LOCOMOTIVE CONSTRUCTION PROJECT—DESIGN IS BY PAUL BRIEN—1 ½" SCALE LIGHT MOGUL—DESIGN USES A MINIMUM OF CASTINGS

by Greg Glos

2/7/97—I finally started machining parts for the 1 ½" light mogul locomotive designed by Paul Brien. I purchased the wheel and cylinder castings from Paul last Sunday and he gave me some of the drawings to get me started. After work today, I had already setup one of the drivers in the 4 jaw chuck. Charlie Hamilton helped me get started. I did most of the turning and facing at 494 rpm with the carbide tool. I setup the stop to give me the offset of .125 between the counterweight and face of the wheel. I started by truing up the outside face of the wheel up to the counterweight. I then removed about .090 from the front face. This was done by taking .015 cuts moving from the inside moving outboard. Next, I faced the counterweight to a dimension of .125 outboard of the primary wheel face by turning .020 each cut from the outside to the inside. . Next, I turned the rolling surface to a dimension of about 6.070 to leave some dimension for final finishing of the wheel for a width of about ½". I then center drilled, drilled a 5/16" hole, then drilled a 5/8" hole and then bored the center hole within about .020 of final dimension of .750. I finally reamed the hole to .750 which came out about .0015 oversize. I'm not sure why, but I need to leave the shaft a few thousandths large for Loctite anyway. I just need to remember this. I spent about 2 ½ hours doing this.

2/9/97—I spent Saturday and Sunday (about 16 hours) machining on the drivers. I repeated the above process for machining the front faces of all 6 drivers. I bored the center hole within .005 of the final dimension of .750 and then reamed it. I got a good dimension of .750 this way. I then moved to the Clausing lathe to machine the larger OD which will be the flange of the drivers and face the backside to get a total width of 13/16". I used the 6" three jaw chuck and the carbide tool to do the facing at about 450 rpm. I also made an arbor to do the finish work with. I turned down a 1" piece to .750 and then down to ½" and threaded for a ½"-13 nut.

2/11/97—I received my 10" three jaw Bison Chuck, 7/8" drill rod for the axles, 3/16" broach for the wheels, and a dead center. I also ordered a Heinrich 6" drill press vise, and drill bushings to make a crankpin drilling fixture. I am spending a lot of money to get ready to make this locomotive, but I need them to do general machining anyway.

2/15/97—I worked on the wheels again for about 10 hours today. I started by broaching the keyways in each wheel with a 3/16" broach and a single shim on the second pass using the arbor press. I then mounted the arbor I made last week in the 6 jaw Buck chuck and bucked it to eliminate runout. First, I machined the width from the front face to .594 and to a diameter of 6.015 to allow for the 3 degree taper. I then setup the compound to 3 degrees and set the carbide tool in the corner of the flange to wheel joint and just touched off on the 6.015 dimension of the wheel. I then backed off the compound to get the 3 degree taper. I did this at 495 rpm. I then setup the Rogers Cooke form tool for the wheel flange. I ran it at 95 rpm to minimize the chatter as the tool contacts the wheel in many places as it gets near the bottom of the flange. We went out to early dinner and I worked again on the front wheels this time. I machined both down to rough dimensions and drilled, bored, and reamed the ½" hole. I bored the hole to .495 and then reamed it to final dimension. I also made a ½" arbor to do the finish work. I hope to go to Paul Brien's

house to drill the crankpin holes as Paul has made a fixture to do this which will save me doing this.

2/16/97—I went to Paul's house and drilled and reamed the crankpin holes for the 6 drivers. Later in the day, I finished machining the front wheels by doing the 3 degree angle and using the form tool to create the flange. ON the drivers, I left the rough flange 3/16" tall before using the finishing tool. On the front wheels, I left it a little taller, about .015 to get a full form on the flanges. I then milled off .062 from the face of the weights on 4 of the drivers so they were 1/16" thinner than the center hole flange using the 2" diameter carbide milling cutter. I also did a little cleaning up of the spokes on the wheels.

2/18/97—I got some more material and tools for the locomotive, a new Jacob's 16N chuck for the drill press and 2" and 2 ¾" gray cast iron and some phosphor bronze rod for misc. pieces. I also got the oilite bushings for the axle boxes. This came from MSC.

2/19/97—I got some more steel and cast iron, approx $225 worth including stainless rod for the piston rods and valve rods, also some 12L14 . I got this from Metal Buyers Mart.

2/20/97—I did a little machining tonite. I cutoff the 7/8" drill rod and the 5/8" drill rod for the axles. I faced them to length on the Leblond lathe and then used the collett chuck to center drill all of them to prepare for turning on centers. I have never turned on centers before and need to make a dead center to go in the chuck for the left end. I have a large lathe dog which I think I can use for this purpose. I need to hold the 7 1/8" dimension very close. I could use the collett chuck to turn down one end to diameter and to a width of 15/16" end to flange. I also need to drill the oil ways with a #34 drill

2/22/97—I spent about 6 hours on machining the axles. I used the collett chuck and machined the .750 dimension to a length of .937 (15/16") using the dial indicator. I repeated this process on both ends. I did this at abut 900 rpm as the axles are oil hardening drill rod. I sped up the lathe to 1400 rpm to drill the oil holes to a depth of 1 9/16" with a #34 drill. I drilled dry to a depth of about 1" and then about every 1/8" backed the drill out to remove the chips. I then applied a little Cool Tool II on the drill. This is a slow process but I didn't want to break the drill off in the work. I repeated the same for the front axle, but with different dimensions. The drawing shows about .002 undersize axle to driver bore, but when I talked to Paul, he said to make it about .0005 undersize. I need to learn how to align these parts for assembly as I will use loctite along with the key to hold the drivers on the axles. I then used the square collett block with a 7/8" collett to mill the 3/16" by 3/32" deep key slots. It is critical that the keys be 90 degrees apart and in the correct direction as Joe Nelson's book shows. On the first one, I took .032 cuts each pass and all went well, but when I turned the block to mill the second slot, on the second .032 pass, the axle moved and I had to spend time getting it back in alignment which I think I did well, but if I didn't, I will have a binding condition. I also used an adjustable parallel under the axle when I milled the slot to control any down pressure. After I had the part move, I really tightened it well, and then took .010 cuts to minimize potential for movement. I then cross drilled the oil holes with a #34 drill. When I brokke into the lengthwise hole it sounded like chip interference was occurring but I kept removing the dirll and a little Cool Tool II helped.

2/23/97—I worked about 6 hours on the locomotive today. I finished cross drilling the oil holes in the axles today. I then worked on cleaning up the drivers, rough castings and

chamfers for the drive pins and axles. I then cutoff the pieces of 5/8" rod for the crankpins. I then used the Leblond lathe to face them all to dimension by using the dial indicator. I then put the pieces in the collett chuck in the Clausing lathe. I also used the dial indicator to turn the pieces to the proper length. Each of the 6 crankpins got turned to .5015 to fit properly in a press fit. I still have some work to do on these. I had to make one of them over again as I turned it too far over on the 11/32" dimension.

3/1/97—I spent about 5 hours making some small parts for the project. I made the phosphor bronze caps for the lead drovers. I bought a 1 1/8" bar 13" long and put the whole thing in the 6 jaw buck chuck in the Leblond Lathe. I turned it down to 7/8" for a distance. I drilled and countersunk the face for the flat head screw. I almost screwed up by using the wrong degree countersink, I think it was 90degrees instead of 82 degrees. I put the cutoff tool in the toolholder and squared it up to the face of the bar, and setup the dial indicator to offset the width of the cutoff tool plus the .065 thickness and then moved down to get the .370 dimension that recesses into the crank pin. I then indexed over the correct amount, .075 and cutoff the whole thing.

The next part was the nut/washer made together for the trailing driver crank pins. It is made from 12L14. I turned down a piece of 1" to 13/16" and then turned down a distance to .435 which is the diameter of the points of a 3/8" hex nut. I parted off about 5/16 piece of this and made another. I then went to the Clausing lathe and drilled and tapped for ¼-28, I then put the part in the collet in the hex collet block and set it up in the milling machine. I set up a stop in the vise to position the collet block. I then milled .030 off each face in .010 chunks with a ¼ milling cutter. Finally, I rotated the assembly to position the part to cut cotter slots in the nut. I used a .036 saw on the slowest speed. Finally, I turned and threaded a ¼ piece to screw in the nut so I could hold it in the 6 jaw buck chuck to remove the excess material to get 3/32" thick washer section. This part was a lot of work and tool changes.

3/2/97—I spent about 6 hours again on the locomotive. I made the long pilot truck equalizer out of 3/16 x 1" crs. I layed it out with layout dye and the scribe and drilled the holes first. Then I rough sawed the shapes and finally used the milling machines to clean it up to the layout marks. I used the small belt sander on the final radius work. Next, I made 2 equalizer bar clevises from 12L14, 7/16 stock. I faced to length, drilled and tapped the ¼-28 hole, cross drilled the #11 hole and finally setup to mill the ¼ slot in one of them at .030 at a crack to a depth of .650, almost running out of milling cutter. I had to do the one that required the 3/16 slot with a slotting saw. The last thing I did today was to saw some of the crs fro the cross pieces of the frame. I also made a turnbuckle out of 9/32 hex and put ¼-28 threads on it. I did this in the Clausing lathe with the collet chuck.

3/3/97—I milled all of the cross members for the frame to length, 6 pieces in total. This took about 2 hours..

3/4/97—I milled the slots in the pump cross member using ¾ end mill to a depth of 1 3/16" taking .050 bites at about 600 rpm. Then I turned the piece flatwise and milled the rdius using the same ¾ end mill at 420 rpm taking the full ¼ depth. This took about 2 hours.

3/5/97—I finished the pump cross member tonite drilling the rest of the holes and milling the diagonal flats on it. I also drilled and tapped the 10-24 holes in the ends to connect to the frame. This work took about 2 hours.

3/6/97—I worked about 1 hour today on the engine. I made a bottoming tap from a 10-24 spiral tap and finished tapping deep the holes in the pump support frame crosspiece. I also drilled and counterbored the holes in the rear buffer beam for ¼-20. This is the first time I have used the counterbore. The one for the ¼ bolt has a pilot 1/32 bigger than that or 9/32". I used a slow speed, about 200 rpm to counterbore. Charlie showed me a trick to get the correct depth for the counterbore. I used the temporary stop for the quill, and put the counterbore flush with the work and inserted the 9/32 drill between the temporary stop and the quill stop. I then used the quill handle to do the counterboring. I also got some more drawings that Bob Brand copied for me and ran working copies.

3/8/97—I worked about 2 hours tonite. I machined the rear frame crossbrace that attaches to the buffer beam. It required drilling and tapping six 10-24 holes in the ends of the 3/8 plate. I got a new spiral tap that seems to cut better in the blink hole. I also had to mill 7/8 slots using the ¾ end mill and moved over 1/8 to finish taking .050 bites at 420 rpm.

3/9/97—Paul Brien came over today to bring the piece of ½ x 3 cold roll for the frame. He also made me some parts that I need to have including some parts for equalizing the axle boxes and the tender truck. I made another cross support for the buffer beam out of ¼ x 1 ¾ bar. I also did some roughing out and machining of a replacement part for the cross piece that attaches to the rear buffer beam and across the frame rails. Paul changed the design which required making a new part even though I had already made this part once.

3/10/97—After work, I spent about an hour drilling and tapping the 10-24 holes (6) in the ends of the rear frame crossmember plus a 3/8 hole for the tender drawbar pin. This re-make of this part is now complete.

3/11/97—I did the machining on the front buffer beam. It was fairly simple, milling two .125 deep slots ½" wide and drilling four 17/64 holes inside the slots to attach it to the frame. I received my Mitutoyo micrometer with spherical ball on the fixed end to allow measurement from a radius to the flat such a measuring the cylinder bore to the flat.

3/14/97—I spent 3 hours making the front pilot truck equalizer bracket. This part was machined out of 3/8 x 2 flat bar with a section machined to a thickness of ¼. I had to use a ½ ball end mill to so part of the operation and the ¾ end mill to hog out a 1/8 thick portion. There are also twelve 10-24 tapped holes, six on the ends and six on the flat. I also machined two 1 x 1 x 1/8 angle pieces each with seven holes in them for attaching it to the bracket and pivot points for the equalizer bar. It did not seem like it should have taken that long to make but I was busy the whole time.

3/15/97—I spent about 7 hours today on the project. The first thing I did was to made the six axle box caps out of ½ 12L14 square bar stock. I cut off the pieces in the band saw, next I faced one side of each in the collet chuck in the Clausing lathe, then I stacked them up and clamped them together in the milling machine vise. I then milled them to the same length. Next, I put them in the horizontal position all six together and milled off .125 for a length of 2 ½". Then I drilled 9/32" holes in each end of them since all 6 stacked up to

exactly 3.00, I could use the Y axis readout to move in ½ increments and drilled all six pieces, both ends in the same setup. Finally, I turned them face up and used the convex cutter radius the edges of the parts all at the same time. In the afternoon, I started working on the frame longitudinal members. These are made from ½ x 3 cold roll. I cleaned up the mill oil and then lightly sanded with 400 grit paper. I then blued the parts and milled one end of each square. I then laid out the length and milled it even. I got out the cast iron surface plate and the 24" vertical layout gage. I clamped both rails vertically to the big angle plate and spent the next 3 hours doing the layout. I had to do a lot of math and marked the numbers on the drawing. At the height of 24", I had to turn the parts end for end and picking up the witness mark for the middle axle box centerline I continued to do the layout work. I probably have 2 hours work to finish the layout work, not including the chain drilling marks for doing the milling of the openings in the frame and the radii in the openings.

3/17/97—I received the new Kurt Anglelock Vise today and the coax indicator gage. I did a little machining tonite making the ½ x 1.140 x 7 1/16 gar for the pilot truck. I had to machine it out of a piece of ½ x 1 ¾ bar. I just roughed it out taking about an hour.

3/18/97—I drilled and tapped 8, 10-24 holes in the pilot truck bracket while I was waiting for Charlie to come home from work. Charlie helped me setup the frame rails to start machining. First we put some 5/8 pins in the milling machine slots after removing the vise. Then we clamped both bars together to do the work on the bottom of the frame rails. We bumped the frame rails against the 5/8 bars and used the toe clamps (3 sets) to hold them down. We then swung the head around to get to the end of the milling table and the end of the frame rails to indicate them in using the edge finder. WE then drilled and tapped the 10-24 holes for the first cross bracket. WE then swung the head around to 0 degrees and using the tap in the last 10-24 hole, Charlie used the Starrett Last Word indicator to pickup center. WE then put this value in the digital readout by resetting both to 0.000 and then hitting "enter" and put the absolute values for x and y in and hit "enter" again. This process is repeated for each x and y. We then continued to center drill, tap drill, and tap each of the ¼-20 holes for the axle box caps. I then set the digital readout to some number on each x and y and recorded the numbers and then shutdown. Next, I need to mill the slots for the axle box bearing caps.

3/19/97—I finished doing the edge work on both frame rails by milling the 3/16 slots that the axle boxes key into. I did this with a 1/8 end mill to get exactly the 2.504 dimension inside to inside of the tab to keep the axle box slot together if it tends to spring open after milling out the big slot.

Next, I took apart the setup and set it up on parallels flatwise toe clamped down missing as many of the cutouts and holes as possible. I pushed it up against the 5/8 round stock bars in the milling table slots and used the edge finder to find zero. Charlie showed me how to plunge a 2 flute ½ end mill through the part and rough mill full depth around the cutout areas leaving about .060 to be finished milled with a ¼ end mill later. He also roughed out the front part with the 2 ½" radius also. I ran the ½" cutter at 270 rpm as you could almost see the individual flutes as the cutter was working. It is important to tighten the way guides to minimize chatter but you still get some if you push it too hard. I kept the feed slow enough that the chips did not turn color. After I finished roughing out

openings, I used the edge finder to get things back in position, loosening and retightening the toe clamps. This took about 3 hours to do all of the work above.

3/21/97—I worked 6 hours tonite on the locomotive left side frame rail. I first drilled all of the holes in the area of the steam cylinder and some of the cross supports. Some of the holes had to be tapped such as the ½-20 for the exhaust on the cylinder. I also had to drill one 9/16 hole and counterbore some of the clearance holes for 10-24 cross rails. I drilled these with #6 drill and used the counterbore on slow speed. I also used the #6 drill in between the temporary quill stop to set the proper depth. Next, I clamped the frame on both sides of the front driver axle box to minimize spreading of the frame since the bottom of the frame is cut out and replaced by the frame brace. I think I will cut part of the way into the axle box area on the next one and then put the frame brace in place before roughing out the bulk of the material. I then put a ¼ end mill in place and did the finish machining of the axle box to dimension by cutting full depth of the frame rail and to final dimension in one pass taking about .060 left after the roughing operation. I ran the ¼ end mill at 320 rpm. I also finished the decorative opening final dimensions using the same process. Finally, I put in the boring head and set it to finsih the 2 ½ " radius on the front end of the frame rail. I did this by setting the center of the boring head at the point where the 2 ½" radius center should be in space. Something is wrong with the power feed on the boring head. I need to work on this. I finished tapping the rest of the ¼-20 holes for the axle box braces. I then moved the frame to be able to finish the rest of the machining. I used one of the holes that I knew the dimensions of and centered it up using the Starrett Last Work indicator. I then put those dimensions in the digital readout in both the "absolute" and "incremental". I finished tapping the ¼-20 holes in the right side frame rail also.

3/22/97—I finished up the left side frame rail today before we left on vacation. It took me 6 hours. I first drilled and tapped all of the holes in the rear end of the frame. I then finished machining the axle box holes first by starting the ½ rough cut end mill up about 1 ½" from the bottom of the frame. I then put on the brace across the bottom of the axle box and then finished the rough cut except for the last ¼" and then removed the brace, cutoff the rest of the cutout with a hacksaw to keep it from jereking the machine when it broke off. I then finished the rough cut. I then put in the ¼" end mill for the finish cut and went up about 3/8" from the bottom on each side and put the brace back on and finished the final cut. I did rough a little close on one of the boxes and the finish cut did not clean up everything. I kept about .050 for the finish cut on the other box. After finishing the axle boxes. I did the rest of the cutouts first roughing and then doing the finish cut. I used the band saw to trim off the diagonal piece on the end of the frame and then lined it up and used the ¼ end mill to do the finish cuts. I had to turn the piece over to mill the slot for the axle pump bracket .

3/29/97—We returned from our vacation to Clearwater Beach today and I went to the shop as I have been reading books on locomotive construction on vacation and was ready to get to work. I read Joe Nelson's book on Locomotive contstruction and two books by Martin Evans from England and the book on Shay construction by Kozo Hiroka. I did some machining on the right side frame rail today. I worked similar to the left one, except I bought a "Roughing Mill (1/2")" at Enco while we were in Florida. This mill did a lot nicer job on the roughing work as it makes small chips and doesn't grab chunks of metal

out thereby causing chatter. I did the two front axle boxes tonite along with drilling all of the holes in the front half of the frame rail. I spent about 4 hours doing the work.

3/30/97—I worked on the right side frame rail today again for about 6 hours before we went to Thibaudeau's for Easter dinner. I got done roughing out all of the openings, drilling and tapping the holes, and had to move the part to get the machining done on the rear end. I still need to do the finish machining on the openings and the tapered part of the rear end. I did use the new coax indicator to get the location for the hole that I used to reference the part when I moved it to do the rear end. The ½" roughing mill makes it a lot easier to rough out the openings., I did drill a 5/8 hole in each opening to get it started as the end mill will not plunge cut.

3/31/97—I spent about 4 hours working on the frame today, finishing the milling of the openings and the rear end. I used the bandsaw to trim the angled piece and then use the milling cutter to finish. I then setup the angle plate on the mill table to drill and tap the ¼-20 holes in the ends of the frame rails. I had to rotate the head on the mill to get it far enough out to the end of the table. I extended the angle plate slightly past the table so I could clamp the frame rail vertically to use the edge finder and drill and tap the ends. I then assembled all of the frame pieces with 10-24 and ¼-20 allen head capscrews. I was pleased that everything fit without any finesse. I assembled all of the frame crosspieces to the main frame rails.

4/2/97—I ordered some more steel from Metal Buyers Mart for the connecting rods and other coupling rods. I used the internet to do this on their on line order form. I also put the vise back on the milling table and setup the bar I am machining for the pilot truck crossbar. This all took about an hour.

4/3/97—I received the steel I ordered from Metal Buyers Mart, approx $100 worth which brings the steel total to about $350 so far. I worked for about an hour on the pilot truck bolster milling out the 23/32" x 1 3/8" slot in the middle using the roughing mill first and finally a ¼" end mill taking a full depth cut. I also drilled 2 #11 holes in the edges to complete the part. I did a little sanding on the frame to complete tonight's work.

4/4/97—I worked 6 hours today on the locomotive fabricating the axle boxes. I started on the top bearing caps, sawing pieces of ¾ x 1 ¼ crs. I milled them to length with a ¾ end mill cutting full depth. I then drilled the #6 holes for the 10-24 screws to go through. I also counterbored them with a #10 drill spacing the quill travel. I repeated this for 6 bearing caps. I then bolted two caps together and prepared to create the 1 1/8" bore holes for the bronze bearings. I center drilled and progressively drilled larger holes, ½, 5/8, 13/16, and finally 1" at 80 rpm. I then put the boring head on and used the biggest boring bar I could and at 160 rpm with .030 cuts, I bored them out to 1.130, the OD of the bronze bearings. I repeated this for the 3 pairs which will become the caps for the 6 axle boxes. The boring bar broke through the sidewalls of the bolt clearance holes which will hold the ½ bearing in place in the caps after I drill through the holes with the caps in place. After completing the top caps, I started the bottom bearings which are made from cast iron. I used 2 x 2 ½ cast iron I got from Metal Buyers Mart or MSC. After sawing pieces to rough dimensions, I milled them to the 1 ¼" thickness using a ¾" 2 flute end mill taking .100 cuts. I got 3 pieces to this dimension. I then milled the 2 ½" dimension to 1 7/8" taking roughing cuts of .100 and finish dimensions of .025. I got one completed

with 2 more to go. This mixed bearing with the top half made from cold roll holding a bronze bushing and the bottom just being a cast iron bearing is very complicated to build just so you cam change bearings without pulling the wheels from the axles.

4/6/97—I worked abut 6 hours today on the cast iron bottom bearing caps for the axle boxes. After milling them all to the 1 7/8" width and taking a .040 cut on the top and bottom after squaring the part up in the vise and then turning it over and taking a squaring cut on the bottom. I then setup a piece of ½ x 3 cold roll in the band saw to clamp the blocks to so I could slice them in two. After this, I milled them to the ¾ thick dimension using the same ¾" end mill. I got all 6 pieces to the same dimension, but kept them in pairs as they were cut apart. I then setup to drill the #25 holes for the 10-24 tap. I used the milling machine to tap the holes after drilling. I set it up to 80 rpm and ran it through within about 4 threads of bottom and stopped the machine, hit the brake, and then reversed it to remove the tap. I did break a tap by reversing from the run position without stopping with the brake first. I then had to hand tap the final few threads through since the block is ¾ thick and the tap is that long.

4/7/97—After work today, I worked about 1 ½ hours on the cast iron bottom axle blocks. I clamped the blocks together in the vise with parallels under them. I then centered the blocks to get on the parting line between the blocks and centered from the edges and center drilled and drilled a 3/8 hole and then a 13/16" hole to prepare for boring. I then put the largest boring bar in that I could use and took about a .020 cut the first pass. I then took subsequent passes until I finished about .003 over (.878"). the strange thing is that is the first two passes, the cut was about .002 less than the boring bar was adjusted, such as setting for .025 cut, the result was .023 except the last pass was exactly what it should have been. I have never had a consistent result with a boring bar even though I was using a very rigid bar with short length and ¾ shank. I cut a test piece of 7/8" drill rod for a test piece.

4/10/97—I worked for about 1 ½ hours today on milling .234 deep slots in the bottom of the cast iron bottom caps for the axle boxes called the "cellar" for a felt packing to wipe oil onto the axle. I had to use a 3/8 end mill to make a flat in the bototm of the radius and since I did not have a center cutting end mill so I had to switch to a ¼ end mill to "drill" a hole the correct depth so the end mill had clearance in the center. I then switched back to the 3/8 end mill to finish the fill depth. I used a 'stop" on the vise so I could repeat with all 6 caps.

4/11/97—I worked for 2 hours today on the bearing boxes for the axles again. I started by putting the 1 1/8 x 7/8 bore by 1 ½ long bronze bushings into the 6 jaw chuck in the Leblond lathe and parted them off to the correct 1 ¼" length. I then put the arbor that Paul Brien gave me to hold the bushings for slitting in the 7/8 collet in the square collett block in the milling vise. I used a 3/64" x 3" slitting saw and sliced them all lengthwise to a dimension of 9/16 thick to fill the top bearing cap. I then assembled the bushing in the top cap and mated up the bottom cap with a piece of 7/8" drill rod and clamped it in a small tooling vise and drilled thru the top cap and edge of the bushing with a hand drill, #6. I assembled and marked all parts but need to do a little finessing to get smooth operation of the 7/8 drill rod in the bearing block. I had to go to Porter Walker to get some 10-24 capscrews and drill bits.

4/12/97—I spent about 4 hours on the axle boxes today. I first mixed and matched tops and bottoms to get the best bearing fits between them. I then setup to mill the edges to 1.620 from the 1.875 total width to fit the axle boxes. I used a 5/8" end mill leaving a 9/32 flange. It was important to get the same amount off each edge so the axle bore is centered in the box. I measured the total width and milled half of that dimension from each edge taking .050 per pass at about 270 rpm and a final pass of about .026. I used the power feed so I could do other tasks like filing while it was milling. Paul Brien made me some parts for the locomotive including the saddle, and the two leaf springs out of sewer tape. I met him at the Mid South Live Steamers club at Maury County Park today to get them.

4/13/97—I spent 8 hours today working on the locomotive, first finishing the axle boxes machining them to the 1.620 width so they fit into the chassis axle boxes. The really disappointing work was with the machining of the cylinder casting. There is not much extra material and I squared up all sides and the ends and then centered it up to bore the cylinder. After spending 2 hours boring the cylinder, There are terrible sand holes in the bore and several on the valve face which I think will make it un-useable. I also made an arbor to do the finish work on the ends of the cylinder but when I center drilled it, it moved in the chuck so it was no longer concentric. I should have used a live center and faced the part correctly first. I may have to make it over. A pretty disappointing day!

4/15/97—I took the bad cylinder to Paul Brien's house but he was not home so I left it on the doorstep. When I got home, I finished the arbor I made to machine the cylinder ends in the lathe. I made it so an end cap with a center drilled in it slips into the bore of the cylinder about ¼" with a couple of 10-24 bolts to hold it on. This took about 2 hours. I used the new 10" three jaw chuck on the Leblond lathe to do this work.

4/17/97—I started to make the axle boxes for the pilot truck tonite. I worked about 2 hours, sawing out blocks of cast iron and machining them to 1 x 1 x 1 3/8" dimension.

4/18/97—I went to Porter Walker today and bought a 39/64" drill and 5/8" reamer to make the holes in the pilot truck axle boxes. I also ordered some stuff from MSC, some Knat Twist clamps, 3/8 and ¾" roughing mills, Brown and sharpe telescoping gages, 16N, 5/8" Jacobs Super Chuck with adapter for ¾" collett.

4/19/97—I worked about 6 hours today on the locomotive project. I drilled the mounting holes in the pilot truck axle boxes with #9 drill. I then drilled and reamed the 5/8 holes for the axle. I first center drilled, through drilled with 3/8" drill, drilled with a 39/64"and reamed with 5/8" reamer at 80 rpm. I then installed the axle in the boxes and clamped this assembly to the front truck frame and used the axle boxes to drill the #9 holes in the front truck frame. I mounted the axle assembly to the pilot truck bolster and front truck frame. I also made a steel pivot bushing for the front truck frame. I then machined a center pin bushing from a piece of 1 ½" stock which included drilling and reaming a .500 hole thru it. This took a while as some of the part had to be machined down to ¾" diameter. I used the Leblond lathe. I then had to drill 6 holes, #30, on 1 1/8" bolt centers. I used trigonometry to calculate the x and y axes and used the milling machine as I had the part in the collet block.

4/20/97—I made the pilot truck pivot pin this morning in about 1 ½ hours. It was a turning job and then had to mill a .210 wide slot in the pin by drilling a clearance hole in

the center and then using a 3/16” end mill moving .156 in each direction to give a ½” long hole completely through. I had to use a file to do some radiusing at the ends of the slot so the ends were square not round.

5/18/97—It has been nearly a month since I have bee able to work on machining the locomotive parts. Paul Brien got me a replacement casting for the bad cylinder casting that was full of pits after I got done boring it to the 1 ¾” dimension. The replacement casting had the center cored hole off center so Paul put it in the 4 jaw and took a cleanup cut on the end to make sure it would clean up and it did. I put the 6 jaw buck chuck on the Leblond lathe and put the cylinder in it tightening the chuck as I twisted the cylinder. I then put a heavy boring bar in the quick change toolholder and took .030 cuts until I had about .040 left for the final cut. I took .020 cuts each of the last 2 cuts. I then put the positive rake carbide toolholder on and cleaned up the face of the cylinder that would be the end of the valve face part of the casting. I then moved over .281 (9/32”) and set the stop on the lathe. I then faced off the end of the cylinder casting that the end cap mates up to so that it is 9/32 from the previously machined face. I had to hone the cylinder a little with a brake hone. I then put the cylinder on the arbor I had previously made. I put the cap which has a center hole on the arbor with 2 10-24 capscrews and put the arbor in the 6 jaw with the live center in the end cap. I faced the other end of the valve body part of the casting to get a total width of 3 1/8” and faced the accessible part of the end face of the casting to the 3 11/16” dimension. Since the cap was on, I still had about 1/8” to face off the end. I used the surface grinder to do this taking .050 cuts after dressing the grinding wheel with a diamond. I started facing the second casting in a similar way. I spent about 6 hours doing this today evne though I have a bad cold that is slowing me down.

5/20/97—I spent 2 hours tonite finishing the lathe work on the second cylinder. I repeated the above process and then used the surface grinder to finish the end to end dimension of 3 11/16”. I took .050 cuts the first 2 passes and a finish pass of .007. I only moved about .020 in the “Y” dimension each stroke. Charlie also showed me how to use the new end mill sharpening fixture to sharpen a ½” end mill on the surface grinder taking about .002 passes.

5/25/97—I worked for 6 hours on the cylinders today. I started by machining the valve face and then the port face that bolts to the locomotive frame. I clamped the cylinder in the vise by the cylinder end faces to the vise jaws. I used an indicator to get the valve face parallel to the vise. I then used a ¾” end mill with a ½” reduced shank to mill the port face (which is now vertical in the vise) and I had to mill it is 2 passes as the face was longer than the end mill. I took .015 passes and left .015 to finish in the Harig surface grinder. I also milled the face opposite the port face in the same setup to get an overall width of 3 ½” plus the .015 to be ground off later. I then clamped parallels across these newly completed faces and allowed them to rest on the top of the vise jaws to give additional rigidity. I then used the same setup to mill the top (valve face) within .015 of the finish dimension taking .030 passes. To get the proper height, I touched off of the cylinder flange which I had machined to exactly 2.500 and lowered the knee of the mill the proper amount to get 2.000 from centerline to top of the valve face. Once again, I saved .015 to be removed with the surface grinder.

On the surface grinder, I setup “V” blocks and put the cylinder on the arbor that I had made for turning. I setup the arbor in the V blocks on the magnetic table and used the 2-4-6 block and a C Clamp to get the port face up and parallel to the surface grinder magnetic chuck. I took .010 on the first pass and .005 on the second pass. I then did the valve face. I then drilled the holes in the part face in the milling machine. I drilled and tapped the 8 ¼-20 holes for mounting the cylinder to the frame. I also drilled the ½” hole for the exhaust. I then used a 9/16” end mill to face the surface to drill 7/16” to tap for ¼” NPT for the steam pipe inlet into the cylinder. I repeated all of these operations for the cylinder that George Towne had machined except the surface grinder operations as George had used the mill to finish dimension.

5/26/97—I worked about 6 hours again on the steam cylinders. Basically, I milled the slots in the valve face, two steam and one exhaust that are under the valve and one slot for the entrance of steam. I used a similar process for each. I used the edge finder to locate the slot and then drilled a hole to depth to allow clearance for the center of the end mill as I plunged it. I milled the exhaust slot first ½ x 1 1/8” long. I used a ½ end mill taking .050 deep cuts. I used the air nozzle to keep the chips clear as I milled. I had to go to a depth of about 9/16 to match up to the ½ hole in the port face. Next, I milled the slot for the steam inlets, 5/32” wide. I centered a 1/8” mill as I did not have a 5/32” mill. I first drilled a hole to a depth of ½” as I milled these slots to a depth of 7/16”, the maximum length of the ground flutes of the end mill. I took .030 cuts moving from center to each end. After I got the 1/8” slot to a depth of 7/16”, had to open it up to a total width of 5/32”. By the way, I was running the 1/8” end mill at a speed of 1750 rpm. I then moved the mill .010 and moved it from end to end and on the second pass, I finished taking an .006 pass to give a total of .016 on each side. I repeated this on the opposite side of center. I also milled the slot for the steam inlet into the steam chest. The problem here is that the 3/16” end mill was not long enough to break through into the cross drilled hole. I had to drill a 3/16 hole on each end of the slot and used the end mill to go as deep as I coould and finished it with a file and Dremel flex tool with a long, small round burr. I finished a few other misc milling operations by milling a slot for the cylinder cover. I also did a cleanup pass on the bottom gussets below the port face..

6/1/97—I worked for 3 hours today on the cylinders. I drilled the #22 holes for the steam passages from the valve ports to the ends of the cylinders. This was somewhat difficult as it was on a compound angle since the steam ports were ¼” offset from the centerline of the cylinder so I had to set up the cylinders on 60 degrees in the vise and then tilt the head of the mill to 9 degrees toward the rear of the milling machine to hit the center of the ports. I scribed a centerline on the edge of the cylinder and used a 1/8” mill to spot face to allow the center drill get a good start. I got one of them about 3/32 off center or 3/64” from centerline but I think it will be ok to drill the holes for the cylinder end cap bolts. I used the Dremel tool with a small cutoff wheel to clean up the ends of the cylinder to give 5/32 clearance from the end of the cylinder. There were 5 holes in each end of the cylinder or a total of 20 holes.

6/2/97—I spent some time setting the milling machine head back in place after tipping it 9 degrees to drill the steam ports. I removed the vise from the table and put the Starrett Last Word Indicator with the long 3 joint shaft and swept across the table with it in the

drill chuck. I also installed the new Kirk Angleock Vise and indicated it in also. This took about an hour.

6/4/97—I worked for about 1 ½ hours on the steam cylinders. I setup the cylinder in the mill vise and used the center finder to find center of the cylinder and then used the digital readout and the calculations for X and Y that Eric Doig did for me for a 2 1/8 bolt circle and 11 even spaces, leaving out the one for the area where the steam ports are drilled from the end of the cylinder to valve face ports. I first center drilled all 10 holes, then drilled to a depth of 7/16" with a #29 drill and then tapped with 8-32 tap finishing with a bottom tap. I did both ends of one cylinder, 20 holes total. I still need to do the other cylinder..

6/5/97—I spent about 1 ½ hours tonite on the steam cylinders. I drilled and tapped the other 20, 8-32 holes in the ends of the steam cylinders using the same process as I described yesterday. In addition, I setup the rotary table on the mill and ued a milling cutter to remove the rough flange from the outside of the cylinder to the 2 ½" dimension that is the outside dimension of the ends of the cylinder.

6/8/97—I spent 7 hours working on the steam chests for both cylinders today. I started with cast iron bar stock which was 1 ¼" thick and 3 ½" wide and machined it to 15/16" thick plus .025 to grind off in the surface grinder and machined the width to 3 1/8" by 2 3/8" long. I used the carbide insert end mill with 3 inserts and a diameter of 1 ½" about 160 rpm taking up to .100 deep cuts. I then had to cut out the middle of the block where the valve will work. I drilled a ½" hold for access for the ½" roughing end mill running at about 210 rpm. I had scribed lines on the block to rough to and finished with a long 3/8" end mill to give finished wall thickness of 3/8". I then drilled 16 #25 holes around the perimeter. It is hard to believe that it took me 7 hours to do this.

6/9/97—I worked for about 2 hours tonite on machining the steam chests. I first put both of them on the magnetic chuck on the surface grinder and ground obth sides to a finished dimension of 15/16" (.937). I then drilled a 15/64" hole and reamed to .251 followed by drilling the #43 holes and tapping for 4-40 holes for the valve rod guide and finally using a .500 end mill counterboring the .251 hole to a depth of .250. I then turned over the part and drilled with an "I" drill followed by a 5/16-24 tap. I then counterbored this hole with a 5/16" hole. I repeated this on both steam chests.

6/13/97—I went to Paul Brien's house tonite to get some tips on machining steam cylinder parts. When I got home I roughed out the steam chest covers from a single block of cast iron. First, I made a rectangular block 2 3/8" x 3 1/8" and then sliced it down the middle as it was about 1 1/16" thick to get two pieces. I then put them back in the milling vise and milled about .140 off of the sawed face on each piece. This took about 2 hours.

6/16/97—I spent about an hour tonite starting the cylinder end caps. I cut off a 4" long piece of 2 ¾" cast iron bar in the band saw and put it in the 6 jaw chuck and turned about an inch on the end and then put that end in the 6 jaw with the position of the #1 jaw marked on the part. I then faced off the end using some new carbide inserts that are C2 carbide for cast iron. I then center drilled and put the live center in place. I then turned down the part to 2.462 per the drawing for a length of 3". I then turned down a 3/8" length down to about 2.150 which will later be shaped for the packing gland and support for the crosshead slides.

6/18/97—I got some stuff from MSC today for the locomotive project. I got stainless allen capscrews for the steam chest and cylinder end caps. I also got an angle plate about 4" x 5" x 6" and ¼-28 left hand tap and die and a 5/16-24 bottoming tap. I also purchased a Goss air/acetylene torch outfit and a "B" acetylene bottle from Welding Unlimited in Franklin. I will use this to do silver soldering as the temperature is 3600 degrees F instead of the regular oxy acetylene flame of about 6300 degrees. I need to get an additional tip on Friday as the #3 is good for up to ½" copper pipe.

6/21/97—I worked about 2 hours today on the cylinder caps before my knee hurt too bad to even stand up. I still had the piece of cast iron in the 6 jaw chuck that is turned down to 2.462 and the end turned down to 2.150" and was center drilled so I could have the live center in it. I started by drilling a .500 hole ½" deep and then removing the iron bar from the Leblond lathe and sawing it off 11/32" in the band saw. I then put it back in the Leblond lathe holding it by the 2.150" dimension and putting the dial indicator on it to make sure it was centered in the jaws.. I then turned it to a thickness of .287" and then turned down 1/16" of it down to 1.747" taking .015 cuts. I then cneter drilled the piece, drilled to 23/64" and then reamed to .376 to provide a hole for the piston rod. I then put the iron bar that I had turned down to 2.462" back in the 6 jaw putting the point I marked to the #1 jaw. I then put the dial indicator on the part and found some runout. I tapped it with a brass hammer until the jaws were tightened and got the runout within a couple of thousandths. I then repeated the process to make the second rear cylinder cap. It was after I got both parts done, that I realized that I had a dimension wrong and that I had made the flange of the rear cap .225 thick instead of .250. I had read the dimension for the front cap instead. I think I can solve the problem by not counterboring as deep for the capscrews as the aluminum cover will cover it up, but the supports for the crosshead that mounts to the motion plate will have to be .025 longer. I then put the bar back into the lathe and turned down .087 fo the face to give a finished dimension of .500 diameter for the countersunk 8-32 screw to hold the aluminum cap on. I also turned down an undercut area for a length of .050 from the .500 diameter area to within 3/8" of the edge of the flange. The part is still in the chuck as I cannot stand up on my bad knee to do any more work.

7/13/97—After knee surgery 2 weeks ago, I spent about an hour in the shop machining a 3" diameter 5c collett to a dimension of 2.462" to hold the cylinder end caps for final machining and use in the collett block for drilling and countersinking holes for the allen capscrews. I spent an hour on this task. I will have to take it slow as I still cannot straighten my leg all the way.

8/3/97—After a long time of not working in the basement due to knee surgery, I spent 6 hours working on the front cylinder heads. I still had the partially machined part (one head) in the LeBlond lathe. I sawed off the piece in the band saw and put it back in the lathe and aligned it with mark I put on the #1 jaw and used the dial indicator and tapped it with the brass hammer to get it running true. I then did the turning , center drilling and tapping to 8-32 and countersinking for the flat head allen screw. I then sawed this piece off the bar using the Starrett jack to make the back of the band saw clamp even with the thickness of the iron bar so it would clamp properly. I then put the part in the collett I had machined to 2.462" and finished the back of each part leaving a 1/16" thick section to go into the cylinder bore. I then used Charlie's collett block to hold these parts to center drill

and drill #18 for the head screws. Afterwards, I put the head in the small vise I counterbored them to a depth of .150". I finally put the parts back in the collett block and milled off an area from the 1/16" to allow the steam into the cylinder. I spent about 6 hours doing this work.

8/9/97—I spent about 7 hours today working on the rear cylinder heads. I had previously done all of the turning and drilling the piston rod holes in each cylinder head on the LeBlond lathe. Today, I worked on machining the boss that supports the crosshead guide and form for the packing gland. I setup the rotary table with the 3 jaw chuck and started machining before I figured out that I could not cut the curves for the packing gland. I then just marked out the curves with a scribe and machined close and finished with a file. I used a 3/8" end mill at 420 rpm taking .050 cuts. The surface that supports the crosshead guide is 3/8" thick so I had to make several cuts. I used the collett that I machined out to 2.462" to hold the part in the rotary table. On the second part, I just used Charlie's 12 sided collett block and machined it in the Kurt vise after centering it in with an edge finder. I also drilled and tapped the 2 , 6-32 holes in each head for the packing gland and the 8-32 hole in the top of the surface for the crosshead guide. It took a good bit of filing to get the part outlined. I also drilled the 10 #18 holes in each head for the head bolts. I had to put the heads in the small vise to counterbore the holes .120 deep using the 8-32 counterbore..

8/10/97—I worked about 6 hours today on the aluminum cylinder head covers. I had to start with 4" diameter 6061 aluminum that I had gotten from Clark's Iron and Metal several years ago. I had to put the 10" 3 jaw chuck on the LeBlond lathe because the Buck 6 jaw would not open far enough. I took .100" cuts at 495 rpm toturn it down to an OD of 2.530". I parted it off with an 1/8" parting tool using some WD-40 for lube. I had to put a 7/64" radius on the outside edge with a file. I had to put a countersunk hole in the end on 2 of the 4 pieces for the rear cylinder heads for a 8-32 flathead screw. After parting off all 4 pieces, I Then put the part inside facing out in the 6 jaw using parallels to get it in the jaws straight. I then used a boring bar to bore the inside to 2.472" ID to a depth of 5/16" leaving a wall of 1/16". This was a lot of work for these 4 aluminum pieces. I still have to mill or file out the shape for the packing gland on each of the rear head covers. I ended up with a big pile of aluminum chips which are really Gnarley.

8/16/97—I spent about 2 hours milling out the outline for the packing gland and crosshead guide support on the rear cylinder aluminum cover. I started out with the cover in the 3 jaw chuck on the rotary table on the milling machine and using a ¼" cutter, roughed out the scribed part. I then used files to finished fit the part.

8/26/97—I worked about an hour machining the two packing glands for the rod end of the cylinders. I did the lathe work using cast iron in the LeBlond lathe. I did the turning to a max diameter of 1.250 and the small end to .495" for a length of 3/8". I then parted the pieces off for further work later.

9/1/97—I finished the packing glands today. I marked out the oval shape using 7/8" radius after spotting the .530 centers using a small center drill while holding the parts in Charlie's 12 sided collett holder in the milling machine. I then used the mill to trim close to the line and then used the 1" belt sander to finish the part. I started the 3/8" polished stainless rod for the piston rod. I machined the pieces to length on the Clausing lathe and

then turned down one end to 5/16". I then put a 1/16" wide groove to the minor diameter for 5/16-24 thread at the end of the thread. I then used the lathe to cut the thread. I set the compound to 29 degrees, brought the threading tool up to the part and set it to 0 on the crossfeed. I also set the compound to 0. I engaged the gear for thread cutting into the feed screw. I took .010 cut for about .040 and then went to .005 cuts and finally .003 cuts. I fed in .072 total using the chart on the back of the center gage. I cut 3/8-24 thread on the other end of the rod. I worked about 4 hours on this.

9/3/97—I started machining the ¼" polished stainless 303 rod for the valve rod. I first used a slotting saw 3/64" wide to put a screwdriver slot in the end. I used the mill on the slowest speed possible. I then turned down 1 3/16" long down to .184. I did this by machining about 5/8" length at a time taking .020 cuts to .190. I then moved the bar out further to expose the full 1 3/16" and machined it down to .190. I then took the final cut on the whole length to .184. On the first part, I did not use any cutting oil and it was a little rough. I used a file to smooth it, but final diameter is .182. I used a little cutting oil on the rest of the cuts. I took about 1 ½ hours to do this.

9/11/97—I finished the valve rods tonite in about 1.5 hours. I cut the ¼-28 threads on each end of each rod, 4 sets of threads in total. I first used the 1/16" parting tool to make an undercut to the minor diameter .211" to get a starting point. The rear thread is a left hand thread that I cut on the lathe with it turning CCW facing the end of the work and starting from the left side of the thread moving to the right side. I cut the right hand thread by going from right to left. I used a little cutting oil taking .005 cuts each pass, to a total of .045 on the compound as per the chart on the back of the center gage. I ran a die over the threads for a final pass, using left and right hand dies for a good thread. I used the lathe to make sure that the thread was centered around the shaft.

9/28/97—I spent 2 hours sanding and painting the frame and smoke box saddle with Rustoleum Barbecue Black paint. I used lacquer thinner to remove layout dye and sanded off any rust and bad areas. I also sawed some 1 3/8" square blocks of cast iron that will be machined to make the steam valves.

10/1/97—I spent about an hour making the cast iron blocks square and to dimension for the steam valves. I machined them to 1 3/8" in one dimension and then finish machined the other dimensions of the blocks on the surface grinder to .800 and 1.360. I am ready to make the recess on the bottom and the slot for the key.

10/3/97—I spent almost 8 hours working on machining the steam valves and the drive blocks that move them from the valve rods. I started by machining the steam pockets on the bottom by plunging a center cutting end mill .187 deep. I had first rough marked the parts with layout dye. I needed the pocket to be .814 wide but I messed up one of them by getting almost .020 wide with my roughing lines. I was afraid the cylinders may not perform in a balanced way so I made a new block and remade the valve. I had to machine a 5/8" wide slot in the top .540 deep so I first used a roughing end mill to get pretty close to the finished dimension and then used a 5/8" wide end mill to finish it. I also had to mill a ¼" wide slot but did not have a roughing mill that small so I used a 2 flute ¼" end mill taking .050" deep cuts. I then made the drive blocks roughing out pieces of cast iron and then finishing them within about .020" of finished dimension with milling cutters and

then used the surface grinder to get final dimension of .620 by .540" by 1 3/8" wide. I had to drill and tap for ¼"-28 hole for the valve rod.

10/4/97—I started fabricating the valve guides that bolt to the face of the steam chests. I started by sawing off pieces of 2" dia cast iron. I machined them down to about 1 7/8" dia then machined a 5/32" song section .498 dia. Finally I drilled and reamed to .251" a hole through the piece. I did all of this in the Leblond lathe. I then made an arbor that the part would slide over (.2505" dia) and put a ¼-28 thread at the end so I could nut it up and then center drill it and use the live center. I then turned down the major part down to 11/16" and then set the compound rest to 6 ½ degrees to make a taper on the part. I had to extend the tool holder in the quick change holder to allow enough room to clear the chuck as I turned the part.

10/6/97—I worked about 2 hours tonite machining the 5/32" wide flange on the valve guides from round 1 7/8" dia to 15/16" x 1 3/16" rectangular to bolt onto the face of the steam chest. It was more difficult thatn it should have been. I clamped the flange in the vise and used a milling cutter to cut .030 at a time but it chattered quite badly. I held onto it to stabilize it and even put toomaker clamps to help. I milled each flange on one side and then did not have enough flange on that side to hold it in the vise. I sprayed the part with layout fluid and sawed the flange close to the line. I then held the part with 2 toolmaker clamps on the magnetic chuck and machined it with the Harig grinder. I then had 2 parallel sides so I could hold it in the vise. I then used a ½" end mill and machined it as it overhung the side of the vise. I had ot remove .344 from each side to get the 1 3/16" dimension.

10/11/97—I spent the day assembling and mounting the new Lincoln Ranger 8 welder/generator onto one of the glass moving carts. This is a gasoline engine Kohler 18 hp engine model with 8000 watts of auxiliary power. In the afternoon, I finished the valve guides by drilling the #32 holes to mount it to the steam chest and mounting the same. I also rounded the corners on them. I spent about an hour finishing this.

10/12/97—I spent the day making up a rolling cart for the new Lincoln square wave Tig 175 welder. I will have full welding capability either Tig, Mig, or stick. In the evening, I started making the pistons for the engine. I machined the piece from 2" gray iron to 1.780 leaving .030 for final machining when the piston rod is fitted to the piston. I cut the piston ring grooves 1/8" wide with the parting tool, 1/8" deep plus the .030. I drilled the hole for the 5/16-24 thread with an "I" drill and then bored the hole 3/8" deep with a small boring bar to .375. I then parted off the piece with a 1/8" parting tool about 132 rpm. This tool about 1 ½ Hours.

10/13/97—I spent about 2 hours tonite finishing the other piston to match the first one. I had to put the piston in the Clausing lathe to face it off to total thickness of ¾". I then found out that the piston was galled onto the shaft which is polished stainless even though I only hand tightened it, it was a little tight. I had to use a channelock pliers to get it off and put a few teeth marks on the piston which should clean up ok since I made it about .030 big. I did a little polishing to make the fit snug, but not gall. I then used Loctite 640 which is good to 400 degrees F to secure the pistons to the shafts.

10/15/97—I put the piston/shaft assembly into Charlie's collett block and center drilled and drilled #38 and tapped 5-40 for a "Dutchman" to keep the shaft from coming

unscrewed from the piston. I also used Loctite 640 on this screw as well. This took about a half hour.

10/17/97—I finish machined the piston assemblies. The cylinders are actually about 1.753 bore and I made the pistons 1.751". I assembled the cylinders by putting the pistons in the bore and put the end caps on with a couple of capscrews. I then fitted the valves and valve guides and radiused the edges of the cylinder, steam chest, and steam chest cover. I started to machine the bronze valve guides that go on the front of the cylinders. I started with ½" stock which is actually about 1/32" oversize. I turned it down to ½" in the LeBlond lathe so I could use the collett chuck in the Clausing lathe. I roughed out the steps on the OD using the dial indicator to travel the correct distances. I parted off using the 1/16" parting tool in the Diamond toolholder. I spent about 4 hours on this work.

10/18/97—I finished the bronze front valve guides by drilling and reaming to 3/16" and cutting a 5/16-24 thread with a die. I finished by milling the flats for the 3/8" hex by removing .031 from each face of the .437 od while holding the part in the hex collett block in the mill vise using the work stop to get the block in the same position each time I rotated to another face. I then made the spacers to space the cylinders out from the frame by 1/16". I made both at the same time by clamping the stock together and used the surface grinder to get them square and the same size. I then clamped them together and put them in the mill vise and drilled all of the holes, 8 mounting holes and the clearance holes for the steam and exhaust pipes. These jobs took about 3 hours. I played with my new tig welder (not very successfully) for a little while. I got the tungsten in the pool (carbon steel) and it wicked up the tungsten. I also did not have a very good control using the foot pedal and I burned through. Oh well, practice makes perfect.

10/19/97—I made 8 parts today taking a total of 7 hours. I made the brass levers that slide over the stainless drain cocks. I made the brass levers from 3/16 x 1" brass bar stock clamping all 4 pieces together and working them together in the mill vise. First, I drilled and reamed the holes and cut off some ¼" and 1/8" drill rod to hold them together so I could mill away the excess material on all 4 at the same time.I finished the outline in the 1" belt sander. I then made a small arbor with ¼-24 thread to hold the brass parts to the arbor. I then put the arbor with each part in the collett chuck. I took .005 cuts to minimize chatter as I needed to remove .031". I did all 4 pieces this way. I made the drain cocks from 3/8" polished stainless rod. First, I machined the steps on them for the 10-32 thread and the .250 surface to pivot the brass rods on. I then drilled a #47 hole .400 deep in the end. I put the thread on with my tailstock die holder. I then parted it off. After I did all 4 parts to this degree, I put the square collett block in the mill vise and centered it and held the parts from the 3/8" diameter part and center drilled and finish drilled with #51 drill. After doing all 4 parts this way (keeping them in the same relative position with the stop clamp on the fixed jaw of the vise), I then held the parts from the .250 part and used a 3/64" saw to cut the screwdriver slot .060 deep on each part.

10/26/97—I spent 4 hours working on some fixes for the drain cocks. I did not realize that I had to get the holes in the side of the drain cock to be to the outside of the cylinders when they were tightened into the cylinder. As a result, I had them in various positions when I tightened them. First, I milled a small flat onto the bottom of the cylinder where the cylinder drain cocks screw into the cylinder. Next, I ran a 10-32 bottom tap into the hole into the cylinder for the drain cock. Then I put a 3/8" dia brass into the collett chuck

and drilled a .193 hole into it to allow it to go over the 10-32 thread. Next I parted off a piece .125 thick and put one of the drain cocks into the cylinder with this shim. I estimated how much thicker or thinner it needed to be based on .031 for a single thread on a 32 pitch thread. The first one was about ¼ turn past where I wanted it to be so I made the next one .008 thicker and it came out pretty close. I continued to do this going a little over on each one and using sandpaper to fine tune. I did all 4 this way. I also had to drill the #51 holes in the edges of the brass levers that go over the drain cocks. These had to be drilled at an angle of 25 degrees so I had to use the angle blocks in the mill vise to set this up. Finally, I made the ¼" wide by .075 thick rods (2) and drilled 3 holes in them. I used the Harig surface grinder to take the 3/16" dimension to .075. I took .020 cuts at each pass and a small final cut.

10/31/97—I spent about 3 hours working on some more linkage for the steam cocks. I had to make some of the parts out of 1/8" x 3/8" stock. I took a piece of 1/8" x 1" cold roll and slit it lengthwise. I then clamped the pieces together to a parallel and used the Harig surface grinder to make them parallel (they sprung when I slit them) and to get the correct width. I had to bend some ¼" offsets in them and used the vise and a hammer and bar to bend them. I then put them in the milling machine vise and drilled the holes and reamed the ¼" hole in them. I had to make some 3/8" round by 1/8" thick spacers which I did in the lathe. I then silver soldered them to the levers using the acetylene/air torch.

11/1/97—I worked 10 hours on the project today. I started by making some linkage bars from 1/8" round having to turn up the ends at a 90 degree angle. I did this by measuring and using the vise and a hammer. I had to drill some #51 holes in them after bending. I did this in the mill vise and used a small center drill. I also milled a small flat on the ¼" bar that goes through the locomotive frame to attach the left side linkage bar with a 5-40 set screw. The big project was making the eccentric straps for the water pumps. I started with ¼" x 2 ½" bar and cleaned and sanded the surface to spray on the layout dye so it would stick well. I used the template that Paul Brien gave me to use and scribed the outline which included a 3/16" gap between the cap and main assembly. I roughed sawed it out on the band saw. I then milled the edges that would be parallel to the screws that hold the cap onto the body so they would be parallel to each other. I then used a square to mill the flats that the capscrews would touch down on. I then used a center finder to find the center between the edges that are parallel to the capscrews and then moved 1/062 out from center to each location for the capscrews. I center drilled and then drilled with a #36 for the 6-32 screw thread and then drilled down through the cap with a #28 drill for clearance of the screw body. I tapped the holes while it was in the setup. I also used a milling cutter to cleanup the long edges by clamping in the vise using a parallel to align the edge to the vise jaw. Next, I put a 3/16" thick cutoff saw in an arbor and using the slowest speed (80 rpm), and using parallels to align the cutoff line with the vise jaw, I cutoff the part. I used cutting oil and just before it got to the end, I held the cap with a pair of channelocks. Next, I put the cap onto the body with 6-32 screws and clamped both parts together and set them up in the mill vise to bore the 1.625 hole. I tried to use a 1 ½" hole saw to get a clearance hole to minimize the boring operation, but after about 1/8" depth, it bound up on the inside surface of the hole saw. I then had to switch to using drills to get a clearance hole for the boring bar. I already had a ¼" hole for the hole saw and followed by ½" hole and went up in 1/8" increments until I had a 1" hole. I used a

heavy carbide boring bar 160 rpm, and took .050 cuts until I got close and went to .020 cuts. I was using .003" per revolution feed rate until final cuts when I switched to .0015 per revolution. I then put a wide bar in the mill vise and clamped the eccentric straps to this bar so that the center line was parallel to the vise jaw. I then used the center finder to find the center of the large bored hole and then used the digital readout to find the center of the hole that is 5/16. I drilled this 1/64 under 5/16 and reamed it to 5/16". I then turned down an aluminum bar .002 larger than the bore of 1.625. I put the rotary table on the mill table and a 1/8" mill at about 625 rpm milled the radius on the outside of the strap. I then used the belt sanders to radius the small end with the 5/16" hole. Finally I cleaned up the edges with files and sandpaper and deburring tools. I finished by painting these and several other parts with Krylon satin black.

11/2/97—I spent 6 hours today making the eccentrics for the 2 axle water pumps. I started with a 2" diameter cast iron bar in the 4 jaw chuck in the LeBlond lathe. I adjusted the jaws so that the bar was running true and then machined a long enough section to make both eccentrics down to 1 ¾". Next, I used the parting tool (1/8) at 69 rpm to cut the ¼" wide slots down to 1.622" for the area where the eccentric straps will ride in. I then setup the dial indicator on the centerline of the bar and adjusted the bar over .250 offset. When you rotate the bar, after doing this, the total travel of the dial indicator is .500. After I offset the bar, I turned a 5/16 wide section to 1 ¼" dia at a speed of 495 rpm. Next, I center drilled the bar and used a 3/8" drill to a depth of 2 ¼" to allow for both eccentrics and parting off. I followed with a 13/16" drill at 250 rpm. I then put a fairly stout boring bar in the quick change toolholder and took about a .010" cut to clean up the hole. Next, I took a .020 cut and also cut on the way out of the hole without changing the compound setting so any bar deflection was out of the picture. I took a final cut the same way to a bore of .875". Charlie came by as I was parting off the part at 69 rpm and told me to lower the bar a little to eliminate the chatter which helped. I used the same process on the other eccentric. I did have to put the eccentrics in the Clausing lathe and use a bar with emery cloth to clean up the bores a little to get them to slip over 7/8" drill rod which is what axles are made of. I had to use a .005 shim under one side of one of the straps to get smooth running operation.

11/8/97—I spent 4 hours working on the axle water pumps. I started with 2" dia brass and sawed it in 1 7/8" length. I put it in the 6 jaw on the LeBlond lathe and faced the part and turned it down to .750 for a length of 7/8". I took .100 cuts. I then center drilled and drilled with a 27/64" drill, but I forgot that I needed to flatten the cutting edge a little to keep it from sucking into the brass which it did and pulled the taper out of the tailstock. I then used the diamond file and put a small flat on the drill and continued. I then used a reamer to finish to 7/16". I think the tailstock is slightly off center as the hole was wide at the entrance of the hole and correct at the bottom. I had to put the boring bar in and take a couple of thousandths out to get a straight bore. I then made a boring bar that was .094 wide by using the Harig surface grinder and holding the boring bar in a V block. I then ground some back clearance in it. I needed to cut a groove for an O ring that is .056 deep so I used the dial indicator to move the correct depth into the bore and then moved back .112 on the crossfeed dial to get a .056 deep groove. I then turned the part around in the lathe and faced the other end and turned it down to 1 3/8" diameter. 11/9/97—I worked on the pump more today. I finished the brass pump body by doing the work on the milling machine. I put the pump body in the square collett

block and centered it and drilled a 11/64" (1/64" shy of 3/16") and reamed through both sides. I then put a 5/16" center cutting end mill in the spindle and used the knee to raise the part .406 to get a flat face to let the stainless ball to seat in and also 5/16" is the correct diameter for 1/8" pipe thread. I did this on both sides and then threaded it. Later I drilled a #52 hole in one side 11/16" deep for a 1/16" stainless steel stop dowel which I soft soldered in using the propane torch and solder and flux. I then made the pump pistons by turning the part down to about .010 over final dimension in the 6 jaw in the LeBlond lathe. I then put the part in the collett chuck in the rotating device for use on the Harig surface grinder. I used a parallel to get the device in the correct position on the magnetic chuck. I turned the rotating device at the same time as I cross indexed it. I had to remember that moving down .001 in the surface grinder head caused a reduction of .002 in overall diameter. I then put the piston in a 15/32" collett but I had to put a .005 piece of shim stock around it to get it to fit the collett correctly. I then machined the ¾" round end down to 9/16" by ½ " by machining off all faces and milling off on a 45 degree angle a 1/8" chamfer. I then put the collett upright and milled a ¼" slot 17/32" deep in .030 increments. I did final filing to get a good finish. This work took about 8 hours.

11/15/97—I worked about 6 hours today on finishing the axle pumps and starting the main connecting rods. First, I did some machining on the 1/8" pipe to 5/16" tubing fittings that feed water into and out of the pump. I had to mill a flat on the 1/8" pipe side of the 90 degree connector to allow the stainless ball check to seat on the face of the fitting. This is the intake side of the pump. The straight fitting had to get 3/32" wide by 3/32" deep across the face of the 1/8" pipe face to keep the ball from seating. I did have a problem in one of the fittings in that the ¼" stainless check ball fell through the straight fitting. I found that I had different fittings and had to go back to Auto Value and get some more fittings with a smaller hole through them. I put some Loctite thread sealant on all of the fittings and assembled the parts. I had to get some 7/16" x 9/16" O rings for the seal of the pump shaft to the body. I got these at True Value. Next, I started to make the main connecting rods. I cutoff 9.25" long pieces of 7/16" by 1 ½" cold roll. I ground it to .430" thick on the surface grinder. I put it in the mill and prepared to drill and ream a 7/16" hole and a .750 hole. I had to use the boring head to open up the 11/16" hole to .740 and then ream it to .750. I then made a pin to hold these parts together onto a ½" x 3" plate which had also had holes drilled and reamed 8.125" apart so I can display it in different positions for the further machining.

11/23/97—I worked about 12 hours this weekend. The work was on the connecting rods and the fixtures and arbors to hold them to do the work. I made a fixture out of ½" x 3" the other day and made a few modifications. I made some pins to hold both connecting rods to the ½ x 3 plate out of 12L14 steel. I then put the whole assembly in the milling machine vise and used the ½" roughing mill to get close to the scribe lines. I then used a long 3/8" mill but I chipped one of the flutes and went to a ¾" end mill to finish. I then turned the part so the face of each part could have .050 removed, mostly for decoration. I took this cut in one pass. I made a couple of arbors to hold the parts in the rotary table chuck and used a 3/8" end mill to finish the radius. Finally, I re-blued the parts and scribed the lines to mill the decorative relief of .050 parallel to each top and bottom of the connecting rod. I only did one side of one part, more to follow. I did notice that the part did spring about .025 when I milled the face.

11/24/97—I spent 2 hours finishing the .050 decorative relief on both sides of the connecting rods. I used parallels to align the scribe lines with the vise jaws. I used the woodruff key cutter at the slowest speed and a slow X feed on the power feed. I also used some cutting oil put on with a brush. I only need to finish the 7/16" end by machining it down from .430 to .365". I will do that on the Harig surface grinder.

11/25/97—I did grind the ends on the Harig surface grinder today taking about ½ hour. I went to Paul Brien's today to talk about the locomotive construction and get a few more prints from him. He gave me a piece of Nylatron to make bushings for the coupling and connecting rods. The connecting rods turned out pretty nice. I still have 4 coupling rods to make.

11/29/97—I worked abut 3 hours on the coupling rods. I sawed the 4 pieces of 7/16" x 1 ½" cold roll steel. Then, I put them in the Harig surface grinder to get them to a finished thickness of .425 by removing about .005 from each side. I put them 2 at a time in the mill vise and using the edge finder, set up to drill the holes. In the long rods, I had to end up with two .750 reamed holes and a hole tapped to ¼-28. On the .750 holes, I used the large center drill, a ½" drill and a 47/64" drill before finishing with a .750 reamer at the slowest speed. The shorter coupling rods have one .750 hole and a .3135 reamed hole. I then blued them up for the next operations. I made a couple of arbors to mark out the parts and hold them when using the fixture that I made to hold the rods for additional machining. Basically, it is a piece of ½ x 3 cold roll with holes drilled to hold several of the links.

11/30/97—I worked about 3 hours today on the coupling rods. First I marked up the blued parts with a scribe. I marked up both sides of all 4 rods. I then bolted the two front coupling rods (the long ones) to the ½ x 3 bar. Then I put them in the mill vise and using the ¾" roughing mill in the R-8 toolholder, I roughed the parts (together) at 160 rpm. The roughing mill makes small single curl chips. I then used the ¾" 4 flute mill to finish the part to the scribe lines. I then kept the part bolted to the fixture and then put it upright and using the ¾" end mill, I removed .050 from each face of both parts. I took the .050 cut in one pass using the power feed.

12/1/97—I worked about 1 ½ hours on the rear (short) coupling rods. I used the bandsaw to rough out the parts and then bolted them together and used the ¾" end mill to finish them. I then set them up one at a time to remove .050 from the face of each part, all in one cut.

12/6/97—I spent about 6 hours on the 4 coupling rods. I used the 3/16" woodruff key cutter at a speed of 135 rpm with a little oil to cut the .050 recesses in each face of all 4 rods. I had to make 2 passes since the recess was about .325 wide. I did this work while the rods were bolted and clamped to the ½ x 3" bar and a parallel was used to get the parts parallel to the vise jaws. I then set up the rotary table and used the 3/8" end mill at 270 rpm and milled a nice radius on each part. I also assembled the new Delta 1" X 42" belt sander with 8" disk sander to round parts.

12/7/97—I spent 4 hours finishing the coupling rods today. I started by rounding the small ends of all 4 rods with the new Delta belt sander. I used the disk part of the sander. I set up the 3/16" slotting saw at 80 rpm and cutting to a depth of 11/16 to cut the slot in the front coupling rod. I had to go really slow as the part was cantilevered about 1 ½" from the vise even though I used a heavy parallel clamped to the side of the vise to help stabilize the part.. On the matching part of the rear coupling rod, I used a ¾" end

mill at 135 rpm taking .040 cuts to make the tongue that goes into the slot made in the front coupling rod. Finally, I had to put the front coupling rods back into the vise and using the edge finder, I located one of the .750 holes and moved over 1.125 and drilled the previously tapped ¼-28 hole to 19/64 and reamed to .3135. I still need to paint and do a little finish sanding but these parts are done. I need to make all of the bushings and some pins. Most of the bushings are Nylatron.

12/8/97—I was on vacation today so I worked about 6 hours on the bushings and bolts for the coupling rods. I made 8 bushings for the coupling and connecting rods. I started with a 3" x 6" flat piece of Nylatron. I laid it out so the squares would make a part. I drilled a 5/16" in the center of each hole at 660 rpm without center drilling and I removed the drill many times as I was drilling each hole. I used a 5/16" arbor that I had previously made in the Clausing lathe with the collett chuck. I ran the lathe about 1100 rpm and took .100 cuts using the diamond toolholder and tool. I turned the part to .755 which is supposed to be a little larger than the .750 hole in the rods for a slight press, but after removing the part from the arbor, it shrank to .753. I clamped the part in the ¾" collett to face to proper width and then drill the hole for 5/8" crank pin. I clamped it down pretty well. After drilling at 500 rpm, I slowly ran the drill through again to get a little more material removal. This stuff is tough to machine to dimension as it compresses. I also made the 2 bushings from drill rod for the connection of the front to rear coupling rod. I modified two ¼-28 grade 8 bolts for this same connection. I had to put them in the hex collett block to machine .028 off each face to modify it from 7/16 to 3/8 hex. I also had to put some additional thread on it with a die and shorten it overall. I turned the markings off of the bolt face and used a file to radius it.

12/13/97—I spent about 4 hours today on the crossheads. I started with a piece of 5/8 x 2 stock. I cut it off and used the surface grinder to get it to a length of 1 15/16". I then put it in the milling machine vise and drilled the holes for the Nylatron slipper and the crosshead to connecting rod pivot bolt. The only problem is that I should have drilled the tap drill sizes first for the ¼-28 and 5-40 threads, but I drilled the clearance holes first and ruined the first part. I had to cut off some more stock and grind it to length. I did it right the second time. I had to make a right and a left so I had to make sure I got the holes on the right side with the tapped thread. The next operation was to mill a .510 deep slot 3/8 wide in each part. I put them both in the vise at the same time and tool .050 cuts on each pass and used a little cutting oil on the brush and used the air nozzle to blow the chips out in front.

12/14/97—I spent 6 hours today finishing the crossheads (except for the 5-40 holes for the drop arm). First, I did some layout on the end with the 3/8-24 hole for the piston rod. I milled off .250 up to the marks and then set it up in the rotary table to make a nice radius around the boss for the piston rod. Next, I did the layout of the dimensions and radius on the edge opposite of the piston rod boss. I roughed it out with the ½" roughing end mill at 420 rpm, finishing it with a ½" mill at the same speed. I then did the rest of the deep slot where the connecting rod attaches to the crosshead. It is about 5/8" deep. I did it with a 2 flute end mill at 420 rpm taking .050 cuts at a pass with air blowing the chips out of the way. After completing the crosshead, I did the drop arms that connect to the crossheads. The parts are made from 1/8" x ¾" cold roll. I drilled the holes and milled the edges to dimension after laying out the parts. I finished the radius with the

Delta belt sander mostly on the disk sander side. I also made the Nylatron bushings (7/16 od by 9/32 id) for the connecting rod to crosshead connection..

12/15/97—I spent about 4 hours today on the locomotive. It was a really nice day so I did some painting. I started by masking and painting the drivers and pilot truck wheels. I also finish sanded and painted the equalizers, axle boxes, pilot truck assembly, springs, and other misc parts. I used Krylon semigloss black spray paint. I sprayed some clear lacquer on the drivers to keep the unpainted areas from rusting. I did clean the drivers with mineral spirits before painting. I went to Paul Brien's to get some tips and assembly instructions and some more Nylatron for the crosshead slippers. I also went to Doall in Nashville to get some inserts for the boring bar but they did not have any.

12/16/97—I spent about 3 hours today on the locomotive. Charlie helped me assemble the crank pins to the drivers and assemble the axles to them also. We used emery while holding the crank pins in the collett chuck at a high speed and polished them to give a small taper to allow the crank pins to start into the holes. We polished them down to .500 at the lead end and .5015 for about 2/3 of the length. We also used Loctite 609 and the arbor press to push the pins in (had a wood block to keep from damaging the end). The drivers are a slip fit onto the axles with the 3/16 key to final secure. I first slipped the eccentrics on the middle axles before Loctiting the drivers onto the axles. I also did some fabricating of the equalizer supports out of 1/8" x 2" cold roll. It is good to have the axles assembled. I also assembled the pilot truck axles to the wheels by putting the iron bearings on the axle and Loctiting and pressing the axle into the pilot wheels.

12/17/97—I worked about 3 hours on the locomotive. I finished the spring supports and made 4 brackets for the front pilot truck. They were simple 1/8 x 3/8 bars with two #10 holes drilled. I also make a bar to connect the spring supports for the pilot truck out of ¼ x 5/8 crs and then painted all of these small parts. I also did some assembly work by installing the axle assemblies to the frame. That made it look like a locomotive, having the main drivers in place. I will need to take it back apart to install felt wicks in the bottom of the axle boxes. I also installed the "Gits" oil cups in the eccentric straps. They have 10-32 x 3/16" long threads and I used about a #46 drill to thru drill allow the oil to get to the eccentric.

12/19/97—I spent about 5 hours today on the locomotive. I made some spring supports form ¼" key stock with a 7/32 dia 7/72 long turned on each end. I made the plate that goes in front of the smoke box support and up to the buffer beam. It was fabricated from 1/8" plate 5 7/16 long and 14" wide with scallops laid out to give a nice visual effect. I roughed the part on the band saw but first, I had to take the vise off the mill table and clamp a large piece on the mill table and use an end mill to cut off the part. I laid out the part with die and cut it close with the band saw (during which time I chipped a couple of teeth off the bi-metal blade). I then used the belt sanders to finish the part. I also roughed out the skirts that dropped down from the part I just made using the same process. I had to bend it to get it to follow the contour I needed using a large round piece of steel for a form. The top plate had 4 countersinks for 8/32 flathead screws which I did with an 82 degree countersink. I also fitted the smoke box support to the frame and drilled and tapped the 8-8-32 screws to hold it in place.

12/20/97—I spent about 3 hours working on the locomotive. It was a nice warm day, probably 65 degrees. I finished the front plate that the pilot truck pivot mounts onto. I clamped the side scallop pieces to the top plate and front buffer beam and used the mig

welder to tack the parts together. I then finished bending the scallop piece around the buffer beam which I had to shorten 1/8" on each end and radius it to match the top plate.. I then finish sanded the parts and painted them. I also made the 4 pieces that attach the pilot truck beam to the pivot bracket. I painted them as well.

12/21/97—I spent 9 hours today on the project. I started by making the front buffer beam from a piece of 1 ½ x ½ crs. I had to drill the mounting holes to the front of the frame which also had to be countersunk. I have a countersink that is 1/32" oversize or 9/32 for the ¼-20 capscrew. I used a 9/32 drill to set the correct spacing between quill stop and quill bracket. This gave the correct depth for the capscrews. I also had to make the "pole pockets" which were at a 25 degree angle on the ends of the buffer beam. I used a 25 degree bar to set the angle and used a center drill to start the hole and drilled a #11 drill hole. I then used a 5/8" end mill and plunged to get the correct pocket. I also marked the ends with a ½" radius gage and used an end mill to sneak up on the line and finished it up on the belt sander. I made the beam pockets out of 12L14 in the Clausing lathe with a collett for 5/8 stock. I made the center radius by using a ½ ball end mill in the boring bar quick change tool holder. I cleaned up everything and used 609 Loctite to set them in place. Next, I mounted the pilot truck center pivot to the top plate through the 7/8 hole in the plate. It is mounted with six 5-40 screws. I also drilled the eight 3-48 holes for the coupler brackets. I turned off the hex heads fron the 3/16 bolts that Paul gave me for several of the pivots. Next, I started to assemble the pilot truck assembly with all of its linkage. I had to crossdrill several of the 3/16 pivot pins with #51 and cut them off to the correct length. I also made a pivot pin 17/64" dia for the equalizer bracket out of drill rod. I also painted several parts and put them in front of small electric heater.

12/22/97—I worked 4 hours today. I made the rest of the 3/16" pins (from the bolts that Paul gave me). The pins had to be drilled by #51 drill and cut to length by hacksaw while holding the part in the Clausing lathe in a collett. I then assembled the linkage from the pilot truck equalizer to the lead driver axle boxes and springs. I also made the 5/16" pins for the middle to rear driver axle boxes equalizers. I assembled them to the frame also. I changed the ¼-20 x ¾ from the front buffer beam to 1" long. Finally, I removed the rear bracket that supports the boiler and connects the frame at the rear. I fitted and welded the rear coupler pocket under this part. I had to sand and re-paint these parts. It really looks a lot more like a locomotive chassis.

12/28/97—I ran the ¼-28 die over the threaded portion of the rear crank pins to allow the special nuts to fully seat. I then machined the rear bumper that attaches to the frame from a piece of 1 x 1 ½ x 2 hot rolled steel. There was quite a bit of metal removal required, like one section ½ x 7/8 x 2. I had to drill and countersink the holes for 8-32 socket capscrews. After center drilling, I used a .172 drill which is the same size as the pilot on the counterdrill and also used it to set the depth of countersink. I also sanded all of the connecting and coupling rods and masked and painted them along with the bumper I just made. I first cleaned them with pre-cleaner and painted them with Rustoleum Grill Black. I also put them in front of the heat cube to dry. This work took about 3 hours.

12/29/97—I worked 8 hours today making the motion plate support and the angle brackets to mount it to the frame. The bracket was made from ¼ x 2 cold roll. I put it in the mill vise to get it exactly 11.125 using the ½" end mill at 420 rpm removing material from the ends. Next, I drilled the 12 #19 holes for clearance for 8-32 screws and the 4

holes (clearance holes) 6-32 including counterboring for the allen capscrews. I had first layed out the part with Dykem since there were several cutouts. I used the band saw to rough out the cutouts and then used the mill to get it exact. I also had to mount the part to an angle block with a 45 degree surface to mill a couple of 45 degreed angle flats. I then made the 1 ½ x 1 ¼ mounting angles (2) from a piece of 2 x 2 x 3/8 angle. I sliced a slightly bigger piece than the ½" thick and milled it flat in the mill to exactly .500 thick. I then drilled and tapped the 5 holes in each part. I did have to remove some from each surface to get the 1 ½ side .250 thick and the 1 ¼ side .312 thick.

1/3/98—I bought a new Hypertherm MAX 800 Plasma Arc Cutter from BOC Gas in Columbia. I made a cart today for it and also setup a good air filter as the unit cannot stand to have moisture. I then used it to make a rolling stand for the new locomotive. I used the new plasma cutter. I made the base frame from the 2 x 3 heavy wall rectangular tubing that I got from Bob Campbell of Midwest Conv. I made 6" channel uprights and used 1 ½ square tube 7 ½ " apart for the drivers to ride on. This took all day, 8 hours to make this. I also painted it Krylon black.

1/4/97—I worked 8 hours on the locomotive today. I first made the brackets that attach to the motion plate that the reverse rod pivots on. It has a 7/16 reamed hole in it. Other than that, it was just conventional milling and finished with the belt sander to get the radius correct. I then made the slippers for the crosshead out of Nylatron. I used the crosshead to drill the holes in the Nylatron. Nylatron machines well at heavy cuts (.200) and at 420 rpm with a ½" mill. I then drilled and tapped the 5-40 holes in the crosshead for the drop arm. I used the drop arm to correctly locate the holes, but I had to use an indicator to make sure the arm was in the correct position. Next, I made the crosshead bolts out of ½ drill rod. I turned it down to .281 (9/32") for a length of .750 and turned it down to .250 and ran a die over 1/8" with ¼-28 die in the tailstock die holder. I then put it in the hex collett block and milled .030 off of each face to make a hex end on it. I then pushed the Nylatron bushings into the connecting and coupling rods. I assembled the connecting rod to the crosshead using the newly made bolt. Next, I assembled the coupling rods and installed them to the left side of the locomotive. I assembled the right side coupling rods and tried to install them to the crankpins. The rear and center drivers assembled well to the rods, but the crankpin on the front driver was about .035 rearward and would not align to the coupling rod bushing. It appears that I may have an error in the quartering of the axles, probably when I milled the keyways in the axle. I need to do some more measuring to find out for sure what is wrong, but it appears that the .035 offset equates to about 1 ¼ degrees error based on the crankpins on about a 3" circle. This was a bad ending to a very productive day.

1/5/97—I went to Applied Industrial Technology (Dixie Bearings) after work today to get the Torrington B-68 bearings (9/16 od x 3/8 id x ½ long needle bearings).I also received the boiler barrel from Bailey in Knoxville (7.5" od tubing with .268 wall thickness. I ordered the smoke box at the same time, but UPS may not have delivered them both today, I hope!

1/6/97—I worked about 2 hours tonite on correcting the problem with the front set of drivers crank pins not aligning with the coupling rods. I turned the chassis over and removed the front set of drivers and set it up on V blocks on the surface plate. I made the crankpin on one side exactly the same level as the axle and aligned a square on the other side with the crankpin and axle and found out that they were not exactly 90 degrees apart.

I remember that one of the axles slipped in the collett block when I was machining the keyway in it and I tried to align it correctly before proceeding. I guess that I was slightly off. I then clamped the axle between asbestos pads in the vise. I then used the Prestolite torch to gradually heat the driver and axle with the bearing puller putting some tension on it as I heated it. I first made a piece of ½ " cold roll exactly the same width as the diameter of the driver and then milled a 1" square slot in it to allow it to go around the axle so I could pull against the cold roll instead of the cast iron driver. I then cleaned off the old Loctite with Loctite 709 Chisl cleaner. I put the axle TIGHTLY in the square collett block and supported it with the Starrett screw jack support as it was overhung quite a bit. I the milled a 3/16 wide and 3/32 deep taking .020 cuts at 660 rpm. I cleaned the old Loctite out of the driver bores as well and sanded up the outside and resealed with clear lacquer thinner.

1/8/97—I spent ½ hour assembling the drivers to the lead axle and trying it out on the locomotive. I hooked up the coupling rods and they aligned well. I then cleaned up the driver bores with 500 grit paper and used Loctite 7070 cleaner and blew it off. I then used Loctite 609 applied to the bore of the driver and installed it to the shaft and put the key in place.

1/9/98—I worked about 2 hours tonite. I started machining the brackets for the end of the motion plate that support the expansion link. I drilled the 35/64 hole after center drilling and reamed it to 9/16". I had both sides clamped together with a Kant Twist clamp in the mill vise when I drilled and reamed to 9/16. I then set the parts (still clamped together) to remove the material from the rear edge. I used a combination of the ¾" roughing mill at 210 rpm and a ½ mill at 42o rpm. I then turned this edge up and used the edge finder and drilled and tapped the 8-32 holes (3 per part). Finally, I turned the part bottom up and drilled the #18 holes that will attach the guide bars for the crosshead to this bracket. I then sanded, cleaned with degreaser, and painted the motion plate and brackets (except the one I just made) sith Rustoleum Grill Black.

1/10/98—I worked about 5 hours today plus a trip to Paul's house to get some felt for the axle boxes and look at his engine. I finished the brackets to support the expansion links that mount to the motion plate. I had to use the ¾ roughing mill at 420 rpm to remove some material on the radiused areas before using the Delta belt sander to finish sand. I then painted them. Next, I made the guide bars for the crossheadfrom the O-1 ground bars (3/8 and 5/8 wide). It was mostly getting all bars the same length and then drilling and tapping holes. I also made the guide brackets to space the bars apart. Next, I removed the axle boxes and cut the felt for the oil wipers and used 40 weight oil to wet them for the first time. I reassembled them and then installed the coupling rods onto the crank pins.

1/11/98—I did some assembly work today for about 3 hours. I filed the crossheads to get the guide bars to smoothly slide through the crosshead. I also installed the cylinders to get the correct position of the motion plate. I then put the locomotive chassison the welding table and setup the small drill press to drill the #29 holes and tapped the 8-32 holes. I then did some measuring and found the cossshead guide bars were .013 out of parallel to the valve face on one cylinder and .008 on the other cylinder. I also found that the cylinders needed to be about .030 more outboard than the shims put them. Anyway, I need to do some more measuring and shimming to get the cylinder piston rod running true.

1/12/98—I worked about 1 ½ hours tonite. I did a little more measuring to make sure what thickness shim I needed. I decided on .030. I used the shim punch that Charlie made me to punch the holes in it. I removed the front top plate and removed a little material from the ends of the apron where it was interfering with the cylinders. I also had to put the somkebox on the mill and remove a little material where it interfered with the allen capscrews that hold the cylinder onto the frame. I did a little touchup painting on the smokebox.

1/17/98—I made the return cranks and pins today. They are made from 3/8 x 1 crs. After milling them to length together, I also drilled and reamed the .250 and .500 holes while they were clamped together in the mill vise. I then blued the parts and roughly marked them for milling. I made some plugs to go into the .250 and .500 holes to mark the 1" and the .460 holes. I removed .090 from part of one side and .035 from part of the other side. I made arbors so I could put them in the lathe and rotary table for more work. I used the Leblond lathe to turn a .625 dia , .090 long around the .500 hole. I setup the part edgewise and drilled and tapped the 6-32 hole and clearance hole. I then set up the rotary table onto the mill table and did the radius work on the .460 end and then on the 1" end. I then put the 3/64 slitting saw in an arbor and slit the .500 side open, using a little oil and going about 220 rpm. I then setup the part edgewise and miled off the rest of the waste to the layout line. I had to do some filing and finish with emery cloth and finally 500 grit wet/dry paper. I also made the .250 pins that go into the .250 hole with a 10-32 thread on the end out of drill rod. I had to use emery backed up with a file to get it to a light push fit into the .250 hole. I put a little Loctite 609 and pushed it in with the arbor press. I then put them in front of the cube heater to start the cure. I spent about 6 hours on this.

1/18/98-I had Paul Brien over today to critique the locomotive. He said that the axle box bearings were a little too tight and the flange of the drivers should be radiused a little more. Other than that , I was doing a really good job. He also brought me some templates for making the ash pan out of stainless. He also did some videotaping of my tools and project. After Paul left, I removed the cylinders and connecting rod and guides. I then removed the coupling rods and turned over the chassis to remove the axle box keepers and axle assemblies. I made some shims to go between the axle box halves. Some got .005, some got .010 and some were ok. I then put the assemblies between centers on the Clausing lathe and radiused the flanges with a file. Paul said that this is important to go through switch points. I spent about 3 hours working.

12/19/98—I worked a hard 8 hours today machining the expansion links, expansion link mounting plates and the Nylatron shoes that go in them. I used Paul Brien's fixture to hold them on the rotary table. I had to remove the three jaw chuck from the rotary table. I used toe clamps to hold Paul's fixture to the rotary table. I made an arbor ½" to go into the rotary table center and 5/16 to go into the cneter of Pauls fixture. After finding the center of the 5/16 arbor, I aligned the plate in the Y direction to be parallel to the vise jaw. After setting the rotary table to 0 degrees. I moved out 5 3/16 in the x direction and zeroed the digital readout. I first drilled a 11/32 hole at center and drilled the pivot hole at the correct xy axis. I had both parts bolted to the table together with a 10-24 allen bolts at the ends of the link past the finished dimension. I used a 4 flute 5/16 end mill taking .050 cuts until I got through the .500 thickness of both the parts clamped together. I then moved plus and then minus .010 in the x direction until I had

moved .032 in each direction to get a total slot width of 3/8. The final pass I did .003 using some tapping fluid for lube. I then moved out to get a 3/16 wall on both the inside and outside, once again taking .050 passes. I then machined a piece of Nylatron using much the same process holding it down with the 3/16" holes in the center. Finally, I made the back plates. First I drilled and tapped the ¼-28 holes for mounting them. I mounted them to the plate with the 10-24 bolts and this time used the ½" roughing mill taking the full .500 depth. This was much faster and I did a couple of passes on the belt sander to clean them up. I also had to remove .140 from the center part of the plate also using the roughing mill in one pass. I had to clamp down the rotary table clamps to keep the mill from turning the table. I machined off the end of all 4 parts and used the belt sander to clean up the paart and radius around the bottom link hole.

1/21/98—I spent 1 ½ hours on the expansion links. I drilled and tapped and countersunk the 4 screws for 3-48 allen capscrews. This was more difficult than it sounds as I first had to make up a shim pack .140 to close the gap betweed the link and the back plate so when I used a ¼-28 screw to attach it to the plate, I did not crush the backplate. I also used a clamp to keep the link from rotating. I used a speed about 1750. I center drilled, drilled a #47 all the way through, #38 half the way through for clearance, and then tapped 3-48. I then went to slow speed, and put a 3/16 end mill to counterbore .093 deep using the knee. I then put the 3-48 screw in. I had to repeat this 4 times.

1/22/98—I finished drilling, tapping, and counterboring the 3-48 holes in the other expansion link. It took about an hour plus I sanded the parts, cut up the Nylatron slides and pushed in the 5/16 x 3/16 oilite bushings.

1/24/98—I spent 6 hours making parts for the ash pan. It is made from 16 gauge (.056") 304 stainless steel which is terrrible stuff to work with. I started trying to cut it on the band saw but it did not work well as the teeth are 14 per inch and all I did was to chip off teeth. I used my new Hypertherm plasma arc cutter at about 35 amps and it worked very well when I was using a straight edge (1/2" away the cut line). However, when I used it freehand, my problem as usual is following each line. I had to do a lot of grinding and sanding to get to the mark lines. I then layed out and drilled the 9 --5/16" holes at the top of one piece. I also drilled and tapped the 5-40 holes and made the matching plates to hold the springs in place. I then did the bending of flanges. I used Pauls small homeade brake to do the small flanges and mid point breaks. I used the hydraulic press to do this. Finally, I used the bronze hammer and bent the long flanges in the heavy duty vise. I cleaned off all of the layout dye.

1/25/98—I can't believe it took me 7 hours to finish the ash pan. First, I setup the tig welder which I have almost no experience with. I set it up to a max of about 60 amps and used 308 stainless filler rod if I did not have a flange to melt over for filler. I had difficulty fitting up the parts and finally made a couple of blocks to clamp to and made a couple of bars the width of the top flanges to make sure it did not come out too wide. I did the tig welding and saw some warping so I did some more clamping before finishing the welding. I then setup the Hypertherm plasma cutter and a guide bar and cutout the opening in the end. I made a couple of bars to form the doors on the bottom of the ash pan and used the plasma cutter to cutout the blanks. I then did the forming in the big vise with a chisel and the bronze hammer. I then made a ¼" od by .128 id by about 2" long stainless bar. I did this in the collet chuck drilling with a #30 drill going in from both sides to get deep enough. I assembled these to the doors after drilling the holes in the

doors. I had to do some finessing with files and sanders. Finally I put a small mig weld to hold it to the ash pan. Making this was NOT fun.

1/31/98—I spent 10 hours on the project today. I spent most of it making the radius rods (2). They are made from ½" hot rolled square stock. I used the Harig surface grinder to remove material to get both parts exactly .492 wide. I then setup to drill and tap all of the holes. I then milled a ¼" wide slot almost 2 inches long taking .050 cuts with a ¼" mill at 650 rpm. I clamped them flat and used the ¼" mill to cut .100 deep on one side and .200 deep on the other side to the layout lines. I then used the ½" mill to cut the small end down to .248 taking some off each side. I did quite a bit of calculating to make sure I got it right as the sides are not symmetrical. I then used the ½" end mill at 420 rpm to remove .200 from one side along the major length and .100 from the other side. I then did some layout to remove material from the center section on a taper mostly for decoration. I also used the belt sander to remove and radius the parts. I then cut some pieces of cast iron and put them in the 4 jaw in the Clausing lathe. I turned it to .250 od and drilled and reamed to 3/16" and parted off .250 long. I then pressed them into the small end of the radius rod. I then made the pivot pins for the expansion links out of 5/8 drill rod. I turned it and drilled and tapped it for ¼-28 . I put it in the hex collett block and milled .031 from each side to get 9/16 face to face. I did this in the mill vise. I then heated the to red heat with the Prestolite torch and cooled them in oil. I cleaned them up and used brake cleaner to get them really clean. I cut off some grade 8, ¼-28 threads from a bolt and screwed them into the pivot bolt with 109 Loctite. I also sawed off some material for the rest of the links to get ready to machine them. I also pressed the B-68 bearings into the motion plate link.

2/1/98—I started machining the valve rod clevises bu putting the ¾ square block in the collett chuck and removing material from each end and getting the blanks to length. I then set up the blocks in the 4 jaw in the Clausing lathe with a 1/16" offset. I used a layout center punch mark with the long center locator to get the part centered. I then turned it down to 7/16 diameter and .395 for part of it. I then drilled and tapped for 10-32 screws.

2/2/98—I spent a total of 3 hours today and yesterday on the clevises. I used the belt sander to round the end and the ½ roughing mill taking .050 cuts to go .593 deep for the open end of the clevises.

2/4/98—I worked for about 1 ½ hours tonite on making the combination links. I started with a ½" square hot rolled steel bar and milled .062 from each side to get a bar 3/8 x ½ and then milled off the ends to length while both bars were in the vise. I used a ½" roughing mill at 660 rpm. I then drilled and tapped the holes for 10-32 screws and the ¼" reamed holes. Next, I put the 5" diameter 3/16" wide (side cutting) slotting saw in an arbor in the mill. At 80 rpm, I milled a slot .725 deep and then had to move the part up .062 and repeat to get a full .250 wide slot.

2/5/98—I finished the combination links with the exception of the iron bushings. I used the ¼ end mill with the part clamped to a piece of ½ cold roll and plunged the cutter .156 deep on each side to get the proper radius at the end where the connections are. I then clamped tha parts in the vise and removed .126 from each side of the small end and .156 from the area between the previous plunge cuts. I then clamped the part so I could cut a taper along the length of the bar. I then put the part in the vise at a 45 degree angle to cut the clearance cut. I spent 2 hours doing this..

2/7/98—I spent 4 hours machining the crosshead links. They were made from ½" square hot rolled steel. The milling work was much like the other links to contour and create the slot for connection to other links. I did cut the ¼" wide slot with a new ¼" roughing mill. It left some lines and cut a little wide .260 but I was able to take .100 cuts and probably could have taken bigger cuts.

2/8/98—I made the tumbler shaft lever and the reverse arm assemblies. These were both pretty conventional milling work like the other links and levers. I did have to make inserts on the lathe for part of the reverse arms including a threaded ¼" drill rod and Loctited them all together. I used brake cleaner to clean off the oils to get the Loctite to hold. I used Loctite 209. The tumbler shaft lever required heating and bending with the acetylene torch to get an 1" offset. I then located and drilled the 1/8" hole 2" away from the center of the 7/16" reamed hole. Each of the parts has a 6-32 tapped hole for a set screw. Making these 3 parts took 5 hours.

2/10/98—I spent 1.5 hours machining the lifting links. Pretty much basic milling work with center drilling, drilling, reaming and layout work with finishing the outside radius with the rotary table. I just realized that I have been working about a year on this project. I still have to make the eccentric links and pins and nuts and bushings. This is the work left on the valve linkage.

2/17/98—We were in Gatlinburg this weekend and on the way back we stopped at Tom Beal's house in Crossville. I got several years of Live steam from him (1974-1989) and a small cast iron surface plate and a homeade channel surface plate. When I got home, I made 18 pcs of 9/32 hex into 10-32 nuts. I cutoff pieces of 9/32 hex 12L14 steel about 1 ½" long and through drilled them with #21 drill. Next, I tapped it 10-32. I then used the 1/16" cutoff tool to make the nuts .160 thick. I had to put each piece back in the collett and did a cleanup cut. I need to come up with a plan to cut .045 deep slots .032 wide in each side of each face in each nut. Charlie suggested that I put them on the surface grinder vise and gang cut the slots in them with an abrasive wheel. I put the wheel in the grinder but am yet to try it. I hate to mess up the parts if they move in the vise.

2/21/98—I worked about 8 hours today. I started off by using Charlie's trick to slot the nuts in the Harig Surface grinder. I lined them up against a parallel and put small pieces of steel for end stops. I took small cuts like .001 per pass and then rotated them to do the other sides. Next, I made 6 pins out of 3/16" drill rod. Most of them had 10-32 threads on them. I counted the threads as I used the tailstock die holder. 1/32" of length per thread. I then started to make the smoke box cover since it was a nice warm day. I cut the blank from a large piece of ½" x 12" cold roll that Sam Smith had given me. I used the Hypertherm plasma arc cutter at 50 amps traveling very slow to cut out the blank. I then took a piece of 1 ½" cold roll and faced it and drilled and tapped it for 5/8-11. I also drilled a clearance hole centered in the blank and used a 5/8 bolt to hold the blank in the lathe chuck. I turned it at 132 rpm as it started larger than 8" taking .050 cuts. I used the negative rake Kennemetal square insert tool until I got past the interrupted cuts. I turned to od to 7.530 and turned down a 1/8" deep section to the bore of the smoke box id. I turned the part around on the arbor and turned down a ¼ thick section down to 5 9/16 and then put a 45 degree angle on it.

2/22/98—I worked 6 hours today on the smoke box cover. The lathe work with the exception of the center hole so I put the cover with the arbor in the rotary table. I drilled the 20 holes for the dummy and real 5-40 bolts in the perimeter each 18 degreees

apart. I also drilled the holes for the decorative band mounting brackets and the 6, 4-40 holes for the clamps to hold the center insert into the smoke box. I drilled a couple of holes by mistake and had to put screws in them and peen them over and file them off. I also drilled the holes for the smoke box hinges. I then put the cover in the LeBlond lathe after I turned the jaws around to clamp the part by its 7.530" od. I then attempted to drill the 5/8" hole bigger with my 1 ¼" morse taper drill which snapped off. I got it at Portland at the antique tractor show. It may have been poorly heat treated. I then uset the boring bar to open the hole to 2 ¾" taking .050 cuts at 300 rpm and slowed the lathe down as the chips started getting hot, chips were straw colored. I then started to make the insert for the front of the smoke box. I did not have a piece of ½" cold roll so I took a rusty piece of hot roll 5/8 thick that I roughed out in the band saw and milled off .125 with the carbide mill. This all was a mess and I would not do it again. I then found a 5/16 arbor and put the part in it and turned it to correct diameter in a collett in the Clausing lathe at about 225 rpm. The part is to be 3.750 od. I then put the part in the LeBlond lathe and using a couple of parallels to get the part parallel to face of the chuck. I did the turning on each side and then roughed out the radius on the face of the part. I did some filing and sanding. I still need to do some more finishing.

2/27/98—I made the 6 clips to hold the smoke box door insert into the smoke box door. I made them out of ¼" 12L14 and machined off one side to make ¼ x 3/16 and then cut them off to 15/32" length and milled off some from both sides and drilled a #32 hole in each. It took about an hour.

2/28/98—I worked about 3 hours until I did something really stupid. I made a small arbor out of ½ with 4-40 tapped hole and turned a shoulder on each of the smokebox door clips in the rotary table. I mounted the whole smokebox cover on a 3/8 x 2 bar with the 5-40 holes for the decorative railing. I then milled the slots for the hinges with a 3/16 end mill taking .050 cuts at 660 rpm. I needed to make the hinges out of 3/16 x 3/8 stock. I only had ¼ x 3/8 so I cut off a piece of that and used the Harig surface grinder to remove .031 from each side. I had done one side and had removed about .020 from the other side taking about .010 on each pass. I removed the part from the magnetic table to mike it and was wiping the grit off the chuck when I jammed the tip of my left middle finger into the wheel taking the top tip of my finger and nail off. I had to go to the emergency room where they attempted to curl the tip up and sew it together. They atually had to stich it through the nail as there was no meat to stitch it to. It is all wrapped up with a tip protector and it is throbbing. Really stupid!!!

3/6/98—Well, I got back to the shop tonite for a little while, 1.5 hours. I made the 18 dummy screws for the front of the smoke box. They simulate 5-40 model screws so I made them out of 3/16" 12L14 hex in the collett chuck. First I parted off several pieces (20) with the 1/16 wide parting tool in the Diamond tool holder and the dial indicator to part off pieces .240 long. Next, I turned them down to .124 in a single pass for a length of .135. Next I put the 1/8 round collett in the chock and put each part hex side out with the hex seated against the collett. I set the tool in a fixed position to leave a .095 long head and used a file to round the edge.

3/7/98—I worked 4 hours today on parts for the smoke box door. First I finished the smoke box door hinges from the 3/16 x 3/8 bar that I finished in the surface grinder when I ran my finger through it last Saturday. First I milled the parts together to 1 3/16 length and then machined off 5/32 off the top and then drilled and tapped the 3-48 holes.

Next, I drilled the 1/8 hinge hole. Finally I used the belt sander to radius the ends. Next, I put the dummy 5-40 bolts in the 18 holes around the perimeter of the smoke box. As I put each bolt in the holes I center punched one and finished seating them with a flat punch to get them flush. I had made each bolt .010 longer than the hole depth and had chamfered each hole so the material had somewhere to go when peened over. Finally, I made the stantions for the handrails. I did this from 12L14 in the collett chuck. I radiused them by using the lathe tool to approximate a ball and finished it with a file. I had to turn them around and drill and tap for 5-40. Next, I put them in Charlie's 12 sided collett block in the mill vise. I used a long center drill and then drilled a 3/16 hole part way through on two of them and all the way through with one.

3/8/98—I finished the smoke box door today. First, I rolled a piece of 3/16 round stock around the collett chuck to make a handrail for the front of the smokebox mounted on 3 stantions . The center stantion has a hole all the way through it and the other two have a hole partially through it. I used some 290 Loctite in the two end stantions. I then made some 4-40 screws to secure the smokebox clamps to the smoke box. I turned them out of 3/16 stock and used the tailstock die holder to cut the thread on it. The smokebox really looks good!. Next, I made some stainless steel parts for the exhaust steam in the smokebox. First, I bent the ½" OD x .050 thick wall tubing in the Rigid tubing bender. I bent them to 90 degrees, two pieces. Next, I set the part up to mill away .250 from the back of the tube to create a wye by merging two parts together. I did this by putting the 4 x 6 angle plate in the vise and using the two V Blocks to hold the tube and clamping the V Blocks onto the face of the angle plate to get the tube parallel to the top of the angle plate. I then used a ¼" milling cutter at 660 rpm taking .030 cuts until I got .250 removed. I did the mate to this on the other tube and merged them together. I will get someone to tig weld it as I don't want to practice on this hard to make part. Finally, I made the stainless couplings to connect the exhaust port on the frame tapped to ½-20 to couple to this wye pipe. I used .750 diameter 304 stainless turning down to .500 for a length on both sides of the area that will get a 9/16 hex milled onto it. I then used a ½-20 die to cut threads onto it. Finally, I center drilled followed by 17/64 drill followed by a 25/64 drill through the part. I spent about 6 hours on these parts today. The weather is bizarre today getting to 75 degrees before severe thunderstorms arrived.

3/24/98—I got my computer back from John Wilson who did some programming work for the Microsoft Network. I previously made the steam standpipes for inside the smokebox that connect the cylinders to the steam valve. These are made from ½" bronze. First I turned down the 13" length to .500 as bronze is oversize as received. Next, I parted off 4 ¾" length and cut ½-24 threads on one end. This is an odd thread and is the size of the thread of the tube nut for 5/16" od tubing. I used the lathe to do this. Next I deep drilled a 3/8" hole using a drill with the flutes faced with a diamond file to keep the drill from cutting too fast. I turned the part around in the collett and drilled the other side. Next I cut the ¼ NPT thread with a die and thats where the trouble started. The die cut too small even though I had it square to the stock. It was an adjustable die and I did not check it first. I cut off the bad thread and turned down half of the diameter and cut off part of a ¼ brass pipe and drilled and reamed to a diameter to allow about .002 difference between the bronze tube od and the pipe id. I fluxed it and silver soldered it. I made some brackets for the walkways out of angle iron. I had to mill some flats as the angle iron is not actually 90 degree angle. All of this work is about 8 hours of work over several days.

3/26/98—I finished making the brackets for supporting the walkways on the side of the boiler. These were pretty much milling some pieces of angle iron to make them square and drilling and tapping. Most of the holes are tapped to 8-32 and one ¼-20. Each assembly is made up of three angles and a ¼ x 3/8 flat bar. This work took a total of 4 hours including the work I did while the computer was getting some software work.

4/3/98—I finished making a faceplate for the Leblond lathe. I had a "L0" hub for the lathe spindle and a piece of ¾" 6061 aluminum plate. I drilled and tapped the hub for 4 ½-13 capscrews and counterbored it with ¾" end mill. I did use the Harig surface grinder to grind .100 off the top off the allen capscrews so I minimized how much material I had to remove from the alum plate to secure it to the hub. I did not realize that the head of the ½-13 capscrews was .510 thick and if I had not removed .100 to .410, the .750 plate would be held on by less that .250 thickness. I also started the eccentric straps. I made them from 5/8" square 12L14. First, I milled off .062 from each face of the bar to get a bar ½ x 5/8. Next, I drilled, reamed and tapped the holes on each end, 3/16 on one end and 3/8 on the other end. Next, I milled off ¼" from one face as laid out with layout dye. I also put eh 4 x 6 angle plate in the vise and clamped the bars to mill a ¼" slot through the 3/16 and 10-32 end .600 deep taking .050 cuts at 660 rpm. This work took about 4 hours.

4/4/98—I spent about 6 hours in the shop today. I finished the eccentric straps even though the drawing from Paul recommended waiting until the linkage was assembled. I did the rest of the milling and used the rotary table to radius the 3/8 end. I then clamped the strap to a bar in the mill vise and milled the taper on the center section of the bar to the layout lines I put on it. After that, I used the belt sander to radius corners and files and sandpaper to smooth. Next, I pushed in some oilite bushings into several pieces of linkage and had to make 4 cast iron bushings for ends that were not stock sizes of bushings. I made these from pieces I sawed from blocks and used the 4 jaw to hold them while I turned and drilled and reamed and parted off. I used the small Dake 00 arbor press with a pilot arbor I made to push in the bushings.

4/9/98—I worked for 2 hours on making the front tube sheet for the boiler tonite. I drilled the holes for the tubes to 23/32. I did this on the milling machine using the digital readout. I first enter drilled followed by 7/16 drill at 420 rpm followed by 23/32 at 210 rpm. I also drilled the 17/32 holes for the dry pipes and stays. I then drilled and tapped two 3/8 holes to hold the tube sheet onto the aluminum face plate that I made for the Leblond lathe. I centered it onto the face plate and began to turn it at 132 rpm since it is approx 7" diameter. I still need to finish turning and drill the hole for the center tube to 23/32".

4/10/98—I finished turning the front tube sheet to diameter after using the inside micrometer to measure the inside diameter of the boiler tube to 6.970. I also did a 45 degree chamfer for about half of the thickness of ¼". I took this up to Paul Brien's house. He is going to weld it in for me. Paul also gave me the steam feed pipe that he cut at 45 degrees to tig weld together. I set this up to weld but have not welded it yet. Thiswork took about 2 hours.

4/11/98—I screwed up welding the steam feed pipe with the tig welder. I kept touching the tungsten rod to the puddle and the metal wicked up on the rod causing a hole to blow down into the puddle. I made another piece and screwed it up the same way.. I decided to make a small stand to hold the locomotive at the spring meet.

4/12/98—I worked about 5 hours today. I worked on the axle pumps first. I made a setup to measure the pressure as I pumped. I made a water tank feeding the pump and a pressure gage on the discharge with a valve to bleed off water. I had to mill off the face of the intake fitting and seat the stainless ball check with the bronze hammer. I did the same on the other pump and it worked well so I installed them to the locomotive. I then began to assemble the valve linkage but found out that I threaded the valve rod clevis with right hand thread instead of left hand. I did some assembly work.

4/13/98—I did 8 hours and accomplished a lot. First I made 6 3/16" drill rod pins for the linkage in the Clausing lathe collett chuck. I used the tailstock die holder to cut the threads. I then cleaned the threads and nuts with brake cleaner and then used 290 Loctite and heated them in front of the cube heater to cure the Loctite. Next, I remade the valve rod clevises with the correct left hand thread ¼-28. I then assembled all of the valve linkage but did not adjust it. I then worked on making the brass pipes for the steam inlet into the cylinders. I had to take 3" long brass pipes and make them 2 ¾" by facing off in the lathe. Then I used the ¼" pipe die in the lathe but had trouble. I realized that the od of the base pipe is .540" . I turned down the part to .500 and used Moly-Dee tapping fluid and got better luck. I then took the "Y" pipe and cut it to length and installed it in the frame with the adjustable sleeve sections. I then temporarily installed the smoke box support. I also re-installed the front cover and pilot truck guide after repainting it yesterday. I did the assembly work on the rolling stand that I made for this locomotive.

4/18/98—I went to the Mid South Live Steamers track in Columbia at Maury County part today for a work day preparing for the spring meet but it rained all day so we left after a little while. Paul Brien brought me the boiler tube after he welded the front tube sheet into the boiler shell. I set it up in the LeBlond lathe with the 4 jaw chuck to turn down the end down to 7.250 for 3/8" length. To do this I put the firebox end in the 4 jaw chuck and used the center drilled adjustable block that Paul made me to go into the tailstock live center. First, I got the 4 jaw end running true with an indicator and then used the indicator to get the center drilled block running true and then tightened the allen screws. I faced the part and then turned down the end to 7.250. I had to take really small cuts of .005 and changed the feed rate from .004 per revolution to .010 per revolution. I also had to move the tool down from center a little. I started at 95 rpm but ended up at 179 rpm but still had a lot of chatter. It may be that my live cneter is a cheap one and may allow some chatter but I could not solve the problem so had to take lite cuts. I also used Pauls center scribe lines on the front tube sheet to scribe lines down the length of the boiler tube. First, I roughly centered the front tube sheet scribe lines with the jaws of the 4 jaw. Next I used the 1-2-3 blocks and adjustable parallel to stop the jaw of the 4 jaw against the lathe bed and set the tool bit exactly on the scribe line and then with the high speed tool bit touching the outside of the boiler tube, I moved the compound along the length creating the scribe line. I repeated this process with each jaw until I had a scribe line on 0, 90, 180, and 270 degrees around the tube. Charlie helped me with this along with rewelding the dry pipe for the throttle valve that I had a leak with.. He used the tig welder to do this with a 3/32 tungsten and stainless rod with 110 amp setting but using the foot control. This work took about 3 hours.

4/19/98—I worked 8 hours today on the reverse stand. I started with a piece of 2 x 3 angle iron and trued it up in the band saw, milling machine and finally the Harig Surface grinder. I then layed it out with Dykem as it had several radiuses and centerlines.

I did use the optical center punch to center some of the holes. I also mounted a piece of 3/16 x 1 plate for the backup segment and drilled, tapped, and bolted the two pieces together. I used the ½" roughing mill at 660 rpm to get close to the layout lines and then used files and belt sanders to finish. I milled a slot in the segment with a .097 slotting saw. I then made a little but complicated bracket that will go onto the reverser handle to hold the detent. It had two 4-40 holes a 2-56 hole and a 3/16 and a 3/32 wide slot. I made it out of 12L14 and used a long piece and finally cut it off with a slitting saw. Finally, I started the keeper starting by using the surface grinder to take a piece of 3/16 and reduce part of it to 3/32.

5/7/98—I worked for 2 hours tonite making the handle for the reverse lever. This took longer because the first part that I roughed out I made an 1/8" too narrow. I finally made it out of a piece of ¾" 12L14 square bar. I used the ¾" roughing mill at 660 rpm to get it to rough dimension after laying out with Dykem. Finally, I milled a 3/16 slot in the part. This part has very little material left from the bar as most of it is machined away. I did have to bend the handle to conform to the layout.

5/8/98—I worked 5 hours tonite trying to finish the reverse stand. First I made the slide that latches the handle to the segment. Next, I made the handle out of ¼ x ½ cold roll. This is mostly drilling holes with some milling to give it some angles mostly for looks. I also radiused the handle for looks. Next, I made the pivot bolt out of 7/16 square 12L14 in the collet chuck. I did the turning and threaded the end and then put it in the hex block and milled the faces to give a 3/8" hex. I also made some 12L14 spacers to separate the segments. I then did some asembly which took lots of filing and finessing. I still have a little work yet to do.

5/9/98—I worked 8 hours today finishing the reversing lever assembly, the reach rod and laying out the boiler tube cutout work. I had to cut a slot in the reversing lever blade (the part that goes in the notches for position). This is for the spring that keeps the blade into the notch. I still had to do some filing to get everything to work smoothly. I used the hacksaw to do this. Next, I cutoff pieces of 7/16 square 12L14 for the end of the reach rod. I used the 3/16 slitting saw to cut the 9/16 deep slot in one end of one of the pieces and a 1/8 deep slot in the end of both pieces so that they could fit over the end of the reach rod and be welded in place. The other piece has a ¼ slot 9/16 deep but I could do this with a ¼ end mill. I needed a piece of 3/16 x 7/16 steel but I did not have any so I went to TSC and got a piece of 3/16 x ¾ hot roll and milled 5/32 off each side and had to move it in the vise as it was 24" long. I then bent it edge wise at a 45 degree angle and back again to get a 1 13/16 offset. I then layed it out and cut it to length and welded the end pieces on with the mig welder set for 12 ga. Material. I sanded it up and painted it with Rustoleum grill black. Next, I began laying out the boiler tube while it was still in the Leblond lathe. I then used the automatic Starrett center punch and put a series of punch marks so I could see it while burning it out and grinding. I had to study the prints a good deal before doing the layout work. I still need to layout the holes but the cutouts are layed out..

5/10/98—I worked 6 hours today on the boiler. First, I clamped the belpare rectangular section to an angle plate mounted on the milling table and used a square to align the part and then took a squaring cut on each end. Next, I made a template for the throat sheet by tracing the outline from the print and then cutting out a template from manilla folder. Next, I did some machining on the throat sheet but it quit raining so I

started some of the cutout for the belpaire section on the 7 ½" tube. I used a guide bar clamped to the tube to align the cut to the head of the plasma arc cutter and set it to full power and cut within about 1/8 of the layout line. Before I did any of the cutting, I made a piece of ¼" bar and tack welded it to the remaining part after the cutout. This kept it from springing out when I removed the top section..I finished this section by grinding with the disc grinders and die grinder to get up to the punch marks I used for the layout.

5/16/98—I worked for about 2 hours on the boiler components today. I worked on the 2 side plates that are 4 5/16 x 10 ¾ . Since the plates were so long, I added an angle plate onto the mill tableand both clamped the parts together and clamped them in the vise and clamped the overhang to the angle plate and then final toe clamped the angle plate to the mill table. I first milled the long ends and then put the parts flat in the vise on parallels and milled the edges to length. I also talked to Paul about some operations yet to be done. Paul pointed out that the holes for the stays that will eventually be made out of 7/16 bar stock and threaded with 1/8" pipe thread can be drilled in the side plates and Belpaire section if the tap drill size is used as the holes need to be drilled into the firebox before tapping in the firebox.

5/17/98—I worked on the boiler components today for about 4 hours. I finished the throat sheet using the ½" roughing mill at 230 rpm to get close to the line and finished it with the belt sander. I then drilled the holes in the Belpaire top for the boiler. I clamped it in the vise with a bar the exact width of the inside so as not to crush the wings inward. I drilled 9 holes with a center drill and the a Q drill which is the tap drill for 1/8-27 tapered pipe. I only tapped one of the holes for the top of the water glass. The others will be guides for drilling the holes in the firebox through these holes that will become the stays made from 7/16 rods with a 1/8-27 thread cut on the end. I also drilled two 11/16" holes fro the couplings for the relief valves. Next, I drilled the holes in the side sheets. There are 3 Q holes for side stays and a .705 hole for a ½ pipe thread. I drilled an 11/16 hole and used the boring head to finish it to final dimension as I did not have a 45/64 drill. Next, I cut off a piece of 1 ½ tube with a 5/8 hole to make a 1.125 od x .705 id bushing that will be threaded for ½ pipe. I had to use the boring bar to get the correct id on this part as well. I then started the ½ pipe tap a few threads and then parted off a slice .250 thick.

5/19/98—I spent ½ hour roughing out the steam dome form a 3 ½ + by 1 ¼ blank that Paul gave me. I turned it to 3 ½ od and then drilled a 1" od hole to start boring it to dimension. I first center drilled and then 5/8 drill then 7/8 then 1". The chuck spun on the adapter so I am not sure that it will hold again. I used the other morse taper 3 drill chuck. I also faced one side before going out to dinner.

5/20/98—I worked for about 2 hours tonite machining the steam dome. I bored the hole I drilled last nite from 5/8" to 2 5/8" od by using the boring bar in the lathe at 351 rpm with a boring bar that has an insert in it. I turned the part end for end in the chuck and bored up to the ½" mark for an additional ¼" to a bore of 2 7/8".

5/23/98—I finished the lathe work on the cap for the steam dome. I used parallels to insert the blank in the lathe chuck jaws so they were parallel to the face of the chuck. I had previously used the ¾ roughing mill to rough out the center to ½" deep and about 2 ¼ round so I could bore it to the finished dimension of 5/8" . This took about 2 hours.

5/24/98—I put the steam dome with its cap in the vise of the mill with a large v block to keep them together and used the edge finder to find center. I had calculated the

X, Y coordinates for the 12 holes using trigonometry. My plan was to drill through the cap and into the base of the dome with the tap drill and then drill the body size with a #5 drill and finally counterbore for the capscrews. I drilled the first hole with a #25 drill, and drilled the #5 and counterbored and then tapped 10-24. I then put a capscrew in it. On the second hole, I repeated it and broke off the tap. I decided to switch to 10-32 as the fine threads tap easier. On the third hole, I broke the drill. The problem is that I was drilling through the 1" thick cap and ½" into the base. I decided to change my process to drill the #5 clearance holes first and then drilling the #21 holes and then counterboring. This worked ok. I was able to get the broken drill out but I could not get the tap out. I also made 3 bushings for the 7/16-26 bushings for the Coles check valves and the bushing for the steam throttle valve access through the back end of the boiler. This was simple turning in the Clausing lathe and I had to drill a couple of holes for 5-40 for the packing gland. All of this work took about 5 hours.

5/25/98—I spent 7 hours today but it does not seem like I accomplished much. First, I worked on fixing the steam dome base. I used the Dremel tool and put a 1/8" carbide burr in it and opened up a hole in the inside near the bottom of the hole. I then drove a punch into the broken tap and picked at the bottom. Finally, I was able to break up the tap and get it out. I used the 10-24 tap and cleaned up the threads and was able to use the hole. I made a little peg of steel to put inside the hole and welded it in. I tried to tig weld it but did not have much success. I finally used the mig welder and had better luck. I then put it back into the Leblond lathe and cleaned up the bottom and inside and then put it on the surface grinder and cleaned up the machined surface that mates with the cap. Next, I made the bronze packing gland for the throttle rod going into the back of the boiler. It was a turning job drilled and reamed a .501 center hole, put it into the collett block and drilled the #30 clearance holes for 5-40 and finally used the belt sander to contour the part. The last part must have taken 3 hours, I can't believe it. First, I sliced off a piece of 400 stainless from a block. This was 3/8 x ¾ by 2" long. I machined it to 5/8 wide, 5/16 thick except the area 1/8 thick, all done with the ¾ roughing mill at 270 rpm. I drilled 2 holes and used a file to make a square hole for attaching to the valve stem. I used a triangle file. I also had to radius the part on the belt sander. The 400 stainless drilled very well and machined ok. I also had to make a 3/16 stainless pin and drill a 1/16 hole for a cotter pin in it and push in into the valve actuating lever that I just made. Finally, I tacked welded it into the valve with the tig welder.

6/7/98—There may be a lapse in this story as I am working on a new laptop computer and I did not properly save the file from the Toshiba laptop. I did have it on a floppy but I'm not sure what I may have missed. I did work on the smoke box yesterday and today for about 8 hours total. I put it in the 3 jaw chuck in the LeBlond lathe and faced off the end and bored the inside for 3/8 length to a bore of 7.245 to go over the front end of the boiler. I used about 150 rpm and the stiff boring bar with clamped in type inserts. I then put the finished end over the 4 jaw chuck in the Clausing lathe and dial indicated it in and then scribed lines along the length every 90 degrees by using a parallel lengthwise stopping on the jaws of the 4 jaw chuck. I then put it in the mill vise and clamped a large angle plate to the side of the part and to the mill table for rigidity. I center drilled, then 5/8" drill and then 1" drill and used the boring bar to open it up to 1 31/32" . I then drilled the holes for the steam inlets and the steam exhaust in the bottom of the smoke box. I used calipers to measure the location of these on the locomotive. I

also drilled the smokebox attachment screws holes and the holes for the forward supports that go down to the platfrom. I then put the rotary table onto the mill table and put the smokebox so I could drill holes every 18 degrees for the drive screws to simulate rivets. These are drilled with a #44 drill at 625 rpm with the drill set deep into the chuck with a spot of oil and was able to drill the 60 holes without a center drill.

6/11/98—I went to Columbia Machine tonite to get a 20' piece of 7/16" cold roll for making the stays for the boiler. I turned down the end to .406 and put the lathe in back gear, very slow, and put cutting oil on the end and put the 1/8-27 pipe die on the end and pushed against it with the round bar that goes in the tailstock chuck and engaged the lathe and turned the tailstock toward the chuck as the lathe turned . I did about 5 threads and then took the part out of the collett and put it in the vise and finished the threading using lots of cutting oil. I used the tapping fluid that Bill Conners bought me. I made 8 pcs of 5" long and 10 of 3" long parts. This took about 2 hours.

6/13/98—I spent 4 hours today on the project. First, I drilled and tapped the two 5-40 holes in the edge of the smokebox to hold the smokebox door on. I then made the grate for the boiler. It is made from 304 stainless 3/16 x ¾. I sawed off the 8 pieces 6 1/8" long and two pieces 4 ¼ long and 14 pieces that will be machined to .393 long. I put each of these pieces one at a time in the mill vise and milled them to get tehm flat on one end and then milled them all to .393. Next, I ground off the corners in the 6" benchgrinder to allow some room for the weld. I clamped the parts together getting the whole assembly as square as I could. I set up the tig welder to a max of 110 amps and used the foot control to operate the tig welder. I did not have the clamp exactly on center and as I started to weld the assembly fell apart. I had to put part of it in the vise to get it square again and finished welding it.

6/14/98—I worked for about 3 hours today on trying to get the locomotive to roll freely. First, I disassembled the cylinders and valve gears from the frame. I also removed the smoke box support and coupling rods. I then turned the lococmotive upside down and removed the axle box caps from each set of axle boxes. I then removed the axle boxes form the axles and removed any shims I had in them. I put the axle with wheels on centers in the Clausing lathe and used a long file and cut them down from .875 to .871 to .872 and polished tehm with emery going down to 500 grit. I reassembled them to the locomotive and put the coupling rods on and worked the locomotive froward and back on the stand. It is somewhat looser than it was allowing the axle boxes to move in the frame. It still takes some down pressure to get the wheels not to slip. I also adjusted the pilot truck pivot to get the frame level.

6/20/98—I spent 6 hours making the throttle valve handle, linkage, and clamp that goes over the packing gland. Ithe clamp is made from a piece of ¼ x 2" cold roll. I first center drilled and then drilled a 5/8 hole and 13/16" and finally 1". I then turned the part edgewise and used the roughing mill and milled close to the layout marks, later finishing with the belt sander. I also milled to the layout lines for the clamp screw flat section. I drilled #36 for the clamp screw and #28 half way through for clearance. I made a small piece that I welded to this part that extends rearward to pivot the linkage to. I tig welded it to the clamp. I made a piece of linkage from 3/8" square 12L14. I drilled 2 holes in it, clamped it to a flat bar and milled a decorative inset into it. I then turned it up endwise in the vise using a parallel to make sure it was upright to the vise base. I then milled a 3/16" slot 7/16" deep taking .050 cuts going through and back on each cut to keep from having

steps. I then made a handle from a piece of 3/16 x 7/16 left over form making the reach rod. I had to put it in the 4 jaw vise as I had to turn down the last inch of it donw to 3/16 round. I then turned down a piece of Nylatron for a handle and pushed it onto the handle. The parts look pretty cute.

6/21/98—I spent the day doing assembly work on the locomotive. It took me 6 hours to do what seemed like a little work. First, I installed the pivot rod for the cylinder drain cocks through the frame. Next, I disassembled the steam cylinder to install the rings, packing, aluminum end cover on the cylinder, and the jamb nut. First, I put the piston rod assembly in the 12 sided collett block and found center and drilled 2 holes for a spanner wrench so I could turn the piston into the crosshead. It sounds simple enough but turned into a big job. First the piston ring grooves were .124 and the rings were .126, so I put them on the surface grinder backed up by a couple of pieces of flat stock and ground .0025 from the face of the rings. I used a hose clamp as a ring compressor and slicked the assembly up with way oil and installed the piston in the cylinder. I turned the teflon packing that I bought to fit into the cylinder packing gland. I had to finesse the aluminum cover on the rod end with a file and installed it after removing the crosshead guide screw to install it. I also installed the jamb nut onto the piston rod before screwing it back into the crosshead using the spanner wrench. I installed this assembly onto the locomotive frame with eight ¼-20 allen screws and reattached the crosshead guide bracket to the frame. I repeated this on the other side. When I tried to roll the locomotive I found that the piston hit the back end cover and that I could not screw the piston rod far enough into the crosshead even with the jamb nut all the way back. I ended up unscrewing the piston rod from the crosshead, removing the crosshead from the guides and milling .080 from the end of the crosshead that the piston screws into. I also put the jamb nut on the surface grinder and removed .025 from it as well. I was able to reassemble it and found that I needed a minimum of .060 piston clearance at the rear position and that I had .110 left so I could again install the rear cap. I had to do the same thing on the other side. I reinstalled the valve gear that had to be removed to do this and installed it in the approximately correct position.

6/22/98—I spent an hour removing the pivot rod for the lifting links and milled a small flat on each end for the 6-32 set screws to set on so the two links are parallel to each other. I also installed the 10-24 x ½ allen bolts that the as pan rests on. I also put the grate in it.

6/28/98—I spent 2 hours today on the slide valve (D Valve) packing and fitting. First, I disassembled the valve linkage from the valve rod and removed the clevis from the valve rod. I then removed the steam chest cover and the valve guide assembly. I had it installed with brass 3-48 screws but it took me a while to figure out that the tapped holes were actually 4-40. I thought I had some bad threaded holes. I put a piece of ½" diameter Teflon rod in the collett chuck and drilled and reamed it to .251 and parted it off to .125 thick. I had to make another piece that was .095 thick to be able to clamp the valve guide back down with the 4-40 bolts. I need to buy some 4-40 x ¼" long stainless screws. I then made a temporary bracket for the reverse stand by bending a piece of 1/8 x 2 hot rolled steel. I clamped it in place to position it correctly to the reach rod. I am getting fairly clost to running it on air. I still need to study the literature on Walschaerts valve gear to learn how to set it.

7/1/98—I worked for 2 hours tonite making the door for the firebox on the boiler. I started from a 4 x 4 ½ by ¼" thick piece of cold roll. I roughed it out to 2 ¾ x 4 ½" and then sanded it up and blued it with Dykem. I then layed it out and tehn used the roughing mill (1/2") at 660 rpm and milled it out to the layout lines. I then drilled and reamed the hole for the door handle to 3/16". I then turned it upright and drilled .120 holes for the hinges and reamed them to .125. I turned up a piece of 5/16 12L14 for the handle. I used the belt sander to radius the door corners. I used brake cleaner and cleaned up the handle and hole and puit a little of 109 Loctite on it and pushed it in the hole and then peened over the end.

7/3/98—A historic moment today in the history of this locomotive construction project. I ran it on air for the first time. I made an air manifold and hooked the air supply through a pressure regulator. I had to limber it up but I just rough set the valve position and Walschaerts linkage and ran the air pressure up to about 30 psi and opened the valve and it ran on the stand. It was fun to see months of work go. I also made the two clevises for the stainless rod that connects the throttle valve in the steam dome to the valve handle at the rear of the boiler. I had to use the 3/16 slotting saw to cut the 5/8 deep slot in the clevis that attaches to the throttle handle. As I set up the clevis to overhang the milling vise, to cut the slot, I only extended about ¼ inch and did the slotting and continued to move more of the clevis outboard of the vise. I was afraid that if I extended the whole 5/8+ amount, it would only be retained by ¼ inch in the vise and it might chatter or pull out. Both clevises are threaded for ¼-20 threads. I spent bout 4 hours on the project today.

7/4/98—Independence day! I worked for 2 hours this morning making the hinge for the firebox door. It was basic machining from a piece of hot rolled steel. I left some material on the backside until the hinge is fitted to the firebox door ring that is welded into the boiler. I also made th 3/16 thick catch that the tang on the door will latch to. I also started making the manifold that goes on the top of the boiler for the valves to the injector, gage, and other accessories. I machined this in a collett from a piece of 12L14 turning each end down to .405 and using a die cutting a 1/8-27 male pipe thread on each end. I also drilled a .250 hole all the way through the 1 ¾" long part. I also welded the stainless steel half coupling to the face of the ¾" square bar but when I pressure tested it in water, I saw air bubbles.

7/5/98—I rewelded the coupling to the square bar with the tig welder and was able to get the leak to stop. I then drilled and tapped the holes for the 1/8-27 national pipe thread and the ¼-40 model taper pipe. After I got done, I realized that I cut off the bar ¾" too short by the way I interpreted the drawing. I have to make it all over. Paul Brien came over to help me set up the locomotive to run on air. First, I centered the link block in the link and put the link lift arms parallel to the frame of the locomotive and thelever that attaches to the reach rod straight up. Next, I removed this whole assembly and drilled and pinned with 3/32" roll pins to keep everything in place. I punched and drilled directly with the 3/32" drill using Cool Tool oil. I had to make a new temporary bracket to hold the reverse stand in place. WE then centered the valve with the link block in the center of the link and the reverse lever in the neutral detent. I had preset the return crank to the side view of the locomotive as Paul designed it and we did not have to move it. We moved the reverse lever or Johnson Bar to the forward position and it ran on air well. I marked the position of the latch for the forward position and using the .097 slotting saw, I cut a .100

deep slot. With the Johnson bar in the forward position, there was 5/16" distance between the link block and the bottom of the link slot. I moved the Johnson bar to the reverse position to get the same 5/16 dimension and ran it in reverse and marked this position and cut another slot in the reverse stand. I also cut two slots equidistant from the full forward and neutral position. In order to run the locomotive on air, I put ¼ thick blocks between the frame and the bottom of each axle box. And propped the whole locomotive up on blocks and ran it in position. One thing I realized is that the valve is just beginning to open when the crank pins are either in the full forward or full rearward position and at the 90 degree or straight up position, the valves are fully open. It is important that the valves are equally positioned at each end of the travel, in other words not more open when the crankpin is forward than when the crankpin is in the rear position. I spent 8 full hours today on the project.

7/6/98—I worked for 2 hours tonight making a new steam manifold for the top of the boiler. I made the first one ¾" too short! I started this one with a piece of ¾ x 2 x 2 ½ long cold roll. First, I sawed off a piece to get it roughly to dimension. I then milled it to 1 3/8 tall form the original 2" dimension. I then laid it out and milled it out to a tee shape with the center piece ¾" square and 5/8" long. I also milled it exactly to 2 ½" long. I then put it in the 4 jaw in the Clausing lathe and turned down the ¾" square section to .740 round. I then drilled it to 29/64 and tapped it to ¼-18 National Pipe Thread tapping 9 threads. I then put the collett chuck on and put the ¾" square collett in it and turned down each end for a length of 3/8 to .405 and threaded it to 1/8-27 national pipe thread. I also drilled ¼" to a depth to meet the 29/64 hole in the center. I then put it back in the mill vise and drilled #5 hole and threaded it to ¼-40 model taper pipe thread and also drilled a "R" hole and tapped it to 1/8-27 national pipe thread.

7/8/98—I worked for about 2 hours tonite on the base for the cylinder oiler. First I sawed a piece approx 7/8 x 2 x 1 ½" for a block of cold rolled. I then milled it to correct finished dimension with the ½" roughing end mill at 660 rpm. I then put the block in the mill vise and centered it and using the 1/8" center cutting end mill I went 9/32 deep. Next, I put a 1" diameter 2 flute end mill in and raising the knee 9/32 , cut the well to this depth. This was at about 180 rpm. Next, I put the boring head in and cut to outside diameter to 1.162 od taking .050 cuts each pass at the slowest pulley speed but high on the switch. Next I had to mill a slot 1/8 wide and .230 deep so I started with the 1/8 center cutting end mill again and used the knee to raise to depth. I took .050 cuts running at 1320 rpm and used air to clear ships. I did break one end mill when I was at 660 rpm.

7/9/98—I finished the base for the cylinder lubricator in about 2 hours today. First, I put the block in the vise and found the centers of the two holes that are .578 apart. I then center drilled and drilled to 17/64 for a depth of 7/16". Next, I drilled .120 through the rest of the block which was nearly 1 5/16" deep including crossing the milled slot. I did this at 1320 rpm taking small depths before cleaning out the chips with air and putting a little more Cool Tool II on it. I then reamed it to .125 at slow rpm. I then tapped it to 5/16-24. Next, I turned over the block and using a 9/32 end mill, I used the knee to raise the part .063 per the print. Next I drilled and tapped the ¼-28 hole for the guide rod bushing.

7/11/98—I worked on the steam cylinder oiler today for 4 hours. I made the block that holds the 1/8" drill rods that are the oil pistons, made the guide rod with stop and the brass nut that holds the guide rod into the base block and the keeper plate that holds the o

rings in place. All of these things were basic milling or lathe work, no special things except taking a piece of 12L14 ¼" diameter down to 1/8 for 1 3/32 length as the length to diameter profile is small but I took small cuts and it worked ok. I also turned and bored a piece of 1" pipe to make the reservoir. I bored the inside and finally made a slight step to seat on top of the flange on the base. I also turned the outside to give a nice finish. I made the bore so it was a light push with the arbor press to install it. I also used some Loctite 609 to hold it in place and make it leakproof.

7/17/98—I spent an hour finishing the oiler. I had to drill the hole in one side of the 1/8" compression tube coupling with a #23 drill (.154) which I ground flat so it would cut a flat surface in the bottom to the coupling. This was drilled .225 deep which done by raising the knee of the mill. I also had to seat a 3/16 ball in the face of the body of the oiler discharge hole. I did this by hitting the ball with a brass rod and hammer. I did not use the ball that I made the seat with for the operation of the oiler and installed new balls in this area along with light springs to hold the seat. It seems as the oiler is working correctly as I tried it with way oil and it worked well and I could not blow back from the discharge line into the oiler.

7/18/98—I spent 7 hours today on the locomotive. First, I finished the ball checks for the cylinder oilers. I spent the rest of the time making some of the pieces for the cab. All of the pieces are made from 1/8" plate. I was able to rough out some by using the band saw and pushed parts through the blade slowly and finsihed them on the mill and belt sander. I also had to get out the plasma arc cutter and using a piece of channel as a guide, and at a setting of 4o amps I roughed out many other pieces for the cab floor sides, front and roof. I did get some of them finished in the mill to correct dimension. I think I will have to remove the vise to do the rest of them on a big angle plate.

8/9/98—I did a little work on the locomotive project today, about an hour. We went on vacation to Nova Scotia a couple of weeks ago and this weekend we drove to Cincinnati for Dave Jones 60th birthday. I sawed up a 6 foot piece of 7/16" hot roll round to make 6 pieces a foot long with 1/8-27 male pipe thread on each end. First, I turned down each end to .406 with the bars in the collett chuck. I then put the lathe in Back Gear to run really slow and put a piece of masking tape on the chuck to know where I started. I put the pad in the drill chuck that pushes against the die and put the die against the part and used the tailstock to put pressure on it. I counted 11 turns of the chuck. I used Cool Tool 2 as a lubricant. It occasionally tore a thread but that will have to do. I cleaned up the lead thread with a file at 900 rpm to complete the task.

8/15/98—I worked for 2 hours today on the cab sides. They are made from 1/8" thick plate that I had previously roughed out using the plasma arc cutter. I moved the movable jaw face block to the back of the jaw so I could fit a part 8 ¼" long in the vise. I also clamped the 2 side parts together. I used the ½" roughing mill at 660 rpm to get the dimensions close. I turned the parts to get all of the sides to dimension as the "Y" direction does not have enough travel. I then completely removed the back jaw plate from the moveable jaw so I could hold the part on parallels and inside the vise so I could cut out the window holes. I had to adjust the clamps several times to hold the parts together but not mill through them. I drilled 3/8 holes in the parts where the window holes go to start the end mill. I first layed out the parts with Dykem. I used a 3/16 roughing mill at 1320 rpm getting close to the line. I finished with a 1/8" 4 flute end mill at 1320 rpm.

8/16/98—I worked 7 hours today on the project. First, I milled the recesses in the sides of the cab. I milled a .050 deep offset around the small window using the 3/16" roughing end mill at 1320 rpm. I then had to mill a 1/8" wide slot also .050 deep. At one point I did travel too fast and broke off the end mill so I had to switch to the other end of the double ended end mill. Next, I started on the cab front pieces by milling the pieces I had roughed out with the plasma arc cutter by putting an angle plate in the vise and milling the part to 6 13/16 x 10". I then blued up the parts and laid out the door and window openings. As I had done in cab sides, I drilled a starting hole and used the 3/16 roughing end mill at 1320 rpm to cut the holes, using a screwdriver to keep the part from snapping the end mill as it was almost removed. I put the two pieces together after deburring them with masking tape and then using the Starrett trammell set at a radius of 17 17/32" to scribe a line on the top edge of the cab sides. I used the band saw to rough out the part and finished it with the belt sander. Next, I made the splice plate to hold the cab fronts together. I clamped the parts together and drilled with #43 drill and removed the clamps and drilled the holes in the plate with #33 and then an 82 degree countersink for 4-40 screws. I also tapped the holes for 4-40 screws in the cap front pieces. Finally, I went to TSC to get a piece of ¾ x 1/8thick angle iron. I then milled out the radius on the inside so it was square. I also milled it to ½ x 11/16 to fabricate the arm rest and window sill.

9/20/98—It has been quite a while since I worked on the project, things busy at work and I had to make several trips to Crossville to get Tom Beals shop tools to sell after he passed away and left his tools to the Mid South Live Steamers to sell. This thing I wanted to enter here is the fact that Paul Brien finished my boiler today after having tested it to 300 psi. I am delighted that it is now finished and I can progress with the rest of the locomotive project.

10/4/98—I finally got a work day on the project, at least 6 hours. First, I removed the smoke box support and piping. I changed the steam pipes and put Loctite sealant on the pipes and screwed them in 3 full turns. I then installed the smoke box, which fit well over the pipes so I drilled the holes in the smoke box in the right place. I used a piece of #29 drill sharpened to a point and used it for a transfer punch. I then put the smoke box in the vise on the mill and drilled and tapped all 8 holes for 8-32 screws. I mounted it to the support and trial fitted the boiler to it. It fit well but the bottom of the water legs on the boiler was not quite level so I removed the vise from the mill and using blocks and large V blocks mounted it to the mill table and took off about .050 from the high points. I refitted the boiler to the smoke box and used a large clamp to hold it in place and punched, drilled, and tapped the 4 holes to hold the front edge of the boiler to rear edge of the smokebox.

10/8/98—I drove in the Drive Screws into the holes previously drilled in the smoke box primarily for decoration to look like rivets. I still have more to do but I need to remove the smoke box form its mounts first. I also made 2 angle iron brackets to attach the rear end of the boiler to the frame with ¼-20 screws but I found out after I made them that when I drilled the holes, I would have interfered with the screws that held the rear grate and boiler support to the frame.

10/10/98—I worked about 4 hours today. First, I made new brackets for the rear end of the boiler to attach it to the frame. I made these from a piece of 3" channel milling a ¼" slot about 3/8" long. I plunged the center cutting end mill through the part and

milled the slot. I also used the new Wilton vertical bandsaw I got for my 50th birthday. I also sawed off 4 pieces of 2 x 3 angle 5/8" long for additional brackets to mount the cab to. I welded the brackets to the boiler with the mig welder and using the transfer punches to center punch for the ¼-20 screws. I then remeoved the boiler from the chassis and drilled the #7 holes and tapped the ¼-20 holes in the frame, all by hand. I removed the smoke box and finished driving the drive screws into it. I then turned the boiler upside down and welded the tabs to the bottom of the boiler to hold the grate in place. I then reinstalled the smoke box and the boiler. Finally, I cutoff a couple of pieces of ¼" rod and used the tailstock die holder, cut ¼-28 threads on the end to begin making smokebox supports.

10/11/98—I worked a full 8 hours today. First I made the smoke box supports that attach to the lower front corner of the smokebox via a ¼ hole and finally attaches to the front buffer beam. This took several hours. First I had to for the small triangular piece that is a decorative attachment that goes against the outside of the smokebox through whick the ¼ rod passes through into the smokebox. I then silver soldered it to the ¼ rod using the Prestolite torch. Next, I put the nut on the rod inside the smokebox to hold it in place and used the acetylene torch to bend the rod forward and down. I then marked the rod and sawed it off and using the belt sander formed it to attach to the pad that mounts it to the buffer beam. I put a .005 stainless shim under the pad and silver soldered it in place. I drilled the hole for the 6-32 screw in the pad. I center punched the buffer beam and removed it from the locomotive and drilled and using Tom Beals tapper, tapped the beam to 6-32. I then layed out the 4 brackets 1 ½ x 3 that weld to the boiler to hold the cab floor in place. I did this by using the front bracket and attached a long bar to level it to the frame. I milled off the back corner of the brackets to get a good weld to the boiler frame and welded them in place. I then spent the rest of the day aligning cab parts to the brackets. I must have done something wrong as the bottom of the cab supports is about 3/16 from touching the rear buffer beam which it is supposed to be. I will have to study this.

10/16/98—I worked 6 hours on the project and all I really accomplished was to make and fit the roof to the sides. First, I made a die and punch to make a ½" radius bend on the 1/8 thick steel on the edges of the roof. I welded a ¾" bar to a piece of ½ x 2 for strength. I made a die out of a piece of 1" square tubing that I milled away one surface to make a U. I used the hydraulic press and it was quite a push to make the bend and of course, I over bent it. I then tool a 1 1/8 bar and put it in the bent radius and the press and opened it up slightly. I did the other side and then laid out marks 1" apart to mark where to bend the crown for the whole roof using the bending jig in the press and just slightly making bends at each 1" mark. I fitted it up to the front cab section which was already cut to the proper radius of something like 17 ½" . The whole roof was too wide overall and infact needed to be split along the centerline so I layed out the section to be removed and cut it out on the bandsaw. I used the belt sander to clean up the band saw work and do some radiusing. The sides andfront were then layed up on the surface plate and squared up with magnetic angle blocks. I then setup and scribed the turned down edges of the roof to be removed. This was another bandsaw project with the belt sander for final work.

10/18/98—I worked 8 hours today but it was all slow work with lots of finesse. First, I made a template out of cardboard to match the cutout for the front of the cab. I

then layed it out on the actual steel front which is split in two pieces. I used the new Wilton bandsaw to cut out the section to be removed but it was a little rough as I had already chipped out some of the teeth on a job yesterday. I did lots of work with the belt sanders and files to get it right. I then layed out the center of the Reverse lever where it goes down through the cab floor. I then milled a ¼" wide slot for the lever. I also used transfer screws and layed out the holes for the reverse selector. I also used a 4-40 hex head capscrew that I sanded down to a point and used it to create centers for the holes for the 4-40 screws that will mount the cab floor to the brackets welded to the boiler. I cut off two pieces of 3/8 x 5 by 1/8 bar and welded it to the edge of the roof that will support the center removeable section. I also welded a couple of aligning tabs to the roof. The last thing I did was to finish making the armrest bars out of ¾ angle iron. Lots of layout work milling away surfaces, and filing to make it fit the cab sides. I still need to drill and tap holes to mount it to the cab and to mount the Nylatron armrest.

10/24/98—I drilled and tapped and countersunk the 4-40 screws to hold the armrest brackets onto the cab sides. Paul Brien came over today and we used the plasma arc cutter to cut out a section of pipe that Paul had to make the smokestack out of. He is going to bend it in the hydraulic press and weld it together. I also cut the 11 gage plate for the side walks along the boiler. Paul is also going to bend these as he has a press longer than the 18 ¾" length. Next I started making the front doors for the cab front. Once again, it took a lot longer than I thought it should. First, I roughed out the material with the band saw and using the ½ roughing mill cutter, I machined the outsides to dimension. Next, I clamped them together and drilled a ½ hole through them on the drill press. I then used the roughing mill cutter and cut out the hole for the window. I then used a 3/16 milling cutter and milled a .060 deep section for the door lower at 1320 rpm using an air holes to blow the chips out of the way. I then milled a recess around the window on the inside .060 deep and .094 wide. Finally, I milled a .060 deep slot around the perimeter on the inside and cut the corners on a 45 degree angle. This was repeated for both doors. Next, I started making the hinge our of a piece of 3/16 square 12L14. It had to have 2- 3/32 holes drilled in it. I still need to finish this. I spent 8 hours on these items.

10/25/98—I spent 8 hours on the project today. First, I finished the doors for the cab front. I setup and milled 3/16 slots in the door for the hinges. These holes were milled with a 3/16 mill .045 deep and .281 in from the edge of the door. Next I opened up all of the holes to 1/16" so I could use 1/16 rivets to hold the hinges on and to use as hinges ot the cab front. This worked well. I also drilled a 1/16 hole for the stainless cotter pin that is used for the keeper for the door. Next, I made the shades for the cab sides. I used the band saw to cut a piece of 1/16 plate 7/8 wide from as larger piece. I used the large belt sander to clean up th saw marks. I then marked and bent the ends up to a 45 degree angle. I then tack welded them to the cab sides. I then drilled and tapped 4 holes in the bottom of the oiler to mount it to the cab floor with 5-40 screws. Finally, I sanded the cab sides, cab front pieces, and cab front doors and primed them with John deere yellow primer.

10/31/98—I went to the Mid South Live Steamers track in Columbia this morning as they had a run day scheduled. Paul Brien sold his locomotive that I am modeling to J. L. Meyer. I am kind of disappointed that it is gone but I hope to have mine done by the spring meet. I also rode on Bill Conners walking beam engine that he has done with chain drive but articulated with universal joints so the wheels can swivel as the locomotive goes around the track, quite a unique design and a mechanical marvel. His silver solder work

is very good as he makes his cylinders from scratch by building up from stock and silver soldering together and includes a Bimba stainless cylinder. When I got home I worked about 3 hours. I used transfer punches and located the oiler onto the cab floor and drilled the clearance holes for it. I then sanded the 5 pieces that make up the cab floor and primed them with the yellow John Deere primer. I made up the 1/8 diameter and 3/16 diameter rods that operate the cylinder drain cocks. I had to make some bends on the 1/8 stainless part. I also drilled and tapped the end of the 3/16 rod for 5-40 so I could screw in the end of the 1/8 rod with the same thread. I made a little bracket to support the 3/16 rod as it went under the cab floor and tacked it in place with the mig welder. Finally, I made a new clevis for the throttle rod to throttle handle about ¼" longer than the original one to get the handle a little farther from the boiler so it is not so hot.

11/1/98—I can't believe I spent 6 hours making and installing the cylinder lagging and installing the cylinder drain cocks and linkage. I made the cylinder lagging out of brass shim stock about .010 thick. . I punched the 4 holes that attach it to the cylinder just above the mid line. I had already milled a slight recess in the cylinder previously. After I used the Whitney punch tp put the 1/8 holes in the top edge of the lagging, I marked the cylinder and center punched it. I put a piece of masking tape on the #47 drill to drill a depth of 3/16 which I did by hand using the Makita battery drill. I then tapped the 4 holes 3-48. I had used the straight cutting sheet metal shears to cut the parts to the proper width. I used the shim punch set that Charlie Hamilton made me to punch 7/16 holes to clear the cylinder drain cocks. Next, I bent the flange that attaches to the back of the cylinder. I cut a piece of 3/32 x 3/8 to use as a backing to hold the lagging flat to the back of the cylinder as it is not continuous in the back, it is only 3/8 wide. I also drilled and tapped 3-48 holes. I had to do all of this from under the locomotive as I did not want to remove the cylinder to do the work. I then installed the previously made drain cocks using a little loctite #242 removable threadlocker. I also made a handle for the 3/16 rod that operates the drain cocks that is located at the cab end of the rod. I also installed the previously made front end aluminum cylinder covers with 8-32 flathead screws. I ran the engine on air to make sure the cylinder drains work ok.

11/13/98—I went to Paul Brien's today to pickup the smokestack and smokestack retaining ring that he made for me. He also bent the side walk boards on his brake as his die set is longer. When I got home, I first made the ring that goes on top of the smokestack. I started with a piece of 1/4 x 3""square hot roll steel and drilled a 1" hole in it on the drill press. Next, I put it in the milling machine I put the boring head in the mill and bored the hole to be about .005 smaller than the top of the smokestack. It was slightly out of round so I had to kind of pick an average dimension. Next, I cut off the corners on the bandsaw so I did not have to take off too much on the lathe. I put it in the /Clausing lathe in the 6" jaw spaced out about 5/32 fron the jaw faces. I put the lathe in back gear and ran about 290 rpm. I also radiused it for appearance. I then put it on fire bricks and heated it to blue with the propane torch. I then shoved the stack into it and let it shrink on the stack. I drilled the holes in the retaining ring that Paul had layed out. I drilled #30 holes so I could use the 1/8 transfer punch to position it in the smokebox. I then put it in the 3 jaw on the Clausing lathe and turned it down to dimension. It is kind of strange to turn this part as it is curved to match the smokebox. Finally, I made the Petticoat that goes on the end of the stack where the exhaust steam discharges in to the stack. It is standard turning work that I did on the Leblond lathe. I found a piece of 2 3/8 tubing with

a 1.5” bore so it saved a lot of work turning and boring. It also had a 15 degree angle in the entrance end of the Petticoat so I used the compound to do this. All of this took about 4 hours.

11/15/98—I spent 3 hours tonight on the project. First, I clamped the flange that the smokestack taper fits into onto the smokebox. I then transfer punched the holes and drilled #36 holes in the smokebox and tapped 6-32. I then opened up the holes in the flange to #28 and installed the smokestack. I then clamped the left walkboard along the side of the boiler. I then removed the whole bracket assembly and trilled the #43 holes for the 4-40 screws. I also used a 82 degree countersink and installed #4-40 x ¼” long screws. I also cut a 1/8 x 1” wide piece to splice the cab floor to the walkboard.

11/16/98—I worked 6 hours today. I spent most of the day making the right side running board. The mounting screws were installed like the left side but there were many more cutouts for the right side, a slot at the rear for the reverse lever rod, a slot with some additional radii to clear the reverse rod connection as it moves through its travel, a slot for the feedwater near the front, and a slot for the lubricator lines, and finally, a long 5/8 wide section removed mostly for decoration. Most of the operations were simple milling operations with a 5/16 roughing mill at 660 rpm except for using the bandsaw to cut off most of the 5/8 wide section, finishing with a 5/16 end mill. I clamped the running board to a piece of ½ x 3” coldroll to do the machining. After I completed the right side, I removed the left side and cut off the 5/8” wide section and a notch at the front. I then sanded both running boards and the roof sections and primed them with John Deere yellow primer since it was unseasonably warm at 70 degrees. I also made a fixture to hold piping in position to silver solder the piping from the axle pumps.

11/19/98—I spent about 8 hours today on the project as I was on vacation. First, I went to Nashville to Breeding Insulation to get Kaowool. After discussing how to insulate the boiler with the experts I decided to buy 2” wide fiberglass insulation tube which is probably .090” thick and is woven much like a fabric. When I got home, I removed the pistons from the axle feedwater pumps. I put them in the lathe at 1200 rpm and cut strips of 500 grit emery and using ½ wide barstock as a backup for the sandpaper polished the stainless pistons. I finished them with Crocus cloth which you cant even feel the grit. This should minimize the wear on the pumps. I then worked on the water intake for the pumps laying out the parts and using the fixture I made to get the centerlines correct and wire brushed inside the fittings and using emery cloth polished the 516 tubing and put flux paste on the parts and using the prestolite torch, I soft soldered the parts. I then layed out the parts for the discharge side of the pump which was similar to the other side but the parts had to be silver soldered. I used StaSilv paste for flux and once again I used the Prestolite torch. The fittings need to be dark red before they are hot enough to flow the silver solder. You can tell as the flux begins to liquify, it is getting near the correct temp. I screwed in the Coles check valves in the side of the boiler. They are 7/17-26 straight threads so I had to use shims to get the valves to tighten in the correct position. I also had to mill a slot in the cab floor for the pipe to go up into the cab.

11/28/98—I spent 3 hours today working on piping for the bypass line and valve for the axle pumps. After determining where the valve needed to be, near but just above the oiler, I made up a 90 degree bend on 5/16 tubing and made up a short length of ¼ brass tubing with a ¼-40 model taper pipe thread on the end that will screw into the valve. I fluxed up the joints with StaSilv and silver soldered it as the pressure could be

120 psi plus. I made up the discharge piping from the valve to the connection point to the tender hoses at the bottom of the rear of the locomotive with model taper piping and fittings using Loctite thread sealant. I also made up a clamp to hold all three of the pipes together at the same distance.

11/29/98—I spent 6 hours today mostly on piping. I finished the injector suction line. I found a 1/8 NPT ball check valve and put it in line with the line so once the line is full of water it will continue hold the line full. I hope this will help the injector work even though it is considered a non-lifting injector. Next, I made the Blower line which is made from 3/16 tubing. The blower valve is a Superscale angle valve which has a union fitting on the discharge side. I screwed a short section of ¼ brass tubing which was threaded to ¼-40 on one end and pushed the 3/16 tubing into this piece and silver soldered it in place. After pushing the 3/16 tubing through the dry pipe into the smoke box and routed it around the perimeter to make it easier to put the tube brush through the tubes. I also routed the oiler tubes from the oiler to each cylinder using 1/8 soft copper tubing. This was fairly simple and I finished by pumping the oiler to fill the tubes. Finally, I used one of the stainless couplers from the outfit that I got the injector from and using the coupler pocket from Superscale. I had to cut off the long end of the coupler and radius it with the belt sander and drill a 25/64" hole for the 3/8" pin.

12/6/98—I spent 1 hour installing the front coupler pocket onto the front buffer beam. I removed the front buffer beam form the locomotive and clamped the coupler pocket to the beam. I drilled a #21 hole through the beam and the pocket. This was very tough as the coupler pocket is stainless steel casting and I ruined a drill before I slowed down the drill to about 250 rpm and used cool tool oil. I tapped the buffer beam 10-32 for all 4 holes and reinstalled the assembly to the locomotive frame.

12/9/98—I ordered a water gauge from American Model Engineering in Valparaiso, Fl. It has a 1/8 MPT for the bottom fitting and a shutoff valve and a ¼-32 fitting on the top. This is an odd thread as it is a straight thread, not tapered and an odd size. I had to order a tap and die from MSC to be able to cut threads on tubing to match. I bought a nice Rigid 5/16 tubing bender and also a multiple ¼-5/16-3/8 Rigid aluminum tubing bender and I need to learn how to layout tubing to bend it. It cannot be too tough but I keep getting disoriented in multiple bends on the same tube.

12/15/98—I spent 3 hours working on the installation of the water gage and the pressure gauge. The pressure gauge was fairly straightforward making a 180 degree bend in the 5/16 tubing to be a siphon tube and then used ferrule type tubing fittings to connect it to the manifold. The water gage was quite a bit more work. I had to raise the inlet 1 ½ inches by making a nipple from a longer brass nipple. It was kind of tricky to be able to screw the parts together and allow a final connection to the top fitting. What I did was to install a short ¼-32 nipple into the water gauge and installed a ¼-40 mtp union on the other end of the nipple. I then silver soldered a piece of 5/16 copper tubing over the nipple on the other end of the union that subsequently went into the top of the boiler. I also replaced the close nipple that went into the boiler that the fill and blowdown valve went into with a schedule 80, 318 stainless fitting into. I was afraid that a derail may have allowed the fitting to break as it is located in a risky place.

12/20/98—I spent 8 hours today working on the project. Paul Brien stopped over yesterday to take a look at my progress. We talked about the lagging (stainless steel cover sheet over the boiler) that covers the insulation. He looked at my piping and

thought it was ok. He told me that the steel the boiler is made from is SA-285 Grade C. I was interested if I ever needed to make a boiler myself. I spent some time removing all of the piping from the boiler. I hated to disassemble all of this work but I had to do it to move forward. I spent the next several hours putting Loctite 518 (I think that is the right number) gasket eliminator on all of the faces of the steam cylinders, front cover, rear cover, steam chest, and steam chest cover. I had to remove some of the crosshead guide bars to be able to remove the rear cylinder covers. I then cleaned the surfaces with mineral spirits (paint pre cleaner) and wiped a light coating of this material on the surface before reinstalling the cylinders. I repeated this on both cylinders on all of the parts mentioned. I also hand painted the edges of the cylinder with Rustoleum High Temperature black and sprayed the steam chest and steam chest cover. I used the small electric heater to dry these for about an hour. I then started making the spacing strips that space out the lagging on the boiler. For the one next to the smoke box I used a piece of 1/8 x 3/8 cold roll and milled a .030 recess for the lagging to fit into. I also put a radius on the edge next to the smoke box with the belt sander. Then I wrapped it around the boiler and clamped it with the Bessey clamps and tacked it in place with the mig welder. I had to go to TSC to get some 1/8 x ½ hot roll for some more strips.

12/21/98—I worked for 4 hours today on the 1/8 thick buffer or spacer strips on the boiler to space out the lagging for the insulation. First, I cut 1/8 x ¾ strips along the bottom of the firebox area and drilled and tappped 5 holes 4-40 to hold down the lagging in the Belpaire section. I tack welded them in place with the mig welder. I then placed strips of 1/8 x ½ hot rolled in front of the steam dome, just behind the steam dome, and at the front and rear of the Belpaire section. I used the Bessey clamps to hold them in place and hold them while I tack welded.

12/22/98—I spent 12 hours today on the stainless steel lagging parts, working until 10:30 pm. It was really irritating, hard work. First, I had to make two plates to form the piece that goes on the front of the Belpaire section as it transitioned from round to rectangular. I made one piece out of 3/8 thick hot rolled steel after making a masonite template. I used the plasma arc cutter to rough it out. I ran it at full current, I think 50 amps. I made a matching clamp plate out of ¼ thick hot rolled and then used disk grinders and belt sanders to get the form to shape. I radiused the 3/8 thick piece to ¼" radius. I then used the plasma arc cutter at 35 amps to cut the .035 stainless piece using the former as a guide for the plasma arc cutter. I had a piece of some kind of restaurant door that I used for the stainless. I then clamped the stainless between the two formers in the vise. I then used the bronze hammer and slowly pounded the stainless around the former. Finally, I had to heat the corners that I was shrinking to the form with the acetylene torch. I then turned the form around and beat the round flange to the former. One flange turned forward and and one turned rearward. I then worked on the stainless cover for the Belpaire section. I used the formers to simulate the Belpaire section with a couple of pieces of pipe clamped between the formers. I faced off the pieces of pipe so they were exactly the same length. I messed around with this forever to get the spring back to match the transition piece that I made earlier. I had cut out this piece with the plasma arc cutter and also cut the front piece that will be turned into a 7 ¾ round tube. Finally I tig welded the transition piece to the Belpaire piece which was a real project as I kept burning through it and had to fill up the holes. It tool 2 hours to grind sand and pick up the lows form the heat. All in all it was not much fun today.

12/23/98—I spent 8 hours on the project today. WE had a sleet and ice storm today while the temperature stayed in the low 20's. I took the piece of stainless that I had cut from the door with the plasma arc cutter to Franklin Sheet Metal Co. and had them roll it into a circle 8" diameter. When I got home, I found a log that I turned in the lathe to 7 ¾ diameter to use as a former so I could work on the piece. I had a 3" hole saw so I used the big angle plate and clamped the log with the piece of stainless on it and using the slowest speed I drilled the hole using the knee to raise the part rather than the quill. I then had to open it up to 3 ½ with sheet metal shears to clear the steam dome. I then went to work on the Belpaire cover section. First I laid out the hole for the nipple that the vlave tree attaches to at the rear top of the boiler. I then used the Whitney #20 punch with an 11/16 punch to punch it. The problem was that the clearance between the punch and die was for thicker metal and it did not punch out the slug as one edge held on so I had to fight that. I then put the stainless cover on and used a hammer to outline the relief valve couplings. I then clamped this to a board and using the drill press on slow speed, I drilled the 2 holes. I repeated this for the nipple for the top of the water gauge. I temporarily secured it to the boiler using a long radiator strap and clamped pieces of steel along the running board to bend the offset to secure it at the bottom. I then laid out for the five 4-40 clearance holes on either side. I put the strips of fiberglass insulation on the boiler and installed the Belpaire cover. I do have a small gap about ¼ wide by 1 ½ long that I need to figure out how to cover.

12/29/98—I spent 8 hours today. This morning, I laid out and drilled the holes for the handrails on the round stainless steel cover on the front of the boiler. I also punched the holes for the boiler feedwater inlet check valves using the Whitney #20 punch with an 11/16 punch. I bought some 8" stainless steel clamps for radiators to hold the cover in place until I can get some professional looking clamps. This afternoon, I concentrated on painting. I removed the boiler and put it on the work bench. I used a combination of the brake cleaner and wax and oil remover to prep the boiler for painting. I used the Eastwood stainless steel manifold and header high temp paint to paint the front edge of the boiler. Then, I used Rustoleum grill black paint to paint the rest of the boiler using both a brush and the spray can. I then used Eastwood exhaust spray paint to paint the smoke box, smoke stack, smoke stack support flange, somke box door and the petticoat pipe. I first sanded these parts clean and wiped them down with oil and wax remover. I then cured these parts in the oven for 1 hour plus at 400 degrees. I also sprayed the smoke box supports and the throttle handle assembly Rustoleum grill black. I made a threaded hub for the steam dome cover. I made a couple of tabs of stainless steel to cover the rat holes at the bottom of the transition piece on the front of the Belpaire boiler cover. I set the mig welder on 18 gauge and did a couple of small tack welds in place.

12/30/98—I spent 7 hours today. First, I decided that the Eastwood high temp header paint would never set up on the band of the boiler so I removed it with lacquer thinner and repainted it with Ruistoleum Anodized Bronze paint after heating it with the cube heater. I had to reweld th front spacer band on the boiler. I got some 600 and 1500 grit sandpaper to further shine up the stainless steel Belpaire and barrel covers. I spent quite a bit of time trying to sand out scratches and file marks. I removed all of the nuts and bolts on the valve linkage and sprayed off the oil with brake cleaner and put a dot of blue Loctite to keep the fasteners in place. I also used 500 grit paper and polished some of the linkage. I also replaced some of the Allen capscrews with stainless model bolts. I

drilled and tapped the buffer beam to mount the cowcatcher which I painted with Rustoluem grill black.

12/31/98—Last day of the year and I worked 8 hours on the project. I taped the 2" wide fiberglass strips onto the boiler and installed the Belpaire section and attached with ten 4-40 x 3/16 screws. I also installed the round front section of stainless steel after first covering the boiler with fiberglass tube. I used the 8" clamps that I bought from MSC. I remounted the smoke box using 8-32 stainless steel model bolts. I polished up the copper pump discharge line from the axle pumps and installed it as it was in a bad place to try to install after the boiler was in place. I had to hold the grate on its tabs in the boiler as I sat it back on the locomotive. Susie helped me set it in place and slip it into the flange of the smoke box. I had to wipe off the paint from the buffer beam and repaint it as it was not a very good job. I spent a lot of time fitting the cab to the Belpaire section but it is not perfect. I cut it roughly out with bandsaw and finished it with the belt sander. I polished and reinstalled some more of the piping and injector as I had to mill a slot to clear the steam inlet line to the injector. I also had to clamp the walkboards to a heavy piece of steel in the mill vise and mill off some of the edge to fit it to the boiler lagging. I am fitting up the cab pieces so I can paint everything after it is painted.

1/1/99—New Year's day and I worked 8 hours on the shop. I worked outside for a while fitting the cab parts and clamping them in place. I then marked where I wanted to tack weld them and used the Dremel tool to remove the primer in those areas and re clamped the parts and tack welded them with the mig welder set on 10 gauge. I had to machine off .040 off each side of the cab floor removeable plate. I also had to drill a hole for the cylinder drain cock rod. I cut the stainless rods and installed the handrails on the smoke box. I also installed the smokestack flange and smokestack and petticoat pipe (I put some never seize on it first). I reinstalled the steam pipes inside the smokebox. I reinstalled the piping to the water gage and the water gage. I also bent a 3/16 tube and made a new piping arrangement to the pressure gage. I had used 5/16 tubing and Paul said to redo it with 3/16 tubing. I bent it using the bender I got from Eastwood. I turned a piece of brass and cut a ¼-32 thread with a die in the tailstock dieholder to replace the bad blowdown valve on the water gage. I pressurized the boiler with air to check for leaks. I then sanded and brushed the cab components and re-primed it with John Deere Buff Primer. I also installed the front coupler onto the buffer beam and also installed the cowcatcher with four 10-32 bolts. It is starting to look pretty good.

1/2/99—I spent 6 hours today starting with filling some dents on the cab roof with polyester two part pit filler. I then warmed the parts with the cube heater and painted the two cab halves, cab roof center, both running boards, and both cab doors. I painted 2 coats within an hour and put them in Charlie's room to warm to dry. I then took off the ball checks for the cylinder oilers and re seated the balls in the brass fitting as they seemed to leak back under pressure. I then spent the rest of the time on the decorative cover over both of the relief valves. This is made from a piece of aluminum 1 ½" square by 4" long. I roughed the radius out on the bandsaw and tehn drilled 5/16 diameter holes where the ¾ holes will eventually be to go over the relief valves. I then made an arbor to go in the 5/16 hole and installed the rotary table on the mill table. I used the long cut ½" roughing cutter and cut the radius on each end of the part by rotating the rotary table 180 degrees. I had to do a similar cut with a ball nose cutter to get a radius near the bottom. I used a cornering concave cutter to cut a radius around the top. I used a 3/16 center cutting

cutter and plunged down 3/16 and cut an inside recess around each hole and put the part in the vise ot do the straight cutting part of all of the cuts made on the rotary table. I need ot open the holes to ¾ and do some finish sanding. I also had drilled and countersink a center hole for the 5-40 attaching screw.

1/3/99—I sanded and painted the shroud around the relief valves after drilling the 5/16 holes out to ¾" at 160 rpm on the mill table. I bought a piece of .093 thick Lexan for the cab windows and sawed it to dimension on the band saw. I used Duro thick gel super glue and put small dabs on the edges of the openings and installed the Lexan windows. I reinstalled the cab and running boards and the rest of the injector piping. I had to make a long 1/16 Allen wrench by drilling a .063 hole in the end of a piece of 3/16 hex brass and driving a short piece of 1/16 Allen wrench in the end. This is used to install th flathead screws for the splice on the cab front. I also reinstalled the oiler. I installed the linkage between the reverse lever and operating rod.

1/9/99—I made the armrests for the cab sides from black Nylatron. I milled them to proper dimension and drilled and tapped the 4-40 holes and radiused them. I also turned the decorative number plate for the front of the smoke box door. I started with a piece of 2" diameter brass. First I turned it down to ½" to create a step to offset it from the front of the door. Next, I turned it down to 5/16 and cut a 5/16-24 thread on it to secure it to the door. I then cut off a slice of the assembly with the band saw and put it in the Clausing lathe in a collett. I turned an inset and then sanded and finally polished it with Flitz metal polish. I then installed the smoke box door on the locomotive. I also installled the cab front doors and the rear cab floor. I made the tow bar between the locomotive and tender. I made it of ½ x 1" bar and drilled the holes for the 3/8 pin on the locomotive and the 5/16 pin on the tender. I painted it with black Krylon. I spent 4 hours on all of these things.

1/16/99—I worked for about 5 hours today on the tender brakes. I had Paul Brien's design but I had to modify it as the tender trucks were quite different. I first had to mill off the cast aluminum stops that were part of the crossmember of the trucks. I then made some ½ x ¾ high steel stops to replace them. I needed the stops to be on the truck, not the tender frame which moves with respect to the brake bar. I milled a .030 deep slot in the aluminum crossmember to key the stop into it. I tapped the block ¼-20 and drilled a clearance hole in the crossmember spotting it with a transfer screw. I cut off a 10" long piece of 3/8 x 2" cold roll for the brake bar. I layed it out to have ¼-20 screw heads to guide the bar for-aft and a center shoulder screw with a slot milled in the crossmemeber. I also drilled two #1 holes for the springs to push the brake bar back away from the wheels. I did this while I had all 4 pieces together in the mill vise. I also milled the slots for the brake shoes in the bars 1" wide and 3/16" deep on the center lines of the wheels. I also drilled and tapped the 5-40 holes to hold the brake material into the slots, all while in the same setup. I then ground off the mounting rivets from a disc brake pad. I used the band saw to trim it roughly to dimension. I used a 1/2" end mill at 1320 rpm to shape it to dimension but is still chipped some of the edges. I setup a vise stop and milled a 7/32 hole .300 deep using the knee adjustment on all 8 shoes. I then followed with a #30 clearance drill for 5-40 allen screw. The brake material is very strong in the front to back dimension as it is formed on the backer plate for the disc brakes but it is weak and layered in the edgewise dimension.

1/17/99—I worked 8 hours today on the tender brakes. I first reworked the other wheel truck crossmember like the first one, milling off the cast block, milling a slot for the new stop blocks and installing them, and finally milling 5/16 wide slots for the shoulder bolts for the brake bar. Next, I worked on the long bars that actuate the brake bars. These are called the equalizer bars. I decided to drill and ream 5/16 holes for drill rod pins in the brake bars that the equalizer bars would go over. I drilled a hole on one end of the equalizer bar to go over one of the drill rod pins and milled a 4" wide slot on the other end so as the trucks turned around a radu=ius on the track, it would not bind up. I also made dome hold down blocks to keep these equalizer bars down on the pins. I have not installed them yet but they are drilled to take 5-40 screws. I also started making the actuator cam from a piece of ½" x 3" flat. I bolted a piece of ¼ x 1 ¾ flat to it that will eventually connect to the linkage rod. I also had to grind off the stops from the tender frame that were originally installed.

1/18/99—I worked 8 hours today on the tender brakes. I made .045 thick brass plates between the steel pivot block and the aluminum crossmember that the trucks pivot on. I did this by punching a hole in the brass with the shim punch that Charlie made me and used the band saw to make the circle. I had to do some rework of the clamps that hold the equalizers onto the brake bars to allow the tender to turn a smaller radius. I then made the plate that the cam pivots on that is welded to the center of the tender frame. I made some 1.8 thick pads to weld onto the frame where the crossmember stops keep the tender from rocking from side to side too much. I made a spacer for the pivot bolt for the cam from 1" diameter 12L14. I also made a washer for the bottom of the pivot bolt form 1 ¼" bronze. I mounted the frame back on the trucks. I made a pivot block for the brake lever handle from a piece of ½ x 1" cold roll. I used a long ¼ roughing mil and cut full depth to make a slot for the handle and drilled and reamed for a piece of ¼ dowel pin for a pivot pin. I also made a block to connect between the cam lever and the handle. The equalizer bars may not be thick enough and I may need to reinforce.

1/23/99—I spent 4 hours today doing miscellaneous tasks. I installed the springs in the brake bars, spray painted the tender frame with Krylon, welded ¼ x 1 bars on top of the equalizer bars for strength. I also added a coupling nut with locknuts to be able to adjust the position of the brake handle. I also made an offset in the drawbar by cutting it in two and adding a section on top with a 1/8" spacer in the middle secured with 2 ¼-20 allen screws. I also turned the knobs for the top of the brake handle and drilled and tapped for 10-32. I installed the repaired blowdown valve on the water gauge. I removed the tube fittings from the oiler and put some Loctite thread compound on and reinstalled to stop the leak as the threads are not tapered.

1/24/99—I worked about 4 hours on miscellaneous tasks. I sawed up some of the stainless steel door parts and tig welded them together for a protective enclosure for the brake lever on the tender. I also made some ¾" angle clips and mounted them to the enclosure to mount them to the tender. I also drilled the holes and cut the slot for the brake lever. I also drilled the hole on the handle and mounted the buttons that I made last night. I cut a piece of ¼ plate 4" tall to close out the end of the coal bunker on the tender. I made a new coupling nut to adjust the brake lever to the correct position, I painted the brake lever enclosure and brake handle with Krylon.

1/30/99—I bought a 6" , 3 jaw, Buck chuck at the Flea market, brand new for 125 dollars so I spent the morning mounting it to a L00 adapter for the Clausing lathe. I did

spent 2 hours on the project. I made the shells for intake screens for the tender out of ¾" copper tubing. I cut off a length about 6" long and mounted it in the mill vise and milled lengthwise slots using the ½" mill cutter. I milled 2 slots on opposite faces of the tubing. I then turned the threads off one end of a 1/8" mpt by ¼" tubing brass fitting which turned out to be 3/8" od and then drilled a hole in the end cap for the copper tubing. I then silver soldered the fitting in the end cap. I then soft soldered the end caps on. I did have some combination paste flux/solder that I used to solder the one piece of brass screen that I had but I screwed it up in that I could not close up the small gap at the end of the screen at each end of the slot. I should not have made the slot so long as I only had one piece of screen. I will have to order more. I heated it back up and removed the screen.

1/31/99—Paul Brien stopped over today to look at the locomotive project. He brought me the pipe and formers for the steam dome and sand dome. The pipe is machined down to a very thin dimension and then sections are removed per the template and the remaining tips are heated and formed to the round aluminum former and then welded. The steam dome is made from 4" pipe and the sand dome from 3" pipe. I did a little work on the tender.

2/6/99—I worked at the Mid South Live Steamers track this morning and this afternoon I worked 3 hours on the locomotive. I finished the tender water intake filters for the injector and the axle pumps. I wrapped the ¾" copper pipe with 40 x 40 mesh brass screen and applied soft solder flux and soft soldered it after first tying it with small stainless steel wire. I then tapped the couplings in the bottom of the tender and installed 5/16 tubing elbows in them. I put a short section of tubing in them so I could put a piece of Tygon hose over them with a two wire spring clip. I also hand painted the coal box and bottom of the tender with a brush and Rustoleum Grill Black paint.

2/7/99—I worked 8 hours on the project. First, I sprayed the tender with Rustoleum Anodized Bronze paint to match the cab on the locomotive. It was a nice day but windy, so I sprayed it in the basement and then took it outside to dry. I then worked on the sand dome and steam dome. I marked out the "gores" on the sand dome which was already turned to dimension. The gores divided the top of the dome into 6 sections that kind of looks like the crown on the top of the Delta Queen smokestacks. Iused the bandsaw to cut along the lines of the gores one top and one bottom at the same time. I then heated the remaining tips red hot with the acetylene torch. I then put the aluminum former inside and clamped the outside former onto it. I beat the points down to the former grinding interferences as required. When I got the points together in the middle, I mig welded the tips together with the mig welder set on "14 gauge" metal. I had to make some metal with the mig welder as some gaps were too big. I then put it in the lathe after rough grinding it on the 6 x 48 belt sander. I finally filed it pretty smooth with files in the lathe. I then roughed out the bottom which will sit on top of the boiler lagging. I then clamped the bottom former in place and peened it over. I then put it in the lathe and made this section round. This completed roughing the sand dome. I the took a piece of 4" schedule 80 pipe and put it in the 10" chuck in the LeBlond lathe. I turned it down to 4.250 taking .050 cuts at .004 per revolution. This took a while as it took 6 passes 5" long. I then bored this same piece to 4.110 taking .025 cuts. This allowed the former to fit inside. I then layed out the end of this piece to cut 8 gores using an aluminum template. I cut these as well on the band saw. I started to weld these up but I ran out of time and will have to finish later.

2/11/99—I worked for an hour this afternoon since it was warm and still daylight when I got home. I took the welded up steam dome outside and used the Makita grinder to grind down the welds almost even with the base material. I then put it back in the LeBlond lathe and turned down touching off on the radius area. I blued it up with Dykem so I could see how it was progressing. I finally used files to smooth it. It still needs some finishing. I also opened the box with the Dynafile in it. This is a new tool from Enco that is like a hand held belt sander with belts 1/8 to ½" wide.

2/14/99—I worked 12 hours the last 2 days on the project. I finished turning down the "orange peel" end of the steam dome. I also marked off the end that will sit on top of the boiler lagging and milled away the excess and finished it with the belt sander. I then put it in the former and heated it with the acetylene torch and used a ball peen hammer to form it to the form. i then put it back in the LeBlond lathe and turned the edge that sits against the steam dome. I filed, sanded and used the Dynafile to smooth prior to paint. I also brush painted Ultrafillprimer on the domes before heating them with the cube heater. After sanding and applying an even coat of spray primer, I applied Rustoleum Anodized Bronze paint. I also drilled the holes to mount both domes to the boiler and an offset bar to get the steam dome in the correct position. I also bent and installed the tender pipingfor the water intake and pump relief line. I installed the domes, tender brake handle guard, and reinstalled the tender tank on the frame. I may have to move the tender back a little. I did measure my tender braking scheme for Paul to draw on cad.