Shay Plumbing X -Whistle

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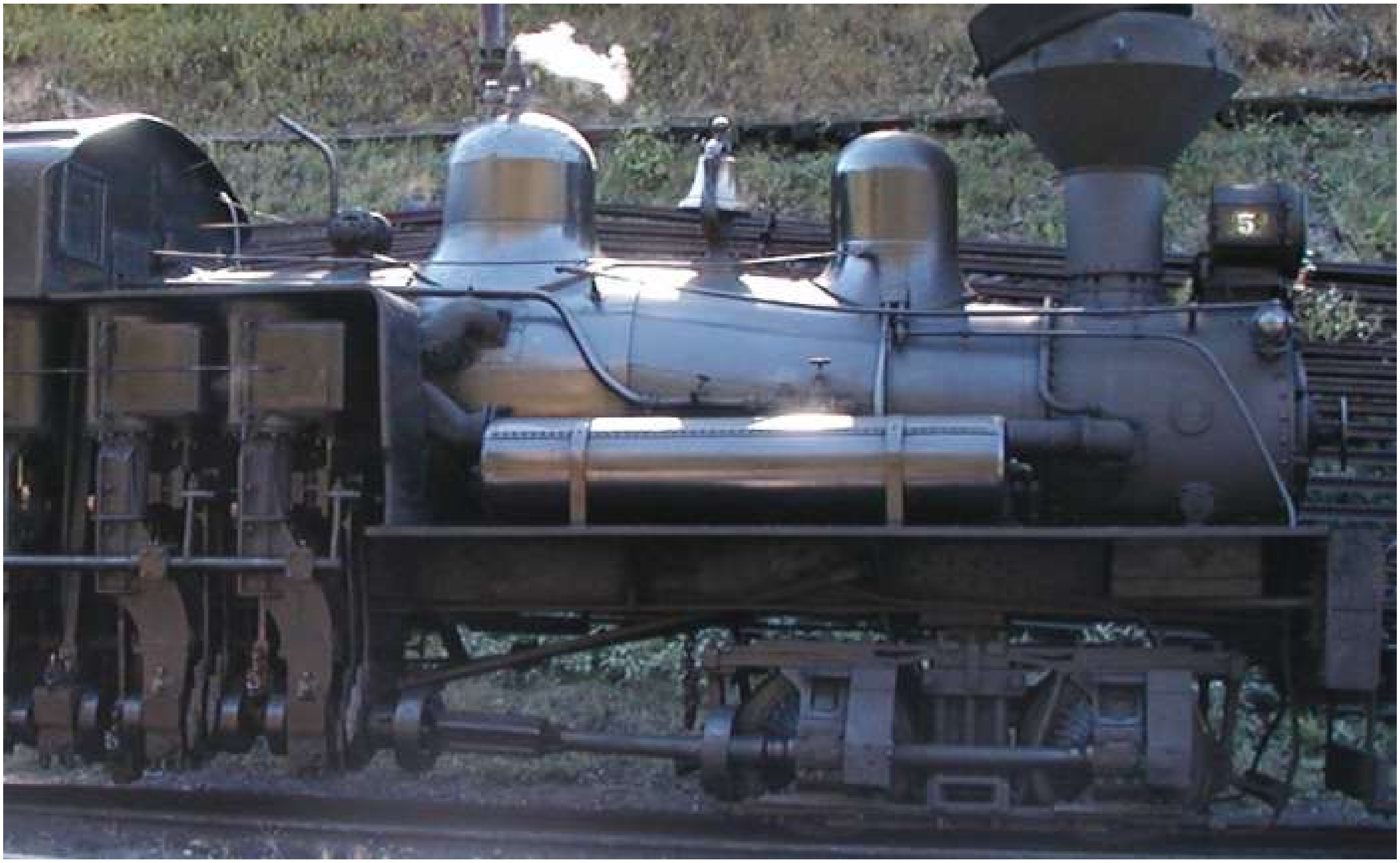
There's snow on the ground and it's too cold to do any more steaming tests so decided to do some of the unfinished plumbing (before the spouse finds something to keep me busy). The whistle valve will finish off the shelf above the rear cylinder and the whistle will help with laying out the right running board.

Some months ago I learned that the air tank on the right side of Kenneth's locomotive was really a whistle. I then read The Whistle chapter in SO YOU WANT TO BUILD A LIVE STEAM LOCOMOTIVE (referred to as the text in the following description) and learned that whistle can't be scaled without raising the pitch. A design using a 1.5" piece of thin-wall plumbing pipe about 10 inches long is presented and seems to match the design used by Kenneth. Castings for this whistle are available from Coles. This design divides the tube into four sections of different lengths to make a four tone or four chime whistle. The overall whistle length determines the lowest frequency tone. The tube diameter is related to the whistle volume.

Next, some photos of the the Cass Shays were examined to try to determine the size of the air tank. The next photo shows the tank on Cass 5, which scales to about 10 inches long and a little over 2 inches diameter.



The next step was to check out the various tone combinations listed in the text and to select one for the Shay whistle. I tried some of the variations of the 4-chime cords on the organ. Have to admit that none sounded very good and none sounded like a whistle. (I'm tone deaf so not surprised with this result.) The whistle chapter was written by J F Nelson and he mentioned experimenting with variations so decided that the whistle listed as the one he used would be a reliable choice. The tones and tube lengths for J F Nelson's whistle are:

Tone	Length (inches)
F# (349 Hz)	9.1
A (440 Hz)	7.75
C (523 Hz)	6.5
D# (622 Hz)	5.4

The text mentions that these lengths are correct for steam. (Suspect that if you try formulas from your old college physics text that are for air you'll get different lengths.)

So, the whistle will be about 10" long including the throat assembly ----- a close match to the air tank on Cass 5. The next task was to determine the diameter. I wanted to make it about 2" diameter but suffered sticker shock when checking out the price of 2" OD brass tubes. And then there's the brass rod needed to make the throat assembly. Some brass strips are also needed for the vanes inside of the tube; the strip width the same as the tube OD. I was designing a steam powered water pump at the same time as I was working on the whistle and had decided to use some 2" OD brass rod (~$40 a foot) and 2" X 1/8" brass strips for the pump. I found a 2" OD - 1 7/8" ID stainless steel tube from McMaster-Carr for about $12 so decided to go with a 2" OD whistle.

Those of you with Nelson's text can refer to the drawings in The Whistle chapter. I don't want to reproduce those drawings here as it'd likely violate the copyright. Besides, that text is a wealth of information for us novices so advise you all to go buy one. In place of the drawing I'll show the sub assemblies first and then show how some of the pieces were fabricated.

The vanes and the ends are made from the 2" X 1/8" strip. The tube is 2" OD Stainless steel. The vane assembly is pressed into the tube and the throat (on the left) is screwed onto the end of the vane assembly. The throat is turned from 2" OD brass rod. The hole in the throat is threaded 3/8"-24 matching the 1" long stud on the end of the vane assembly. The throat is 7/8" long with a 1.67" diameter recess bored 7/16" deep. The nipple is 1/4" MTP. The left 1/2" of the vane assembly is turned to 1.66" (0.10" less than the recess in the throat) with the end plate turned at a 45 degree angle.

Cutting the Vanes and Ends: The brass strip was cut on the band saw and then squared off using the end mill as shown on the right. The vanes were cut 1/8" longer than the longest length in the table above to allow for 1/16" deep slots in the end pieces.

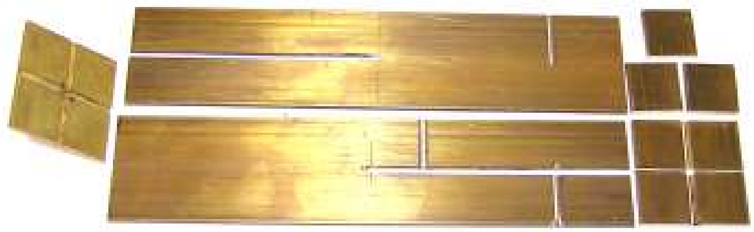
This shows milling the 1/8" wide 1/16" deep slots in one of the ends.

This shows cutting a 1/8" wide slot half the length of one of the vanes. Each vane has one of these cuts.

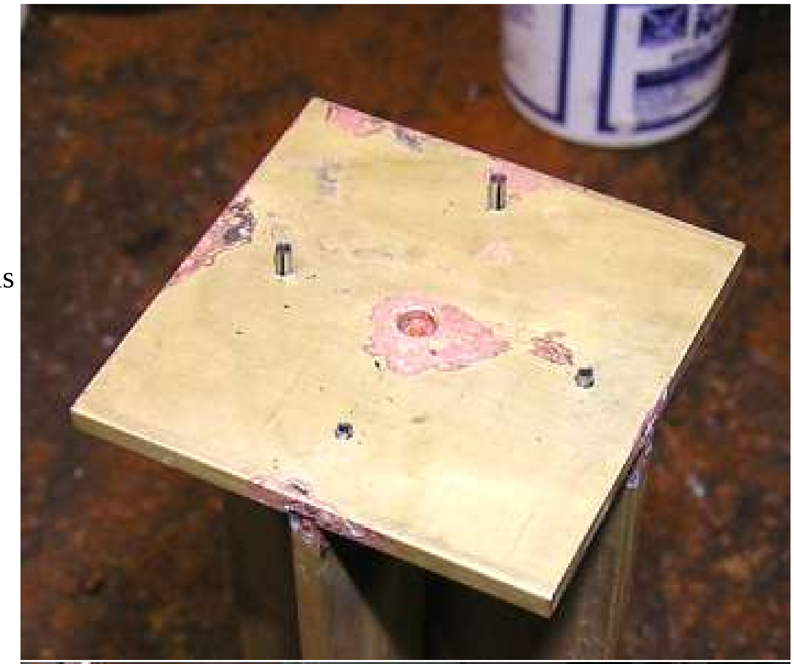
Slots were milled 1/16" deep in the vane to accommodate the stops for the higher tones. The length show in the table above was adjusted 1/16" to allow for the slot in the throat end.

The 3/8 stud was silver soldered in the throat end.

This shows the parts of the vane. The little squares on the upper right are the stops for the higher tones.



Assembling the Vanes: The assembling was started by silver soldering the vanes to the head end as shown on the right.



Next, 1/16" holes were drilled through the head end into the vanes and stainless steel roll pins driven into the holes to hold the end in place when the stops are soldered to the vanes. At this point I had planned to silver solder the stops. However, lower temperature solder was used on the rest of the vanes so these pins weren't necessary. The hole in the center is for holding the end with the lathe tailstock center.   It'll be used later for a fake air pipe.

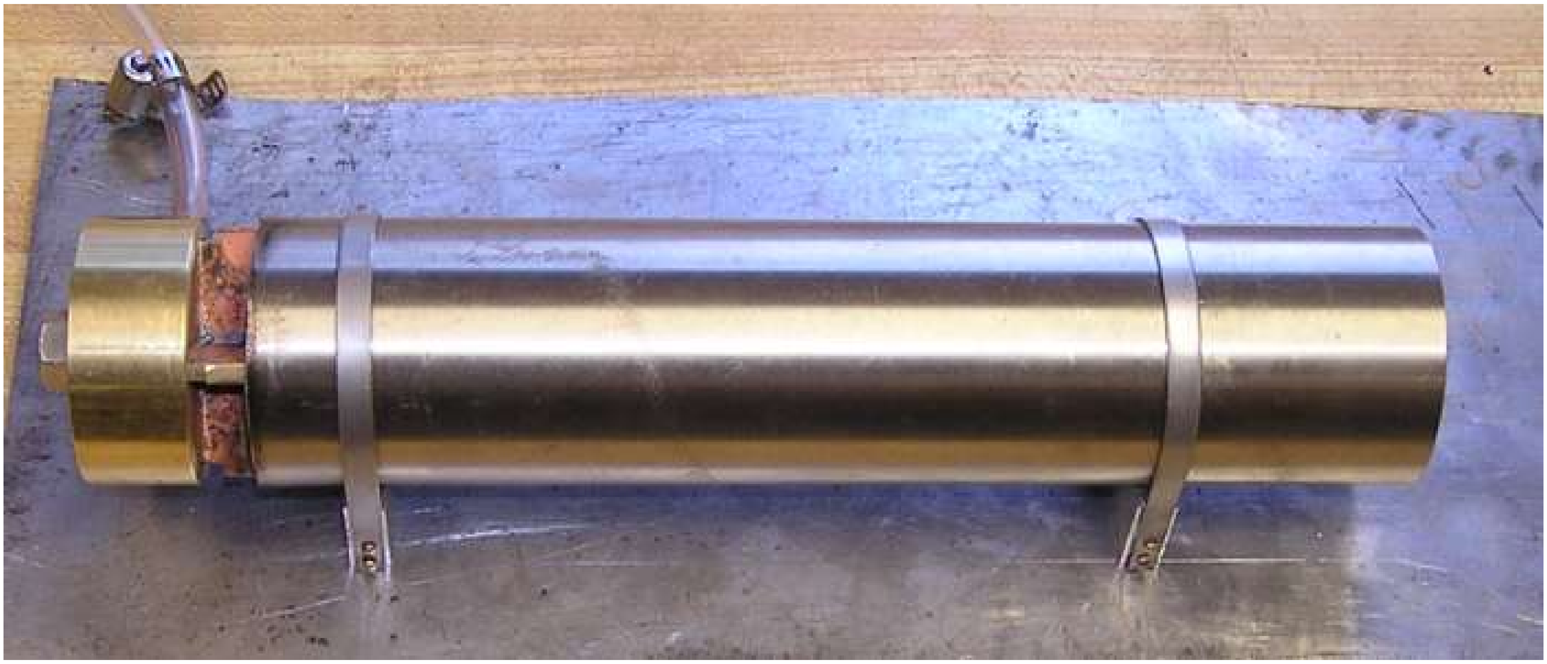
The throat end was silver soldered in the same fashion as the head end. Next, the stops were soldered in using 550 degree soft solder. I plan to power coat the whistle (~ 400 degree curing temperature) otherwise, I'd have used the more common 350 degree soft solder. The stops were soldered one at a time and then secured with 1/16" roll pins. After the three stops were in place and pinned, the seam in the center of the vanes was soldered. (The pink color is from the ruby flux used with the soft solder.)

The assembly was then mounted in the lathe and turned to an OD that was 0.001" larger than the tube ID.

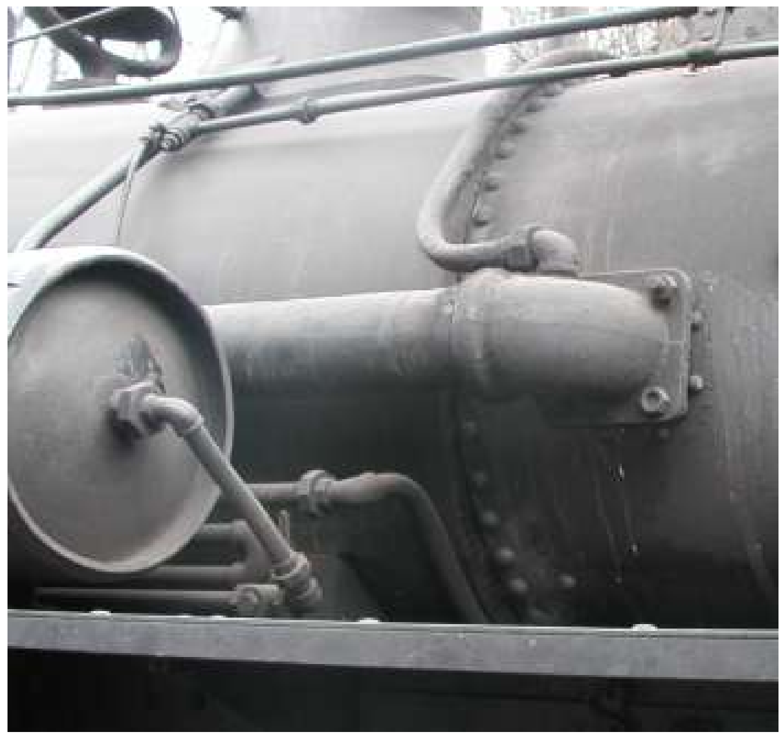
The 1/2" length of the throat end of the vane was turned down 0.010" smaller than diameter of the recess in the throat (~1.67") and the edge of the throat end piece was turned at a 45 degree angle.

The finished vane assembly is shown on the right.

The next step was to press the vane assembly into the tube. I used a 0.001" interference ----not much. The plan was to use a little Loctite if it was loose.   I heated the tube to 400 degrees in the oven, held it with a thick towel and slid the vane into position. After the tube cooled (or vanes warmed) the vane was held firmly. The throat was then screwed on.   The next photo shows the assembled unit.



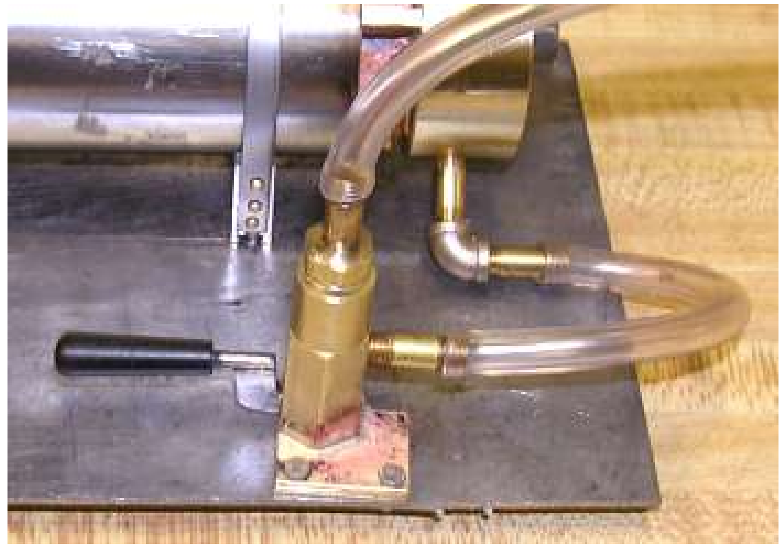
Finishing the End: The ends of the tube purchased from McMaster-Carr were cut square. I couldn't saw the end square and it couldn't be mounted easily in the lathe so I cut the tube extra long, inserted the vane and then mounted the assembly back in the lathe (using the same setup as used to turn the vanes) and turned the end of the tube flush with the head. If I would have checked the photo on the right I'd have left the tube stick out about a quarter inch to give a recessed end. Maybe next time.....



Mount: The mounting blocks were cut from aluminum. The photo on right shows a fly cutter being used to mill a 1" radius recess in a 1" thick aluminum block. The block was later sawed in half and the halves milled to a width of ~0.28".

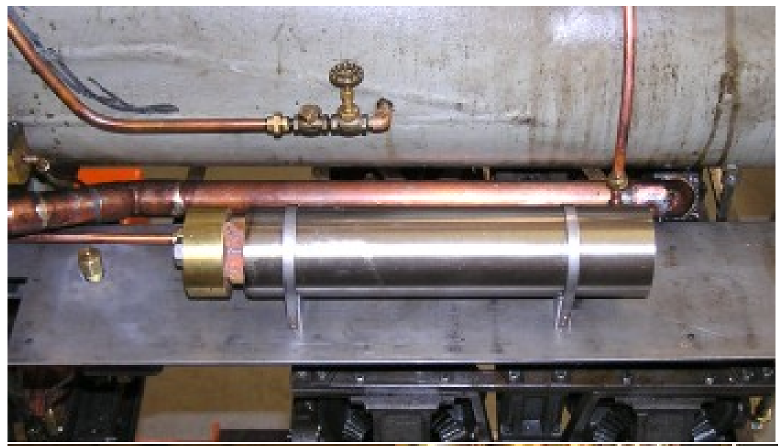
This photo shows a strap and a finished block. The strap is 0.25" wide 0.046" stainless steel. I don't have a shear so I sawed the piece extra wide on the band saw and then finished the edge on the mill. The screws are 4-40 stainless steel. The heads were cut off the screws, ends pounded flat with a hammer and secured to the straps using 1/16" brass rivets. The screws and rivet ends were then silver soldered to the straps. The recesses in the ends of mounting block are for the screws at the ends of the straps. This scheme gives a very nice overall appearance.

Valve: The setup shown on the right was used to test the valve and whistle. The valve follows Kenneth's design except for the operating lever. The black part of the lever was turned from a Delrin scrap. The elbow next to the whistle has a small hole (#56 drill) as per the text. The hole is to drain any condensate; apparently one doesn't want to wet this whistle.

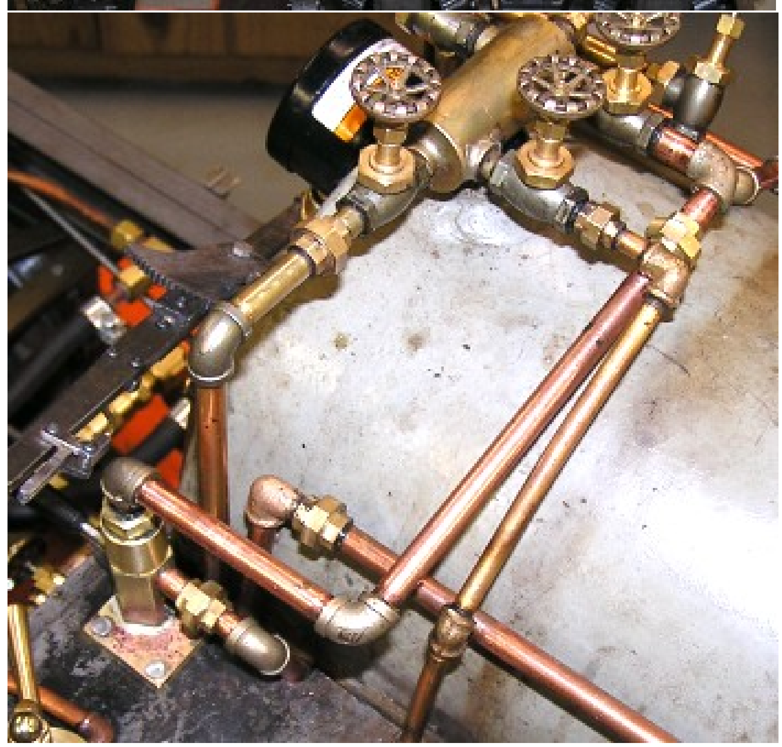


The whistle sounded really good on air after the throat was adjusted (it drove the workshop cat into hiding and brought the spouse from the other end of the house). A concern at this point is that the text indicated the whistle sounds better on steam than air. Maybe I screwed up and this one will sound better on air. It'll have to wait --- too cold to drag the shay outside to make steam.

Installation: The walkways had been temporarily installed and the order of unions and elbows arrived from LSM so it was time to do the installation. The whistle was mounted to the walkway first. It's positioned a little forward that the air tank on Cass No 5; I though it looked a little better in this position. The steam pipe runs along the walkway to near about the middle of the rear cylinder then goes up and through the shelf to the whistle valve. There is a union in the line next to the elbow with the drain hole.



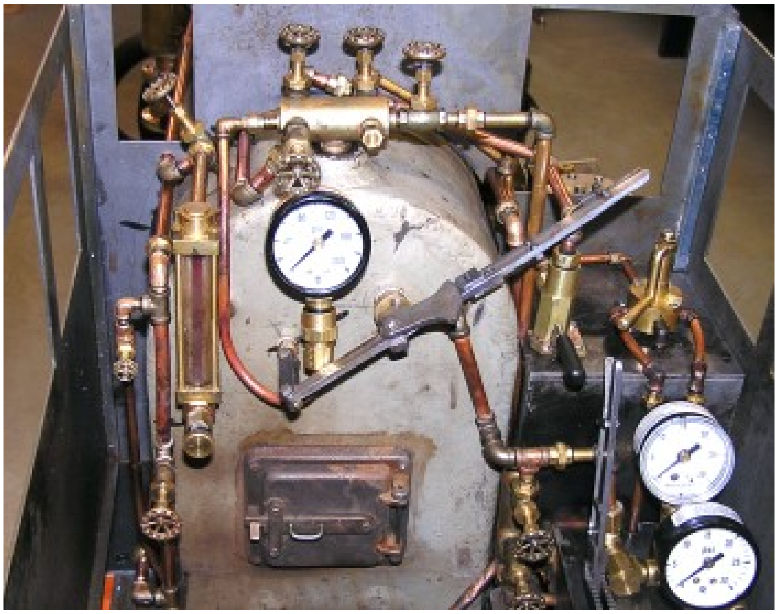
This shows the valve mounted on the shelf. The pipe out the side of the valve goes through a union and elbow and then down to the walkway to another elbow and then on out to the whistle. The input comes off a shutoff valve on the turret through an elbow and union and then a couple more elbows into the top of the valve.



The valve was modified to incorporate a small spring to hold the valve off under low pressure. This was necessary because the lever sticks out horizontally further than on Kenneth's design causing a greater upward force on the ball. The plug in the top was shortened about 1/8" to make room for the spring.

This whistle valve location worked out well. It's in a central location but doesn't interfere with any of the other controls.

Much of the time the boiler in pressurized with compressed air. It's nearly impossible for a male to walk by without giving the whistle a little toot.



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