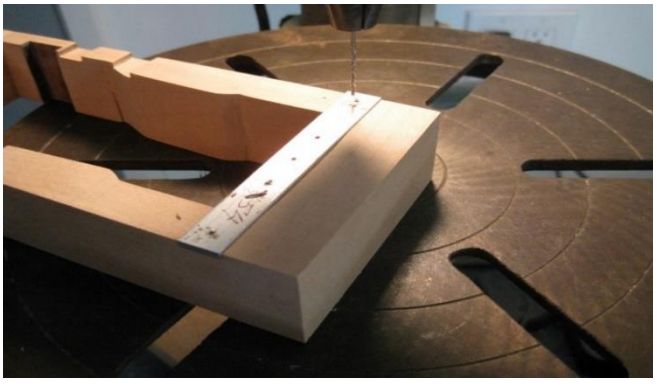
Using a drill press, make pilot holes with a small drill (such as 1/16”).



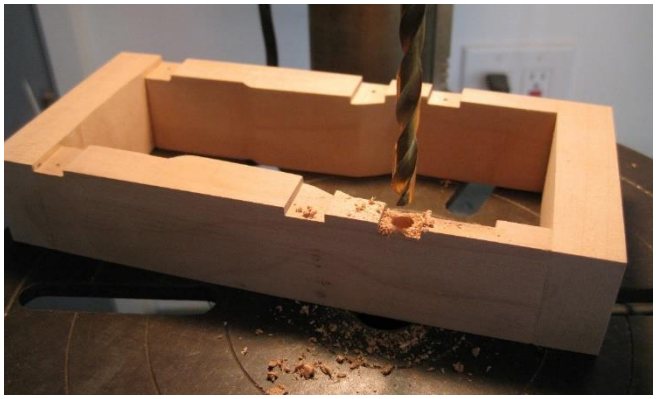
Using the template, drill pilot holes into the BOTTOM side of the cradle. The bottom is smooth and does NOT have the routed notches.

Using the pilot holes, drill the mounting holes on the bottom to full depth per drawing.

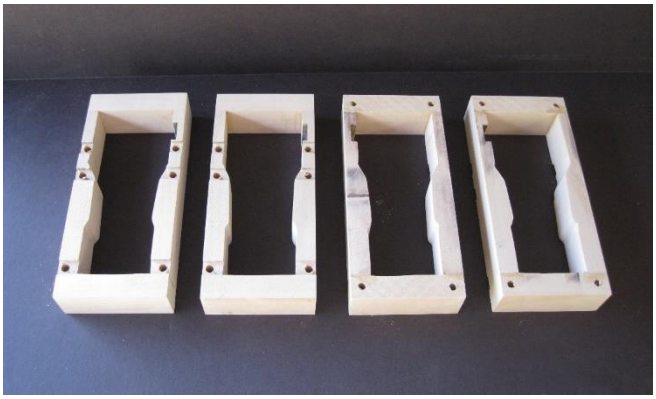
Using a 3 3/4” x 1/2” x 1/8” piece of aluminum bar, make a template locating the capture bar mounting holes and holes for the three buttons on the Universal Controller per drawing. A #54 drill was used here. This will be used to locate capture bar mounting holes in the cradle. Later, for locating holes in the capture bars themselves.



Use the template to drill pilot holes in all the 1/2” notches on the top of the cradle.

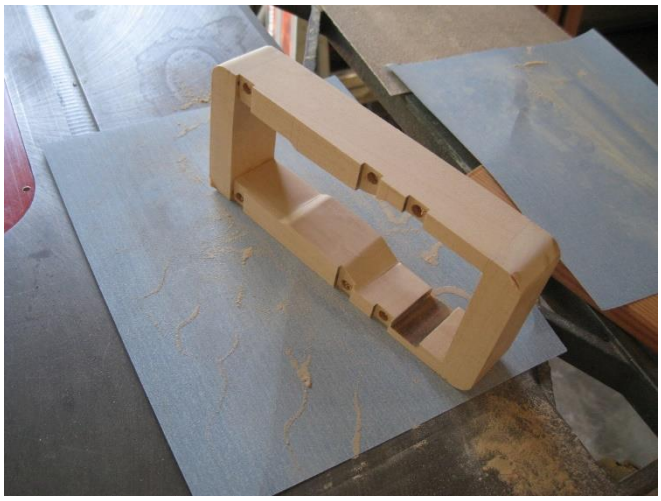


Drill the holes (that will later have threaded metal inserts installed) per the drawing. Six places per cradle.



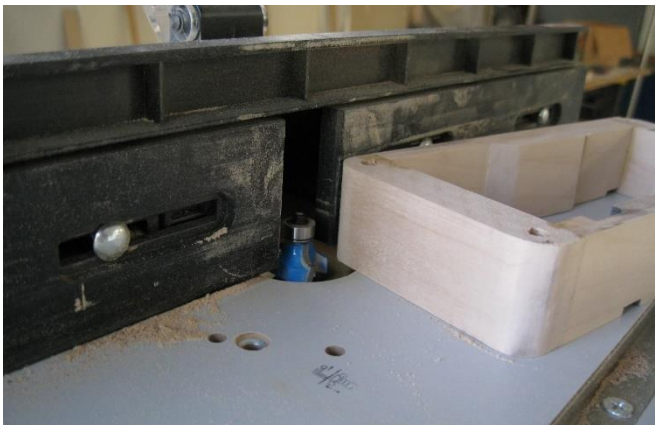
The parts with all mounting holes drilled. The two on the left show the top, the two on the right show the bottom.

Using a router table and a ball bearing 1/2” roundover bit, route the corners.

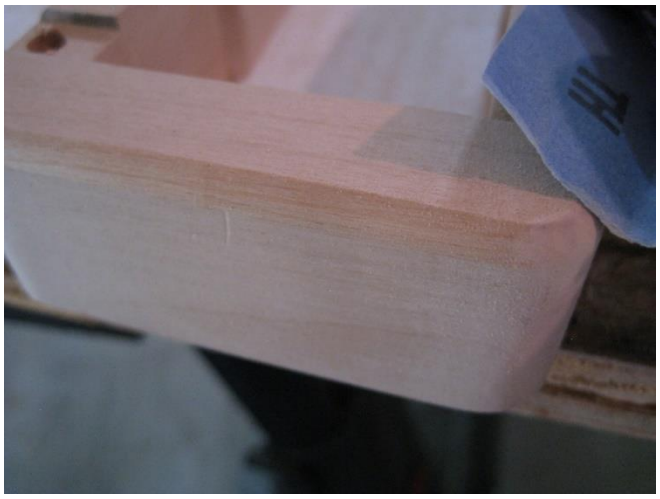


Smooth the corners so they blend will with the side and end pieces.

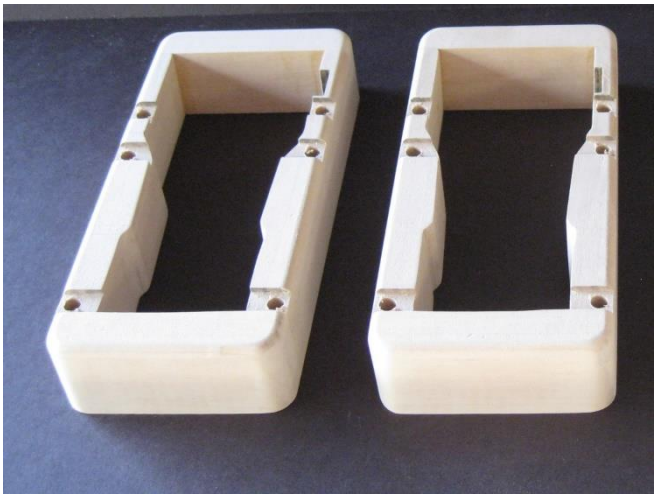
The cradles after the corners rounded to 1/2” radius.



Using a ball bearing 1/4” roundover bit, route all around the top edge.

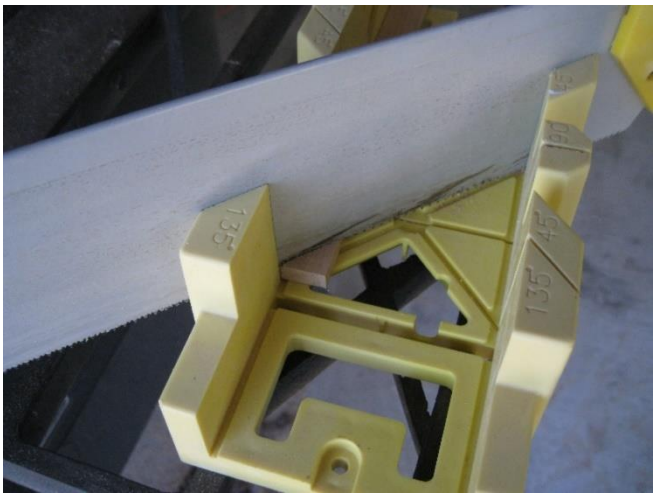


Hand sand the 1/4” radius so it blends well and looks good.



A close up of what the cradles look like with the 1/4” roundover work finished.

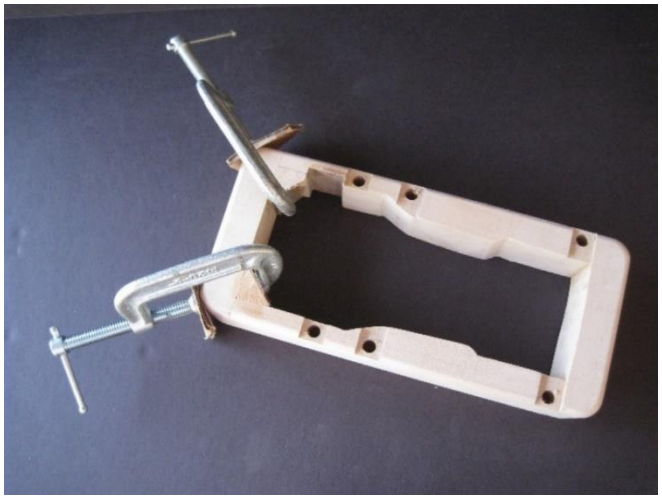
Rip some wood to the cross section for the triangular wedges.



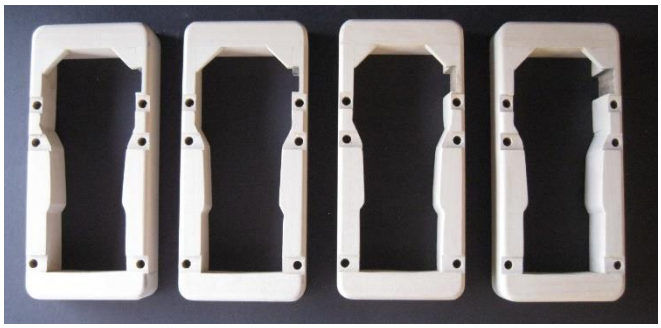
Using a miter saw, cut the triangular wedges.

On a sander, sand the small flat on each triangular part that mounts on the side with the power switch notch.

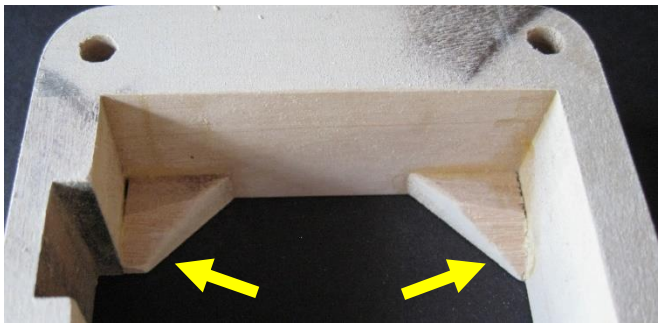
Finished triangular parts



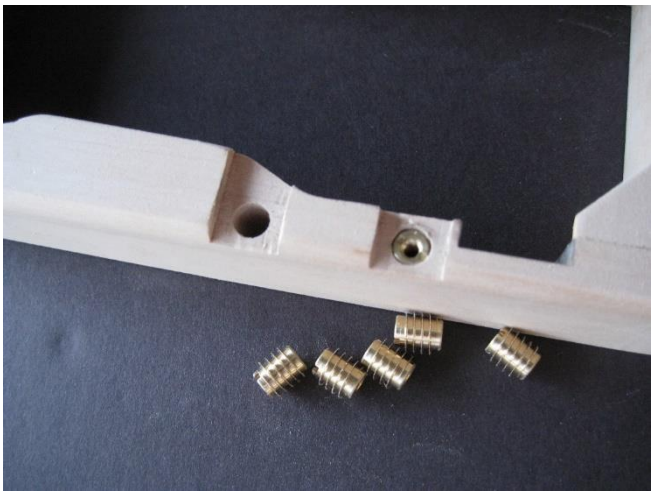
Glue and clamp triangular parts in position.



The cradles after the triangular parts glued on. Hand sand to blend them so the top surface is smooth.

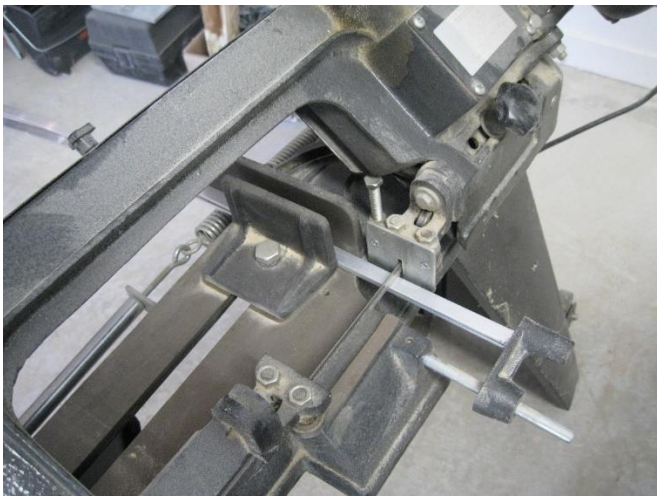


Hand carve a taper as shown. This facilitates installing the controller which much be initially inserted into the cradle at a steep angle.



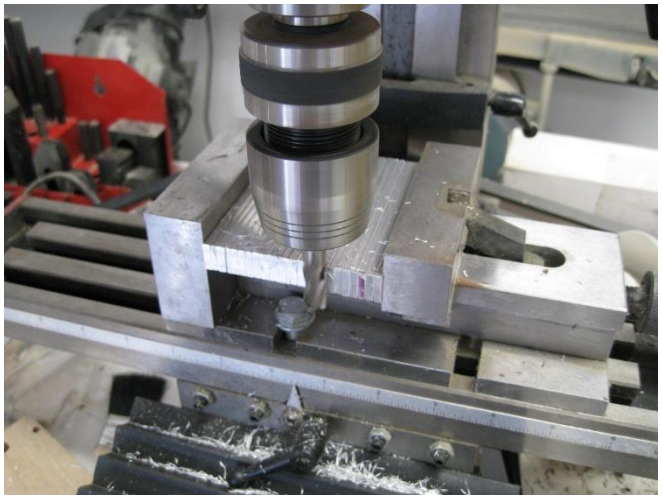
Install the threaded metal inserts – 6 places on the top side.

Stain all surfaces. A little stain getting on the metal inserts doesn't matter.



Cut 1/2" x 1/8" aluminum bars to length or a little bit over. A horizontal metal cutting bandsaw is shown here cutting two bars at a time.

Cut enough pieces for the number of cradles being made (4 per cradle) and perhaps some extras. Some of these bars will later be cut into two filler pieces, but for ease of handling are kept as a single bar for now.

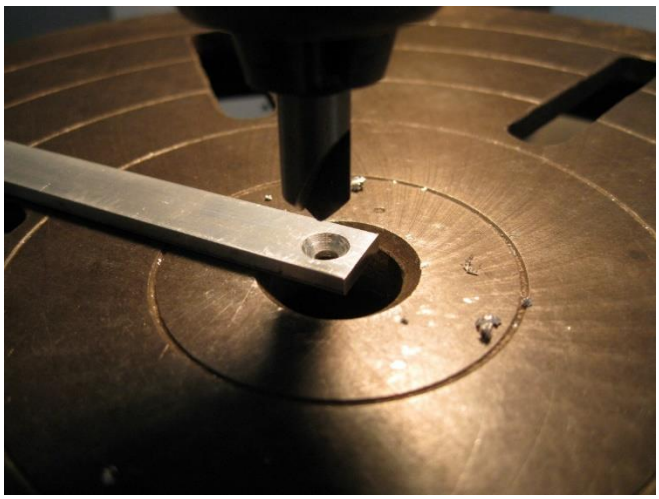


Pieces cut slightly long and all machined to length together on a milling machine.

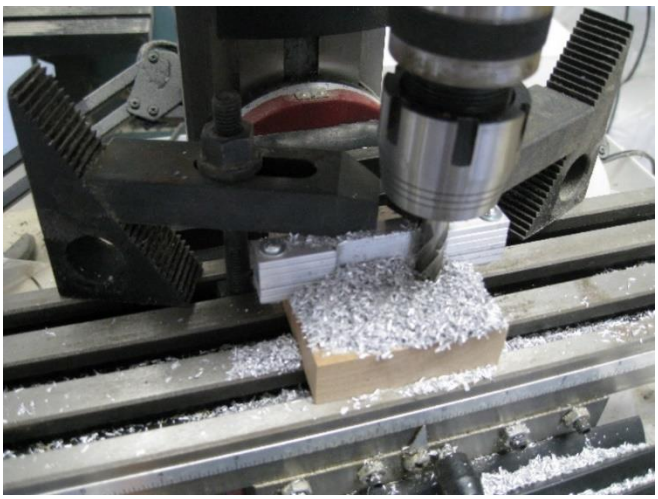
Using previously made drilling jig, drill pilot holes in all pieces.

Machine counterbores in the bar optionally used with the Universal Controller. Then drill the through hole for these locations.

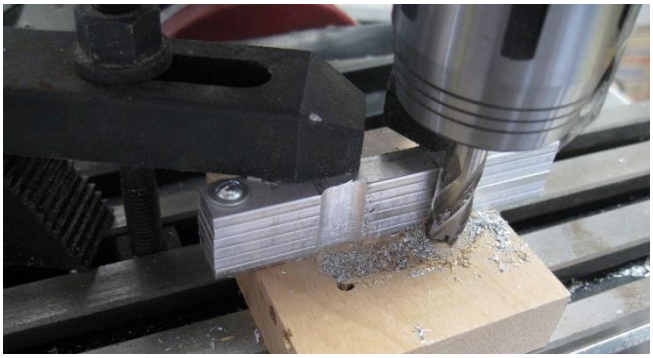
Drill through holes at each end of every piece.



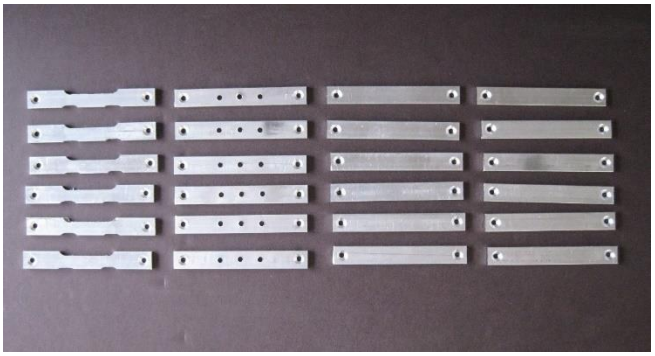
Countersink the mounting holes just enough so the screw head will be flush with the surface.



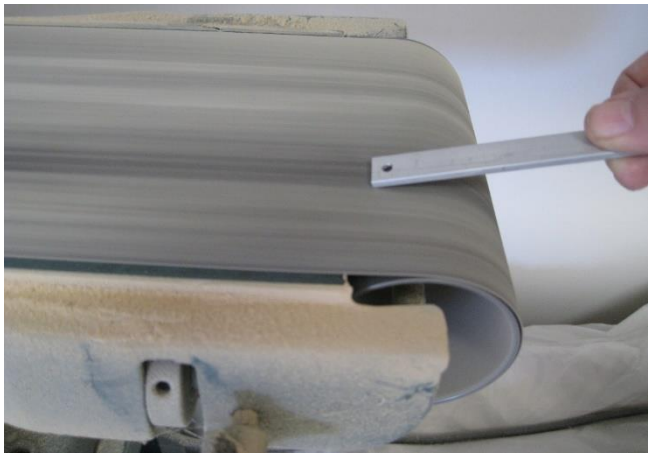
For the top mounting bar, machine the recess that allows clearance for the throttle knob. A milling machine is used here to machine six at once.



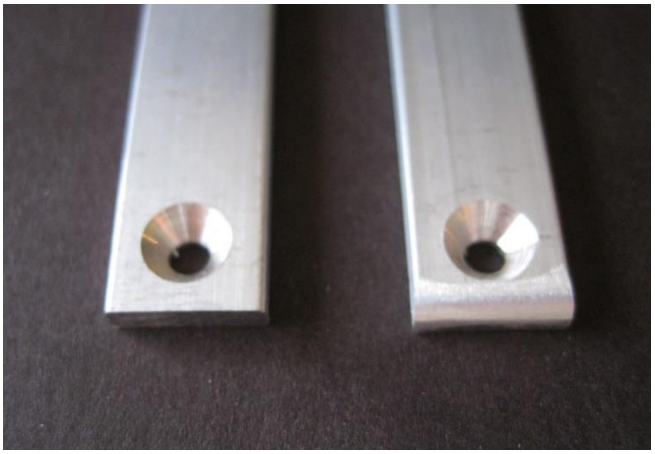
For the top mounting bar, machine the recesses that allow a little more of two of the controller buttons to be visible.



The parts so far. Six sets in this example. Left to right: Top bar, optional Universal Controller middle bar, optional middle filler pieces (to be cut later), and bottom bar.



On stationary belt sander round top edge of end to roughly match quarter round of cradle top edge. Leave the mounting hole countersink completely intact.



Before and after rounding sanding. Note how rounding goes nearly up to, but not into, countersink diameter.

Work on the curved to remove more of the curve towards the edges while leaving most of the metal at the center intact. This will help blend it into the cradle edge. Round the corners and break all sharp edges so there is no risk of snagging a finger.

The left is from the stationary belt sander. The right is after further refining the shape.

Per drawing, or using a cradle as a template to mark, cut the filler pieces from a solid piece (after the ends have been shaped). Then clean up and debur the cut edges.

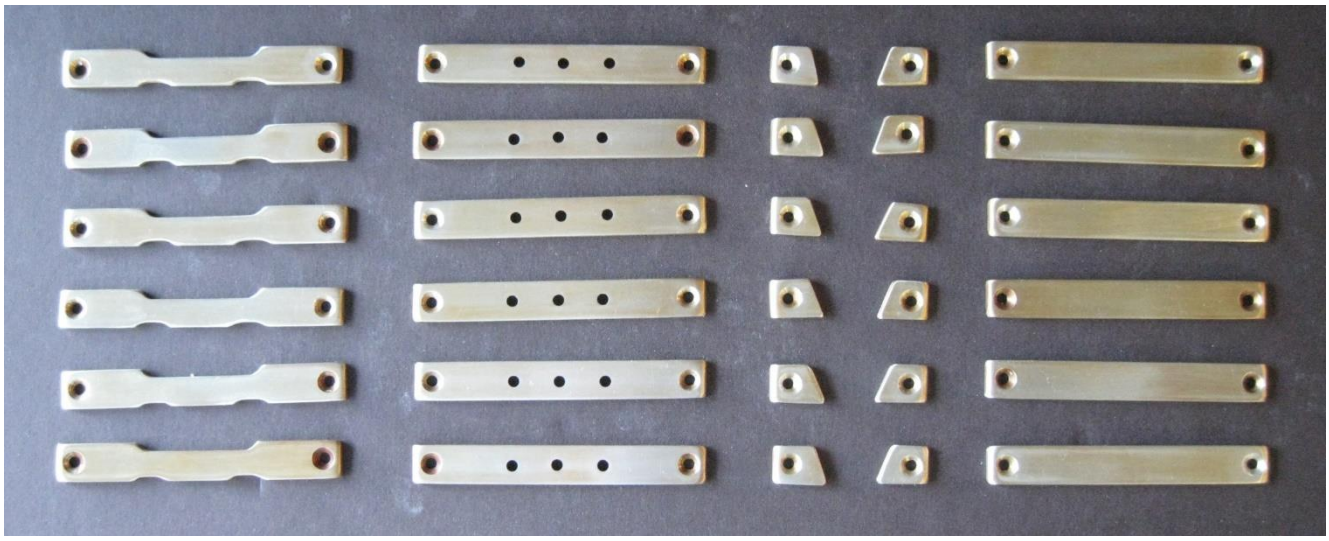
Break all edges and do any other cleanup of the parts needed. Grain the tops and sides with 320 grit sandpaper to remove any Imperfections and leave an attractive finish. This is one set of parts for one cradle.

This photo shows that quite a bit of the edges and corners are smoothed by hand sanding.

Here are the ends of some pieces. Notice the grained surface with all scratches lengthwise.

Wash the parts in hot water and detergent to remove any dirt or oils in preparation for a finish.

Place parts in Bonderite 1201. (This used to be called an Alodine finish.) When they turn gold, remove, rinse, and leave submerged. One by one, remove from rinse water and with a rag rub off any brownish deposit that may be on top of the finish.

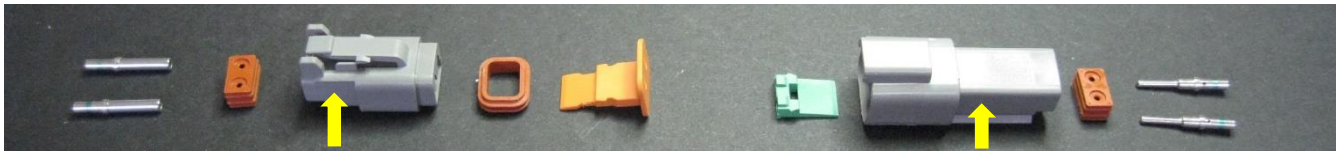


The finished parts after the Alodine treatment. They are now gold in color, but more importantly will resist corrosion (such as from acids from fingers touching them).

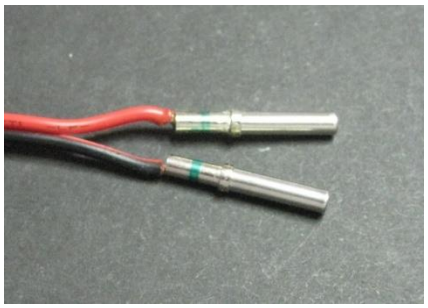
The cradles got several coats of “Wipe On Poly” by Minwax. This is very easy to use. Of course, any wood finish could be used.

ASSEMBLING DEUTSCH DT SERIES CONNECTORS

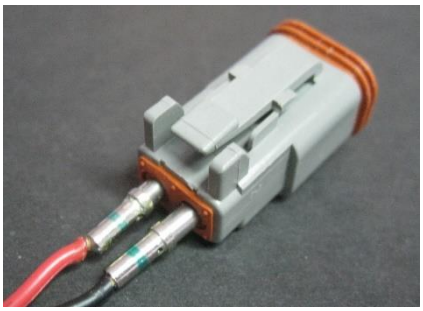
The Deutsch DT series connectors are marketed for automotive applications. While water resistance is not needed for the layout, it is otherwise a very reliable connector type. Its assembly is not intuitive, so the assembly steps are shown below. Contacts are designed for crimping but can also be soldered.



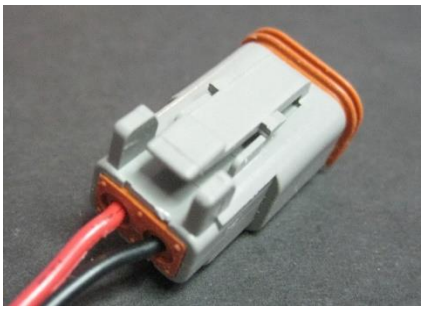
These are the parts for Deutsch connector plug and receptacle. Pin numbers are molded into the housings at locations shown by the yellow arrows (very small and hard to see).



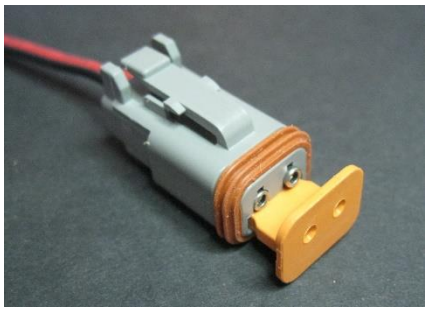
Strip, tin, and solder wires into the contacts. RED is for Pin 1 and BLACK is for Pin 2.



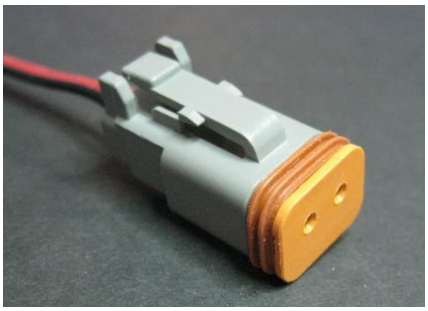
Push socket contacts through the rear grommet of the plug housing.



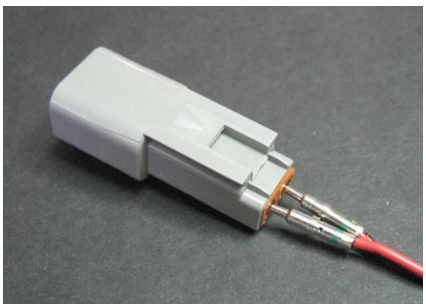
Push until they click into place. Check with a slight tug.



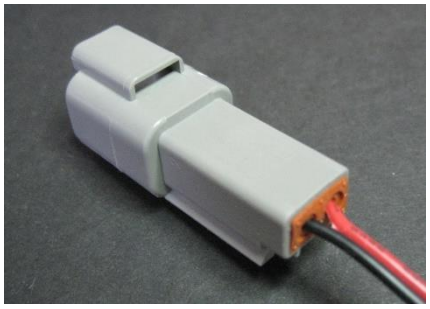
Push the orange wedgelock into the plug.



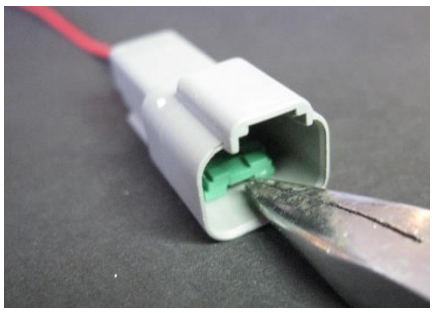
Push the orange wedgelock until it locks into place.



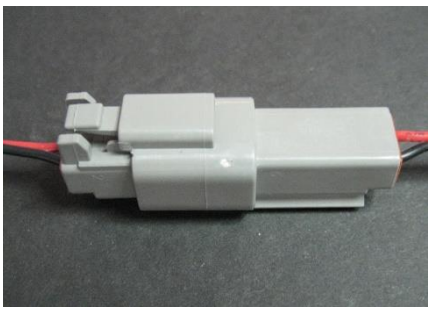
Push pin contacts through rear grommet of the receptacle housing.



Push until they click into place. Check with a slight tug.



Push the green wedgelock until it locks into place. This will be deep in the receptacle so use a tool to push.



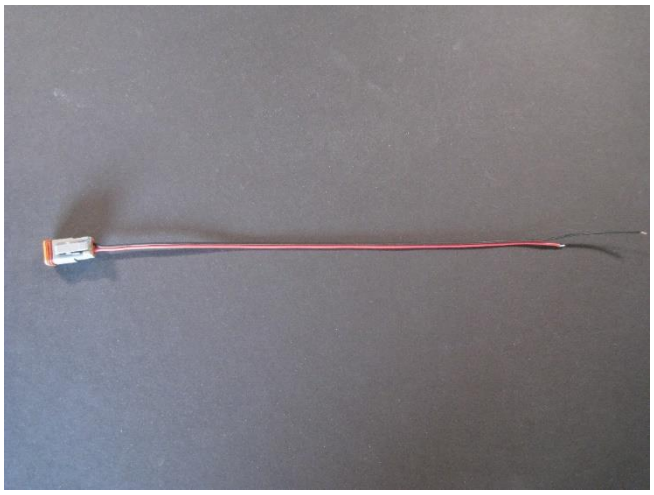
The finished plug and receptacle connected together.

MOUNTING CONTROLLER CRADLES

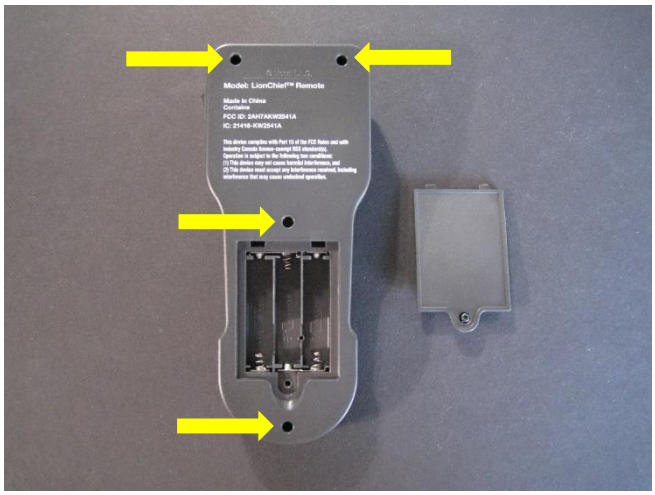
Holes made through layout top for mounting controller cradle using 4” hanger bolts. The large 3/4" hole is large enough for the connector from the controller to pass through.

A piece of Masonite with a matching hole pattern is used under the layout to act as a large washer to spread the mounting force. (Not needed if mounting to something solid like plywood.)

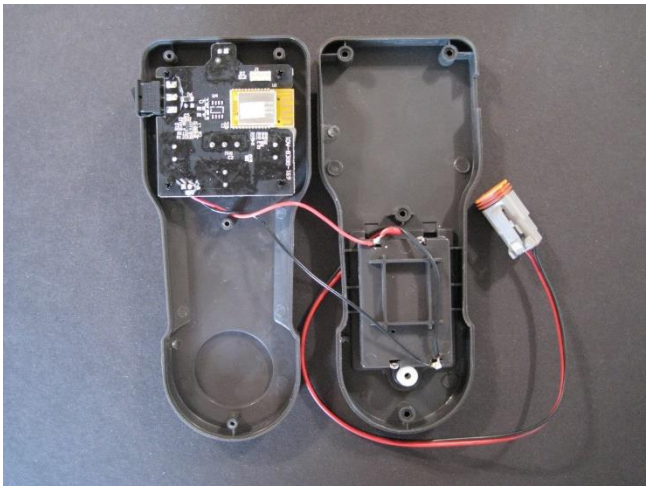
WIRING CONTROLLERS



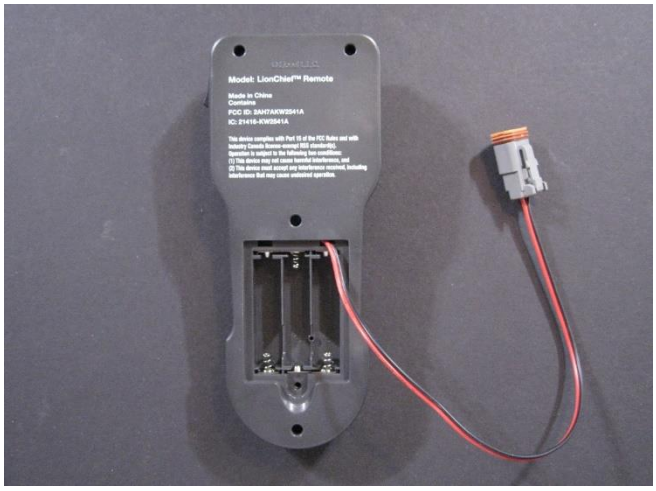
Wiring the controller for power starts by preparing a length of paired wire and mounting a Deutsch 2-Pin connector. The wire length should be short enough so it doesn't sag much when installed.



Remove the battery cover. It will not be used but save it (so you can convert back to battery power if you choose.) Remove the four screws as shown and remove the back from the controller.



Push wires through an opening in the battery compartment and wire them piggyback onto the controller's wires to battery contact. (Red is positive.) Re-attach the back of the controller being mindful of wire location.



The finished result, ready to install into a controller cradle.

INSTALLING CONTROLLER

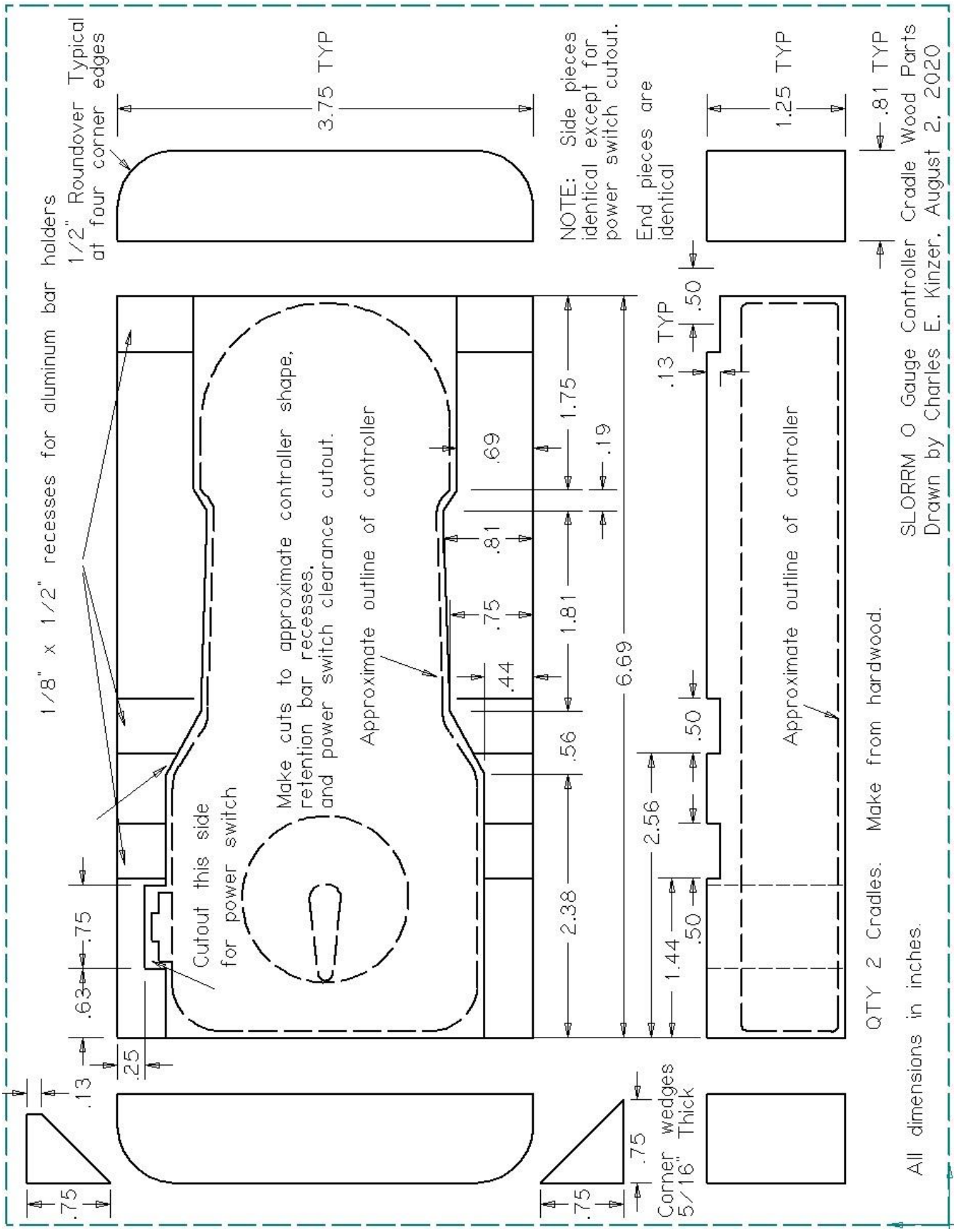
See photo at left. Controllers are installed by pushing the 2-pin connector through the large hole in the layout top, inserting the controller first into the top as shown under the triangular wood pieces, and then lowering to position and attaching the capture bars.

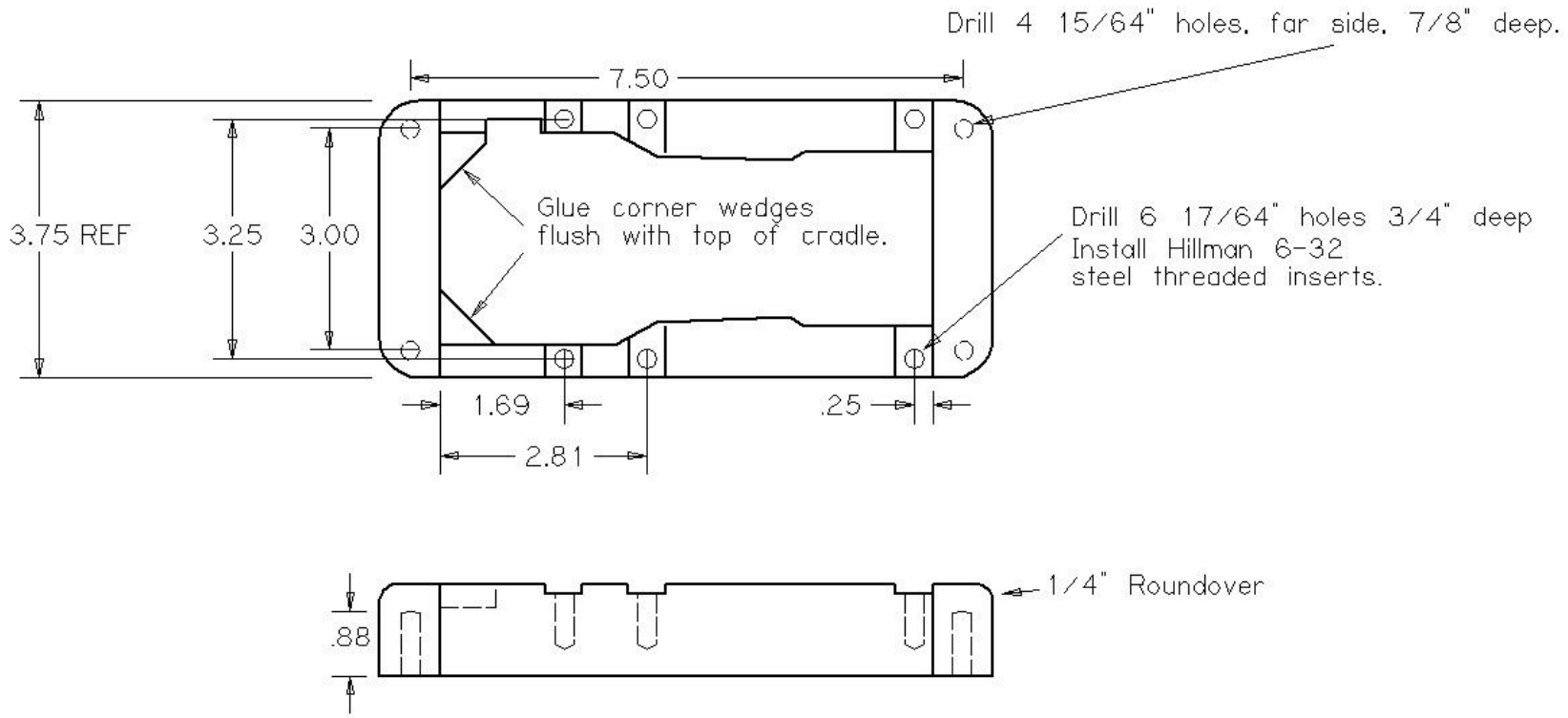
Dedicated Lionel LionChief train set controller mounted. Note short filler pieces used so the center slots won't look empty. This allows all of the controller's graphics to show.

Lionel Universal Controller mounted. Note the middle capture bar with the three small holes to allow access to "Engine Selection" buttons using a small diameter object.

The photo at left (controller cradles not yet with a finish) shows how the top bar limits the rotation of the throttle knob. Also, there are recesses in the bottom edge of the top bar to expose a little more of the bell and horn/whistle buttons. These recesses were really not needed but add some to the style and hide less of those two buttons.

DRAWINGS

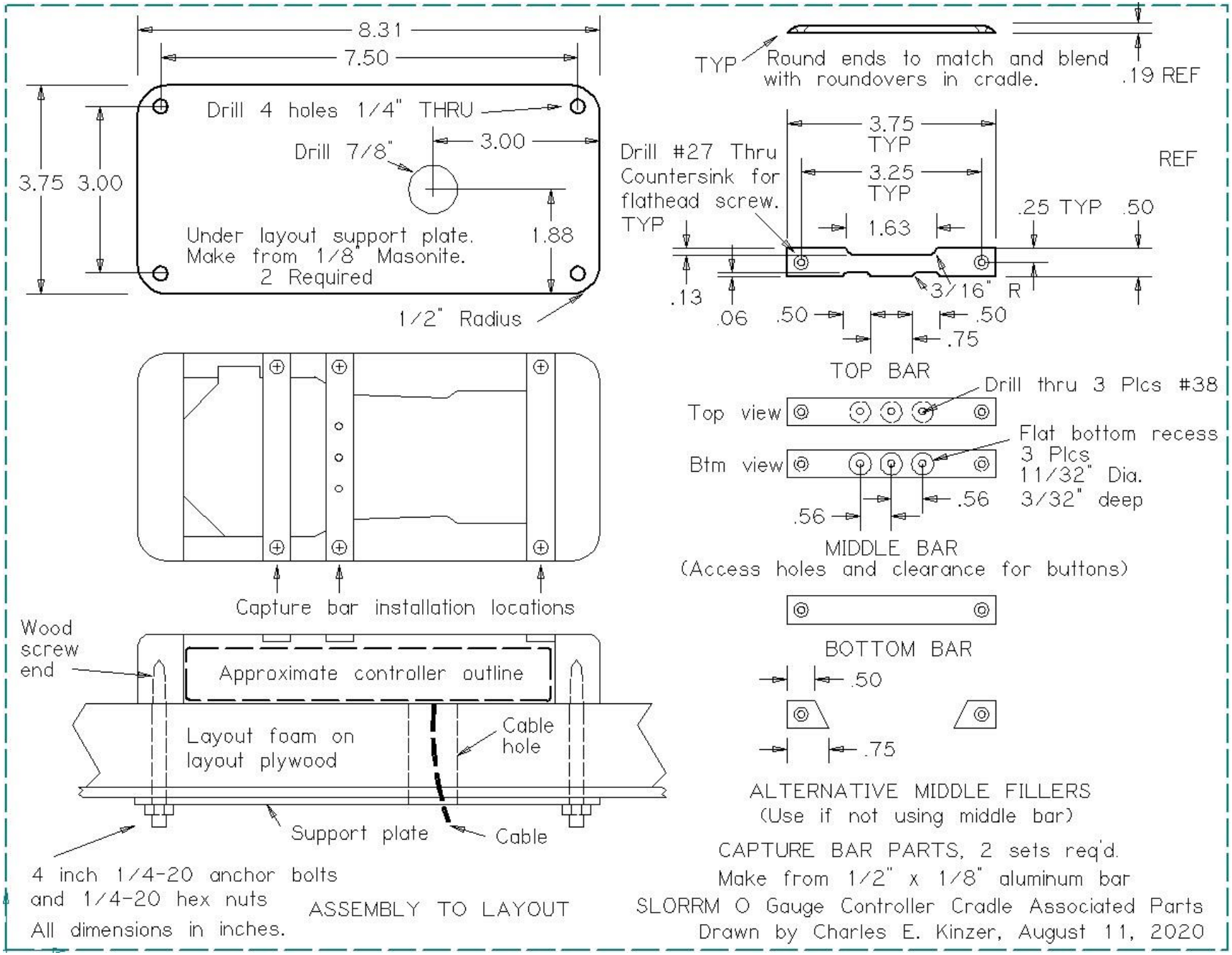

1/8" x 1/2" recesses for aluminum bar holders
1/2" Roundover Typical at four corner edges
3.75 TYP
NOTE: Side pieces identical except for power switch cutout.
End pieces are identical
1.25 TYP
.81 TYP
.13 TYP
.50
Cutout this side for power switch
Make cuts to approximate controller shape, retention bar recesses, and power switch clearance cutout.
Approximate outline of controller
.69
.81
.75
.44
.56
1.75
.19
1.81
6.69
2.38
2.56
1.44
.50
.50
.63
.75
.25
.13
.75
.75
Corner wedges 5/16" Thick
QTY 2 Cradles. Make from hardwood.
All dimensions in inches.
SLORRM O Gauge Controller Cradle Wood Parts
Drawn by Charles E. Kinzer, August 2, 2020



After gluing 4 wood pieces together, roundover top outside edge entire perimeter 1/4".
Install 6-32 threaded inserts for wood in six 1/4" holes.
Install wood thread end of 3 inch anchor bolt into four holes on underside.
Break inside sharp wood edges approx 1/16" radius with hand sanding.

All dimensions in inches.

SLORRM O Gauge Controller Cradle Assy and Drilling
Drawn by Charles E. Kinzer, August 11, 2020


8.31
7.50
Drill 4 holes 1/4" THRU
Drill 7/8"
3.00
3.75
3.00
1.88
Under layout support plate.
Make from 1/8" Masonite.
2 Required
1/2" Radius
TYP
Round ends to match and blend with roundovers in cradle.
.19 REF
3.75 TYP
3.25 TYP
Drill #27 Thru
Countersink for flathead screw.
TYP
1.63
.25 TYP
.50
.13
.06
.50
.50
.75
3/16" R
TOP BAR
Drill thru 3 Plcs #38
Top view
Btm view
Flat bottom recess
3 Plcs
11/32" Dia.
3/32" deep
.56
.56
MIDDLE BAR
(Access holes and clearance for buttons)
BOTTOM BAR
.50
.75
ALTERNATIVE MIDDLE FILLERS
(Use if not using middle bar)
Capture bar installation locations
Wood screw end
Approximate controller outline
Layout foam on layout plywood
Cable hole
Support plate
Cable
4 inch 1/4-20 anchor bolts
and 1/4-20 hex nuts
All dimensions in inches.
ASSEMBLY TO LAYOUT
CAPTURE BAR PARTS, 2 sets req'd.
Make from 1/2" x 1/8" aluminum bar
SLORRM O Gauge Controller Cradle Associated Parts
Drawn by Charles E. Kinzer, August 11, 2020

PARTS

A hardwood should be used. Alder was used in the example.

1/8” x 1/2” aluminum bar from a hardware store, Home Depot, etc. (for capture bars)

6-32 x 3/4” Stainless Philips Flathead machine screws (for holding the capture bars)

“EZ-LOK Knife Threaded Insert for Hard-Wood, Brass Threaded Inserts, 6-32 internal threads, 0.375" length” for installing into wood cradle to accept capture bar screws. From Amazon or other.

Deutsch DT 2-Pin Connectors 14-16-18 ga AWG Solid Contacts (Amazon or other)

16 gauge stranded insulated wire, colors as desired

1/4-20 Anchor Bolts. Length as needed

Bonderite 1201 solution. (A solution for an “Alodine” treatment of the aluminum bars)

Stain as desired

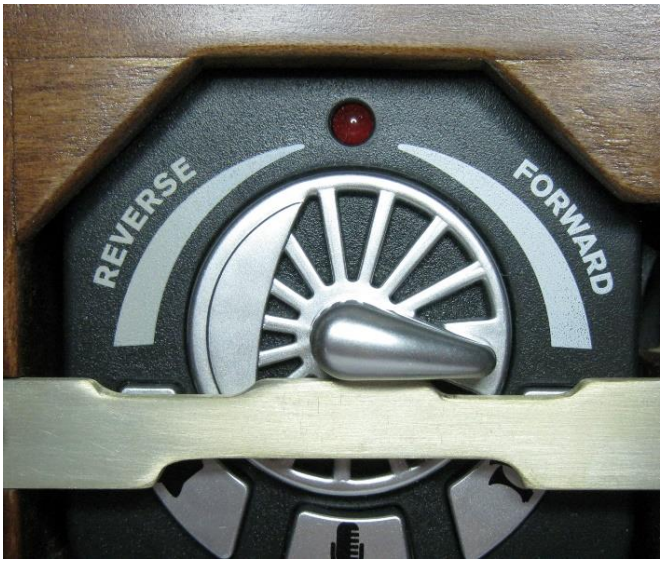
Finish coat as desired

4.5 VDC Power Supply to power controllers was a “Triad Magnetic AC-DC Converter, External Plug in, 1 O/p, 6.75W, 4.5V - WSU045” from Amazon

APPENDIX A: CONTROLLER CRADLE THROTTLE LIMITING TOP BARS

Personnel at both layouts I built using these controller cradles wanted lower top speeds than possible using only the diode voltage dropping scheme provided. At the Exploration Discovery Center in Grover Beach, CA, they made their own version of a top bar to further limit throttle knob rotation. At the San Luis Obispo Railroad Museum, they reversed the standard top bar which further limits throttle rotation a little, but the knob may rub on the bar.

Top bar made by the Exploration Discovery Center in Grover Beach, CA.



Original top bar reversed at the San Luis Obispo Railroad Museum. However, the knob protrusion is prone to rub on the bar.

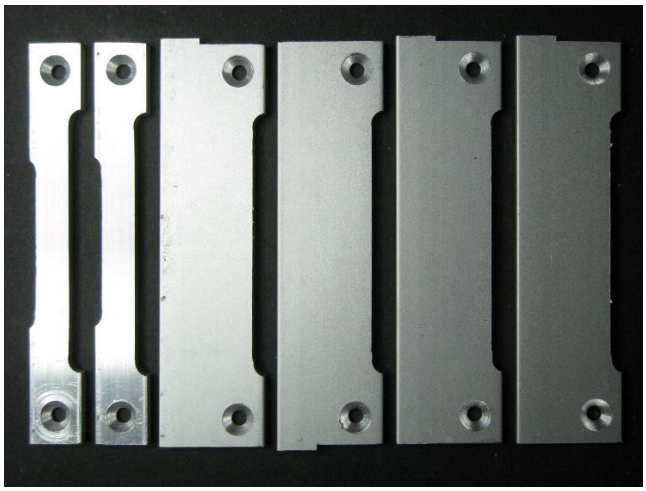
NOTE: The original top bar was not meant to limit speed, although it did somewhat. The goal was to limit knob rotation before it reached the fragile internal stops inside the controller.

The Exploration Discovery Center solution, by having a scheme that places a fulcrum at the center of the knob protrusion, may add undesirable stress to the potentiometer shaft inside the controller. So, one design goal was to not have anything act as a fulcrum.

Due to the desire at both sites for more speed limiting, three new top bars were designed with varying degrees of throttle rotation limits. With the original top bar, the additional throttle limiting ones, and the electronic voltage reduction method, probably any top speed should be possible. And if engines are too mismatched in top speed, different bars can be used with different controllers for different speed limiting.

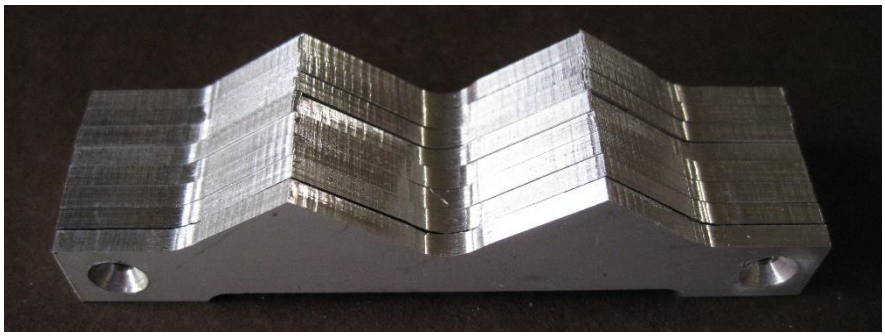
The overall goal was to provide the flexibility to set top speed to anything.

The quantity made was eight sets which was enough to supply four children's layouts using two controller cradles each.



Two sets (of eight sets being made) shown partially made after cutting and milling to length, drilling and countersinking mounting holes, and the lengthwise features milled. (Excess material at the end of each large pieces was removed in a later operation.)

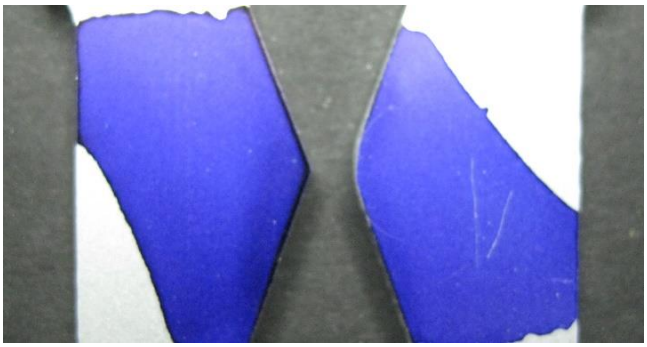
Layout dye and dimensional marking was used. Each part with angles also first had most of the metal to be removed cut off using a band saw leaving enough for finish milling. This is a stack of four 20 degree top bars being machined up to the marked lines on the top piece by eye.



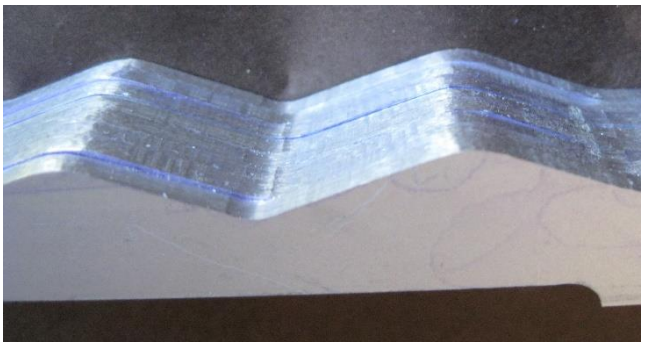
There are inevitable errors when laying out scribed lines and machining to them by eye. After the milling step, this shows that the angled features aren't identical, but easily close enough for this application.

The radius at each end was done on a belt sander. Later hand work would further refine the shape of the ends.

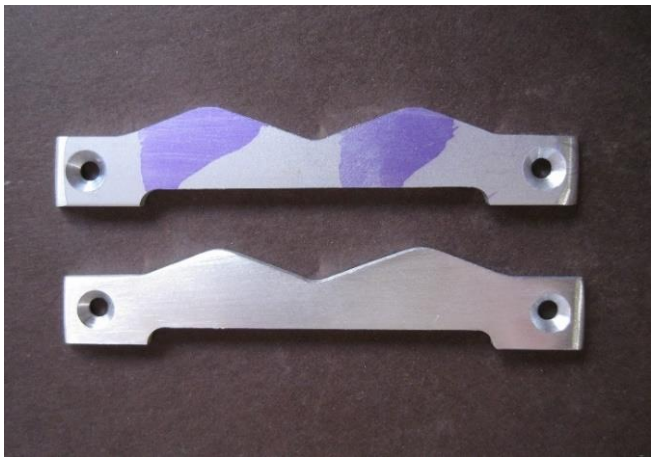
This is the batch of 8 sets of the 3 different throttle limiting top bars after the rough rounding of the ends on the belt sander.



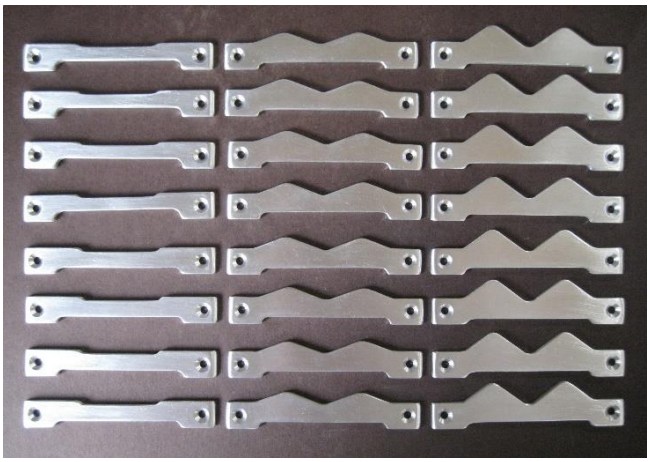
The initial plan was to mark the radii at the peaks and sand to the mark on a power sander. But the amount of material to remove was so small it was difficult to mark and could simply be filed by hand by eye. Photo shows before and after. The layout dye probably did make it a little easier to see the filing result.



This is the eight 20 degree angle bars showing the hand filed radii on the peaks are “close enough” to being uniform and similar looking to the radius in the valley.



When starting to do the final hand finishing steps, discovered that the matte finish of the 1” wide pieces (bought from a hardware store) was a hard anodize treatment. It was far too difficult to grain by hand, and it would not have accepted an Alodine finish later. It was carefully removed from the top surface using a belt sander. The upper piece (with coating stained by layout dye) is before sanding. The lower piece is after sanding to remove the coating. Hard anodizing penetrates into the aluminum some so this resulted in making the parts slightly thinner by two to three thousandths which was not important. The coating was not removed from the bottom to avoid further thinning as it is not important as it doesn’t show when mounted.

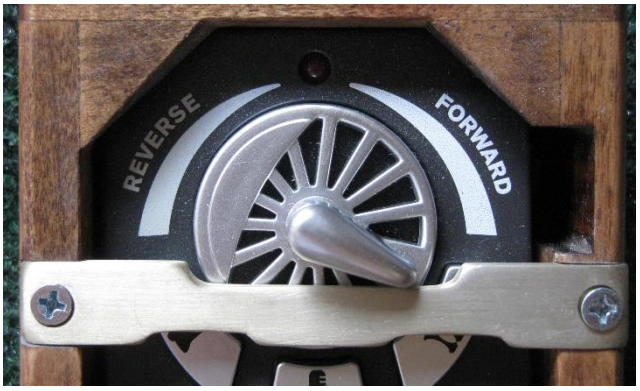


These are all parts after the hard anodizing was removed from the wider pieces and all the hand deburring and graining completed.

The parts were treated with Bonderite M-CR 1201 which is a “conversion coating” also known as an “Alodine” coating. It provides several benefits, but the primary one for these parts is protection from oils and acids from fingers. It also produces a golden color which adds attractiveness

This is what is now a complete set of top bars. At the top is the original top bar design. The other three are the newer parts.

For reference, the parts were labeled simply using a permanent marker. Note that the backs of the wider pieces have no Alodine coating, and some will show layout dye staining.



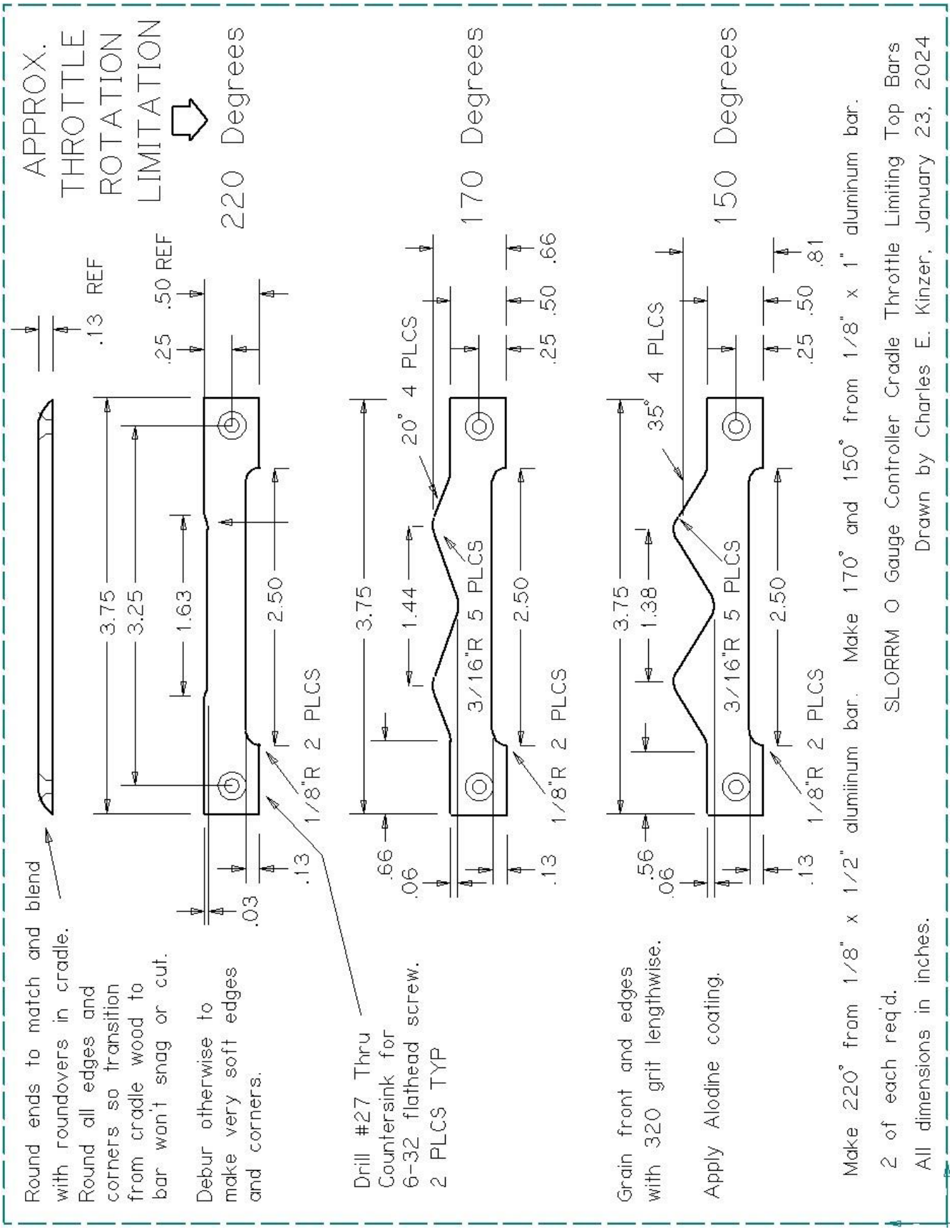
For reference, this is the original top bar that permits about 235° of throttle knob rotation. With no limiting the knob rotates about 295°.

This bar permits about 220° of throttle knob rotation.

This bar permits about 170° of throttle knob rotation.

This bar permits about 150° of throttle knob rotation.

Drawing for the Controller Cradle Throttle Limiting Top Bars:



REVISION HISTORY:

April 16, 2022

Original document

January 21, 2024

Added Appendix A “Controller Cradle Throttle Limiting Top Bars.”