# Scratch Built: Live Steam Quadruplex

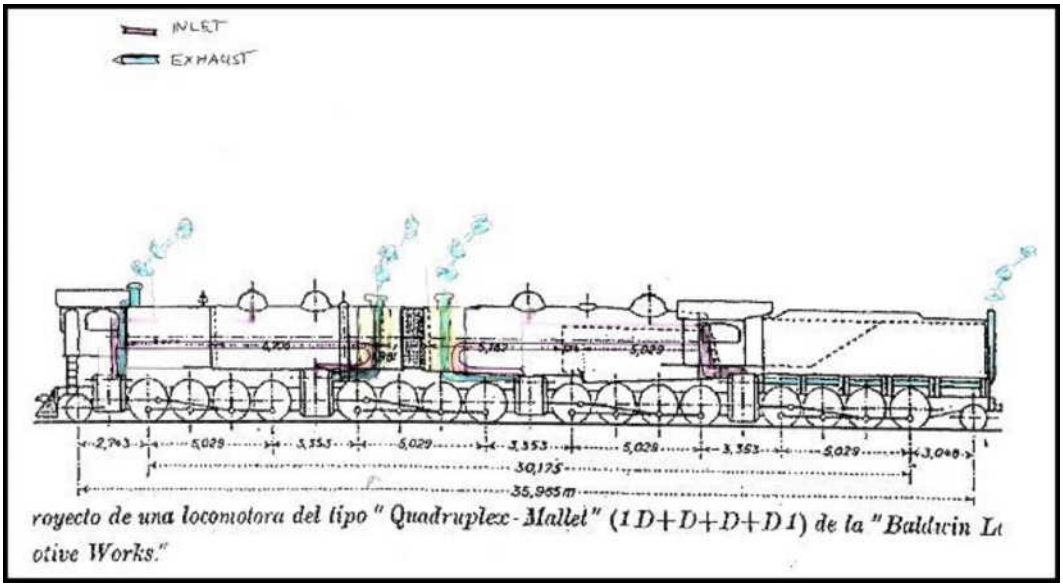
BY
Bill Allen
Woodside, Calif. USA

**(Live Steam Forum/Topic: Live Steam Quadruplex)**
**(Live Steam Forum/Topic: Quadruplex Build Log )**
**(Live Steam Forum/Topic: Quadruplex First Video)**



Found on the web... THE BALDWIN QUADRAPLEX

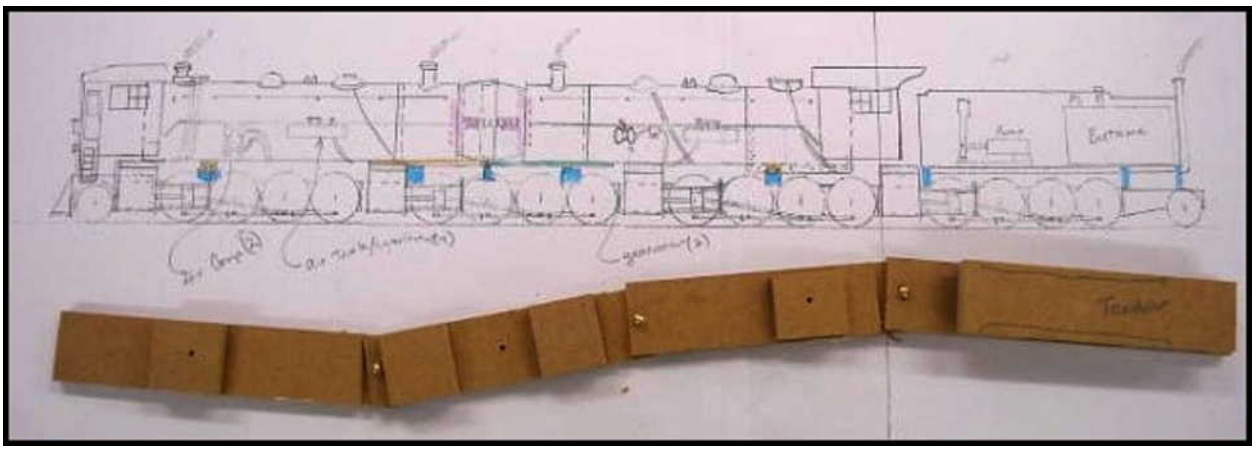
*(29 Aug 2011)* - Originating Posting:
The Baldwin Locomotive Company seriously intended to build this monster, but after it became clear that the Triplexes were failures there were (perhaps fortunately) no customers.



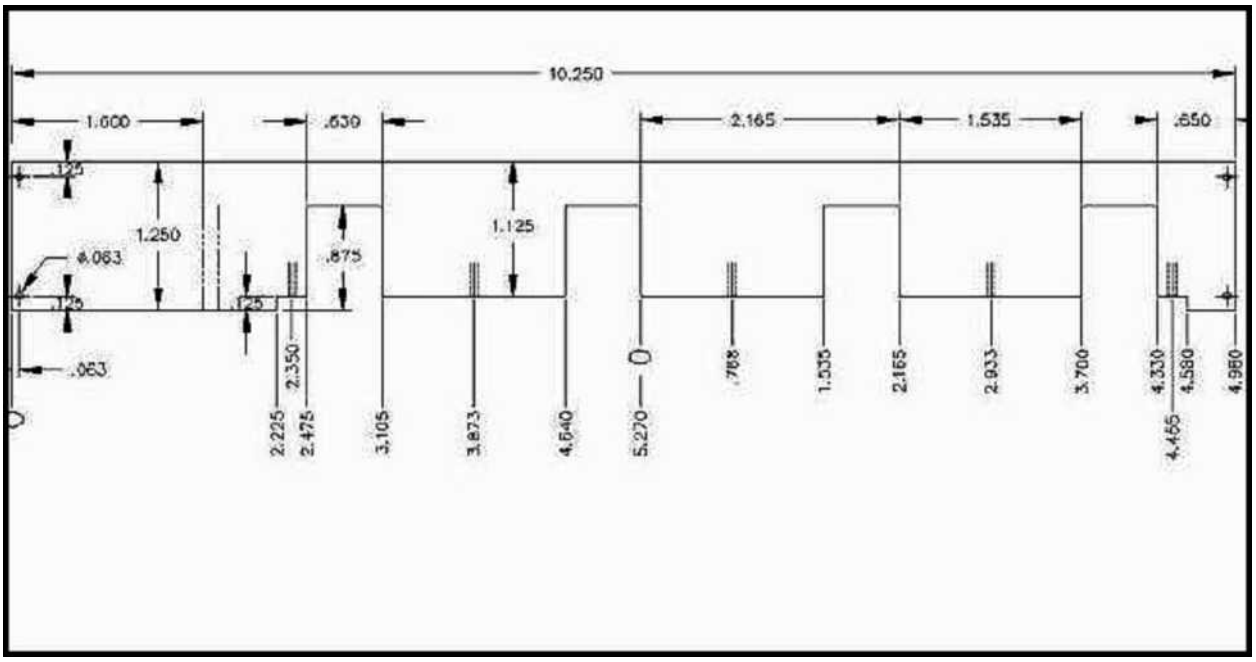

In 1915 Baldwin built three Triplex locomotives for the Erie Railroad, and another for the Virginian Railroad in 1916. Initial results were apparently promising, for Baldwin laid plans to build an even more monstrous loco- a Quadraplex, or four engines in one. George Henderson was the designer. Apparently the Santa Fe Railroad was seriously interested for a while. A machine of this length could not be built with a rigid boiler, so note the bellows connection in the middle. This notion was not specific to the Quadruplex- see Flexible Mallets for another example. In engineering terms, this sort of technique is called "Asking For Trouble". The bellows were found to be troublesome, as the cinders would collect between the fins and cause binding. A later design used a ball joint connection.

Note that the designer recognized that forward vision wouldn't be too good if you had to squint along the length of such a boiler, so the loco was a cab forward. The driver was to communicate with the fireman at the back by means of a voice pipe.

The sketch below shows my design with two butane burners in each of two boilers with the smoke boxes in the center and four exhausts. The wood strips show the pivot points. The blue points are pivots, slides or for the tender mounts.

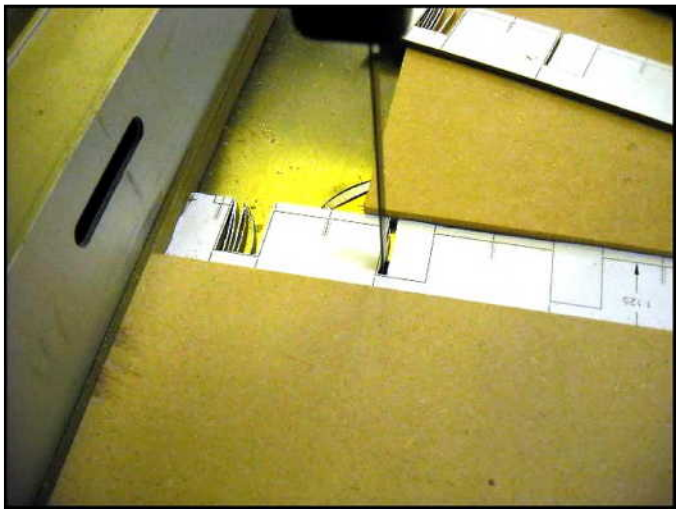


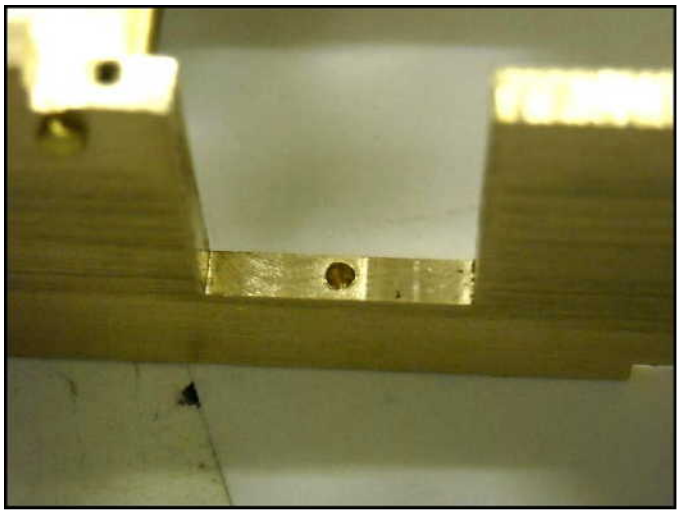

32 wheels are quartered and ready to be shipped by Alan Redeker. These are the wheels that were replaced on his Flat cab project. The axle bearings are not Cab Forward ones but that is ok, as I will be making new frame rails. The tenders are Alan's newest design.



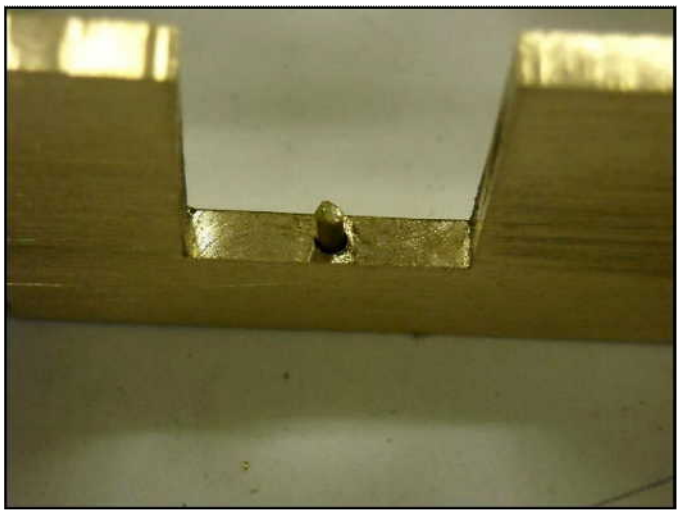

Dennis put my design on CAD and printed up enough copies to paste on my frame rails.

The rough cut is made on the Band saw. The board on the back is to push the piece and keep it square. The board on the front is clamped to the table and stops each cut at the same place. All of the pieces are cut, then the fence is moved 1/16" and they are done again, goes pretty fast and saves wear and tear on the mill

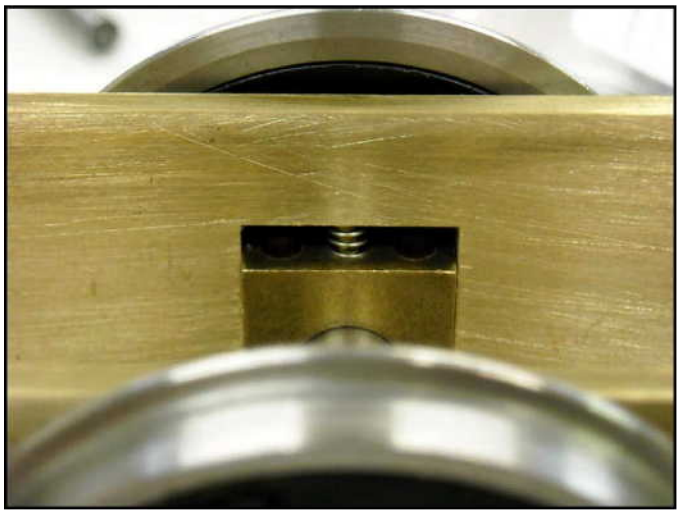




The finish cut is done on the mill with four rails bolted together and the DRO is used for the coordinate milling and drilling a hole for the spring pin.

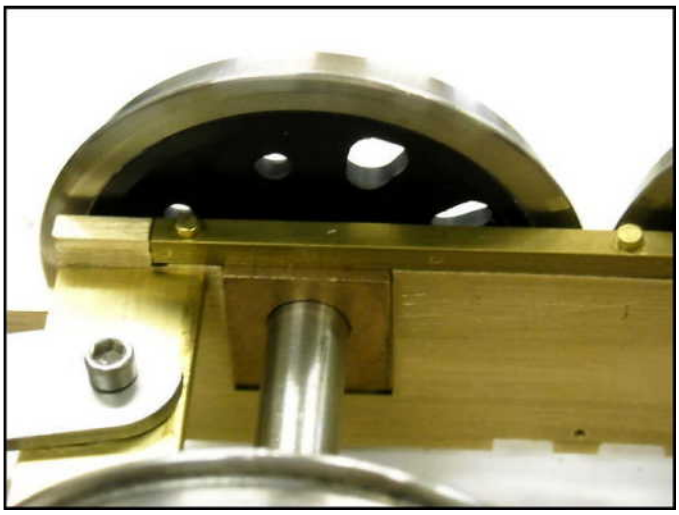


The pin is set in the hole here. Later it is epoxied in place and lightly rounded off with a file.



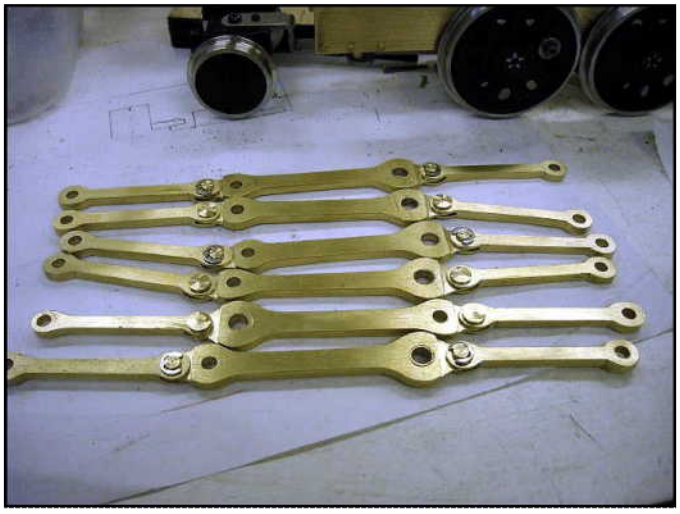
Here is the axle set in the frame; you can see the centering pin inside the spring and the holes in the bearing for the spring to go into.

On the underside the wheels are held in with a 1/8" square bar which also strengthens the frame.

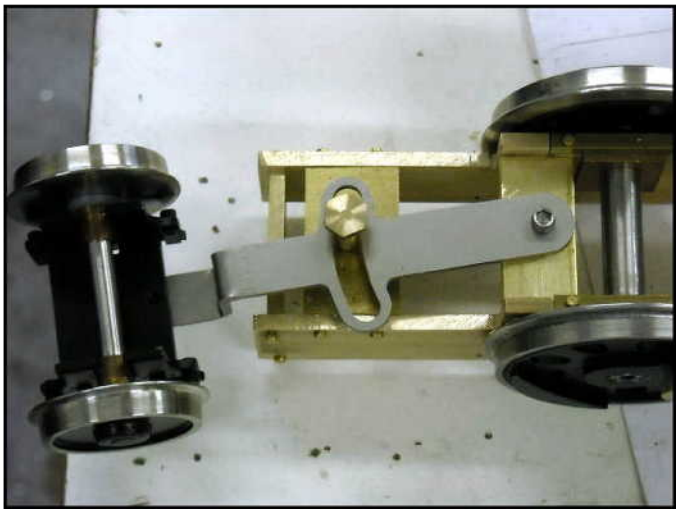


The side rods are drilled in a jig made from the lower brass piece, which has a pin, pressed in which is the same size as the wheel drive pin. The mill is centered and set to zero and the digital caliper on the left side of the mill, which has been modified to fit the mill, is used to drill the holes.

Sidebars are clamped and then drilled. Shaping is then done on the band saw.



The finished sidebars. The joiner pins were made on the lathe. A tool was ground to make the .030 X .030 grove for the e clip



A pilot wheel truck from C-16 is mounted to the front and rear frames using a homemade shoulder bolt.

The four bogies are lined up and clearances are checked. They all roll freely and the length from end to end is 48", which is slightly less than a Cab Forward.

The wood cylinders were to check clearances on turns but Henner thought if they were sealed they might work on steam.

***Comment Bob Sorenson:***

*Bill: Nice start. The spring rigging looks perfect. That will be a big help. You want all 32 drivers on the track. Could I ask some tech specs? Bore and stroke, driver diameter?*

*(29 Aug 2011)* - Reply:

Bob: 1/2" bore, 1" stroke, 1.968" tread diameter, two 3" x 10.5" boilers, four butane burners, super heaters to each cylinder, Rulon piston design, two pressure ga, two sight glass, probably four pop off valves. Modified Baker gear with no outside reverser and cylinder valves. Ruby type reverse valve will be used with RC servos at each valve. 3/32" porting and ID piping on pressure side and 3/32" porting and 1/8" piping on exhaust. Hand pump with diverter valve in the tender and maybe an axle pump. Also but a long shot - servo controlled cylinder drains.

***Comment Scott McDonald:***

*What is the minimum operating radius that this beast will have?*

*(30 Aug 2011)* - Reply:

Scott: Because all four bogies will be articulated, the radius will be less than you would expect. In fact, I gave the axles a little more side play so that even though the inside drivers have flanges; it still will roll on a 5' radius. I haven't tried it with the sidebars yet but I think it will put too much bind on them on the 5" track. I tried the combination on my 7' radius track and also through the #5 switches yesterday and it worked fine so for now, i'm going with 7' radius. Naturally, it will have swing clearances that will need to be taken in to consideration but most layouts that size have good spacing between tracks.

***Comment Steve Shyvers:***

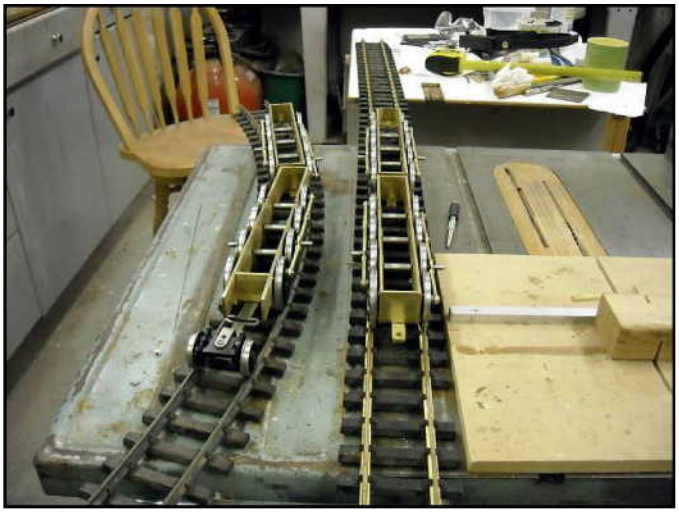
*Bill, I'm really gonna pay close attention to this one. Between Dennis and you there is so much to learn.*

Steve: I am bringing the chassis to Ardenwood Saturday if you want to check it out. Henner wants to pull it around the track with something, probably a Forney. Later, we will probably make a video of it on my dual gauge track being pulled by the Guinness

*(31 Aug 2011)* - Update:

I checked the turn radius yesterday and it looks like it will be ok on a 5' radius. I also fooled around with some PTFE for the flexible joints.

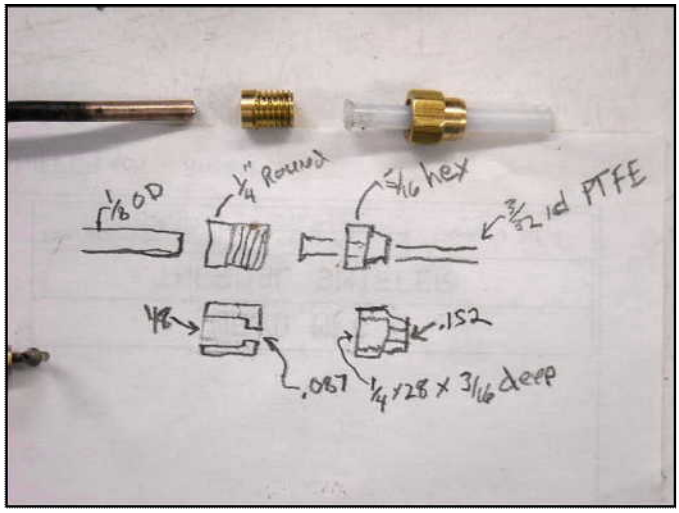
Here are the two locomotive sections on the 5' track sections (one curved & one straight).



You can see that all wheels are on the track.

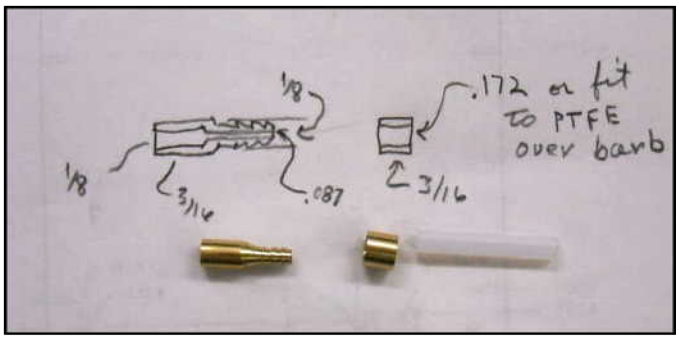
The link needs to pivot on both ends because the overhang on the front is more than the rear because of the cylinders.

As usual, Dennis came up with a way to easily flair PTFE (Teflon) tubing. A 1/4" round is drilled out to the inside diameter of the tube on the lathe. The outside groves are then cut on the mill leaving the raised portion in the center, which is rounded off with a file. A rod the size of the drilled hole is then locktited in and tapered slightly. The flare is made by chucking the tool in a lathe or drill and pushing the tubing in till you get the desired shaped flair.



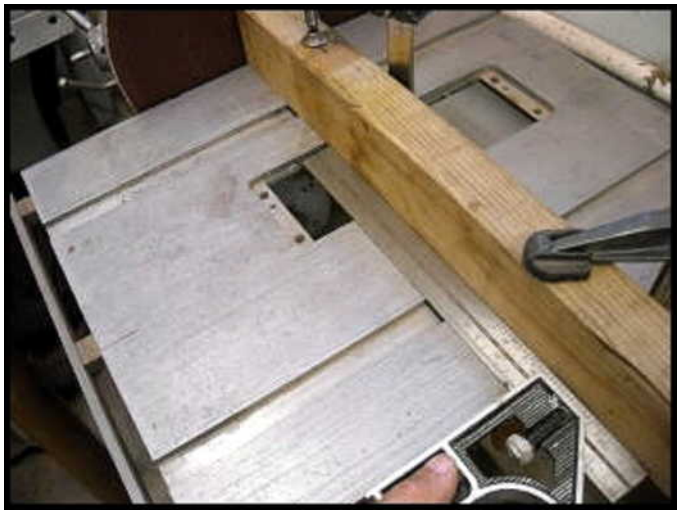

Here is a setup that I actually made for the Fairlie. The male threaded piece will be soldered into the 1/8" pipe. The flared fitting will provide a removable joint. I used 3/32" inside diameter PTFE from McMaster-Carr. It turned out to be .088" rather than .093" but that's ok. This gives me a compact flexible joint, which should stand up to superheated steam. I found out that although silicone tubing is rated at close to the PTFE, it would break down after prolonged exposure to high temp and pressure.

Here is a permanent connector using a barbed fitting and a solid ring to hold it on. This is tricky to do because if the ring is too small, it wont fit on and if it is too big, it may slip off. The tolerance is only a couple of thousands. The tubing can be heated with a heat gun to permanently put a bend in it or to ease attaching to the barb but I found that it got too soft to be able to force it on so I just did it cold.

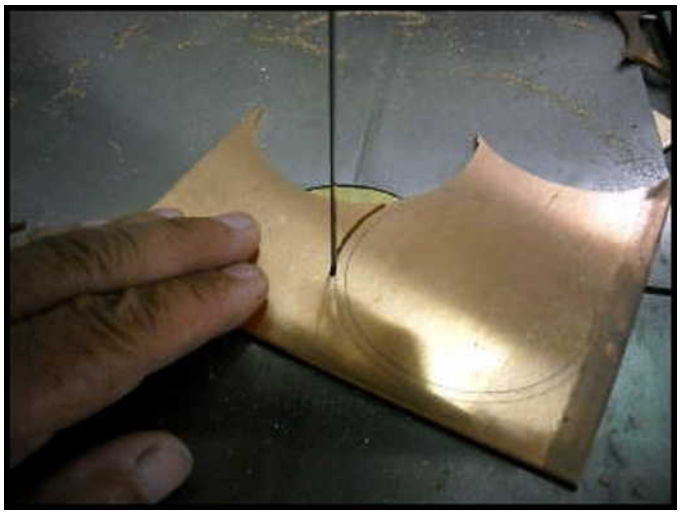



Cutting the barb needs to be done after the fitting is cut because the 1/8" hole is drilled on the other side. Before cutting the barbs, I turned this section down to 1/8". After this last cut, I go back to the first cut and taper it another .005" which gives it a nice starting diameter.

*(07 Sep 2011)* - Update:
Worked on the boilers this weekend and am ready to solder them up. Henner has a huge propane torch which works perfect for these big boilers so we will do it over at his house Saturday. I will try to get some photos of the process.




Squaring up the guide board (on the left). Twisting the tube against the sanding disk to get it perfectly round and 90° to the length of the tube (on the right).




Cutting the end plates on the band saw (left). Plates are super glued to the arbor and each other and turned on the lathe (right).

Here are the boiler parts with the bushings and mounts turned out of bearing grade bronze. The flexible joint is in the background and you can see the boiler mounts on the chassis to the right.

Although the brass sidebars look good, they are not too prototypical. I used a little tin-plating solution, which is used to plate circuit boards and it does the trick.

*(12 Sep 2011)* - Update:
Went over to Henner's Saturday and soldered up the boilers.

Henner and Dennis doing the honors. Henner is holding the propane torch and Dennis the acetylene/air torch. The propane heats the unit fast and the acetylene supplies directed heat.

The finished product is pressure tested and then cleaned up. A coat of low sheen engine paint is applied to the back-head.

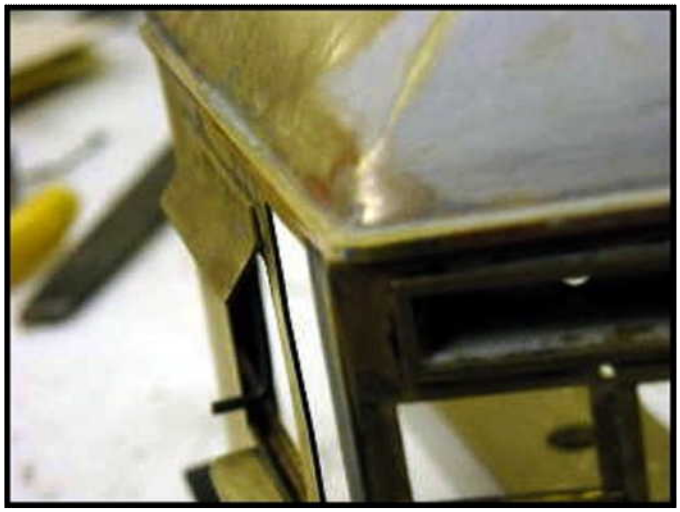
Sunday morning I start on the cab armrest. I need it to be 1/16 thick but with a wider base to solder on to the cab so it is milled from a piece of 1/4 square stock.

Now comes the part I have been putting off. I was able to get a cut off Cab-forward cab front from Alan but the curved top is something I hadn't done before I started by bending the 5" x 5" sheet to the proper radius and slid it back to the sloping point. Then with paper and masking tape, I formed the bends and used the triangles, which were formed to mark and cut the top.

I clamped the outside part on and then bent and snipped the pieces to fit.

I silver soldered the parts together where they were close enough and soft soldered the rest to fill the small gaps from the cuts.

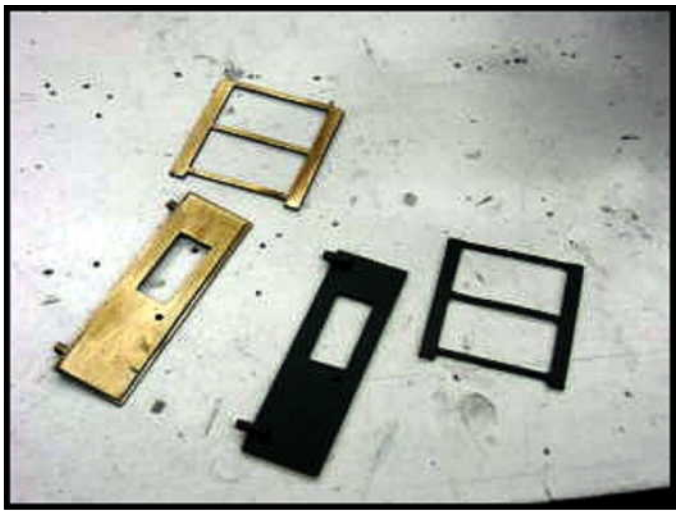
I then wrapped a 1/16" x 1/16" strip around the top for a rain gutter and applied a thin coat of Bondo and sanded back to the brass.



Here is the 1/16 brass rod.

The brass piece is for the top clip. I made it this way to give it more gluing (JB Weld) area and to act as a window stop.

m



Here are the front and back of the operating doors and windows.

I didn't take many photos of the cab construction. Here you can see the cab rear, which is made from three pieces silver soldered together. This assembly was then soft soldered to the CF front I got from Alan. I had to soft solder to prevent the factory parts from coming off. The strips are K&S and the wide one on the windows was cut from sheet on the band saw.

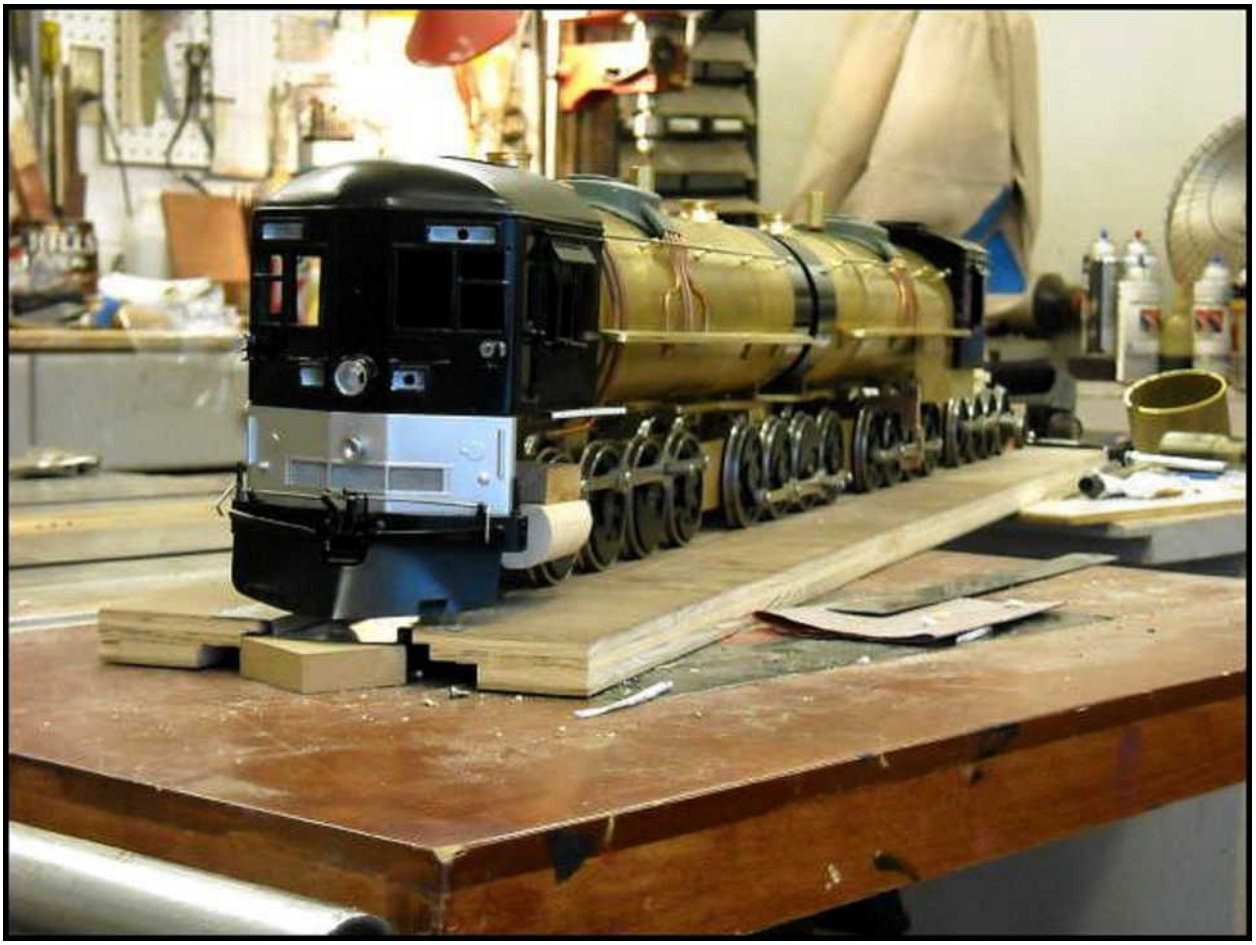
The window channels were done on the mill. Window and door openings were done on the router with a pattern-making bit and the rear openings were cut with a jewelers saw. The wider pieces are the side sun visors.

> ***Comment Semper Vaporo:***
> *AH HA... I see the two smokestacks in the middle now... hmmm... I see a third one at the front just behind the forward cab. ???*
> *Oh well... yes a full second boiler will help a lot in running 4 separate engines. I still think those boilers look like jewelry! VERY nice work!*
>
> ***Comment Bob Sorenson:***
> *Boilers look great. They should do the job just fine. What operating pressure? Cab looks sweet.*

Bob, I am thinking of 60 psi.

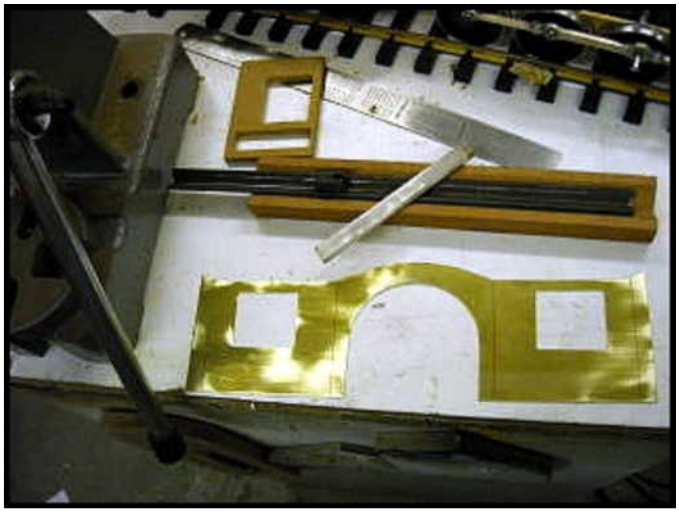
*(15 Sep 2011)* - Reply:
Semper, right, two stacks in the middle and one behind the front cab plus one at the rear of the tender. Thanks for the compliment on the boilers

*(26 Sep 2011)* - Update:
Finished the basics of the cabs and boilers today.

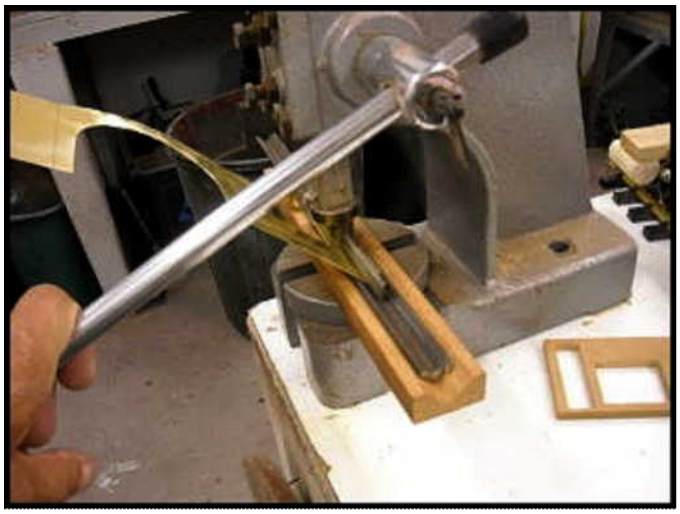


Starting to look like a locomotive now.

The rear cab is cut out on the band saw.



The corners are done on my homemade break.



I start on the rear bends and work toward the middle (front).

Finally the rear bulkhead is clamped in place and drilled and screwed together.

My jig for bending the wrap is made on the table saw. You can see the pencil mark on the piece on the left.

I measure the width of the cut and then move the 2 x 4 fence so the leading and trailing cut are that distance apart. The blade is raised 1/8" at a time till I have the correct depth of cut.

The finished piece on the left.

The wrap is annealed and then rolled to shape with a pipe.

Two 1/8" square strips are silver soldered to the ends of the wrap.

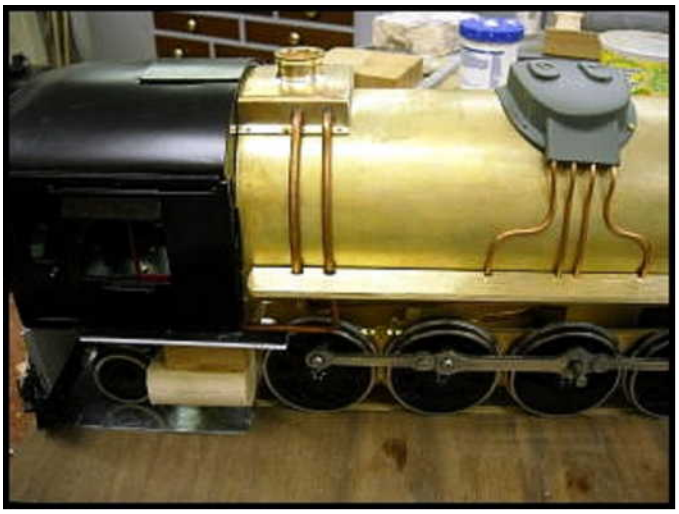
They are then connected with #0-80 screws with the threads tapped into one piece.

The sand dome is made from four pieces silver soldered together.

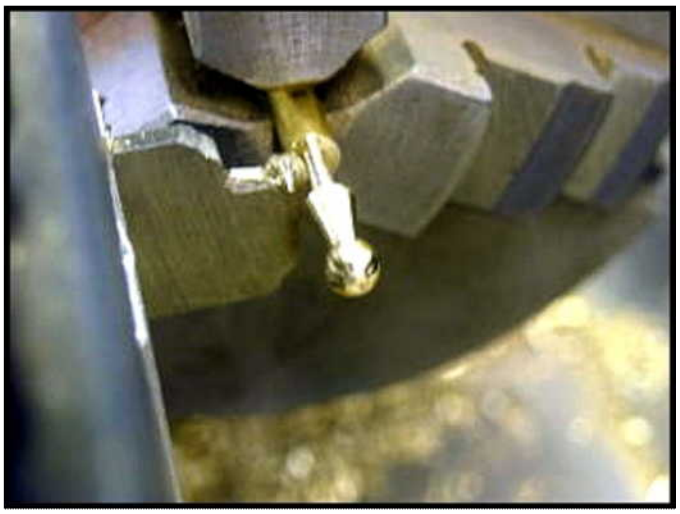
Here the front exhaust will be fed through the front pipe, and as can be seen the sand dome is complete and primed.

Stacks were turned on the lathe; the flanges were contoured on a spindle sander with a 3" drum.

Here the firebox is notched out for the Crosshead and reverser brackets.

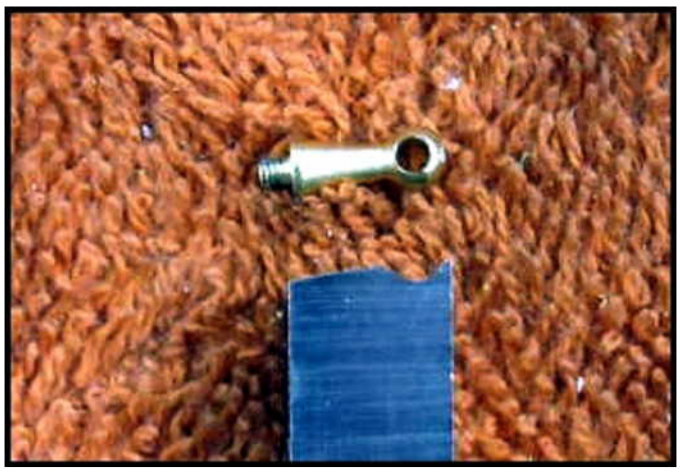


The mocked-up cylinders help to gauge clearances.



*(30 Sep 2011)* - Update:
I have some more shots to share.

Here I am cutting off the stanchion after the shoulder is sized for a #0-80 thread forms the ball part.



Here is the tool to form the part. A Dremel mounted in a vice with a cutoff tool.

Finished stanchions are threaded into the boiler wrap and secured.

Here is the finished rear cab with JB weld for extra strength.

The rear cab roof hinge.

These whistle parts are turned on the lathe and drilled on the mill. The screws are machined to make needle valves for sound adjustment.

The whistles are nestled in the firebox area.

Lights are grain of wheat bulbs, green for the marker lights and white for the number boxes and headlight. Round number plate was turned from aluminum. Decals were made in Excel with black fill and white letters and printed on decal paper

***Comment Dave Measheey:***

*Bill; is that the locomotive's whistle I see in the lower left corner of your most recent post? WOW! That is going to be SOME whistle! Great modeling,*

***Comment Greg Elmassian:***

*Ditto! Those tubes are long enough to make something almost realistic!*

*(30 Sep 2011)* - Reply:
Yes, the longest one is 7"

***Comment Randy Lehrian:***

*Wow Bill, This is an amazing build to watch. I'm blown away by the speed at which you progress. I'm eagerly awaiting cylinders and valve gear to appear. Is there a reason you started with the boilers and cosmetically finished them too, before completing the chassis? Thanks so much for sharing your progress with us.* ***Fantastic work!***

*(30 Sep 2011)* - Reply:
Randy, I wanted to build the chassis and boilers with the cabs on them first so i could make sure the flexible boiler joint and the articulation points would work. I found I was able to improve on my original design that way. When the cylinders, valves and tubing is installed, there will be no room for changes.

My friend Dennis Mead is working on several things for me at his house. He has a commercial type mill and lathe so doing things like the cylinders and valves will be done at his house. He has put our design on CAD and we will start on that next. I just finished the crosshead and reversing lever brackets this morning from his drawing and will do the valve heads today or tomorrow. He will do the valve bodies and if our mills are both accurate, they will go together next week. Dennis will take pictures of his work and I will post them here.

The cylinders will be a different story. We are going to try rulon pistons. Henner found a design on a German website using PTFE and we will try it with Rulon. If that doesn't work, we will try brass pistons with Rulon rings and if all else fails, brass with o-rings. In the mean time, I will be working on cosmetic accessories like air compressors, generators, air tanks, tubing and valves etc. The boilers just lift off the chassis so this can all be done at any time as fill in work. By the way, they are not close to being cosmetically finished.

> ***Comment Rodney*** *(MLS-Rods UP 9000)**:***
> *Bill: Fantastic build. I don't know how I missed this. I will be watching the rest of this. I see you rough cut the frame on the band saw, I take it you only have a small mill is the reason why.*
> *On the tool that you used for the stanchions, did you grind that yourself??? I've tried to grind one for flanges but it will not work without a lot of chatter and I have a big lathe. So I know it ridged enough. I'm sure it the way I ground it.*
> *Cannot wait till you get to the cylinders. Are going to use a CNC or manually machine them??? I want to build some with 3/4" bore X 1" stroke. I've never attempted cylinders and vale work yet.*

*(30 Sep 2011)* - Reply:
Rodney: Yes, the mill isn't even a mini mill it is a Harbor Freight micro mill. On the Stanchion tool, I get the lathe tool stock from Enco and grind the taper on the bench grinder and the cut out for the ball is done with the cutoff wheel. I use a less aggressive angle than the standard tool for the brass to keep it from grabbing and use feeler gauges to get the height about .001 to .002" below center.

Don't have a CNC so it will be old school. All of the valving and porting will be via coordinate milling. I have my mill and lathe set up with digital read outs.

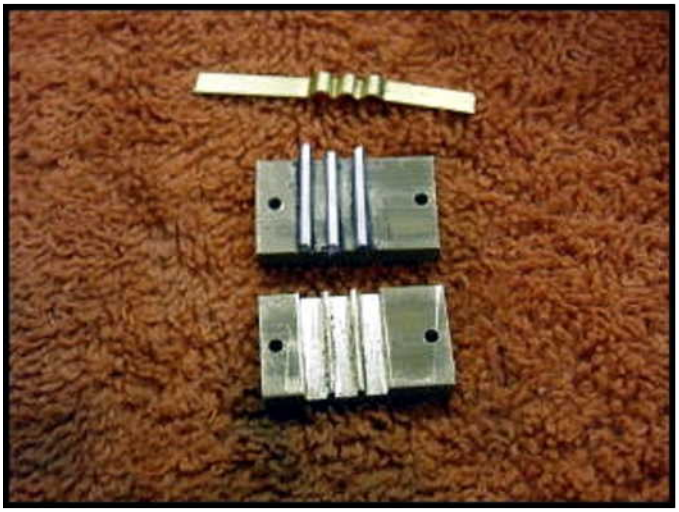
> ***Comment Rodney*** *(MLS-Rods UP 9000)**:***
> *Bill: DRO's are a lifesaver. Got it on Bridgeport and the mill drill. Also have a home made one on the lathe. I built a CNC mill with a HF mini mil back in 2006 and it has not made a chip yet. I have played around with some CAD programs but cant figure it out.*
> *Keep up the good work and the postings. This is such a monster project did you use anything between the wrapper and boiler?? When you do the cylinder and vales, please take lots of photos.*

Rodney: I used 1/8" fiberfrax. You can see it in the whistle photo at the top of the photo. My DRO is home made also. You can see it in the 9th photo down from the top in the drilling the sidebars procedure.

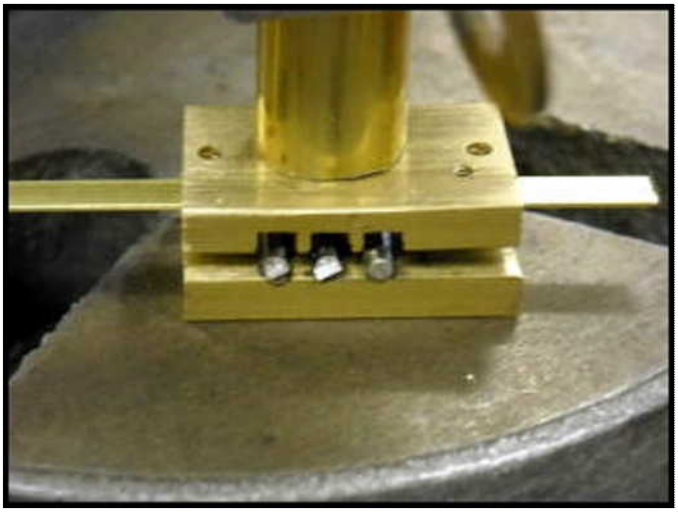
> ***Comment Eric Maschwitz:***
> *Bill that angled setup you did on the table saw to create a coved piece of stock is one cool trick. Where did you learn that? I am definitely adding that to my bag of tricks.*
> *As usual you put everybody in the hobby to shame with your outrageous speed in this build. It took Henner, David and I five year to build four steam donkeys-- we should have had you on the team back then ;-) Gorgeous work and a joy to watch it progress. Let me know if you need to bead blast anything.*

*(04 Oct 2011)* - Update:
Added a few goodies over the weekend.

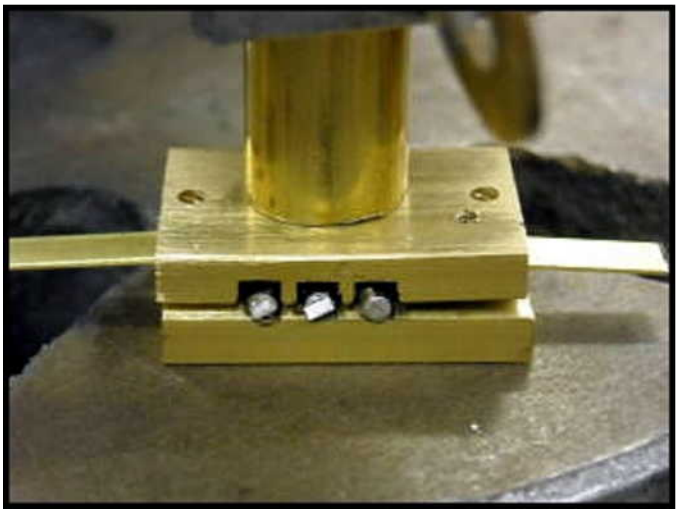
Cab steps, side piping, and air compressors and cross head brackets are added. Brackets are just set in place here.



This jig is made by milling 3/32" wide by 1/16" deep on the female and 1/16" wide and .010" deep on the male to center the 1/16" SS pins The ridges on the female form are rounded with a file.

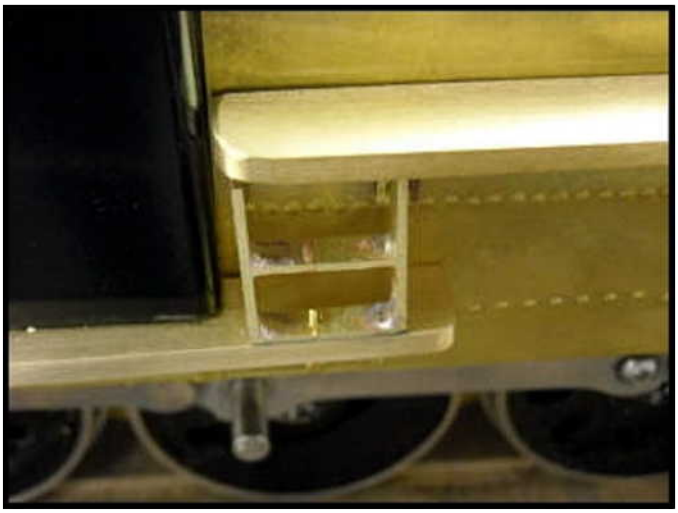


Here it is ready to form.

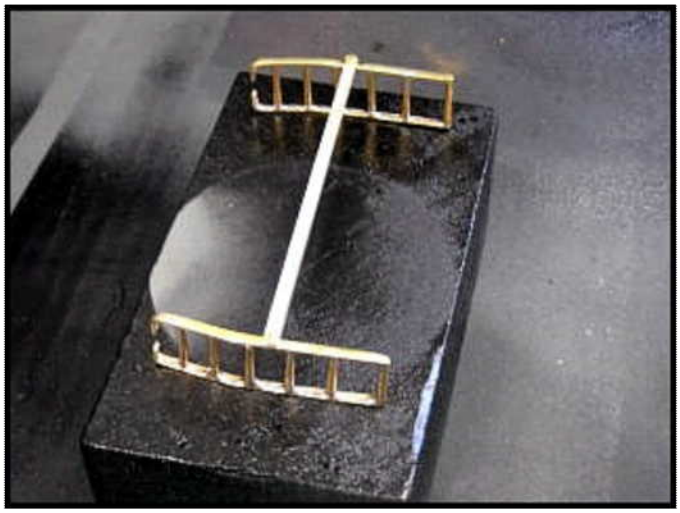


After pressing.

Now, the pieces are bent with needle nose pliers.

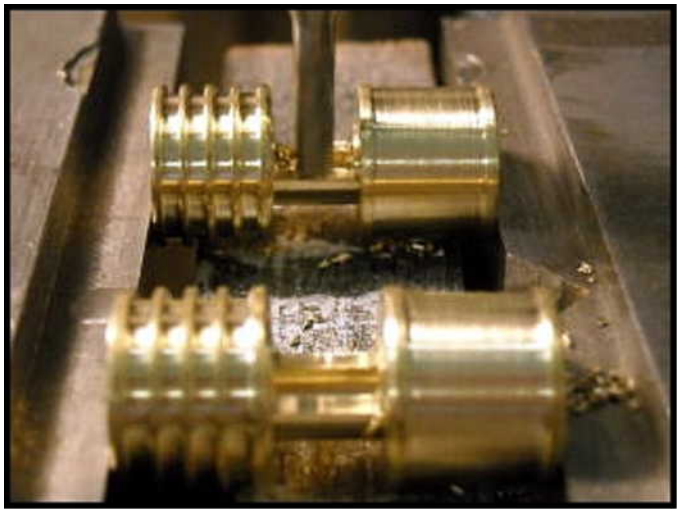


Walking board step is bent and silver soldered. Screw on the bottom is cut off and filed flush.

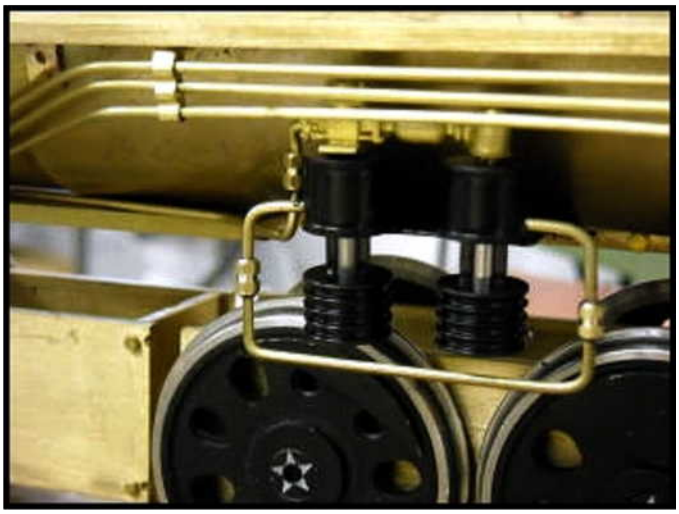


Cab steps are ready for paint.

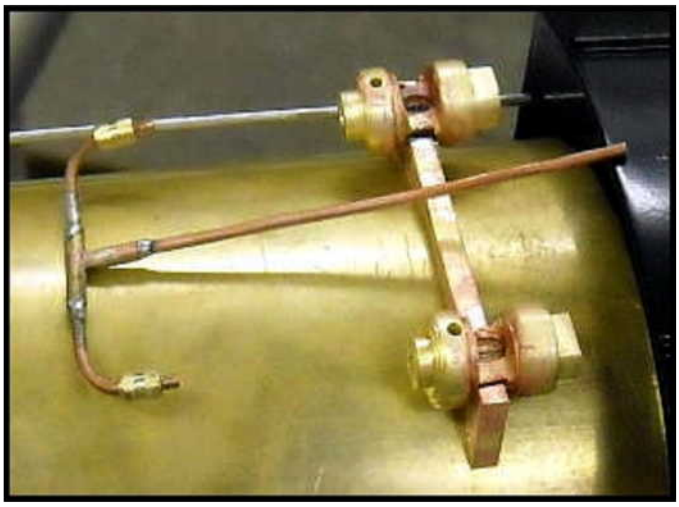
Air compressors are turned on the lathe.



Then milled to expose the connecting shaft.



Finished product - one on both sides of engine.



Generators are started - they will be fed steam through manifold shown.

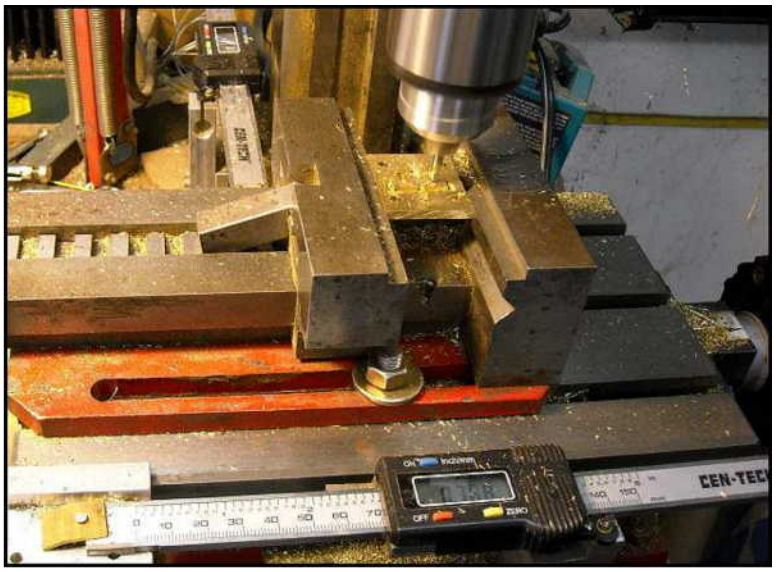
*(06 Oct 2011)* - Update:
There will be a valve in the cab to control the steam, which will shoot out the sides from each generator

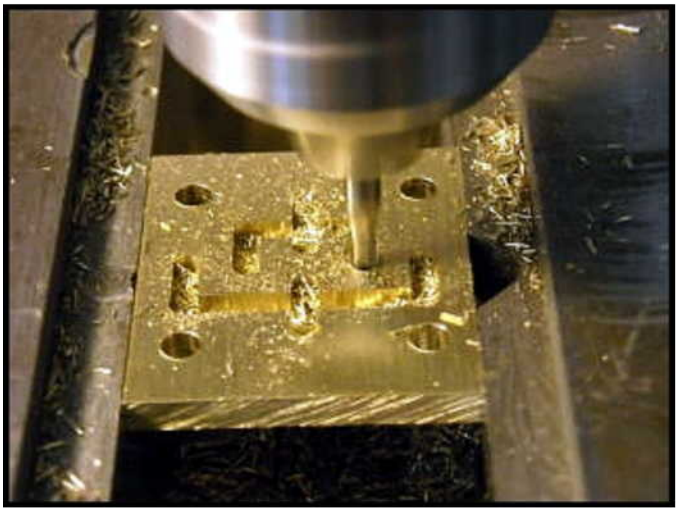
***Comment Greg Elmassian:***

*WOW! That is looking great. Is there a separate shaft inside the compressors?*

Greg: Yes, a SS 1/8" shaft. Also, here are the steam generators with a 1/16" shaft. There will be a valve in the cab to control the steam, which will shoot out the sides from each generator.

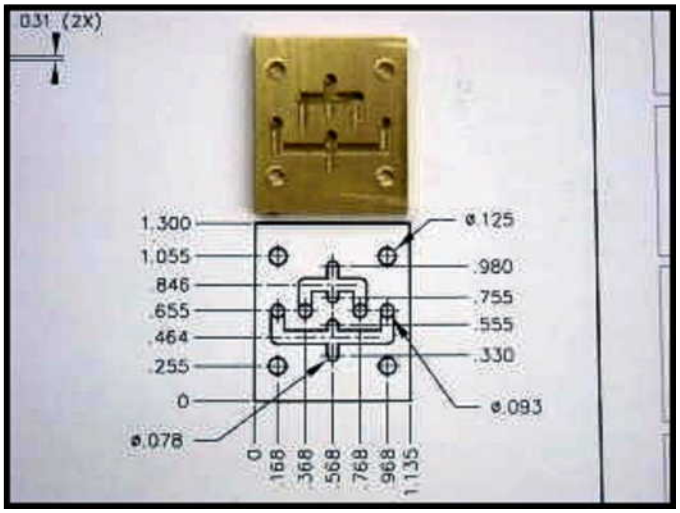
This is the set up for the reversing valves. The DRO's are Harbor calipers with the jaws cut off.



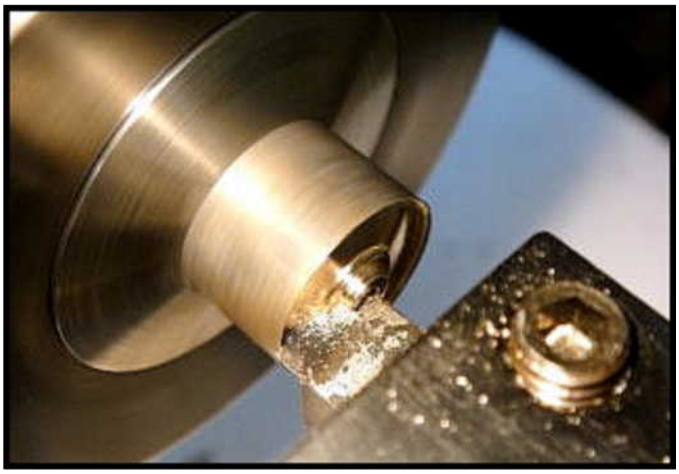


The grooves are .093" X .093".

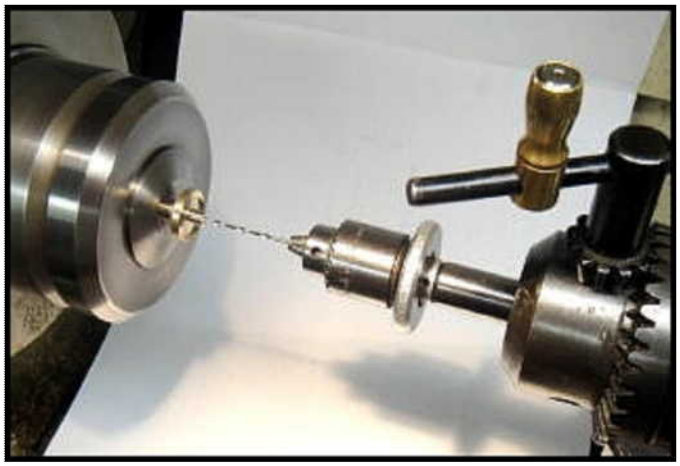
The finished piece next to the CAD drawing.



Lapped and ready to go.



A tool is made to form the lubricator end caps.



The cap is drilled.

... and tapped to #2-56.

The feed tube comes out the cap on the left and the cap on the right is also the adjustment valve for the lube flow rate. The needle valve is made from a #2-56 SS allen head screw. The taper is formed with a file on the lathe.

The assembled lubricators; three of these will be positioned under the running boards with the filler going through the board and only the knurled cap protruding up. They will be disguised as air tanks. There will be a fourth one on the tender.

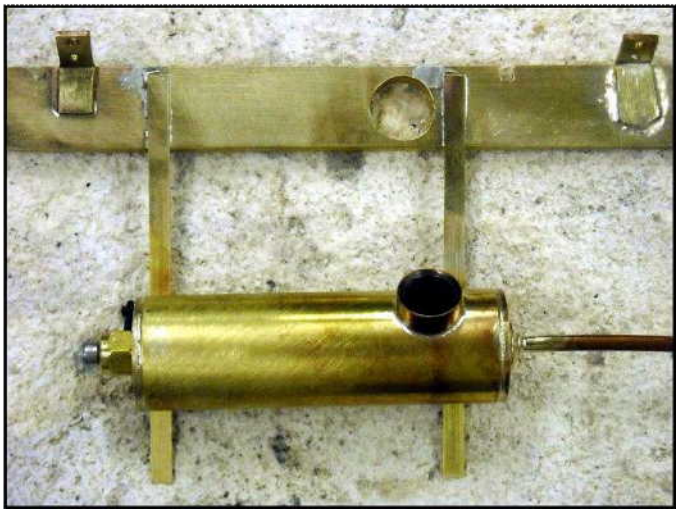
***Comment Rodney*** *(Rods UP 9000)**:***
*Bill: What did you make the lubricators out of??? I think I will try to make one to get the hang of hard soldering.*

*(09 Oct 2011)* - Reply:
Rodney: The lubricators are made from K&S brass tubing. It is the largest diameter they had at the hobby shop. I had a piece lying around the shop and it looked about right. Big enough for the volume of oil I need and small enough to fit under the running boards. Everything else was turned from brass bar stock by Dennis.

The hard soldering (silver brazing) is really quite easy. You can get the silver solder at a welding supply place or McMaster-Carr. You need a good paste flux. I use Handy Flux. The best joints are formed with a couple of thousands gap between the pieces. You need some way to keep them in place during the operation. On bushings and end caps for the lubricator cut a ridge to fit in the hole and the shoulder keeps the part from falling through.

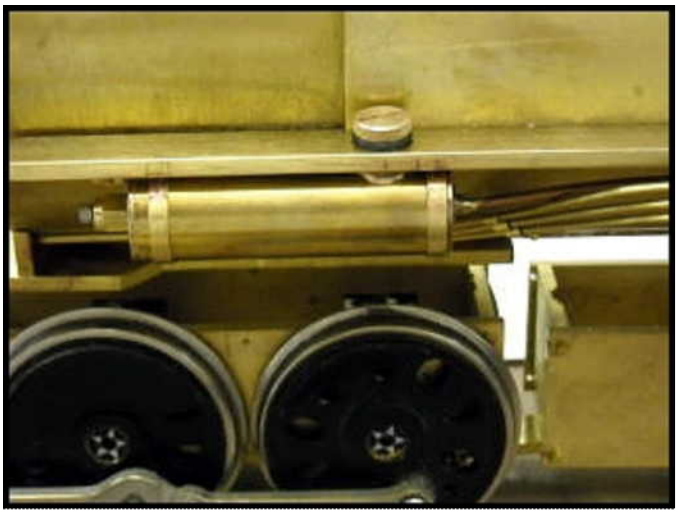
If you do the soldering in dim light, wait till the parts start to get red before soldering. After a while you will know when to solder by the way the flux is melting. Hold the solder on an area that is hot but not near the torch tip. Then move the tip toward the solder and it will melt into the joint and flow towards the torch. You can then move the torch around the joint and the solder will follow it. Add more solder as you go around the joint as needed.

You can get some citric acid from McMaster-Carr or I got mine online from a cooking supply place for half the cost. Use this to "pickle" the part afterwards. After 1/2 hour in the pickling solution, the black oxidation stains will wipe off easily. The part will have a pink color, which comes off with a wire brush, or wheel and the part will look like the last photo above.

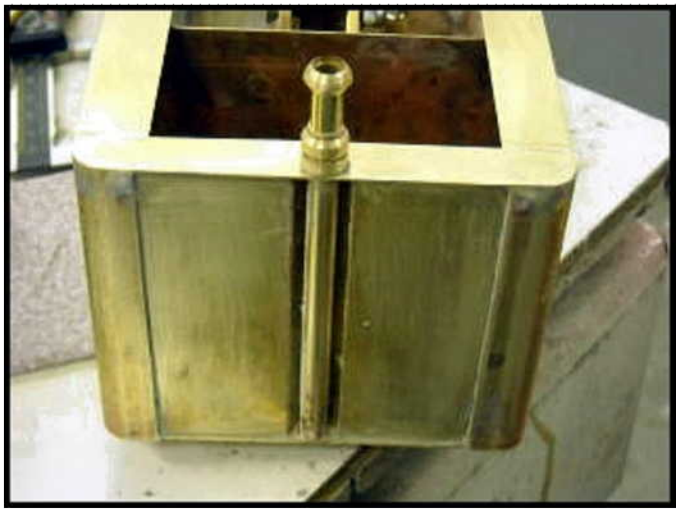


*(15 Oct 2011)* -Update:
Started on the tender this week and mounted the lubricators.

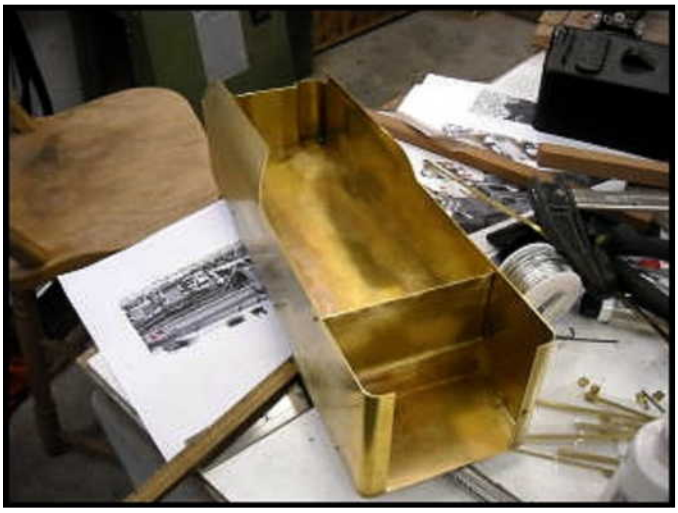
There isn't room to bolt the strap on to the running board so it needed to be soldered on.



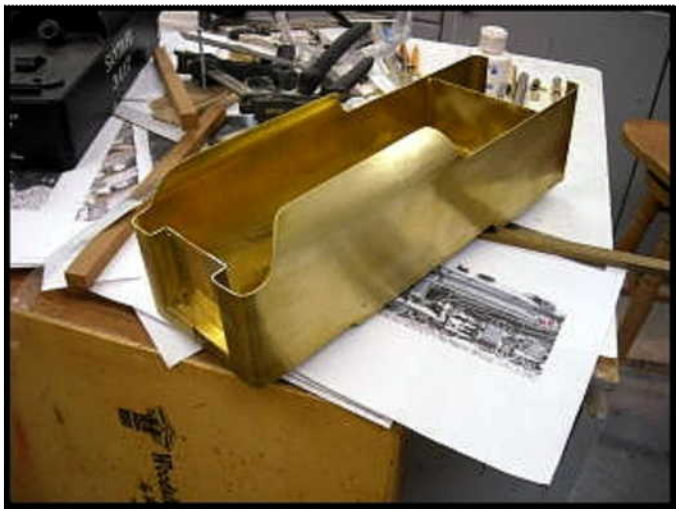
It is then screwed to the wrap with #00-90 screws.



The rear exhaust is on the tender.



Here are the parts bent into shape.

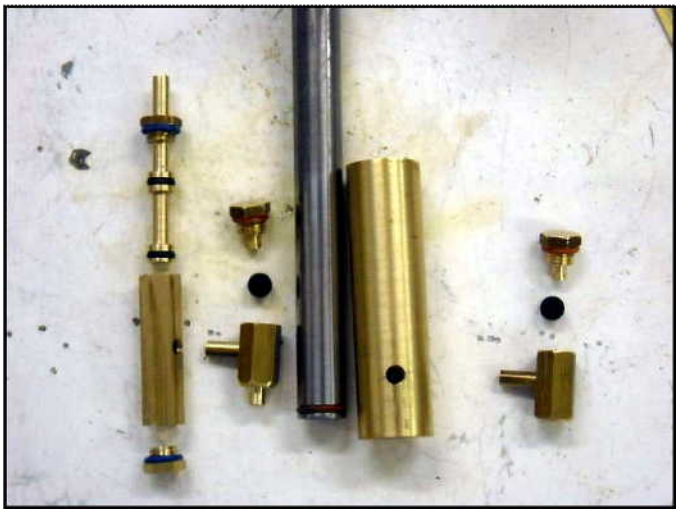


Then fastened together with brackets ready for soldering.

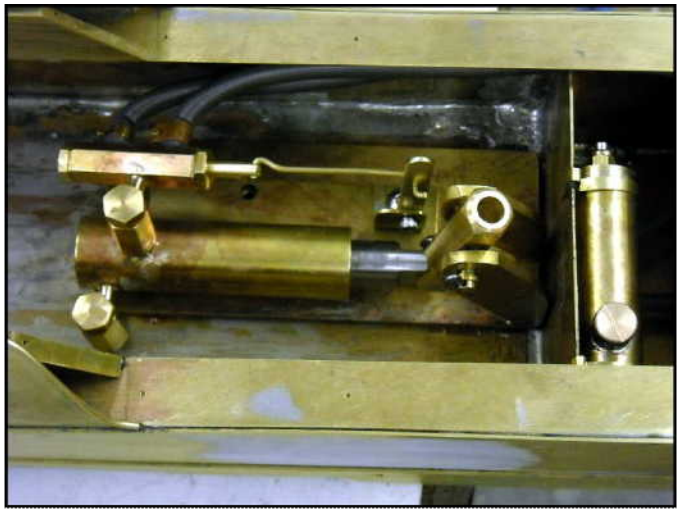
A piece of 1/16" brass tubing is ripped on the table saw leaving about 60% of the tube to form the beading.

The beading is epoxied on and held on place with tape.

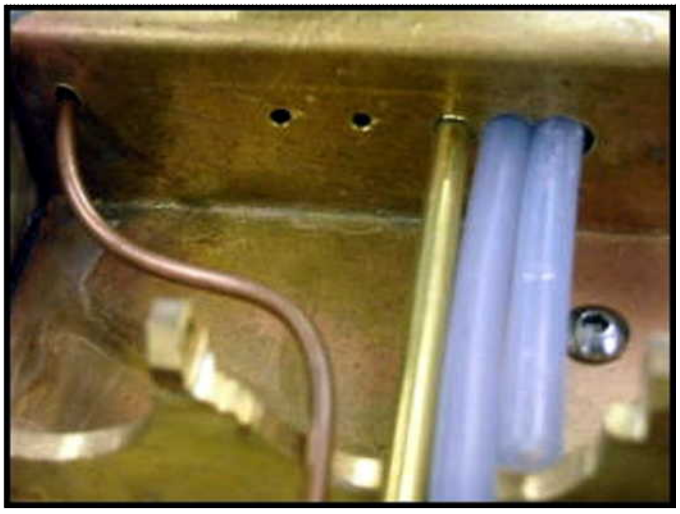
The finished product.



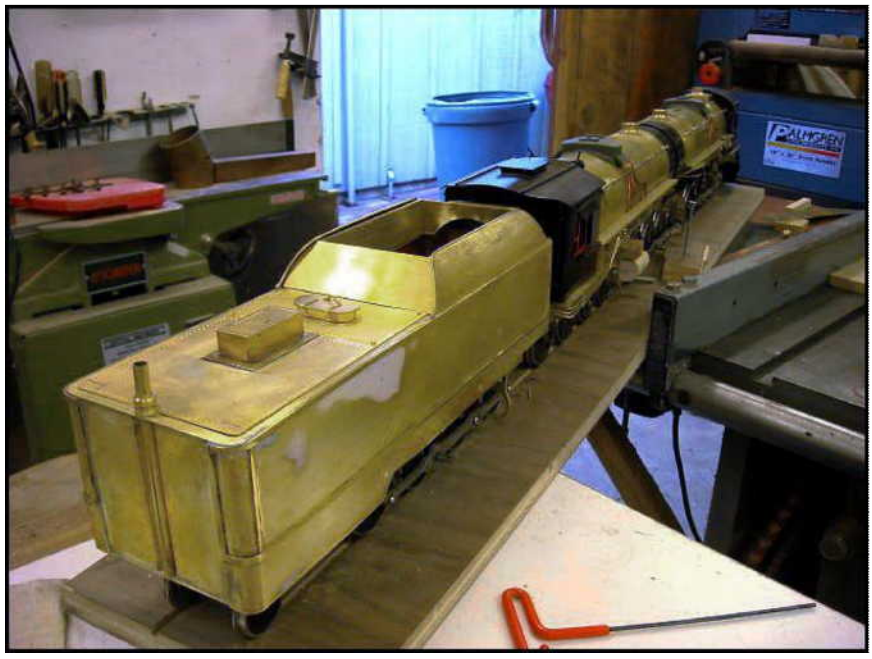
Here are the parts for the water pump. The piece on the left is a diverter valve, as I will be pumping to two boilers. Check valves use nitrle balls.



The pump is installed. The silicone tubing at the top is wrapped with SS expansion spring, the rear lubricator is on the right.



Underneath the tubing is set for routing. On the left is lubricator, in the center is rear exhaust, and on the right is boiler water feed.



Here is where I am so far. There were a lot of challenges on the tender. The height of the drive wheels limits the depth of the tender tank. The four burners will require a substantial fuel tank so you can see where the cutout in the front is made to accommodate the 2-1/2" diameter tank. The toolbox on the rear accommodates the water pump handle and the drop-frame design in the rear allows for extra room for batteries and electronics as well as the lubricator and insulation from the exhaust tube. The original design was for a coal load but since I will be going with a SP design, I think I will convert to oil.

***Comment Eric Maschwitz:***
*Crikey Bill that is one menacing beast!!! Simply fantastic looking. How is Dennis coming along on his end?*

***Comment Greg Elmassian:***
*Another picture please! More of a side view? Just astounding so far.*

***Comment MLS-lownote:***
*What kind of band saw can cut 40% off a 1/6" brass tube?*

***Comment Greg Elmassian:***
*Table Saw was what was mentioned I believe: "A piece of 1/16" brass tubing is ripped on the table saw leaving about 60% of the tube to form the beading"*

***Comment MLS - lownote:***
*Ok, what kind of table saw cuts a 40% off a 1/16" inch tube? I suppose I could glue the tube to a piece of stock, and run the stock through the table saw, but then I've got half a 1/16" tube glued to a piece of wood...*

***Comment Greg Elmassian:***
*I would assume a slot in the bottom of a board, put the tube in the slot, then move the assembly over the saw with the blade up just high enough to cut a kerf in the tube, deep enough to cut through the wall of the tubing, but not any deeper... so you have cut a slot in a tube and you have beading.*

***Comment Phippsburg Eric:***
*I have a **"Preac" Miniature table saw** that could do that job quite nicely though it is still a tricky operation.*

*(15 Oct 2011)* - Reply:
Eric Maschwitz Thanks: Dennis had a death in the family and is off to NY.

Guys: On the tubing, the secret is a zero clearance blade throat. You cut out a throat plate; out of MDF or whatever you have around and then lower the blade all the way down and insert the new throat plate. Then you turn on the saw raise the blade just enough to cut your work piece.

On my saw, the fence does not contact the table at the bottom so I clamp a 1/8" X 1/2" strip of brass to it so the work piece won't slide under the fence. Now set the fence at 60% of the tube (.037" for the 1/16') and use a long piece of tubing, 2 - 3 feet. Hold your left hand a few inches from the blade to keep the piece against the fence and feed the piece with your right hand by holding it at least a foot from the blade. You can cut to within one foot of the blade and then stop the saw and remove the piece. You need to hold the piece firmly with your right hand otherwise the piece will want to rotate from the saw action and will be ruined.

An alternative to holding it with your left hand is to cut a 1/16" X 1/16" notch out of the corner of a block of wood and hold it against the fence with a clamp. Your blade and fence must be perfectly in line for this to work and this is not an operation for the faint at heart. The saw is a Delta Contractor's table saw with a stock fence, you can see it in the photo of the whole engine above.

***Comment Steve Shyvers:***

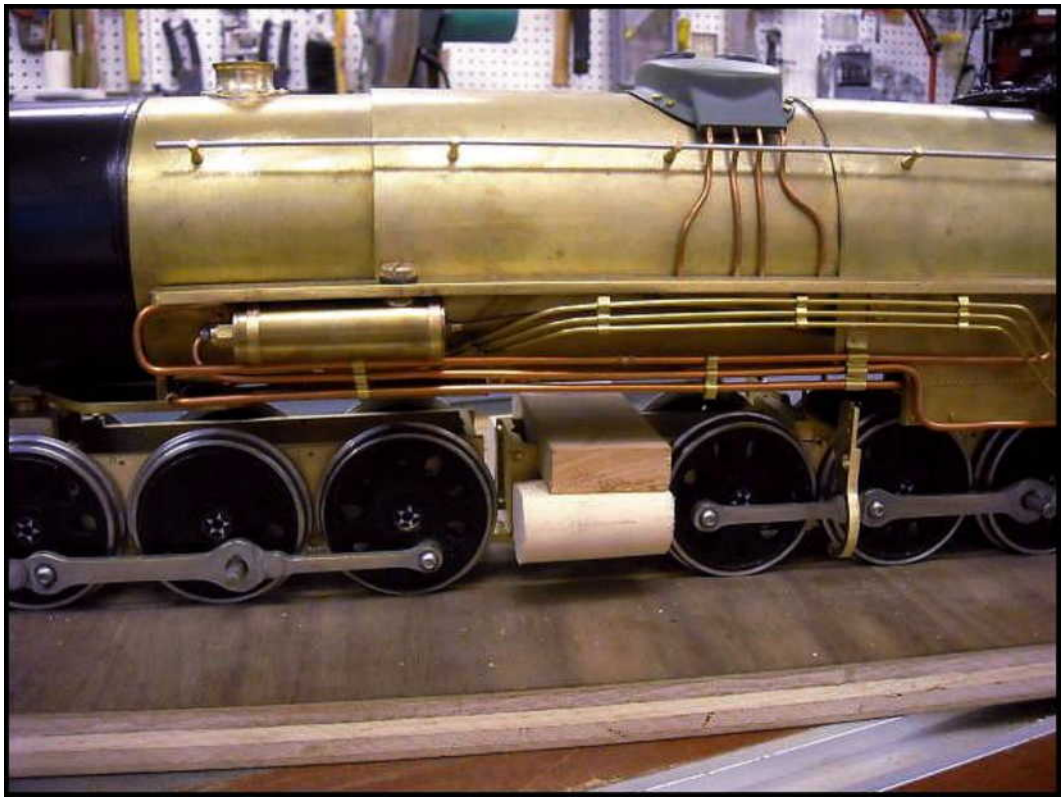
*Hi Bill: Please tell me what saw blade you use for cutting the 1/16" tubing to make the beading. Your Delta table saw is probably a 10" or 12". Is it a special type of blade to cut such a narrow kef? Thank you.*

*(17 Oct 2011)* - Update:

Greg, Steve: Here are some photos I took this morning

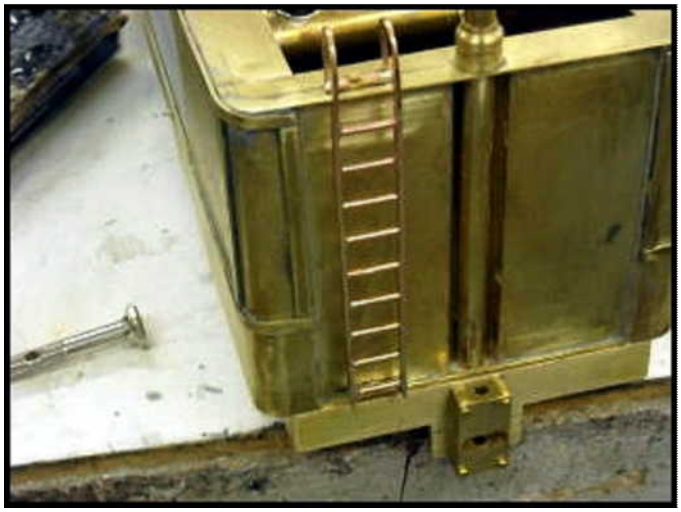
Side View

Front side view



Here is my progress on the decorative piping. Most of the working piping will be behind this.

The ladder rails were cut out of .040" brass sheet on the band saw.



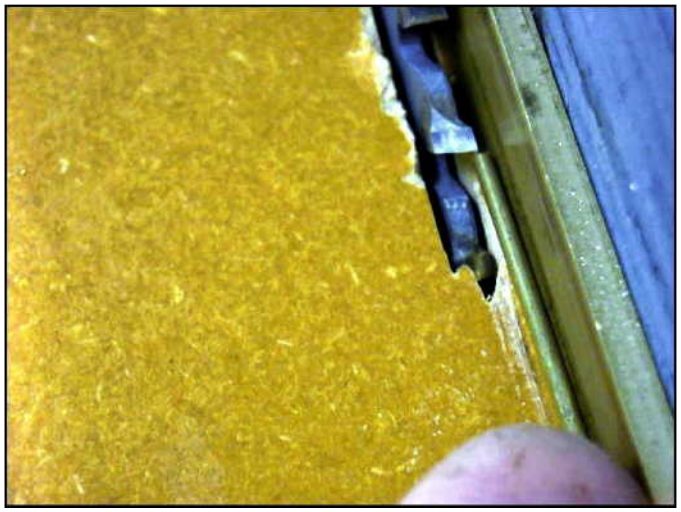
Silver soldered and attached and then filed and sanded. The rungs are 1/16" rod

Marker lights are turned on the lathe.

Rear of tender with marker lights and coupler.

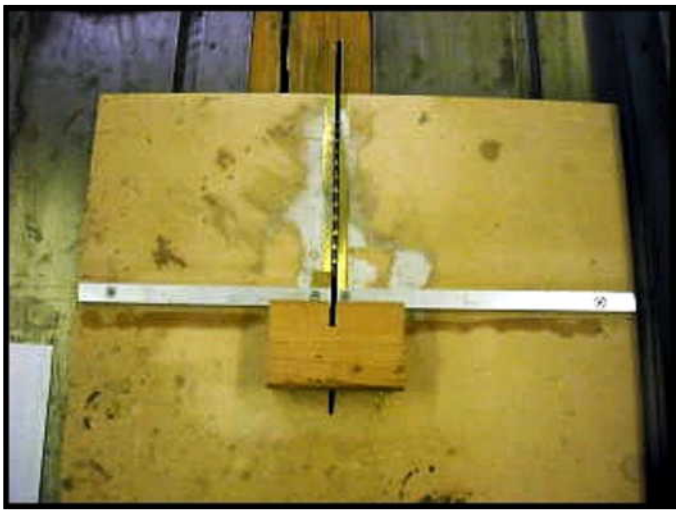
Here is my set up for ripping small pieces. The blade is a Harbor 10" - 80 tooth but they make a 50-tooth combination saw that seems to work better.

The brass strip is clamped to the fence and is touching the table. The throat plate is one of many I have and was set up just for this operation. The second slot you see is used for a different operation and the plate is turned around.

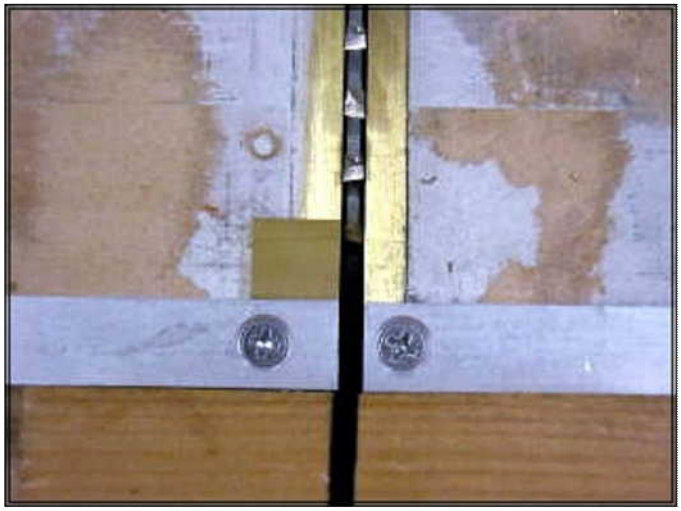


Here is a close up of the operation. You can see the slot has rounded off slightly. This is from the brass chips being pulled between the blade and the throat I may have one more use of this and then the blade can be raised to expose a new surface.

Here is the back of the cut-off jig I use. I start with a square piece of MDF I then set the two aluminum strips in the two table groves and shim them up so they are above the table. Then a bead of super glue is laid on the and the MDF is set on top of them and squared against the saw fence. The strips are then screwed in place for extra strength.



Using a framing square I screw a single aluminum strip to the top of the board and then cut through it and the board. The wood block on top prevents the loss of digits.



The MDF will round off in the grove if you cut a lot of brass so I set this brass strip in a grove that I cut with the dado and epoxied it in place

***Comment Jason Kovac:***

*That thing is getting scary. Need a large track I'm sure.*

*On the beading I also needed some to solder on a bunker I built. I ended up milling a slot so I still had the full round.*

*I had the same issue finding a suitable round. Half Round was easy to find but I wanted to have the full round look.*

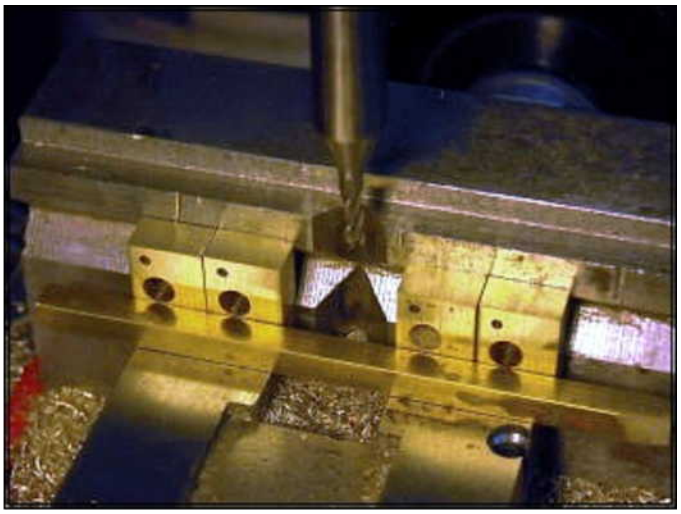
*(19 Oct 2011)* - Reply:
WOW! Jason, that worked out great and it looks better than mine. I assume you used a 1/32" end mill which would have been a bit loose for my .025 sheet metal but still workable. One thing nice about my technique is that depending on how much you take off the tube, you can get different widths on the slot, which helps, on the compound curves but the mill is more accurate and safer provided you have a nice vise like you do.

> ***Comment Jason Kovac:***
> *Actually I used .020" brass sheet for those bunkers. I figured the solder would fill right in and it did. I used a solder paste and added as necessary.. I ended up breaking just 1 end mill on about 2' of material. If I used bras it would of been easier as the copper is more gummy but bends easier. Was going to use a slitting saw on the mill but ended up not setting up the right angle head as I only had a short length.*

*(30 Oct 2011)* - Update:
Yes, I have had problems with copper too. If you use brass in it's natural hardened state and then anneal it after the machining, it seems to work pretty well

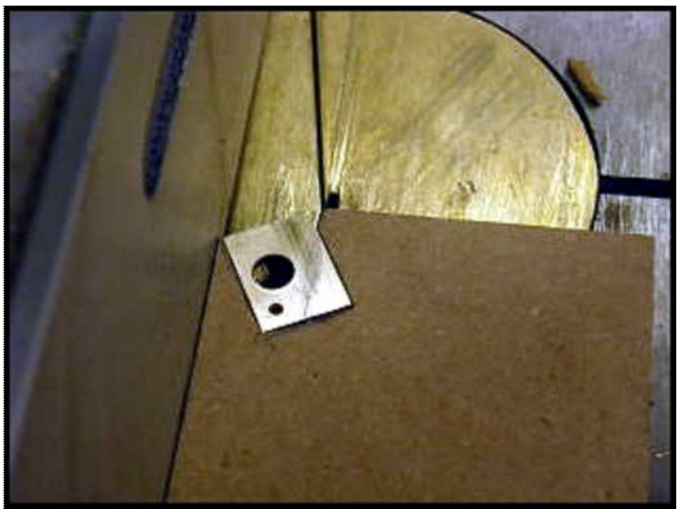
Well, I spent last week away from the workshop and started back making some small parts.

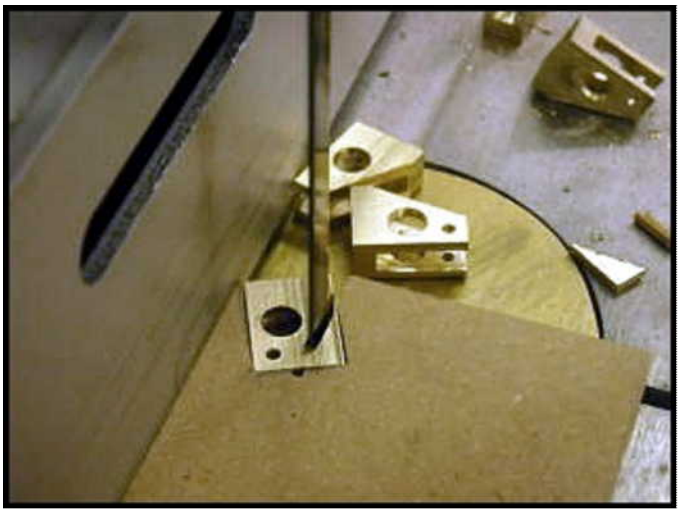
The pivoting bracket for the reversing gear is quite complicated. First, on the mill, I drilled out the two holes shown as well as some #0-80 holes on the bottom of the bracket as it is shown here.



The square stock at the bottom of the vise is used to put all of the clamping pressure on the bottom, which is not milled out.

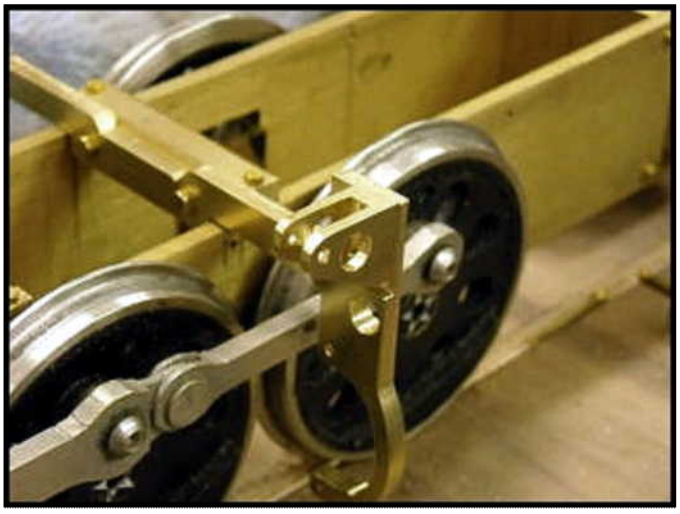
After the milling process, the diagonal cut is made.





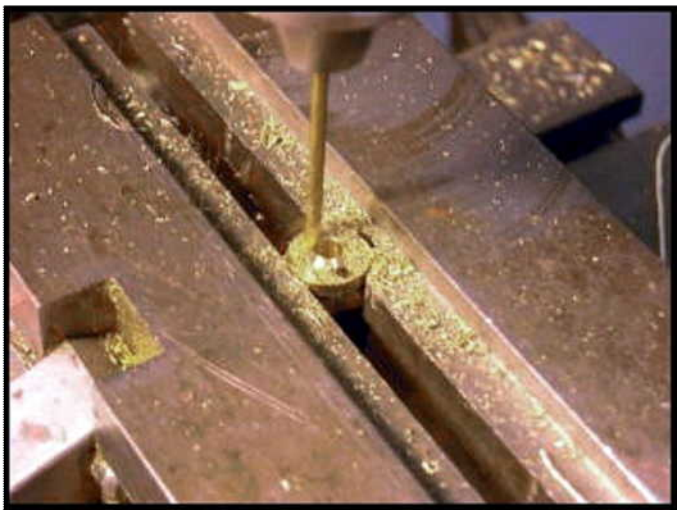
By cutting out the shape of the part at the proper angle on a piece of Masonite to form the cutting jig.

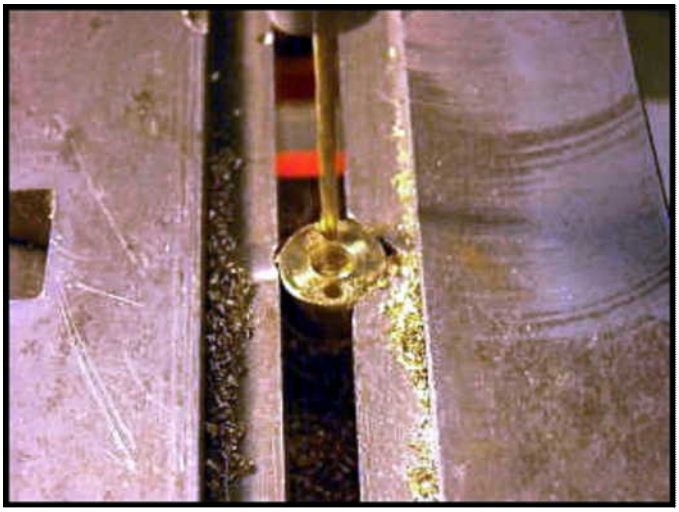
The ends are rounded off on the bench disk sander and it is bolted to the crosshead bracket.



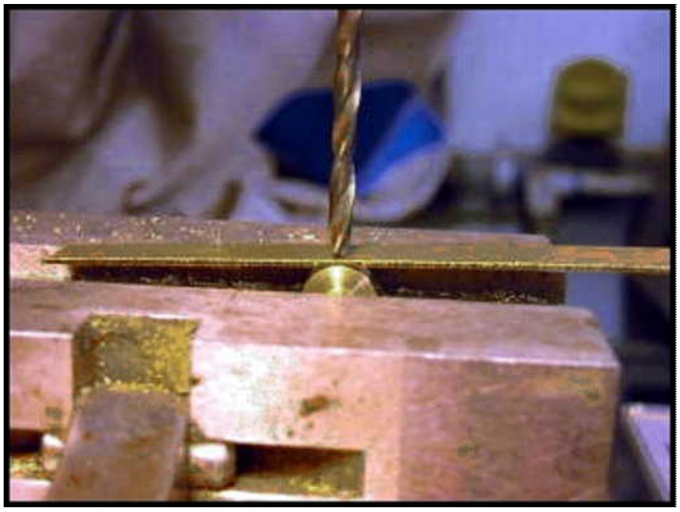
I will need right angle fittings for where the SS super-heater tube goes in and comes out of the burner flues. A cone is turned on the part on the left. This cone has a .125 inside diameter and will mate to a female seat drilled to .150. This will seal the fitting similar to the way a ferrule does in a standard fitting.

Mounting holes are drilled on the mill using coordinates on the DRO.

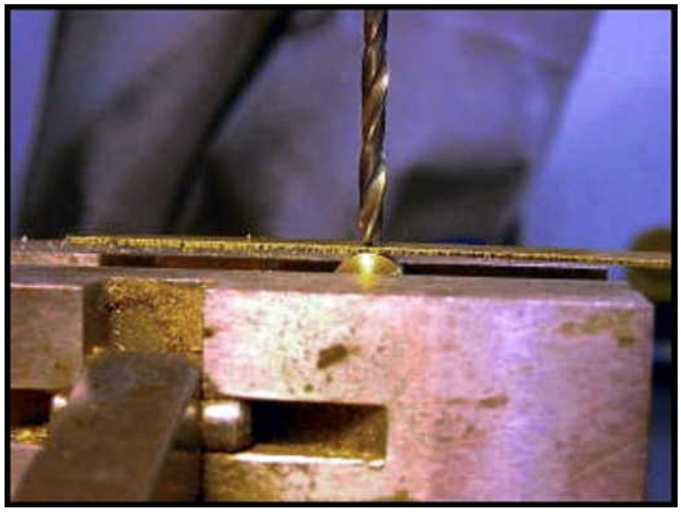




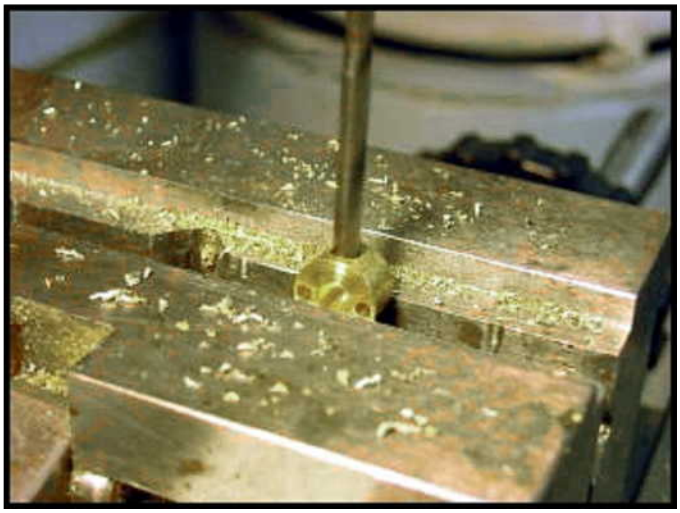
The female part is turned and then drilled using the same coordinates.



Here is a neat trick Henner taught me. A strip of sheet stock is placed on top of the round object to be drilled. You can see it is dropping on the left, which means the drill is left of center.



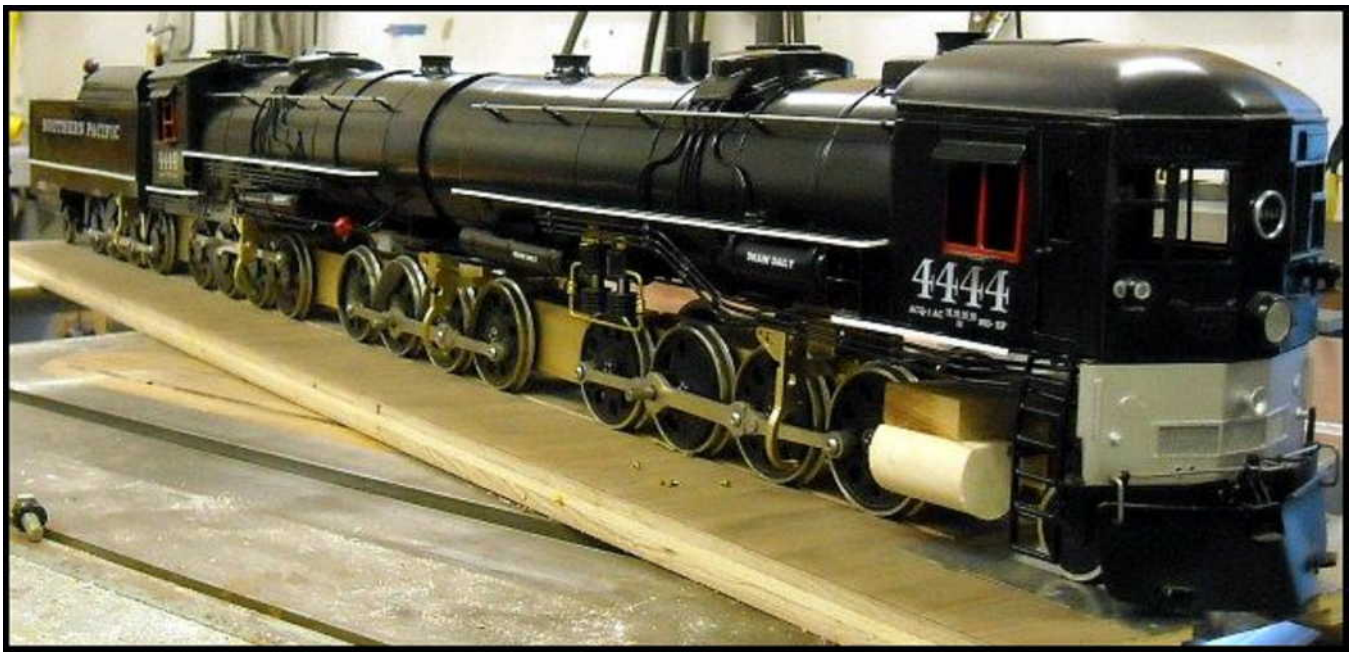
The table (drill) is moved till the sheet stock is level.



The result, a perfectly centered hole is then made.

Here is the finished fitting which will be silver soldered to the tubes. You can see that the flat surfaces do not touch and the contact is at the cone.

*(04 Nov 2011)* - Update:
Got the Decals from Stan in the mail this morning and put them on. Most of the plate work and paint is done. Here are some shots. The rear cab is off a little as it was just set on the frame.

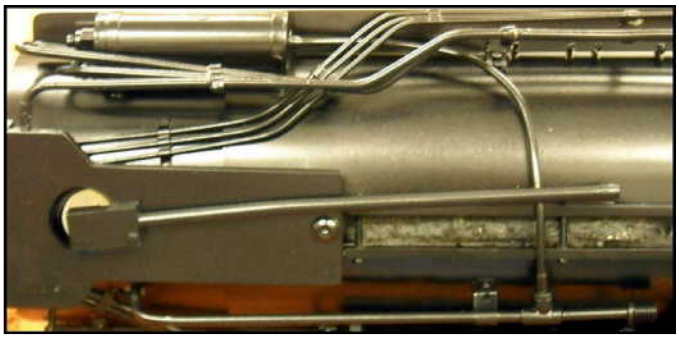





It is hard to show the tubing but the brass one on the left is from the super-heater. The "T" just before the bend connects the lube tank tube with a compression fitting Just above the brass tube is a black curved tube. This goes to the front exhaust stack just behind the cab.

A PTFE tube will connect to the superheated line on the threaded fitting at the end. The exhaust will be connected with Silicone tubing. On the right are the tubes for the second engine with the superheated tube on top with the lube fitting 1-1/2" from the opening and the exhaust on the bottom.

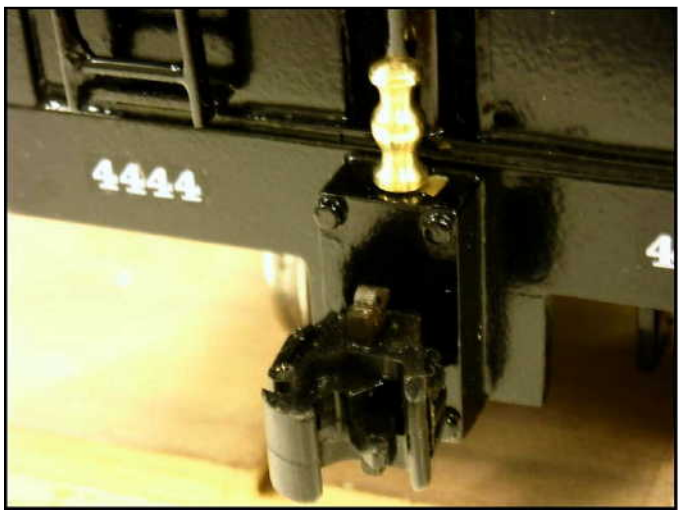
Here are some fittings on the rear boiler. The rectangular fitting in the center is threaded to accept an exhaust tube. The superheated tube is coming out the bottom of the smoke box and runs along the bottom of the photo.



This is the steam "T" which makes for removable parts. You can see the hole drilled at 35 degrees on each side.

Here is the assembly. The tubes shown up-side-down go to the steam domes. The throttle valves are on the left. The needles are not shown. The "T's" are shown below. The two parts below the "T" on the left will be silver soldered to the super-heaters and will seal against the o-rings in the "T."

*(21 Nov 2011)* - Update:
I spent a little time on the tender last week and Dennis finished up the cylinder and valve bodies. Once I got them I was able to start on the cylinder mounting, covers and drains.




A fancy pin is added to the coupler.

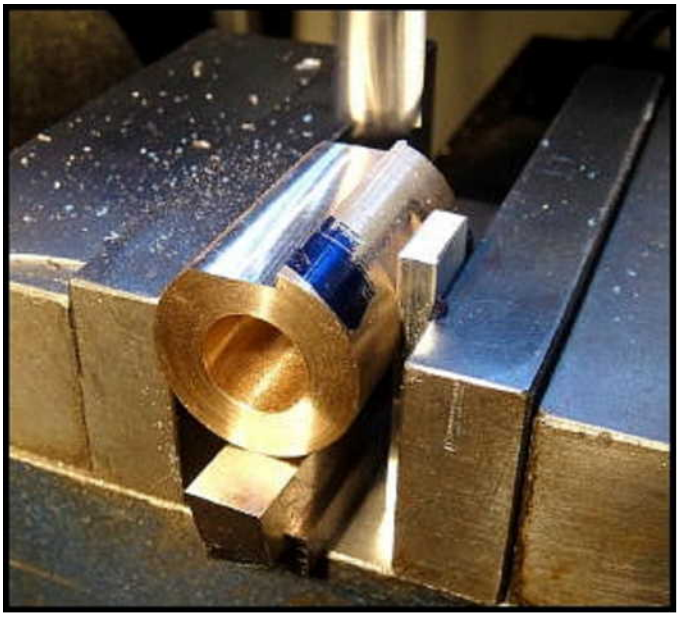
Lenses are turned from a transparent acrylic rod.

Here the red lenses are in place and lit.

Over at Dennis' the blanks are laid out...

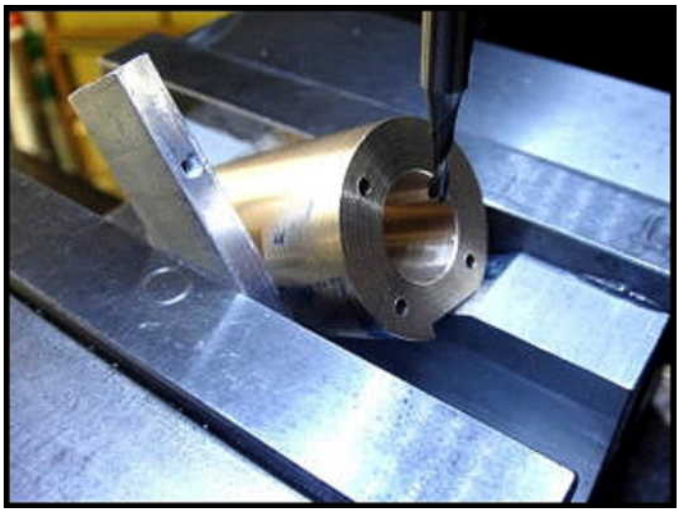
... and the milling begins.

The notches are used to index the cylinders...



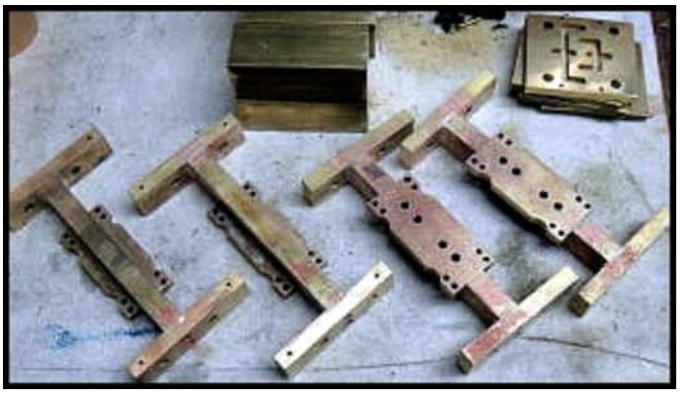
... for the milling...

... and drilling procedures.



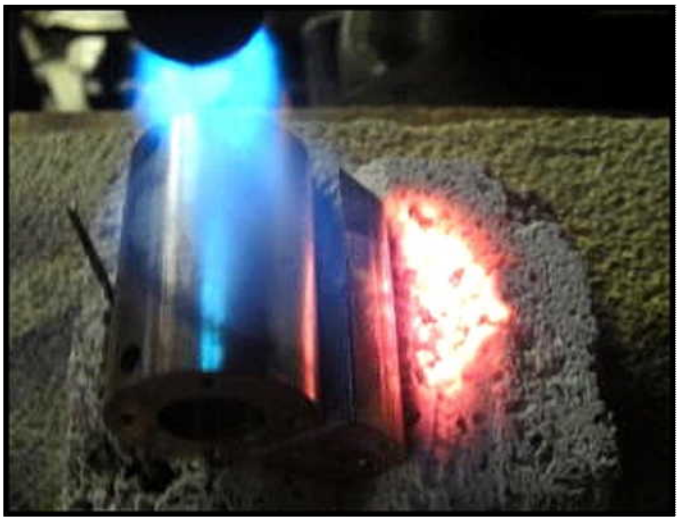
You can see the sloped fitting to the right of the cylinder used to set the correct drilling angle.

The manifolds are silver soldered after the drilling has been done.

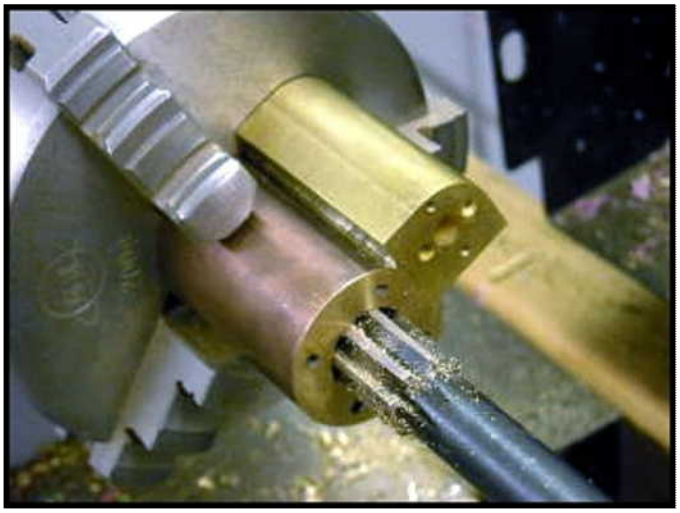


The flat in the middle accepts the reversing valve and is used for mounting to the frame.

On the right are the cylinder valves,...

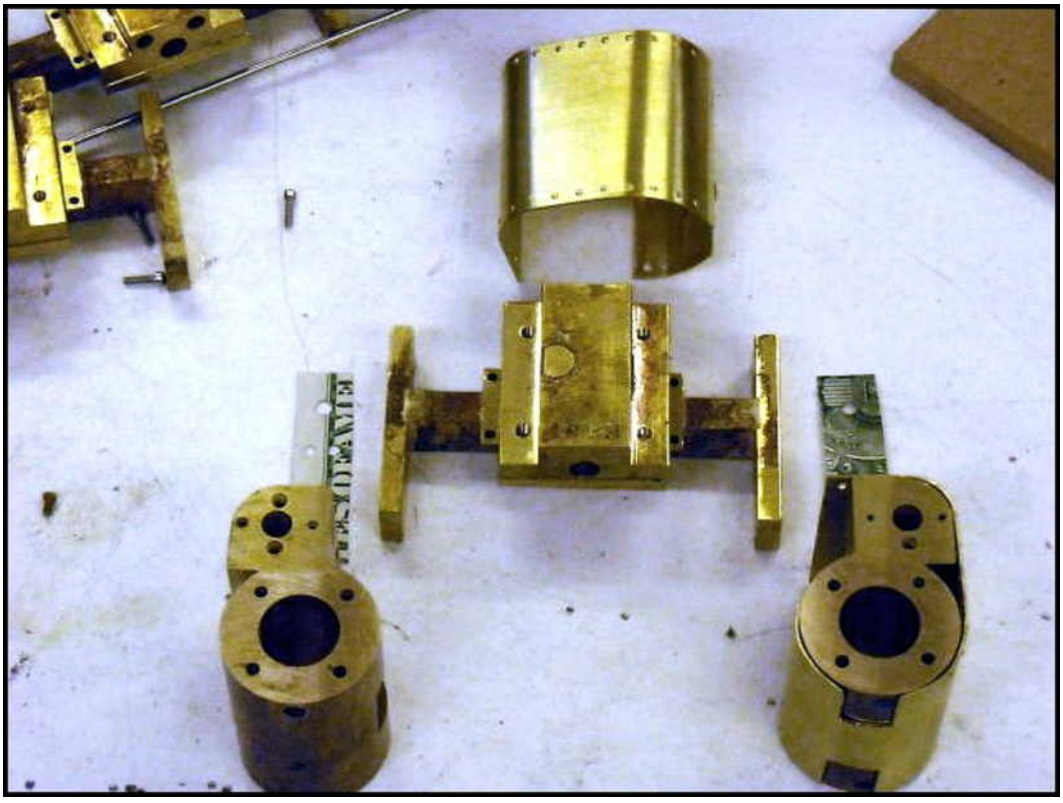


... which are silver soldered to the cylinders

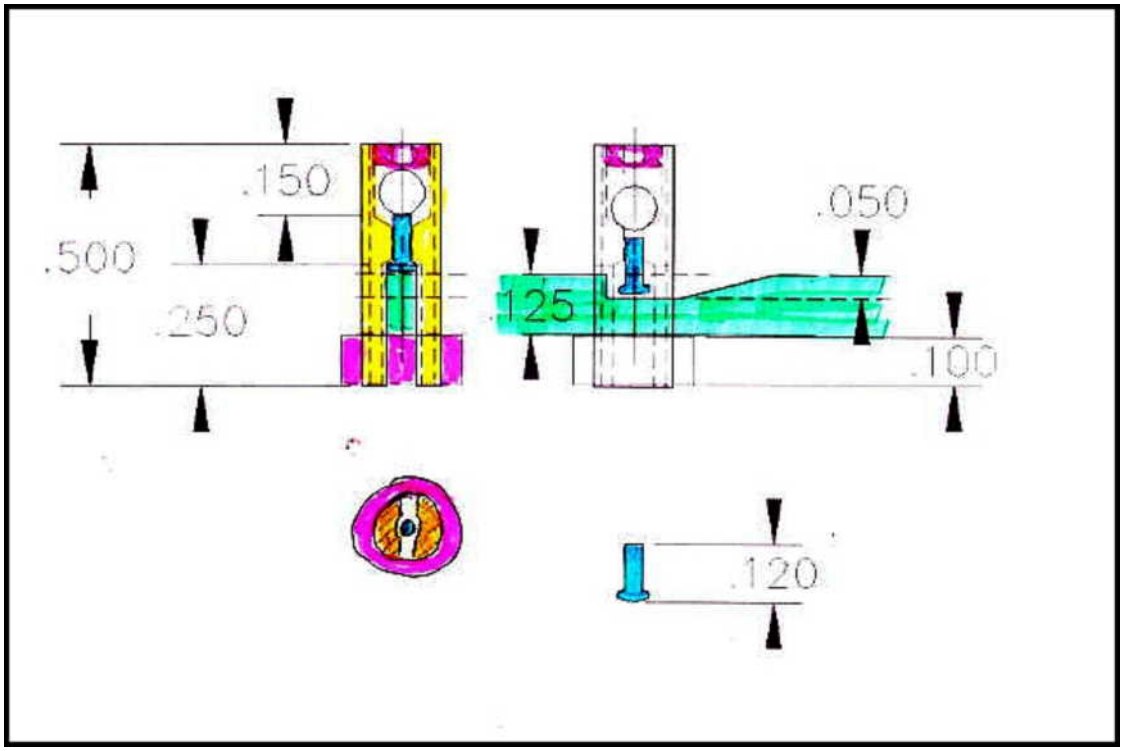


Back to my house for where the cylinder ends are finished...

... and the final reaming is done.

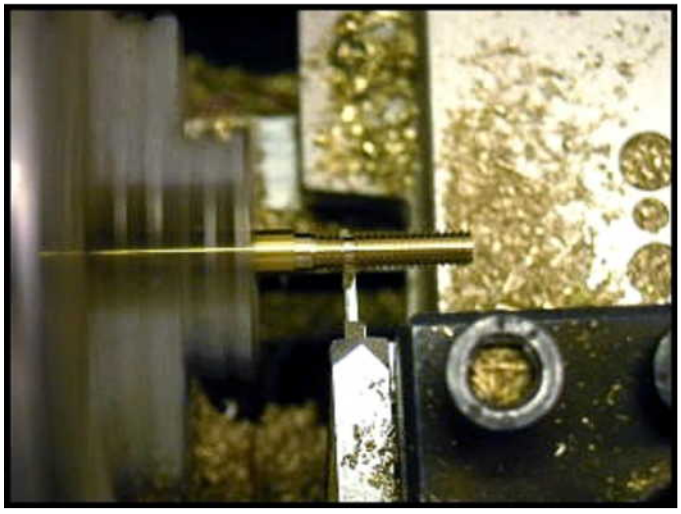


Above is the assembled valve body and cylinders. A George Washington came in handy for the gaskets and the cylinder covers are at the top and around the one cylinder.



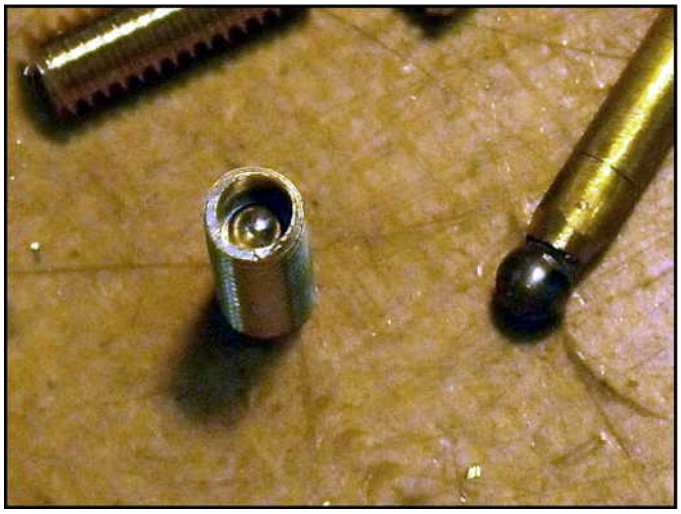

Here is a drawing of the drain cocks I made for my Double Fairlie. I only had to make a few adjustments to the size. They are now .460" long vs. .500".

I start by threading a rod to #8-32 and then drill the through hole to .050" and the .150" hole is now .124" deep.



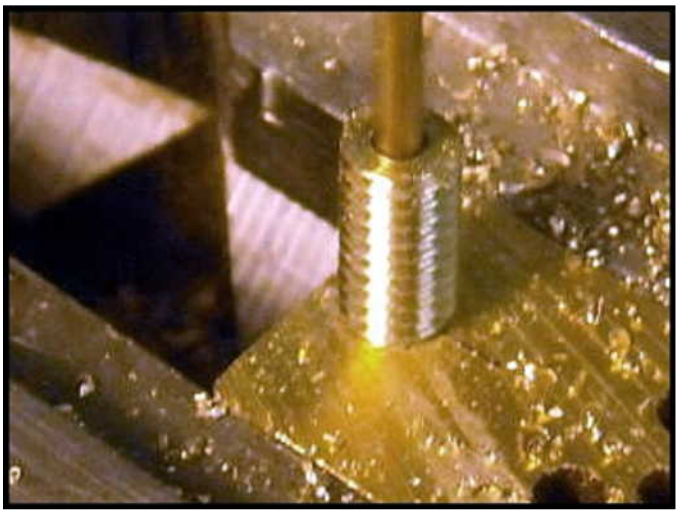
Then the piece is parted off and on to the next.

A 3/32" SS ball is silver soldered to a 3/32" brass rod and with a jeweler's saw I put cross-hatching. This is used to burnish the valve seat.



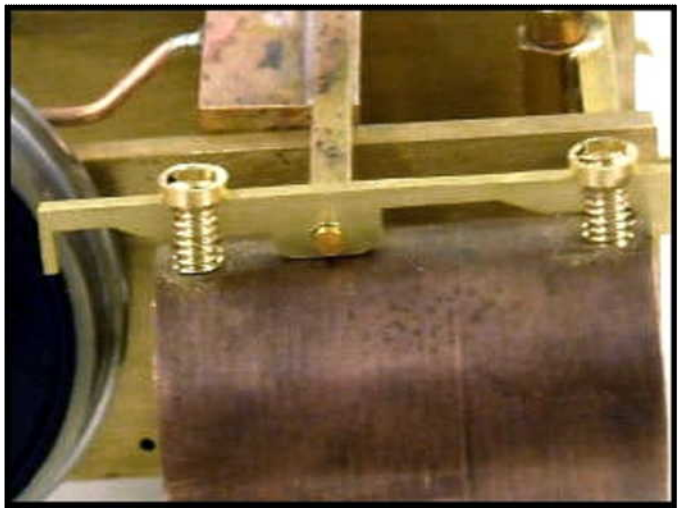
Here the ball is in the seat. This would be looking down from inside the cylinder. A pin raises the ball to drain the cylinder.

I made this tool to hold the valve during the machining process.



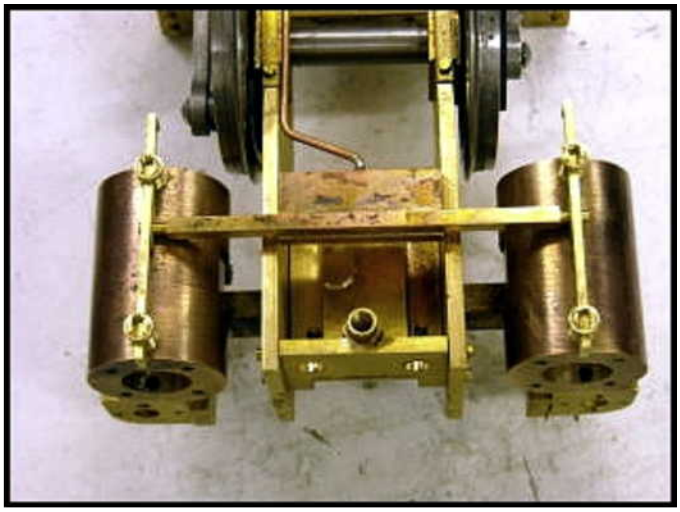
Now I drill a .070" hole for the pin head clearance and to allow the water to pass the cam lever.

The 1/16" slot is cut with an end mill before the valve is taken out.



Here are the valves in the cylinder with the cam lever installed. The round adjustment nuts will be set with Locktite during final assembly.

A top view shows how the "H" shaped bracket is kept parallel by the rectangular piece soldered to it, which slides between the frame rails. The bent rod at the top goes to the servo.



*(02 Jan 2012)* - Update:
Well, I have been busy with holiday decorating and cleaning up around the house. I have had some time to spend on the Quad but haven't had the time to post anything. It seems like I am missing some shots on the construction but here is what I have and I will post some more later this week or next.

I put everything together for the Christmas party. It looks pretty good but underneath there is still a lot to do.

I made the side handles out of Mahogany and half-lapped and doweled the joints. The engine is 50" long and it will fit in my trunk diagonally, thus the mitered corners.

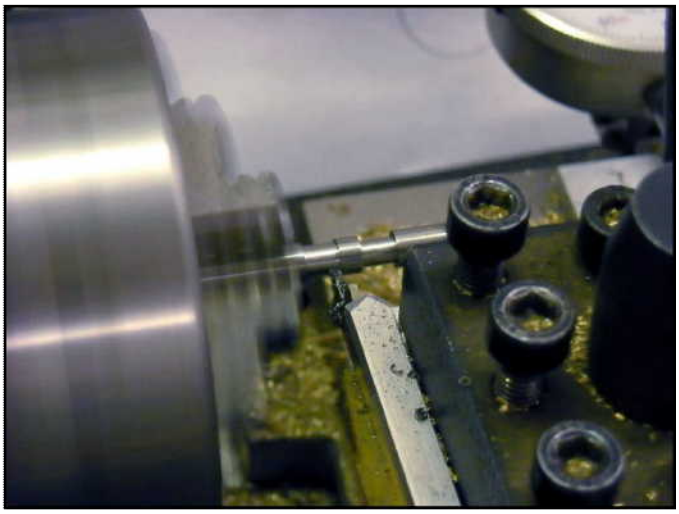
The dowels were cut from a piece of Ebony. Three 1/4" brass rods will keep everything in place. The front and rear ones go through the frame.

The smoke boxes are fitted with Fiberfrax.

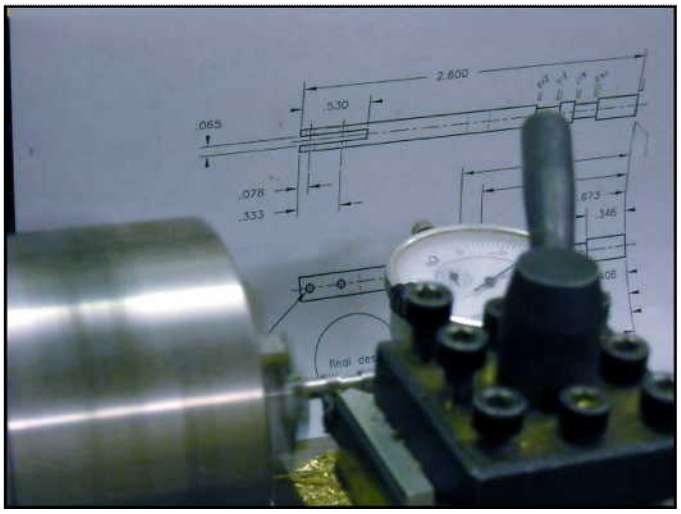
And then lined with brass.

The flexible boiler pieces are fitted with steps and handrails and a layer of Fiberfrax.

The working ends of the boiler are coming together. The pressure gauges came in last week and the burners and jets are ready to be tested and installed.



Here is a shot of turning the piston valves. Precision ground Stainless is used for this job.




This shot shows the cad drawing by Dennis, close to the lathe so I don't make any mistakes.

I am now installing the servos and wiring for the reversers and cylinder drains. I want to have as little wire hanging around but still want everything to be on plugs so I can remove one bogie or one servo without de-soldering anything.

***Comment Dan Pantages:***

*How do you intend to produce enough steam for this engine?*

***Comment Charles:***

*Bill, All remarkable work, in particular the flexible unit and connects...can't recall but what is the radius for the engine?*

*Dan, Bill, My question is what is the water capacity of the tender supplying water to each boiler in order to keep up steam?*

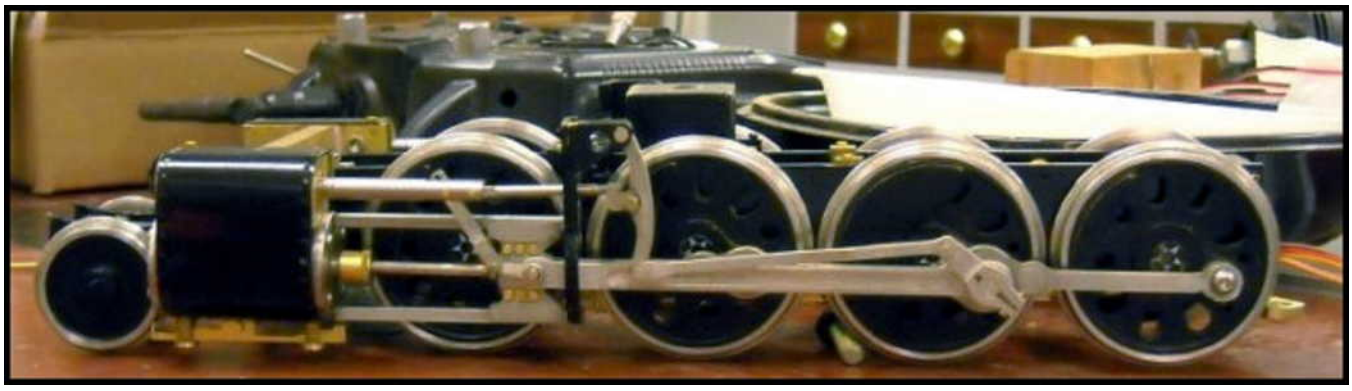
*(03 Jan 2012)* - Reply:
**Dan:** Hopefully the required steam will be produced by four butane poker burners similar to the two I have on my Garratt, so double the number of cylinders and double the burners. Plan B would be to go with larger burners or convert to radiant burners.

**Charles:** It is designed for a 7' radius. I pulled the chassis over my 7' track before I made the boilers and then the rough boiler/engine combo after the boilers were done and it seems to work ok. The biggest obstacle was the Cab Forward wheels, which initially bound up at the side rods. I made small spacers to give them a little more give and that worked. Since then, I had to move the front drivers in a little to ensure clearance with the crossheads and haven't tried it out again.

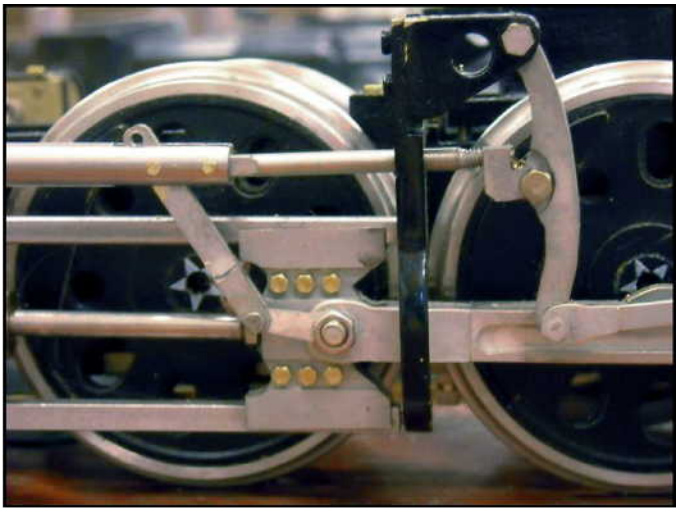
The Tender is proportional to the original Baldwin design and is going to be light on water capacity. The boilers will hold about 1000 ml of water each so I should be good for 20-30 minutes on that amount. Because of the small tender capacity, I don't have an axle pump and for extended runs, I will probably need to stop it every five minutes or so to fill the tender and hand pump the boilers up. They also designed a Quinteplex, which had two tenders, which could be something to consider. The second tender could be non powered and detachable.

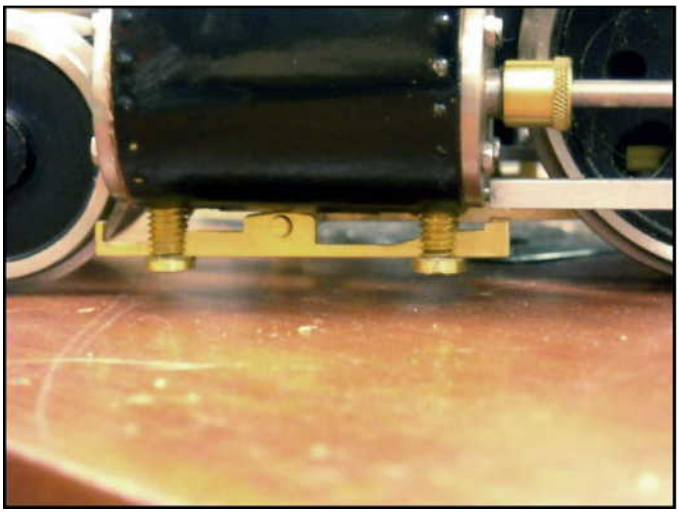
*(04 Jan 2012)* - Update:
So, I had a little time this afternoon to take some pictures of the chassis wiring
I now have four reverser servos and four cylinder drain servos mounted and wired together. The whistle servo is in the rear cab and the wiring will pass under the cab directly to the tender where all of the electrical power is. I want each engine and/or boiler to be removable without any soldering or cutting of wires and for all servos to be able to plug in to a socket for easy replacement. The servo position varies from engine to engine, as I don't want them too close to the superheated steam lines or under the smoke boxes.

Here is the front engine, which is almost finished. Still need to make caps for the valves and a few other cosmetic items. I have run it on air and it will pull it's own weight at 5 PSI and is almost impossible to hold back at 60 PSI. Dennis and I have gone through several different designs to get this running the way I want it to be.



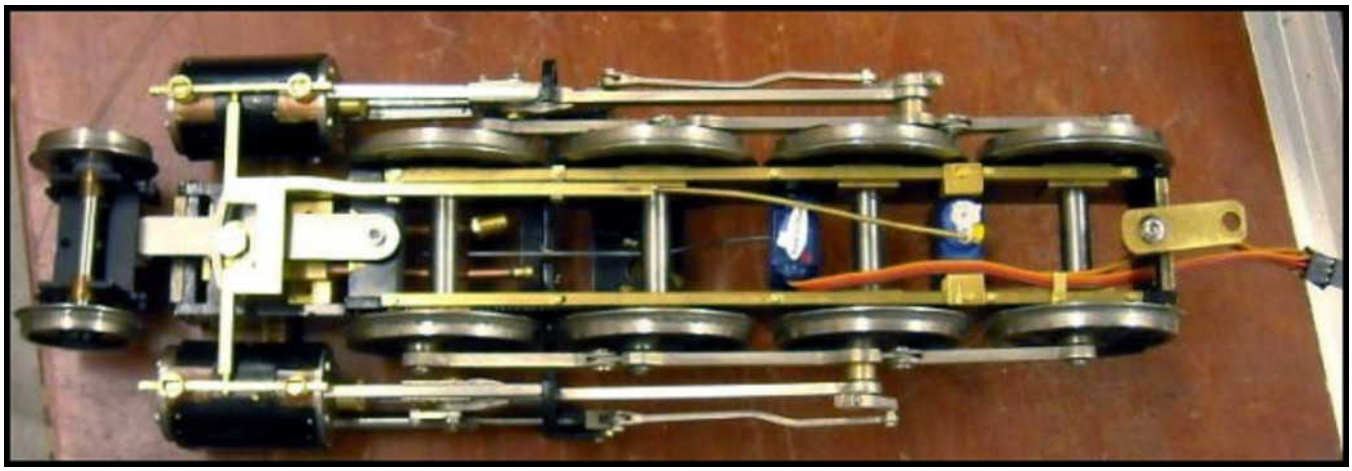
Here is the crosshead section. I designed a combination lever, which is now inactive but can be changed to a working one with a slight change in the design. The reverse is handled by a valve between the frames so there is no need for external reversing but it too can be easily converted if needed.



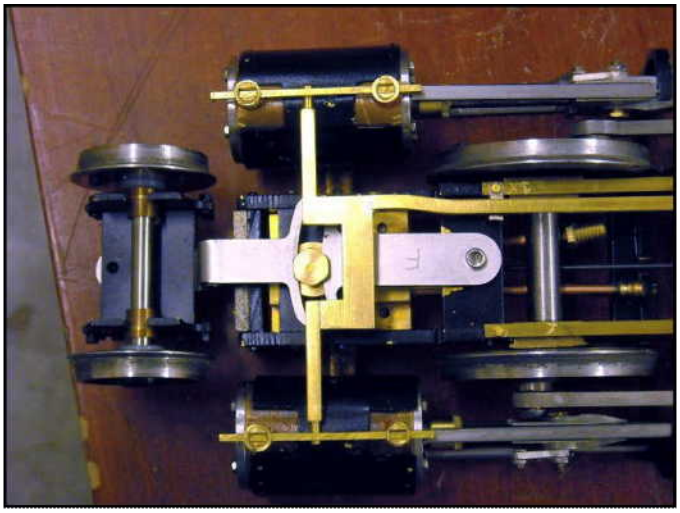


Here is a side view of the cam lever actuated cylinder drains.

A view of the bottom shows the cylinder drain linkage, which is designed to clear the front pilot. The front servo is for reverse and is connected to the valve with .044" music wire. The rear servo is for the cylinder drains. The pigtails at the back connect at plugs in the next engine.

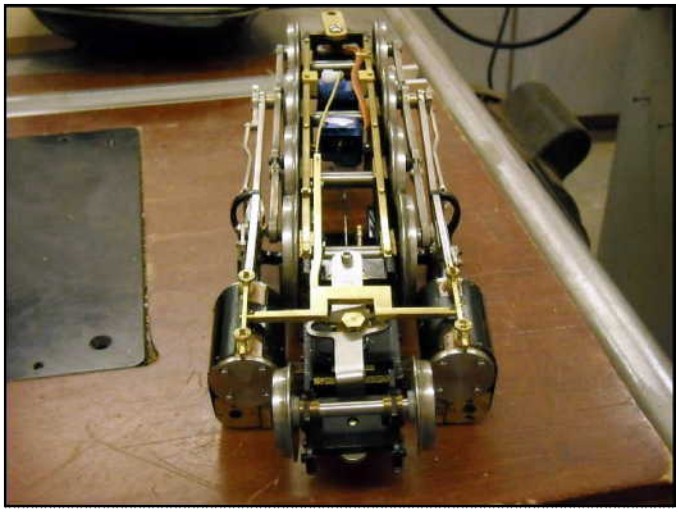


Here is s close-up of the cylinder drains. The steam fitting is going to be close to the frame and a wrench is inhibited by the valve rod in the center of the frame.



A few minutes on the grinder and one of my old 5/16" wrenches should clear just fine.

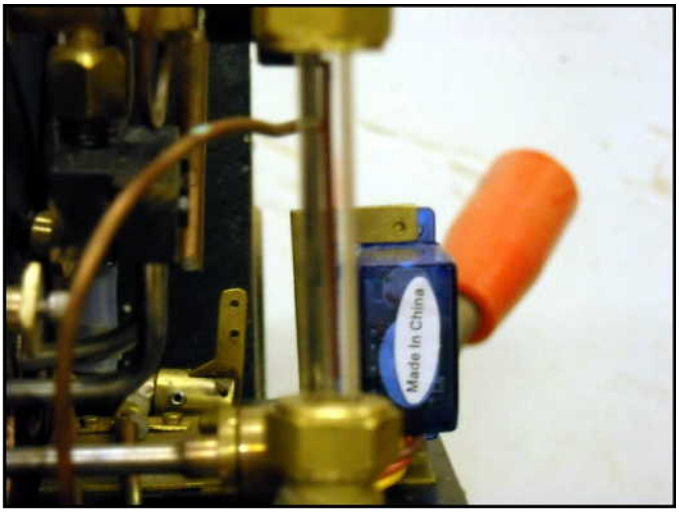
A shot from the front shows how it should work. The two brackets on the left frame keep the cylinder drain lever true.

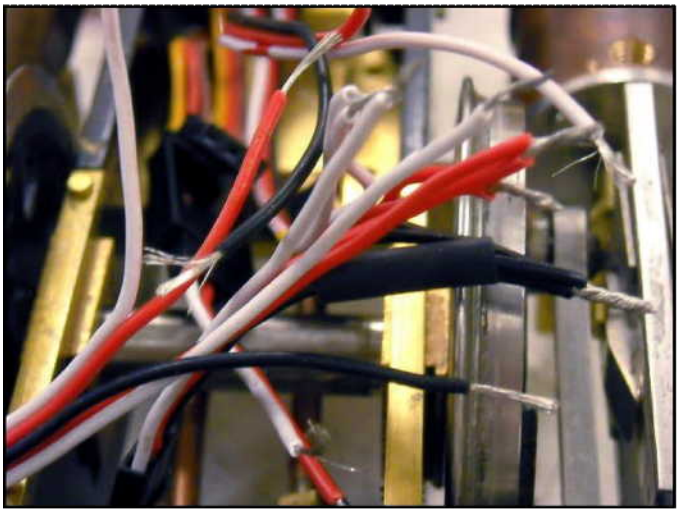


Dennis made four pop off's for me. Two on each boiler, one set at 60 PSI and the other one set at 70 PSI.

Here is a close-up of the sight glass a piece of 1/16" automotive striping tape is put on the back side and when it has water in it the.

Strip appears to be about double the width. This gives you the water level at a glance and lets you know if it is totally full or totally empty.

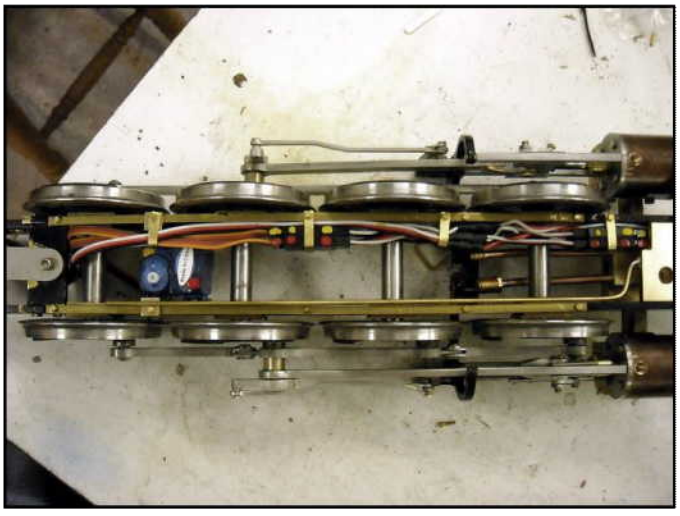


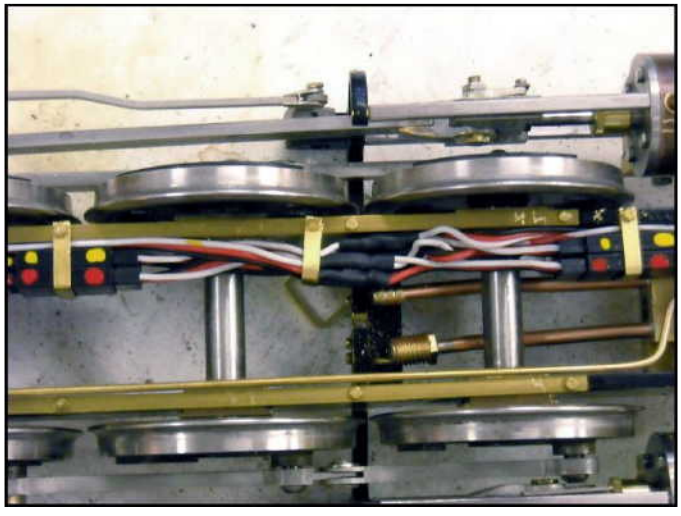



On the front engine you saw a clean wire job with only two pigtails in place.
I wasn't as lucky on the rear on where they all seemed to collect.

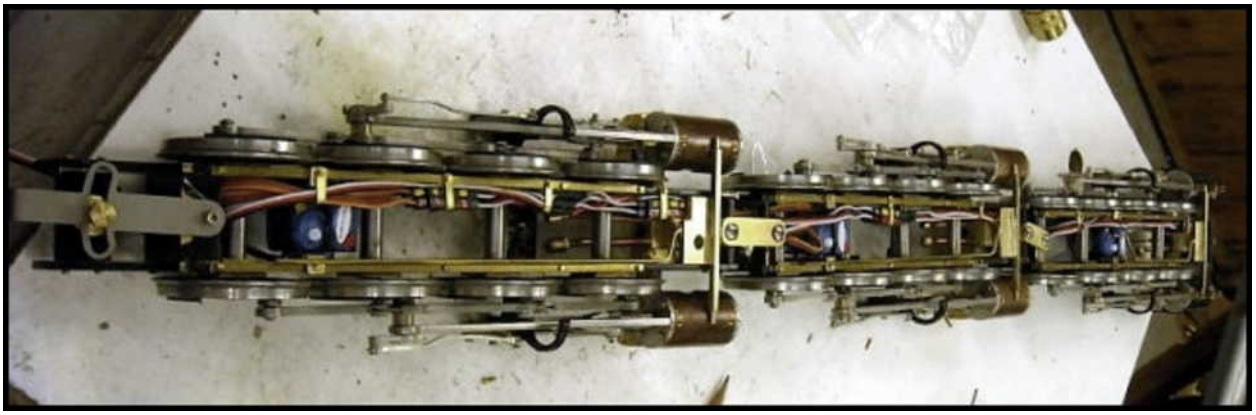
A lot of patience and a little shrink-wrap tubing made marrying the eight servos look somewhat professional.

I could have gone with less wire but I would have had to cut plugs and splice which would have been a problem down the road.





A close up of the main wire splice.



Above is a shot of the rear three engines with the wiring secured and color-coded.

***Comment Michael Glavin:***

*Bill, I've enjoyed watching you create this masterpiece...*

*Thought I'd offer a tidbit with regard to servo wiring and eliminating the wire count. If it makes sense you can create a power buss to feed the servos 12V (the red is positive + and the black or brown is negative, while the white and or orange is the signal wire which controls the servo movement). This would help eliminate some of the wires traveling to and from the servos and receiver. The Receiver's female socket for each servo with regard to the 12V wires are all connected to a positive or negative power buss inside under the plastic casing (FWIW: you don't even need to route the servo power through the receiver) accordingly you could bring one positive and negative wire forward and wye off to each servo as required. With the micro servos in play, the current carrying ability of the wires used are a moot consideration given the wire gauge utilized.*

*I have a lot of experience with giant scale radio control airplanes, these 40lb. monsters sometimes have 14-16 high powered digital servos in play, many sharing control signals and such. A lot was learned, some the hard way but today's giant scale model airplanes properly rigged are incredibly reliable.*

*Looks like you're driving multiple servos from a single channel? Are all four reverse servos and drain servos sharing a single channel?*

***Comment Garry Paine:***

*Michael, Which servos are those? Most R/C servos I've seen are 5 volt; is there a line of 12-volt servos?*

***Comment Michael Glavin:***

Garret, Good catch... Those are 4.8V servos, which as you suggest are not 12V. Not sure what I was thinking when I typed 12V, go figure. Seiko makes some large servos that operate at 12V.

*(05 Jan 2012)* - Reply:

Michael: I was thinking about doing it that way by using the positive and negative leads for both circuits and even asked a friend who thought it would work but wasn't sure. It turned out that there is enough room to run the three wire leads for both, so I decided not to risk screwing something up and having to re-solder everything, If I were going to make the servos permanent, your technique would save a ton of time and space. As I am still using the factory servo pigtails with female plugs from a factory loom, I would still need to do all of the soldering so I would have just saved some space.

Thanks for the information. I am sure it will be useful on future projects, especially bypassing the receiver with the power leads.

You are correct. I will be using three channels.

1. Whistle circuit - one servo - not shown.
2. Reverse circuit - four servos.
3. Cylinder drain circuit - four servos.

***Comment Michael Glavin:***

*Bill, Have you tried to drive all four servos thus far with the single channel? In some circumstances we experienced early on a problem with some RX's to adequately sink current to drive multiple servos (as little as two if I recall in some cases. This is a control signal variable). We later determined there were variables in play with a specific OEM RX and another OEM's servo. Never the less it would be prudent to try and drive all the aforementioned servos as anticipated as soon as possible.*

*FWIW: It's generally undesirable to drive multiple servos with a common control signal, simply because each servo and control linkage will have its own needs with regard to travel and end stops to prevent linkage binding. That said you obviously have the skills to build this consideration out of the picture, BUT even identical components still rely on the servo and its own integral idiosyncrasies to match up to Transmitter/RX settings in play. You could have fifty servos on the bench and be lucky to find three that all move the same travel volume in each direction and operate at the same neutral position (early on we actually had to cherry pick servos for this very reason. Later as things progressed there were ancillary devices afforded us that allowed us to match all servo travel aspects and later yet programmable servos and transmitters that alleviated these servo and linkage geometry short comings).*

*It's paramount to insure you've eliminated any and all control linkage binding of the servos or excessive current and will wreak havoc on those micro servos…. Best case is to use the full rotational travel volume of the servos; 120 degrees. It's very easy to measure the current draw of each servo independently by simply utilizing a multi-meter and a pigtail you can adapt for same. Many are surprised what can be garnered herein…*

*Since I'm rambling on, there are transmitters that you can assign all of the available channels to be driven from a single channel, each with its own travel volume adjustments, speed, direction and more. This really is a unique feature for those that have such requirements.*

***Comment Semper Vaporo:***

*I seem to remember running across a device specifically for driving multiple servos from one receiver output. It is inserted in between the receiver and the multiple servos, sort of a "Y" device and I remember that they could be cascaded to split the output of one to two more and thus get 4 outputs from one receiver and 3 of these devices... I suppose each of those could be expanded too. I don't remember where the power came from to supply this device.*

***Comment Tom Burns:***

*Bill, I understand this is an after the fact comment but could prove useful for further projects or if you want to clean up the wiring some on this project to make room for something else. I can confirm that using a common positive and ground for all servos works. To even further reduce wire clutter, I use the engine itself as a ground just like a car. At the servo, I solder the ground wire to a hex head servo mounting bold before installing in —*

*order to make a good solid connection. You obviously need to reverse twist the wire the number of turns it takes to screw the install the bolt. With this technique, you only have to work with one common positive wire (buss) and the control wire for each servo. For all the servos connected to the single channel, you can even use a common control wire for these servos. With the functionality defined, the installation could be reduced to as little as 4 conductors (3 control conductors, one positive conductor, with the locomotive used as the ground).*

*Due to the mechanical complexity, I fully understand why you are using servos for the functions defined. Since you have gone this far, I do not understand why you are not controlling the throttles with servos especially since you have 2 throttles at each end of a very long locomotive. I expect that manually controlling and balancing these throttles will be a challenge given the logistics involved. Even if you want independent throttle control, this can easily be done on conventional RC by having one throttle on the left stick, and one throttle on the right stick and placing forward/reverse on channel 5 and the drain cocks on channel 6. With most modern RC, you could even have both throttles on one stick but independently balance them using a mix function with another channel. Either way, I think this would be preferable than the acrobatics of trying to control this beast with 2 throttles manually especially when an emergency stop is needed. I can only imagine you holding the tender (the only cold part) with 1 hand and not having sufficient arm length to reach the 2nd throttle when an emergency stop is required (or having your face contact the boiler trying).*

*I additionally found it interesting that you did most of the detailing work first before you constructed the chassis mechanics. This showed a great deal of confidence that you could get the 4 chassis mechanics to work which seemed in this case to be one of the bigger challenges. The time frame in which you completed this project is unbelievable even with your outstanding machine shop. Either way, your work is absolutely outstanding and I have really enjoyed this post.*

*(06 Jan 2012)* - Reply:

**Michael:** Thanks for the tips I did test them all and that part works fine. On the reverser servos, I have a screw and lock nut adjustment, which will give me any position I want. I will adjust them all for the optimum forward position, which leaves reverse within a few percent off ideal. Since it is a slide valve, there is no resistance at either end. The cylinder drains are not very critical on the throw. They will be adjusted for the optimum position in the off (running) position.

**Semper:** Those *"Y's"* are what I used but I cut and soldered them to eliminate the extra wire and for proper positioning.

**Tom:** Using the chassis for the ground is a great idea. On this project, I would have had to install ground wires between each chassis, as I wouldn't trust the mechanical connectors to hold up over time in our dirty and oily environment. The speed and direction will be controlled by the reverse valve, which is in series with the throttle and can shut steam off to the cylinders. My thought is to determine the optimal maximum opening and leave it there and use the reversers for everything else. My friend Henner has an engine he built where he pulls the steam directly from the steam dome and directly to one of these valves with no throttle at all. Plan-B is to install two servos for the throttles, which can be done later, I still have three channels left.

***Comment Tom Burns:***

*Bill, Stupid me. Forgot that using piston valves with a reverse valve controller is a perfectly acceptable way of starting and stopping an engine with fixed throttle settings. This on the other hand is an easy way to slip an eccentric crank on a D valve locomotive (I accidentally did this on my K-36).*

*FYI, I went to using the locomotive as a common ground initially to install prototypical lighting. I use the prototypical cable conduit pipe as a positive conductor and simply insulate using a small bit of heat shrink at each point it is supported by a stanchion. For marker lights and headlights, I solder 1 end to the prototypical cable conduit pipe and 1 wire to the engine (solder to a bolt head attached to the light bracket). Once I did this, I then realized the same could be done for the servos. As you indicated, you do need to connect grounds between separate components, which in your case probably offset the benefits.*

*The only thing that did not work by using the locomotive as a ground is that it really messed up the WILD electronic water level detection system I installed. It took me a long time to figure out and cure the problem I had created. As I was initially using a single battery and common ground to power everything (RC, lights, and WILD), in the end I had to power the WILD with a separate battery and not use the common ground for this system and in order to get everything working properly.*

*I forgot to mention earlier that I particularly appreciated the design and fabrication detail on your servo actuated cylinder drain cocks. This is the cleanest design I have seen that appears to be relatively simple to fabricate. I hope to copy this some day when I get some time. I am sure you probably could sell a few if you wanted to produce a batch. I for one would be interested in a few sets.*

**Tom:** Yes this setup won't work with D valves. Piston valves are harder to get right, but offer so much flexibility, it was the only way for me to go on the Quad. Accucraft and Aster use massive screw reverse adjusters. Can you imagine what a mess that would be on four engines?

I did a similar electrical routing on my C-16. I ran a small insulated wire (26 ga.. I think) inside a 1/16" OD tube (replacing the solid Accucraft rod) and used the tube for the ground and soldered it to wires at each end.

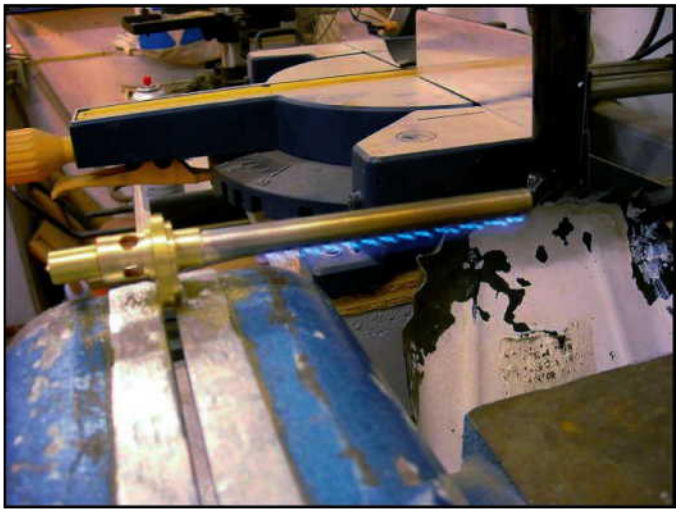
I have seen postings on the water level system. I was thinking of using two on the Quad and put the LED's in each front marker lights, but decided to wait a while on that.

Thanks for the complement on the valves. I believe it is the only setup that will work with RC over an extended period of time, as there are no friction points, which can gum up. I have a similar set on my Double Fairlie, which have been working fine with two servos on one channel. There is a slight seepage in the run position, which actually adds to the charm of the run, but I have come up with a more foolproof valve seat procedure, which should make for zero leakage on the Quad. I would think that each set would have to be made for the particular engine it was going on, or the linkage would need to be done by the end user. The hardest part is making the valve and the cam lever, the rest is just time consuming which is what a hobby is all about. Right?

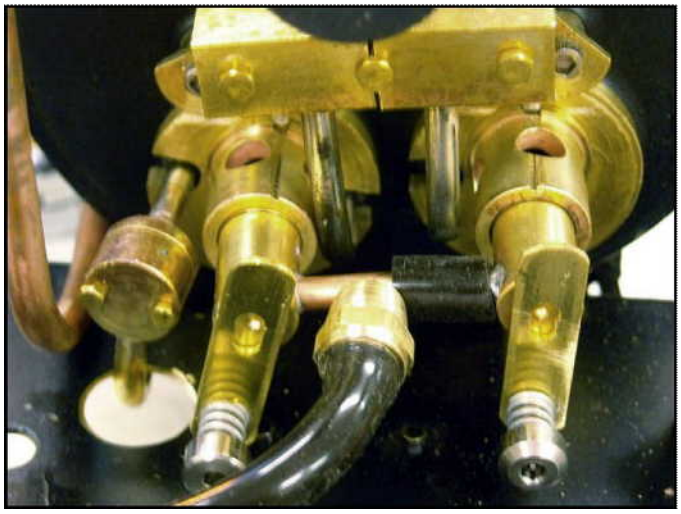
*(16 Jan 2012)* - Update:
Almost getting ready to boil water. Got the burners made and tested and the servos hooked up and timed as well as the four engines air tested and tuned.

Here are the burner pieces laid out and assembled.

The SS tubes are soldered to the holders with a 50% silver content solder.



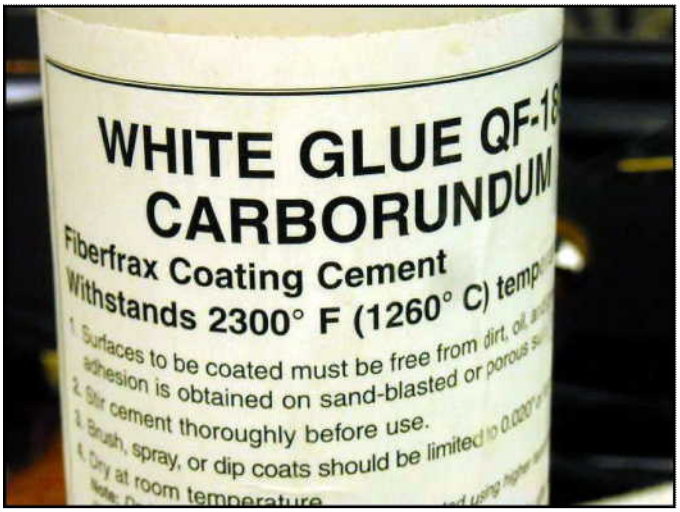
Bench testing.



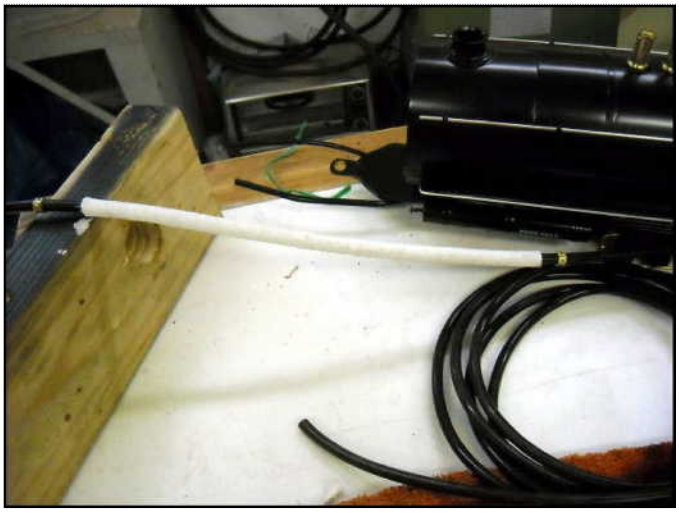
Assembled. The jets are held in with the spring holders and the assembly is held in by the Allen head screws and holders at the top. Inside tubes are steam to the super heaters and the one on the left is from the superheater to the rear engine.

**The tubing is FIRM silicone tubing from McMaster Carr. It will withstand double the pressure of the hobby shop tubing and comes in black. I have used this for the feed water, fuel and exhaust flexible connections**.

Where the tubing passes by the smoke box, I have wrapped it with Kite string.




Then coated it with Fiberfrax glue.



Then painted with high temp paint.

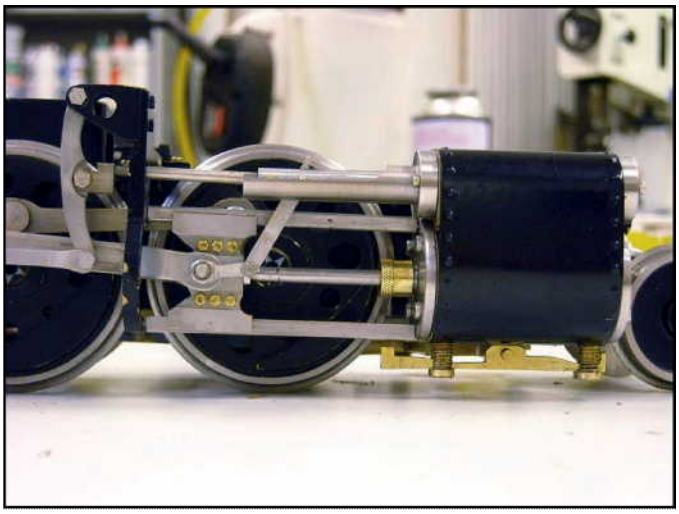
The fittings are for looks and to keep the string from unraveling, the paint will be touched up after final assembly.

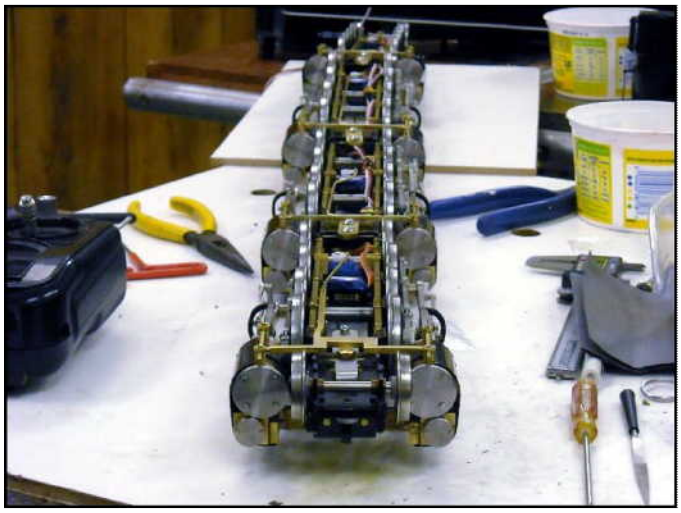

Here are the PTFE steam fittings, which go to the engines.

The majority of the connections pass from the tender to the rear boiler. The tubes are bent to allow movement.

I got these 1/2" gauges from Eric. The red tape on the sight glass acts like a thermometer to show the water level.

Dennis made the valve guides and front caps this week to add the finishing touch to the engines.





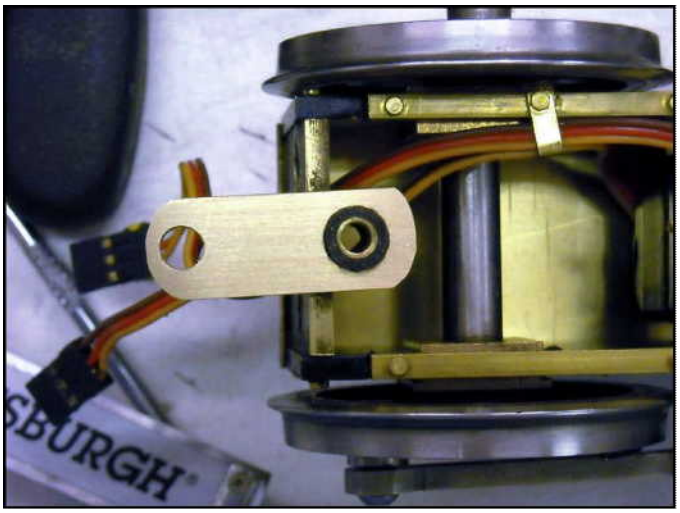
A view of the bottom shows the servos and the cylinder drain hookups.

The top view shows the reverse servos and some of the steam hookups. Now all I have to do is put everything together.

*(07 Feb 2012)* - Update:
Ran the Quad last week and as expected, there were some hitches. Had a few leaks at the reverser valve as a result of the precision ground SS rod being bent and us not noticing it before making the valve pistons. The lapping procedure contoured the bore to the bent valve. We made some sleeves for the valve and new pistons and things seem to be better.

The servo under the smoke box melted from the flash back when lighting the burners through the stack. It must have shot out the bottom hole. I installed insulated baffles under the holes so I should be good to go there also.

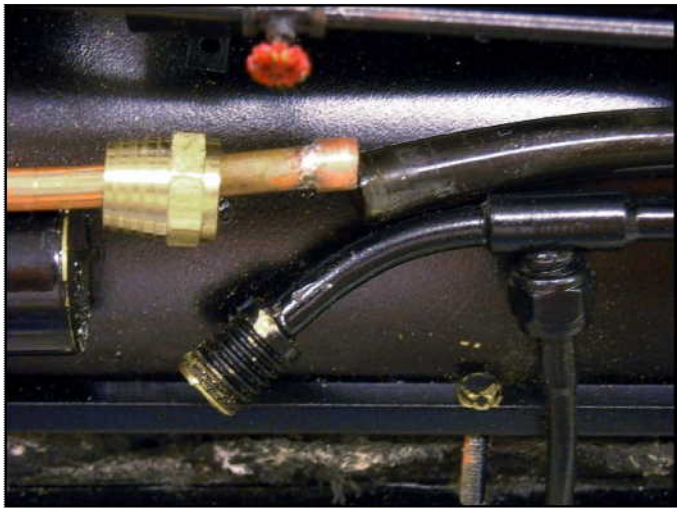
There was a slight bind on my inside radius track. I had designed it for 7' radius but found that the track was not bent in a perfect radius. After repositioning and re-bending the track, I was able to push the two trucks in question through the curve but the clearance was in the thousands so I made some grommets for the links, which should correct the problem. Of coarse, it should be no problem on track of 8' radius or bigger.

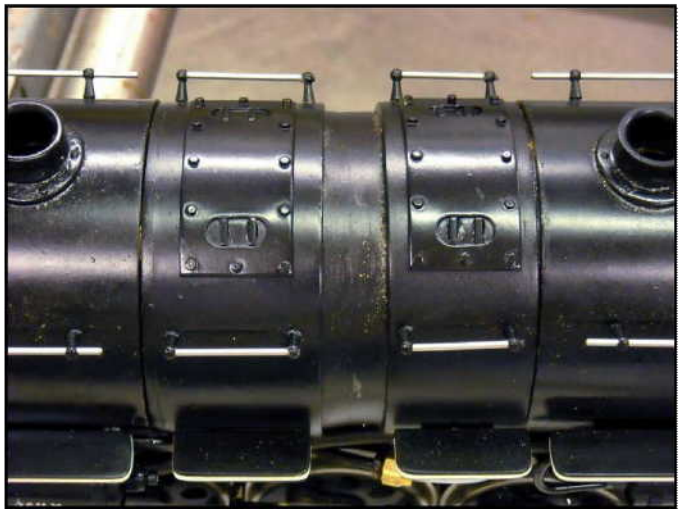



The grommet on the right is just cut from a piece of silicone tubing (firm).

Someone asked about connecting the silicone tubing. I use the same nut as on the flared fitting (1/4"-28) and a slice of 5/32" tubing is soldered to the 1/8" tube.

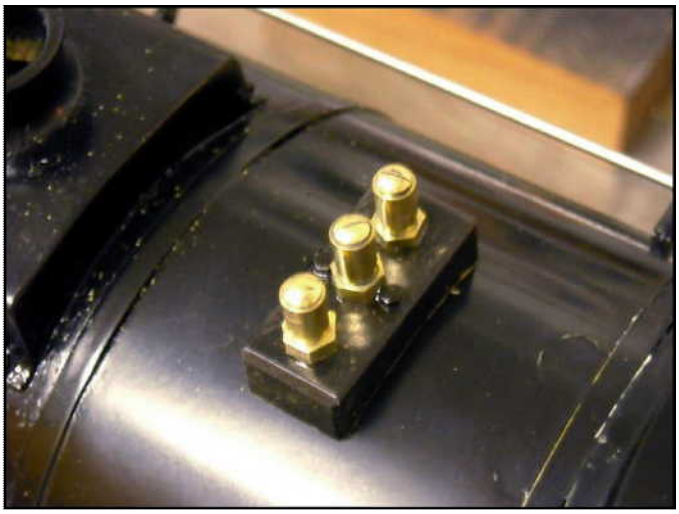
When the silicone tube is slipped over the 5/32" piece, the nut can be threaded on to the part which is over the 1/8" tube but will not go over the hump made by the 5/32" piece.

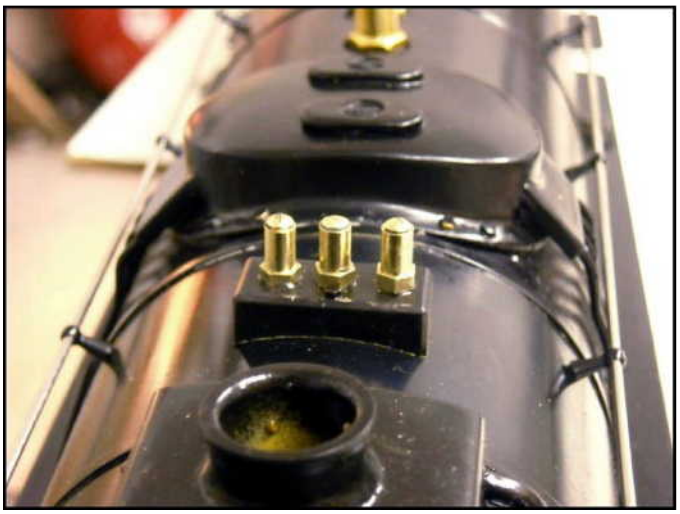




I thought the boiler looked a little too streamlined so I added these cleanout hatches to the flexible joint.

And these decorative valves.





***Comment Alan Redeker:***
*Bill, Extra fantastic! (just an excuse because I hit the submit button twice)*

***Comment Jason Kovac:***
*That's just awesome.*

***Comment Steve Stockham:***
*I will second those sentiments! I have kept up with this thread from the beginning and your project is truly awesome!*

***Comment lownote:***
*This has been really enjoyable to watch--thank you for posting it. I'm really looking forward to seeing a video of this beast in motion.*

*(04 Mar 2012)* Well, I have run the Quad a couple of times and had a problem with the RC. Everything worked fine for 15 or 20 minutes and then the servos started acting up. The two furthest from the power supply were causing the problem.

When I got it back on the bench for testing, everything worked. I took the whole setup over to Henner's and we checked it out on the oscilloscope and all checked out. Our thought was that maybe the servos were drawing too much power from the receiver and causing a poor signal. We decided to add a second battery pack for just the receiver and run the other pack only to the power feeds of the servos. I did these changes but it left no wiggle room in the battery compartment. I bought some Lithium batteries, which are more resistant to high temperatures but still only recommended for 140 degrees or less. The rear exhaust runs through the battery compartment so that may have been the culprit. I insulated it but it may still cause overheating after a long run.

So I came up with the idea of adding a second tender, which could be used for four 'D' batteries and some extra water. I am not sure if it is necessary or if it adds to the look.

Here is a PhotoShop of what I am thinking, what do you think?


***Comment Semper Vaporo:***

*Stunning! I have seen prototype engines with double tenders, so no problems with adding it.*

*BUT! Is there a "Quintraplex" in the future!*

*(04 Mar 2012)* - Update:
A friend just sent me a photo of the Challenger with a second tender.

Semper: No Quint...

Actually, I am now drawing up plans for a CP Huntington in 1:29 scale. It is the first engine owned by SP and is SP #1. It should be in 1:32 but it would be too small at that scale. Aster did the American in 1:28 probably for that reason and this one is smaller. It is a 4-2-4 Forney type and it will be just over 12" long. The boiler has to fit between the drive wheels so the outside of the lagging needs to be less than 1.5" so the inside diameter of the boiler tube will be 1" (1.25" may be able to work with some machining) and the cab is too small to support a conventional T boiler so I am working on designing a box type T boiler. Because of the design, a tender is out of the question and the bunker is too small to carry any water so an axle pump won't do anything. I would like to get 1/2 hour of run time out of it. I was thinking of posting a new thread to see if anyone had done this yet.

**Comment Henner Meinhold:**

Bill, many preserved engines in Europe use double tenders on mainline runs, as most of the water towers have been removed.

***Comment Steve Shyvers:***

*Bill: Sometimes in order to get the boiler to fit between the drivers on smaller G1 locos with low-pitched boilers "dents" are formed in the sides of the boiler behind the tops of the drivers, and the lagging in those locations is cut away completely. Easier to get away with on a British outline loco where there were full "splashers" over the tops of the driving wheels. Does the CP Huntington have a wagon-top boiler or straight? If wagon top there might be a way to incorporate an oval cross section to gain some water capacity.*

***Comment lownote:***

*I think it looks cool with two tenders. Second tender probably ought to just be a water tank though--how would the coal be getting up to the first smokebox?*

*(04 Mar 2012)* - Reply:

**Lownote:** Right The second tender will be a flat top. For the photo, I just copied and pasted the front one to get an idea of he look. I am thinking the top of the rear tender will be level with the back of the front tender with the white stripe at equal height. Two three-axle trucks.

**Steve:** It does have a Wagon-top but it only raises 0.470" and goes back for 1.3" so it would add less than 1.5 ML. Not hardly worth the effort. Thanks on the tip about getting around the wheels.

A 1-1/4 pipe is 1.375 on the outside. I can probably crush it somewhat where the drivers are and work the lagging in somehow. It does have fenders, which will hide my butchering. I'll start another thread on this site after I have the boiler sketched out with some photos.

***Comment Alan Redeker:***

*Bill: Looks really impressive. And I think a second water tender is not only a good solution to the battery problem but adds to the overall appearance.*

***Comment Jason Kovac:***

*Looks like you are coming to an end. Very Impressive.*

*On the servos, Servo City.com sells a part that you would plug your servos into then to the receiver. It's a booster/trim pack. Designed for long servo leads on large planes and such. From what I have read when I was putting the servos in a Garret its not the voltage but the servo signal lead that is the problem and causes erratic control of the servo.*

*Servo City*

**Jason:** Those look good and the explanation seems to make sense. After checking everything out over at Henner's, we came up with the idea that the four servos on one circuit are drawing too much amperage and causing the receiver to give a faulty signal when the voltage drops. That seems to be verified by the Servo City description.

By adding a second battery pack to supply power directly to the servos, we think the receiver, which draws very little current, will always have the voltage needed. It rained the other day here and it is muddy out back but I plan on testing it this week. If it still acts up, I will add the boosters. I may just add them anyway.

***Comment Michael Glavin:***

***Bill:*** *The problem more likely than not is what I eluded to in a previous post herein, driving multiple servos from a single channel or signal source can be problematic with some receivers.*

***FWIW:*** *This problem is NOT associated with the ability of the servo(s) to source power from the battery. It is a function of the control signal not being able to sink adequate current to drive four servos in your case. There also is some consideration for electrical losses; multiple connectors inherently increase system resistance. That said an amplified or boosted extension or wye is one solution and will solve the problem in my experience. In short adding a second battery will not eliminate the problem your describing.*

*But I like the look of an AUX tender!*

*I have a circuit diagram for an easy amplifier somewhere on this computer, I haven't seen it for years now, if I recall for less than a couple bucks you can build a amplified/boosted gizmo that does the job.*

***Comment Henner Meinhold:***

*Michael, we checked the pulse signal with an oscilloscope and did not see any deterioration from 1 to 4 servos. However the supply voltage spiked and broke visibly down. This is why we decided to add a second battery.*

***Comment Michael Glavin:***

*Henner, all right then if you're sure the control signal has not decayed and can provide adequate current, perhaps electrical losses via the herd of connectors associated with the grouping of servos is a contributing factor. That or the power source as you describe is incapable of providing the appropriate power required, do you know what size battery and technology is in play?*

*Did adding an additional battery solve the problem?*

*Have you guys looked at the current draw for each servo and or cumulatively?*

*Some of these things are obvious considerations, of which you may have already addressed. Hopefully those with less experience or knowledge will garner some useful info...*

***Comment Henner Meinhold:***

*Michael, in addition to the separate battery all power is now routed through a bus, avoiding the receiver pins altogether. I don't want to hijack Bill's thread; I am sure he will report the results of this modification together with details.*

*(05 Mar 2012)* - Reply:

**Henner:** Feel free to hijack all you want and yes, I will report out after I run it on Thurs.

**Michael:** The batteries are now Lithium - four AA's supplying the servo red and black wires directly and four AAA's serving the receiver. Only the signal wires (white) are connected from the receiver to the servos.

*(09 Mar 2012)* - Update:

**Jason and gang:** I ran it today and after about 20 minutes, the servos started to act up. I just ordered the *'Y'* servo boosters and will try them. I got two as I have four servos but I think I can just split it into two servos on each end of the *'Y.'*

I run two servos on the Garratt and Double Fairlie without any problems so maybe this will work.

*(13 May 2012)* - Update *(Originating Reply)*:
Well I was having trouble with my servos, which would cause one engine to pull in different directions from the rest. I thought it was an RC issues and tried a few different things with no success. I finally decided to give it a rest and started a new Project (CP Huntington). In the mean time I saw several articles and notes in STiG (Steam In The Garden Magazine) on "Stack Talk". My problem was the heat from the two adjacent smoke boxes was heating up the servos in the second engine.

I finished the *"C.P. Huntington"* last week and decided to bring out the Quad and try to get better drafting at the stacks causing it to draw air in the bottom of the smoke box rather than force hot air out the bottom. First I ran it, and with a heat sensor found, to my amazement, that the frame on the second engine was 285° F. I ran it at the steam-up yesterday and the temp was 85° F. Actually cooler than the other frames. Thank you STiG!!!!


Here is the video in HD:

***Comment Michael Glavin:***
*Bill: Your Quad is awesome..... 4444 is an astounding example of your ability and craftsmanship. What was required to get the desirable updraft?*

*(13 May 2012)* - Reply:
**Michael:** If you can get a hold of the last three issues of Steam in the Garden, there is a lot of info there, but I will give you the short version. Alcohol and Coal fired engines require a draft at the stack to keep the fire going, gas fired engines don't. Because of this not much effort is put into creating a draft in these engines so...

On mine I just had a large smoke box with a 1/2" ID x 1/2" high stack at the top of the smoke box. In Larry Bangham's article in the January/February issues, he mentions having the exhaust pipe tip at 1/10 of the cylinder diameter and the stack inside diameter at 7/10 of the cylinder bore. In the March/April issues Keith Bucklitch noted that there is a formula used in full sized engines, which determines the cone of steam that forms after the exhaust pipe as a 1:6 shape with a secondary cone of 1:3. Larry replied last month and confirmed Keith's info but felt that with our lower pressures, the cone could be less than 6:1.

I started with a drawing of my new stack ID of .355 and used a 1:5 ratio and found that the cone went 1.775" to the point. I then drew a 1:3 cone to determine the pettycoat diameter needed which was just under 3/4".

This worked out well as I had some stock laying around I could try out. I made the insert with the flared pettycoat at the bottom and a 1/2" diameter where it fits into the existing stack (similar to the plugs Larry made but with a Pettycoat at the bottom) I made these with a hand press clearance so I could remove them if they didn't work. I will now take them out and attach them with JB Weld so I will take some photos then and post them.

> ***Comment Steve Shyvers:***
> *Bill: Incredible. Bravo! Phenomenal example of locomotive scratch building. I hope that you will bring it to the National Summer Steam-up.*

*(13 May 2012)* - Reply:
**Steve:** Thanks. Yep, we'll be there. Hopefully I can borrow a few of those 1:32 reefer cars they have up there and get a more realistic video. I think I will have the second Tender done by then also.

> ***Comment Jason Grimes:***
> *Amazing, very cool. :) So.... How much can it pull?*

*(13 May 2012)* - Reply:
**Jason:** Haven't pulled anything yet. I want to get used to it first but it seems to be real strong. I put a pull scale on it the first time I ran it and it showed eight pounds but I'm not sure all of the engines were synced properly because of the servo issue.

> ***Comment StevenJ:***
> *Bill why don't you post the "C.P. Huntington" video on your Youtube in the "C.P. Huntington build"? Nice quadreplex btw, I never though anyone would get enough boiler pressure to actually power one in this scale. How much can it pull?*

> ***Comment Dirk*** *(MLS - SD90WLMT)**:***
> *Bill: Now I'm interested in the all up over all weight of this nice loco??*
> *For a weird comparison, I have a 19.5 pound SD70Mac that measures, ammm pulls.., 8 pounds with a test car, and 8 1/2 pounds using a hand held scale while running along, in either case!*
> *Very nice work and glad it runs so well for You also!!*

*(14 May 2012)* - Reply:
**Dirk:** It weighs 60 pounds. I just hooked the scale to the back of it and hooked the other end to the table and opened it up so the draw bar pull was 8 pounds from a dead stop. This was on my first run and I think it is running much stronger now and I am not sure how accurate the scale is.

**Steven:** I am not sure what you mean about the video. Both videos were taken by David Wegmuller and posted on his Youtube site. I am not versed on Youtube so I wouldn't know how to move it to my site. I posted the CP Huntington on the build site but since the Quad build log has been archived, I posted this new thread. Should I post the CPH as a separate thread?

***Comment Eric Schade:***

*Bill: Both videos were great! I wouldn't worry too much about where you posted them, you did great.*

*The Quad is really cool. I like the shots of it rounding the curve close to the camera! i can't wait to see it hauling a train...perhaps a short double header with the CP Huntington just to see how the size compares. Keep on having fun!!!*

***Comment StevenJ:***

*Bill: Oh I was surprised you didn't link the "C.P. Huntington" video in the "C.P. Huntington" thread that's all. 60 pounds for a scale 1 engine? That's insane!*

*(*Edit, I see it posted in the other thread now. My bad.)*

***Comment Eric Maschwitz:***

*I was lucky enough to be over at Bills place when these videos were shot. Man, watching the Quad in action is a treat! I think I was just giggling half the time. It looks like some sort of monstrous mechanical centipede snaking around the track. The CP Huntington is a real cutie too. Photos don't do it justice because it is so tiny.*

*Thanks again Bill for a great day of steaming.*

***Comment Ray Cadd:***

*Those are simply fantastic!!!*

***Comment Dirk*** *(MLS - SD90WLMT)**:***

*OK, 60 pounds it is... 32 drivers, 1.875 pounds per wheel, pretty good loading there!! My 70Mac runs at 1.625 pounds per wheel to get its 8-1/2 pounds of pull...*

***Comment Stan Cedarleaf:***

*Absolutely awesome, Bill..... What a beast....*

***Comment Bruce Gathman:***

*If I remember correctly Dave Hottmann's Accucraft cab forward pulled something over 10 pounds at DH one year. It remains the highest pull of any steam locomotive. "Diesel-Man" Bob correct me if I'm wrong*

*(14 May 2012)* - Reply:

Bruce: Yes I heard Dave's Cab forward holds the record at something over 10 pounds. The cab forward has a little larger bore than mine but I have twice as many cylinders. Knowing Dave, I am sure he worked his hot rodding magic on every aspect of the cab forward before he added a few pounds of lead to the articulating truck. I'll have to compare notes with him if he is in Sacramento this year.

I am thinking that once I get it broke in and re-tuned, it should be able to crack the 10-pound level fairly easily. Not sure how everyone does it. When I did mine it actually hit 9.5 lbs. but then dropped to 8 lbs.

*(14 May 2012)* - Update:
Here are some photos of the stack inserts with the pettycoat and the revised exhaust pipe

Insert installed.

Shorter exhaust pipe with small nozzle at the tip.

Insert:

***Comment Henner Meinhold:***

*Bill: The ratio between draw bar pull and load is about 1:30 (LBSC/Martin Evans). With a draw bar pull of 10 lbs. you should be able to pull about 300 lbs. I suggest David brings his multi-gauge portable track to the next event and you can try to ride behind your Quadruplex.*

***Comment Dan Pantages:***

*That shouldn't be hard; my little 3-cylinder shay was able to pull people.*

***Comment Winn Erdman:***

*That is superb! 2 very different engines but both extremely well executed. You are definitely a master builder! Thanks for posting for us to enjoy.*

***Comment Norman:***

*Hi Bill: I had no idea that such a locomotive was ever designed. I thought that the MTH triplex was impressive. Too bad that a prototype was never built by S.P. That would have been a great historical example as to the maximum limits of steam locomotive design.*

*Amazing build. Did you combine two Accucraft locos or did you scratch build the entire model?*

*You certainly have a wide range of locomotive interests from the petite C.P. Huntington all the way to this massive four-engined locomotive.*

*(17 May 2012)* - Reply:

*"It is scratch built"*

**Norman:** The wheels are Accucraft and the cab front is cut from an Accucraft cab forward. I also have used a few Trackside Details goodies. Everything else is scratch built. There is a build log in the informative threads section in this Forum

***Comment Richard Kapuaala:***

*Very sweet looking engine and a good runner too :)*