

# LocoGear

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## Technical Bulletin - 14

November 28, 2003

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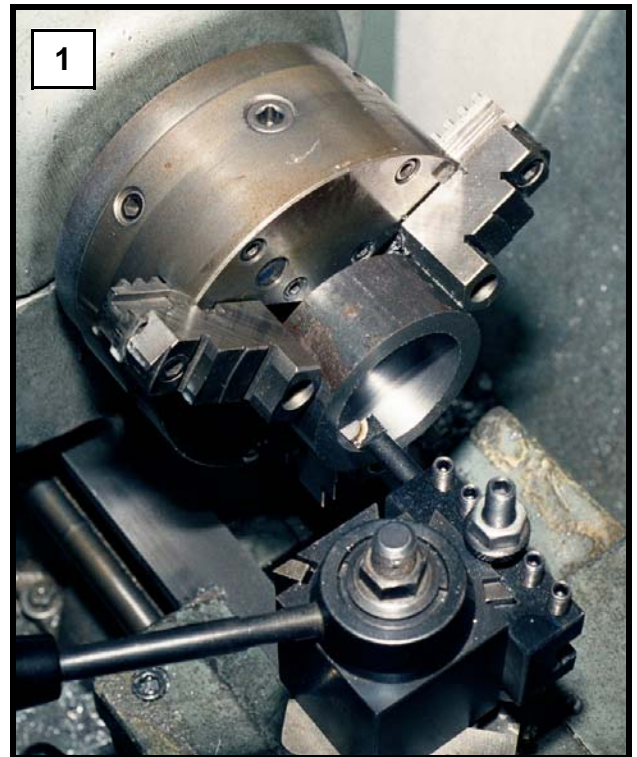


### **Machining and Fabricating Instructions for the Tender Water Tank Funnel Lima Card Number 882-A-5011**

The following instructions are for machining and fabricating the Tender Water Tank Funnel (Lima Card Number 882-A-5011) which was used on both the **Greenbrier, Cheat & Elk Railroad #12** and the **Western Maryland Railway #6**. The Tender Water Tank Funnel is located on the top of the Tender Water Tank and is the opening used by the engine crew to fill the tank with water. Only one Tender Water Tank Funnel was used on each Shay.

A scale drawing of the Tender Water Tank Funnel is on page seven. Lima originally fabricated the Tender Water Tank Funnel from 1/4" steel plate and 2" x 2" x 1/4" steel angles riveted together. For the live steam model, this part can be in part machined from steel bar stock and also fabricated from 16 gauge steel plate and .063" thick wall square tube stock.

Since it would be very difficult to bend scale angle iron and plate to the curved shape around each end of the Tender Water Tank Funnel, these curved portions will be machined as a ring from steel bar stock. These curved angles and plates will thus be simulated in one piece. Both ends of the Tender Water Tank Funnel will be turned together and then cut apart providing the two curved ends. Then the center straight portions will be fabricated much like the prototype. The straight sections will be brazed together with the curved ends. Finally, the lid with hinges and handle will be fabri-

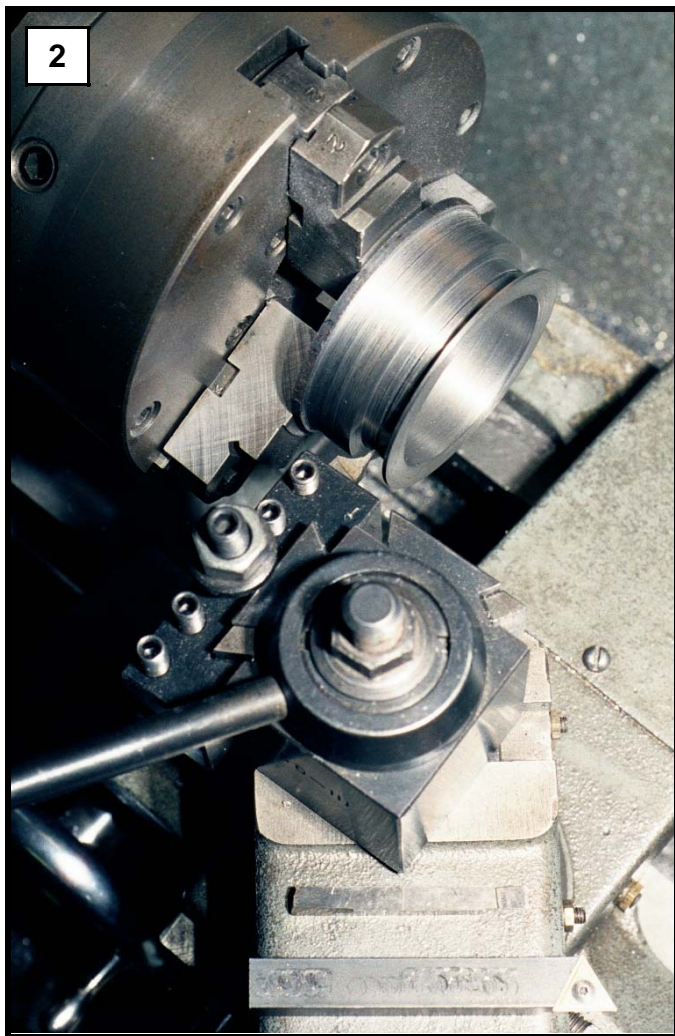


cated from 16-gauge plate and 1/4" and 1/8" diameter welding rod. We will also use 1/16" diameter x 1/4" long round head steel rivets.

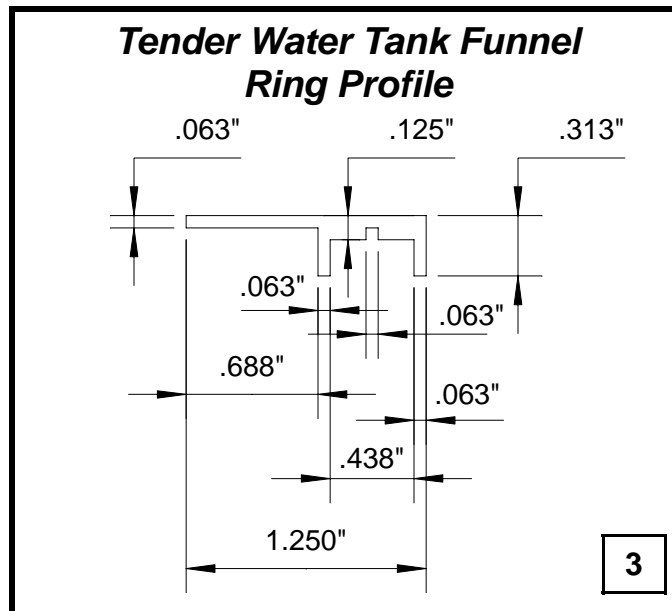
#### **Model Construction Instructions:**

1. The curved portions of the Tender Water Tank Funnel are machined as a ring from a piece of 3" diameter steel bar stock rough cut to approximately 1-3/8" long. Clamp

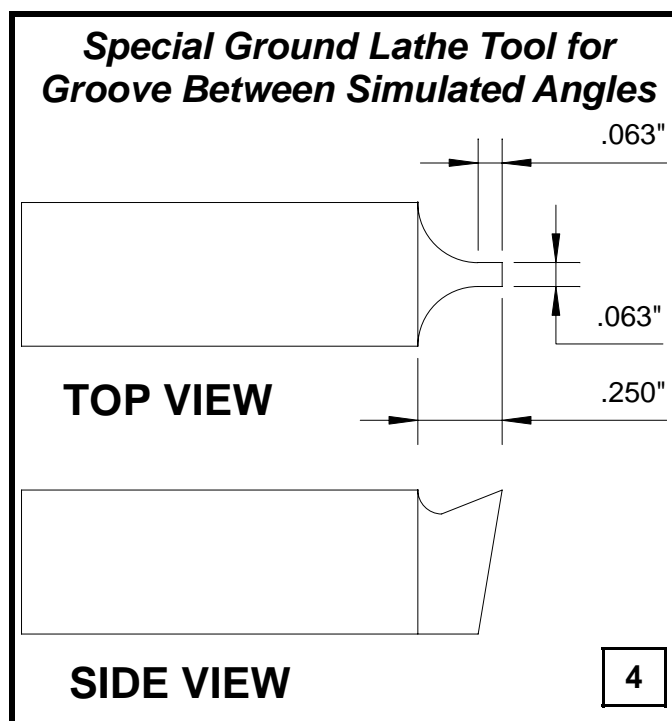
the rough-cut piece in a 3-jaw lathe chuck and face the end. While still clamped in the 3-jaw lathe chuck, center drill a hole, and drill through with successively larger drills until a boring bar can be used to open up the center hole to 2.250" diameter (see photo 1). Do not finish the outside surface of the Tender Water Tank Funnel ring at this time.



2. Next reposition the Tender Water Tank Funnel ring in the 3-jaw lathe chuck clamping it on the inside surface of the center hole with the finished end against the chuck. Face off until the length of the Tender Water Tank Funnel ring is 1.250" long.
3. With the Tender Water Tank Funnel ring still clamped in the 3-jaw lathe chuck, begin turning the outside diameter down to 2.875" diameter over to as close to the chuck as is safe to work. You do not need to finish the entire Tender Water Tank Funnel ring all the way to the chuck end at this time.

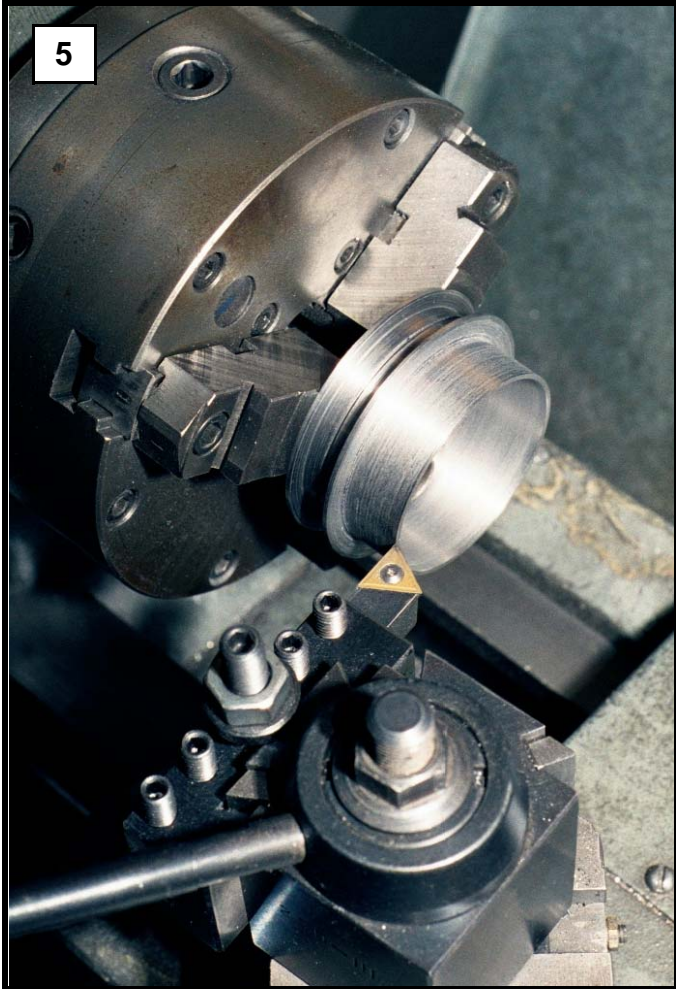


4. With the Tender Water Tank Funnel ring still clamped in the 3-jaw lathe chuck, begin to cut out the space where the simulated angles are located. The edge away from the chuck will be the top of the top simulated angle. Beginning 0.063" from the end of Tender Water Tank Funnel ring, cut a groove 0.438" wide and 0.188" deep, giving a 2.500" diameter to the ring in this area (see sketch 3). Several different lathe tool bits will be needed to cut each surface. A left hand and right hand tool as well as a flat front bit and a special ground bit made in step 5 (see photo 2).

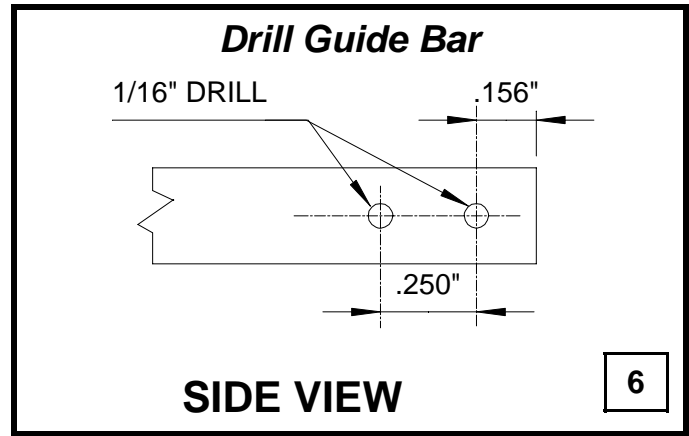




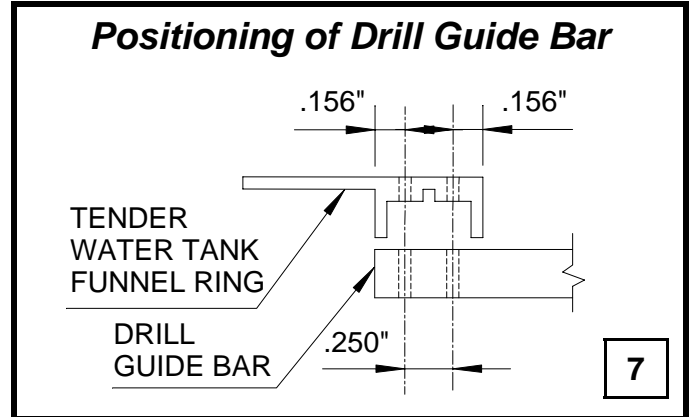
- With the Tender Water Tank Funnel ring still clamped in the 3-jaw lathe chuck, use a special ground lathe tool bit with a 0.063" wide flat edge to cut the space between the top and bottom simulated angles 0.063" deep (see sketch 4). A narrow cut-off tool could also be used to make this flat bottom cut.



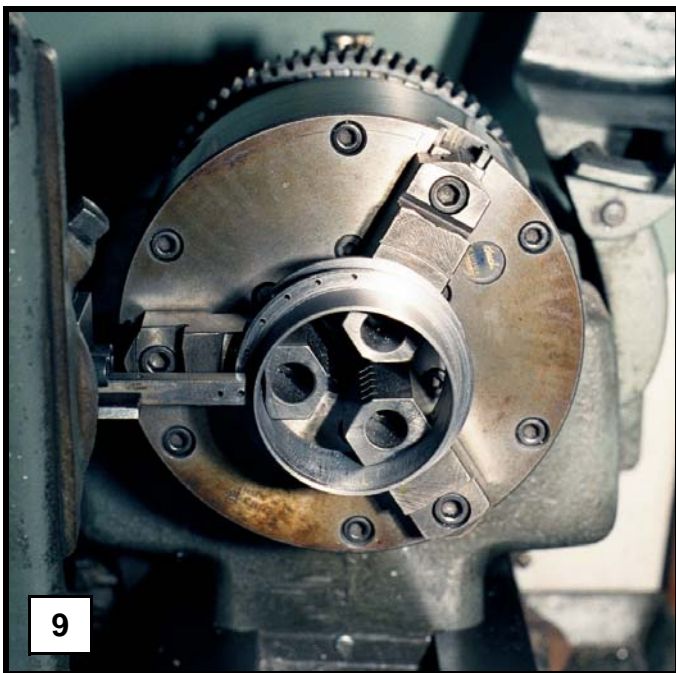
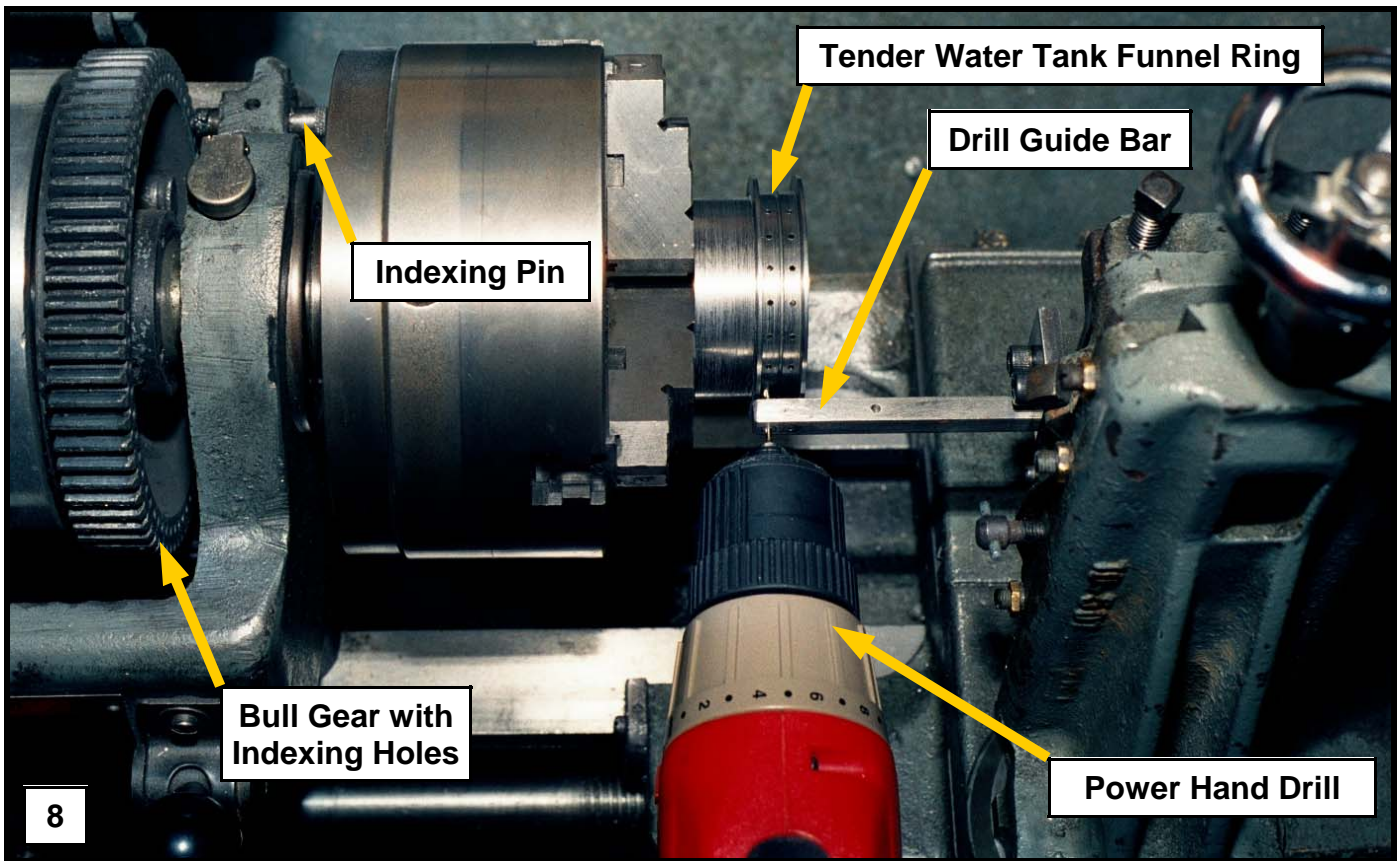
- Next reposition the Tender Water Tank Funnel ring end for end in the 3-jaw lathe chuck with the top of the Tender Water Tank Funnel ring against the chuck. Begin turning down the outside diameter to 2.375" and 0.688" from the end (see sketch 3). This will leave the 0.063" wide flange for the bottom simulated angle. Be careful to take light cuts as you get close to the finished size as the wall of the Tender Water Tank Funnel ring is getting thin and will only be 0.063" thick when you are done (see photo 5 and sketch 3).
- This completes the lathe turning of the Tender Water Tank Funnel ring, but we will use the indexing features of the lathe to drill the 58 rivet



holes necessary in the ring. First make a drill guide from a scrape length of 1/4" x 1/4" square steel bar stock. Drill two 1/16" holes through near one end of the bar 0.250" center to center. The first hole should be centered no more than 0.156" from the end of the bar (see sketch 6).



- Place the Tender Water Tank Funnel ring back in the 3-jaw lathe chuck with the top facing away from the chuck so that the drill bit will not contact the chuck jaws on the inside when the rivet holes are drilled through the simulated angles. Position the drill guide bar along the side of the Tender Water Tank Funnel ring so the holes line up in the center of each of the vertical flanges of the simulated angles (see sketch 7). The drill guide bar can be held in place with the tool post or a milling attachment (see photo 8). The holes in the drill guide bar should also be lined up with the center line of the lathe so the holes will be drill perpendicular to the central axis of the Tender Water Tank Funnel ring.
- We will use the indexing holes in the lathe spindle bull gear and the indexing pin in the lathe head stock housing for the proper stepping

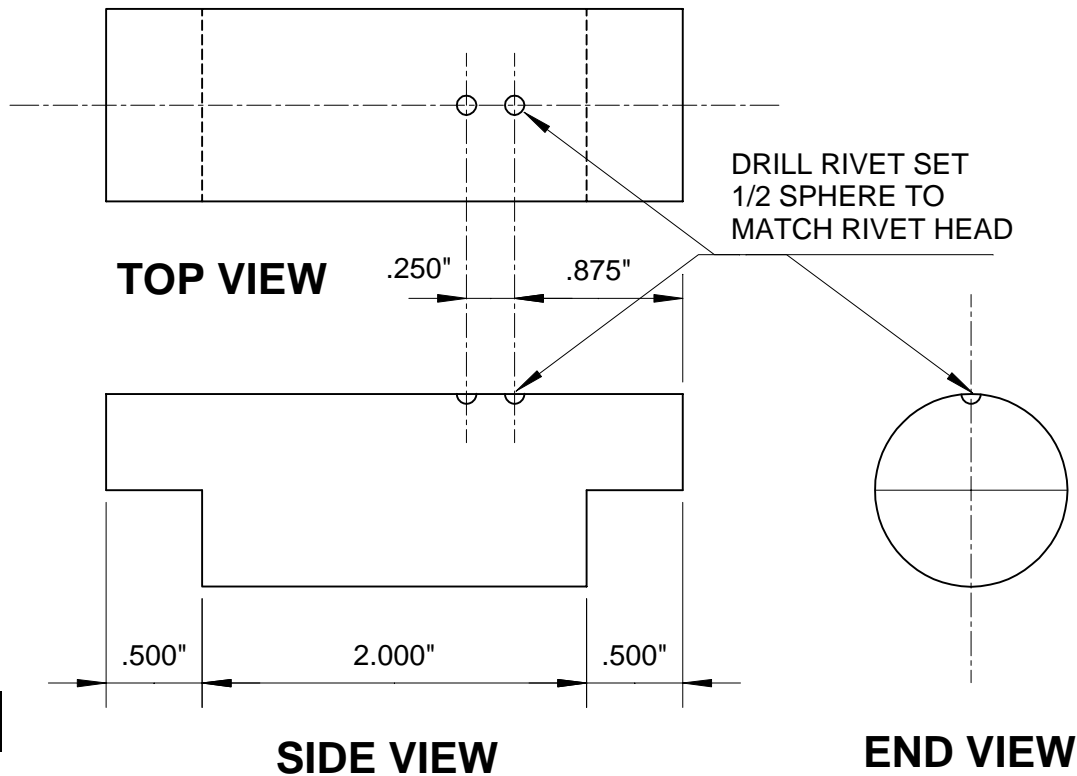


of the holes around the Tender Water Tank Funnel ring. The spacing should be approximately 3/8" center to center. Twenty evenly spaced holes works out to about this spacing which is 18-degrees apart. The bull gear in our lathe has 60 indexing holes, so we will use every third hole to achieve 20 steps around the

Tender Water Tank Funnel ring. Use a 1/16" drill bit in a hand held power drill to make the holes drilling through the drill guide bar. Continue to rotate by hand the Tender Water Tank Funnel ring, stopping at each of the 20 designated points around and drill both holes at each location (see photo 8).

10. Next reposition the Tender Water Tank Funnel ring end for end in the 3-jaw lathe chuck with the top against the chuck. Position the drill guide bar so the end hole lines up with the underside of the bottom simulated angle's horizontal flange. The rivet holes to be drilled here should be 0.094" from the outside edge of this flange and 0.156" from the Tender Water Tank Funnel vertical plate. The end hole of the drill guide bar was located 0.156" from the end, so the end of the drill guide bar can rest against this plate (see photo 9). These rivet holes should not be positioned in line with the vertical holes, but rather spaced half way in between to provide enough room for riveting tools to be inserted later. Use a 1/16" drill bit in a hand held power drill to make the rivet holes through the drill guide bar. Continue to rotate by hand the Tender Water Tank Funnel ring, stopping at

## Special Tender Water Tank Funnel Ring Rivet Set



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each of the same 20 indexing points around and drill a hole at each location. However, skip drilling two of the holes, opposite each other, at this time for a total of 18 holes. Just mark their location with the tip of the drill bit. Don't drill all the way through the simulated angle flange at these opposite points. Holes here would interfere with cutting the Tender Water Tank Funnel ring in half in step 13, so they can be left out at this time and just marked .

11. A special rivet set is needed to form the 1/16" diameter rivets in the simulated angles on the Tender Water Tank Funnel ring. Use a scrap 3" long, 1" diameter, cold rolled steel round bar. Cut a 1/2" x 1/2" notch in each end (see sketch 10). These notches can be rough cut and do not need to be finished as they will be used to clamp the rivet set in the jaws of a bench vise when used. Drill two half spheres 0.250" center to center along the top center line of the round bar to match the size of the rivet head. The first sphere should be no closer than .875" from one end of the bar. A 1/8" Dremel ball end mill will work for this purpose. Test drill in scrap material to gauge the proper depth of

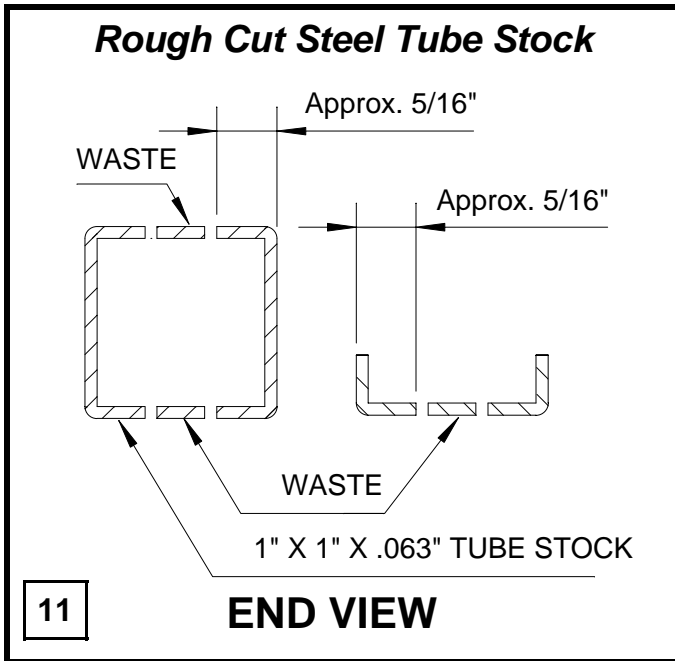
the hole to fit the head of a rivet.

12. The next step is to form the 40 rivets in the vertical flanges of the two simulated angles of the Tender Water Tank Funnel ring. Do two rivets at a time, one on each of the simulated angles. Insert the rivets with the head on the inside of the Tender Water Tank Funnel ring. Slide the special rivet set inside the ring and clamp it with the jaws of a bench vise. Position the Tender Water Tank Funnel ring over the rivet head holes in the rivet set with the two rivets aligned in the holes. Then with a forming rivet set strike each rivet to form the new head on the outside of the Tender Water Tank Funnel ring. Then remove the special rivet set from the bench vise and insert the next pair of rivets. Continue around the Tender Water Tank Funnel ring until all rivet holes have been filled and the 40 rivets formed.
13. Layout a cut line to cut the Tender Water Tank Funnel ring in half through the two points marked but not drilled through in step 10. Use a power band saw with a metal cutting blade to cut the Tender Water Tank Funnel ring in half. You want to take great care to make these cuts



parallel to the axis of the Tender Water Tank Funnel ring.

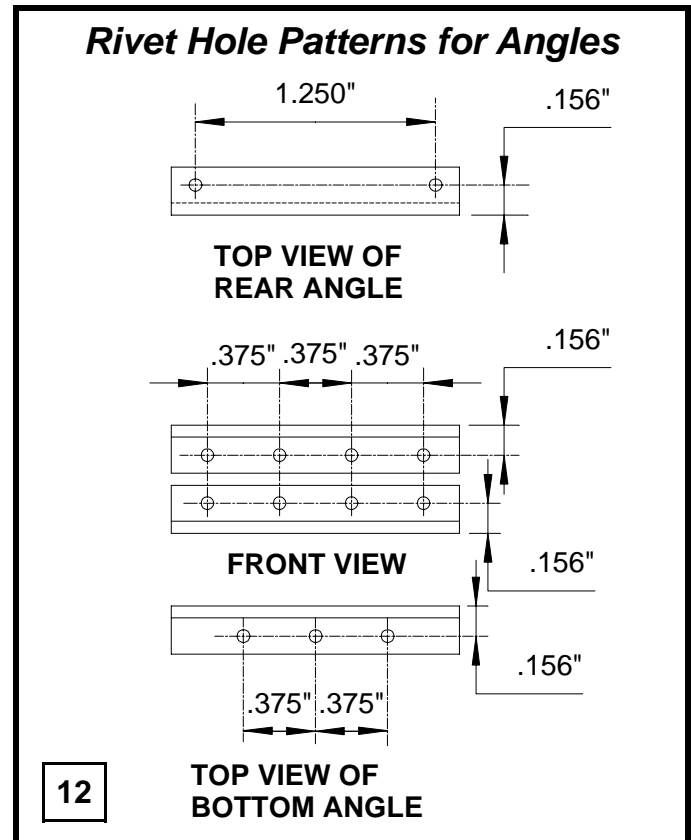
- Next we will fabricate the straight sections of the Tender Water Tank Funnel. Cut two pieces of 16 gauge steel plate to 1.250" x 1.500" plus the width of the saw blade kerf. Check the length of these plates by placing them between the cut halves of the Tender Water Tank Funnel ring and measure the overall dimension. Make a note of the length of these plates as we will next make the four angles to the same length.



- Since  $\frac{1}{4}$ " x  $\frac{1}{4}$ " x  $\frac{1}{16}$ " angle is not a commercially available stock item, we will fabricate the angles by cutting out the corner portions of a 1" x 1" x .063" thick wall square steel tube stock. Take care to select square steel tube stock with the sharpest outside corners as you can find. Some tube stock has more rounded corners which will not look good on a model. This same method can be used in many other parts on the live steam model of the **Western Maryland Ry. Shay #6**. Rough cut a length of the square tube stock longer than four lengths of the plate made in step 14, or approximately 6½" long. Draw two lines along the length of the square steel tube stock approximately 5/16" in from adjacent corners. Rough cut along these lines using a power band saw with a metal cutting blade through both the top and bottom of the tube walls (see sketch 11). Next take each of the "U" shaped pieces and draw two lines

along the length of the piece on the inside approximately  $\frac{1}{4}$ " from the inside corners. Rough cut along these lines using a power band saw with a metal cutting blade (see sketch 11). The result will be four lengths of angle and four pieces of waste.

- The four rough cut angle pieces are next milled to their final dimensions. Clamp the rough cut angle piece in a milling vise and mill off each leg of the angle to the finished width of 0.250". Next cut the four angles needed to the same length as the steel plates in step 14 for the straight portions of the Tender Water Tank Funnel.



- All four angles have four rivet holes each drilled on the vertical legs at 0.375" center to center. Both bottom angles each also have three rivet holes on the horizontal leg located half way between those on the vertical leg. The rear top angle only also has two rivet holes located for the door hinges (see sketch 12). Note that since the length of the angles is an odd length (1.500" plus the width of the band saw blade kerf), take care to position the rivet holes with equal distances from the ends of the angles to the first and last rivet holes. Use the



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# Western Maryland Railway Shay #6

Tender Water Tank Funnel

Lima Card Number 882-A-5011

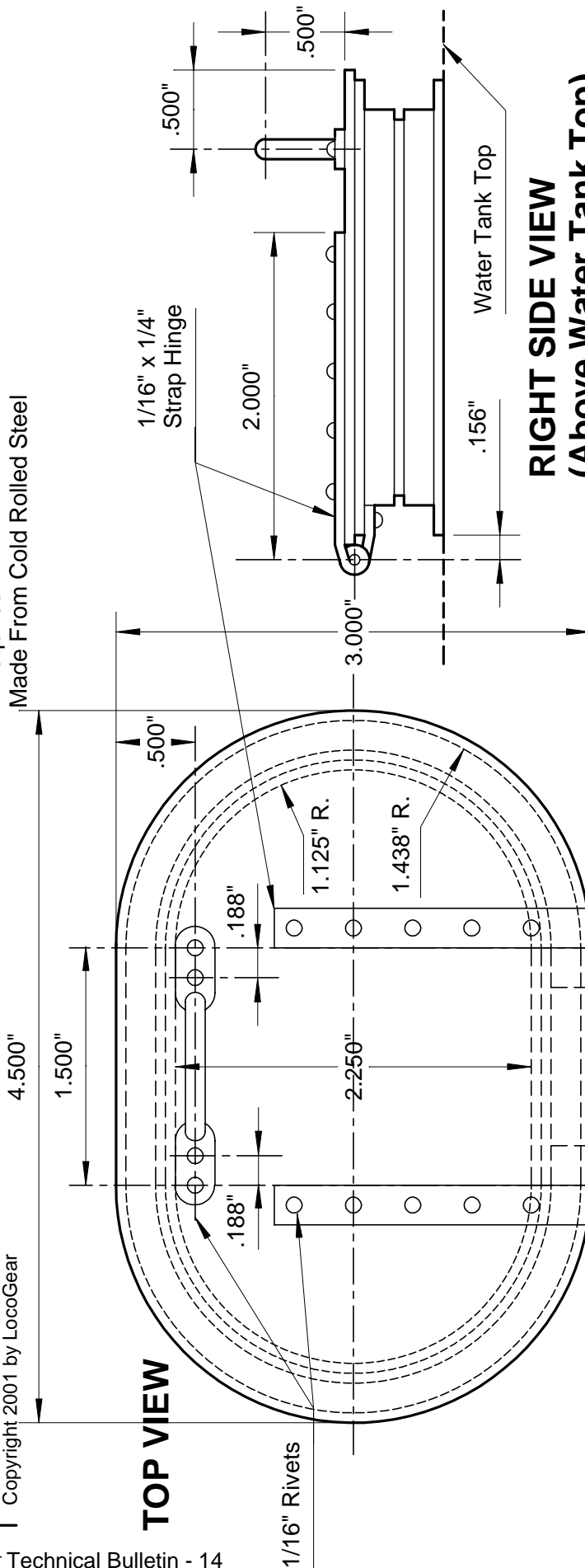
Drawn by John D.L. Johnson 2/5/2002

1 Required

Made From Cold Rolled Steel



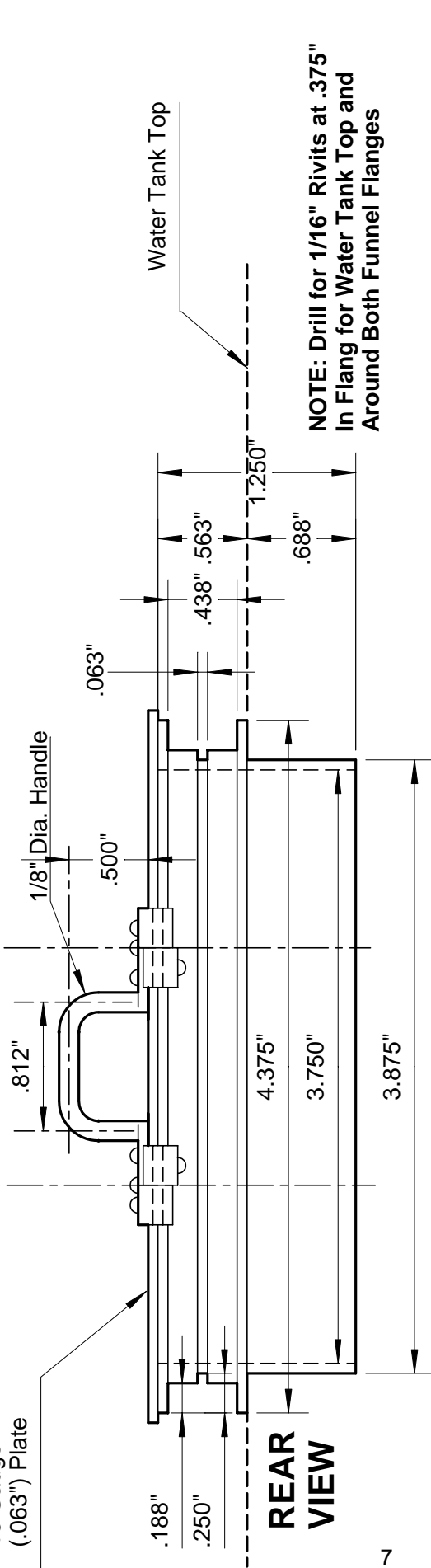
## TOP VIEW



1/16" Rivets

16 Gauge  
 (.063") Plate

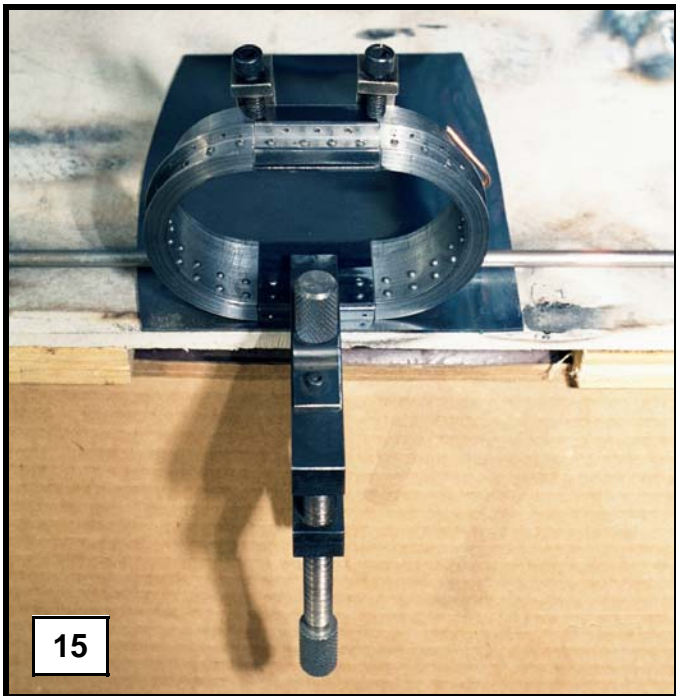
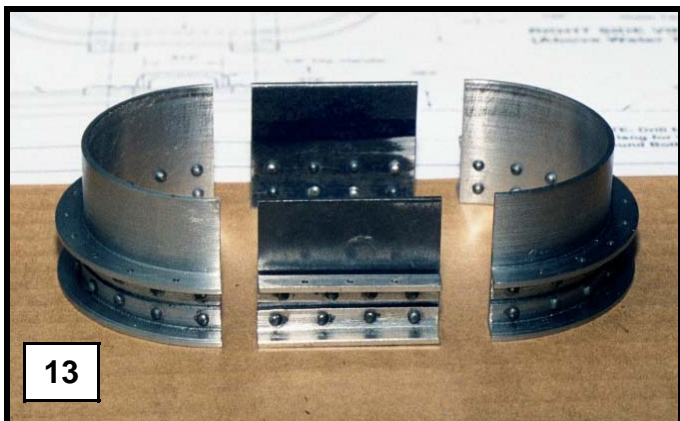
## RIGHT SIDE VIEW (Above Water Tank Top)



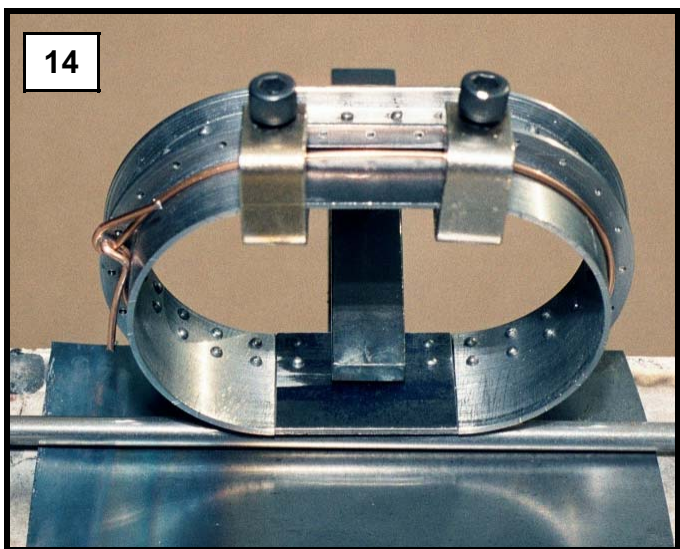
## REAR VIEW

**NOTE: Drill for 1/16" Rivets at .375" In Flang for Water Tank Top and Around Both Funnel Flanges**

angles as drill guides to drill the corresponding rivet holes in Tender Water Tank Funnel plates. Rivet angles to plates with 1/16" diameter x 1/4" long round head steel rivets (see photo 13).



18. Next we will braze together the two Tender Water Tank Funnel ring halves with the straight plates. Prepare the joints by filing a slight chamfer on the inside edges of the joints. To hold these together for brazing, wrap a piece of 1/16" diameter welding rod around the outside just below the bottom angle. Hook the ends of the welding rod together tightening for a firm



grip on all parts (see photo 14). Place the assembly on its side, on top of a 1/4" steel plate, and a 1/4" diameter steel bar to support the bottom of the Tender Water Tank Funnel plate, and clamp to the edge of the welding table with a parallel clamp (see photo 14 and 15). Additional clamps may be needed to hold assembly together as required. Braze together by applying bronze to the two joints on the

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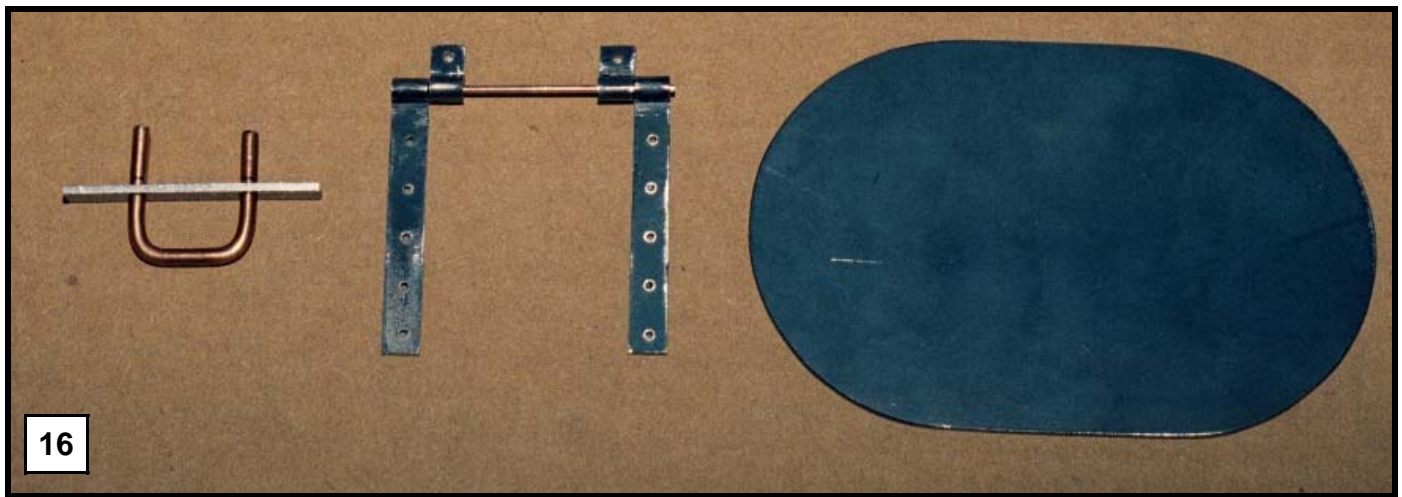
inside of the Tender Water Tank Funnel. Turn assembly over, re-clamp to edge of the welding table, and braze the remaining two joints. Remove welding rod wrapped around the Tender Water Tank Funnel, chip off any flux and wire brush all over.

19. The Tender Water Tank Funnel lid is made from a piece of 16-gauge steel plate cut to 3.00" x 4.500" with 1.500" radius ends as shown in the scale drawing on page 7 (see photo 16).

20. The hinges are also made from a piece of 16-gauge steel plate cut to 0.250" wide and about 6" long. Begin making the hinges by forming the curved portions of the long hinge sections, bending both ends of the 0.250" hinge plate around a scrap piece of 1/16" diameter welding rod. This is miniature blacksmithing work. Use a bench vise and hammer to make the bends. The 16-gauge plate is thin enough that it can be formed cold. Make a tight curve around the welding rod (see scale drawing on page 7). Once you are happy with the appearance of the curved ends, cut the long hinges to length. With the remaining center piece of 0.250" wide hinge plate, form the short hinges in the same way and cut to length. Clean up the edges of the plate around the bend with a file. Drill the rivet holes in all hinge pieces as shown in the scale drawing on page 7 (also see photo 16).

21. Next we will assemble the hinges. The two rivet holes on the top rear angle made in step 17





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should be countersunk slightly on the top of the top angle. Insert rivets from the bottom holding the short hinge pieces to the underside of the rear top angle. Bend the protruding rivet ends to hold the short hinges in place. Braze the two short hinge pieces in place by applying bronze from the top allowing it to flow into the countersunk rivet holes and spill over the edge of the angle to bond with the small hinge pieces. Be careful not to use too much bronze as you do not want to fill the hinge pin hole. If you do, just drill out the hinge pin hole later. Also be careful to not over heat the Tender Water Tank Funnel and open up the joints made in step 18. Chip off any remaining flux and file the bent rivets smooth with the top surface of the Tender Water Tank Funnel angle.

22. Next we will assemble the long hinge pieces. Insert two 1/2" long 1/16" diameter pieces of welding rod into the two short hinge pin holes and slide on the two long hinge pieces onto the pins. Position lid on top of the Tender Water Tank Funnel and fold the two long hinge pieces down to the top of the lid. With a square, line up the long hinge pieces across the lid. Use the rivet holes drilled in the long hinge pieces as drill guides to drill corresponding rivet holes through the lid. The two rivet holes closest to the hinge pins may be above the rear angle, so do not drill all the way through the lid, just mark them at this time. They can be drilled through later with the lid swung away from the Tender Water Tank Funnel. These rivet holes over the rear angle will also need a slight countersunk on the underside of the lid so these rivets can be made flush. Rivet the long hinge

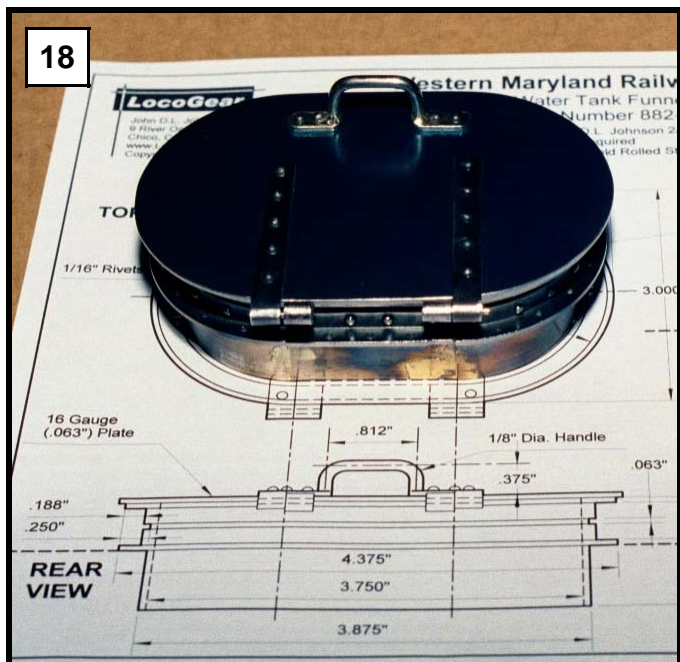
pieces in place on the Tender Water Tank Funnel lid (see photo 17 and 18).

23. The last part to be made of the Tender Water Tank Funnel is the handle. Start with a piece of 16-gauge steel plate 0.250" wide and about 2" long. Place this plate in a milling vise and drill two 1/8" diameter holes 0.812" center to center, centered along this piece. Next bend a piece of 1/8" steel welding rod in the shape of the handle and insert it through both holes so the top of the handle is 0.500" above the top surface plate (see photo 16). Clamp this in a welding vise with the handle facing up and the projections down in between the jaws of the vise. Braze the handle to the plate. Be careful to only use enough bronze to achieve a 1/32"



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radius fillet around the bases of the handle where it passes through the two holes. Chip off any remaining flux and wire brush all over.



24. Return this handle assembly to the milling vise and drill the four 1/16" rivet holes in line with the handle and located as shown in the scale drawing on page 7. Next cut away the plate under the handle and file the four rounded ends of the plate forming the handle bases. Use the rivet holes on the handle to locate and drill corresponding rivet holes on the Tender Water Tank Funnel lid. Rivet the handle to the lid (see photo 17 and 18).

This concludes the machining and fabrication instructions to make the Tender Water Tank Funnel. Installation of the Tender Water Tank Funnel will be covered in the LocoGear Technical Bulletin on the fabrication of the Tender Water Tank.