Steel Boiler Construction

By John Lisherness

This article was extracted from the October 2002 issue of the CallBoy – Pat Young, librarian.

Summary of Boiler Series talk given by John Lisherness

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1. Materials

Boiler shell is conveniently made from standard wall steel pipe (A106 or A53). A local supplier is Pacific Pipe in Oakland. Special sizes are available in 1020 hotroll tube with 3/8 wall, but it's very expensive.

Use A285 or A36 hot roll for steel plate and hot roll 1020 steel bar. Minimum thickness is ¼ inch, but use 5/16 if using threaded stay bolts. For larger boilers, use 3/8 thick plate for flue sheets. Local supplier for plate steel is Ryerson Steel in Emeryville.

1. Design Overview:

Boiler outline should follow general size and shape of prototype.
Simplify where possible. Avoid using combustion chamber, siphons, etc.

A boiler with conical courses can be made by splitting the pipe lengthwise, tapering with a heavy press brake, then trimming and re-welding. All that can be avoided by making a straight barrel and adding rings to support lagging. The smokebox is easily made by using the same pipe as used for the shell. The boiler and smokebox can then be joined with an inner ring.

Water legs should be on the wide side for best circulation and ease of cleaning.
The mud ring can be made from 5/8 half-round hot roll steel which makes preparation for welding much easier. Use washout plugs at all 4 corners of mudring to facilitate boiler washing.

Three are main types of staybolts. The first is threaded at each end. After installation the ends are peened over or welded. The second type is pipe threaded on inside and welded on the outside. It's useful where inside access is limited. The third type of stay bolt is welded on both sides. To prepare the inside of the firebox for welding, use a back countersink. One advantage of the threaded stay bolt is its ability to hold the inner and outer wrapper sheets in alignment.

Crown girders easier to use than staybolts. With girder stays, the downward force on the crown sheet is transferred to the mudring. A curved top crown sheet is stronger than a flat top and less likely to be damaged should the water level fall.

Don't forget to make the firebox door big enough to be able to roll the back end of the fire tubes and install grates, etc. It's recommended that copper fire tubes be used and rolled into the flue sheets.

Layout tube holes with enough clearance to be able to use a tube rolling tool inside the firebox.

Hollow through stays useful for passing small pipes through the boiler. Use schedule 80 pipe.

Openings for water inlets and water glass, etc. can be 1/8 pipe thread tapped directly into the outer shell as needed provided the plate is at least 5/16 thick. For larger fittings or thinner plates, use a bushing or half coupling welded in.

Decide on the type of throttle to be used and make provisions in the boiler accordingly. Throttles inside boiler don't get overheated, but are hard to service. On the other hand, smokebox throttles are accessible, but must be able to withstand the heat and grime.

Finally, the boiler design should take into account that distortion and shrinkage from welding will occur.

2. Fabrication Methods:

Boiler pieces can be cut out with oxyacetelene, plasma, or saw. What follows next is a lot of very dirty work grinding to clean up edges and beveling in preparation for welding. Proper weld preparation is essential. Use a needle scaler to remove all trace of flux.

Welding methods include TIG for tacking pieces together and for stay bolts, and stick welding for the remainder of the joints. MIG welding with the newer, flux cored wires might be worth examining for boiler work.

Electrodes for boiler welding include E6010 for groove butt and fillet welds in all positions with excellent penetration, E6012 for instances of poor fit up, and E7018 for a highly restrained joint. For serious boiler work a good direct current power supply with a current rating of at least 300 amps is necessary. Don't try to fool around with small AC home maintenance welders. If you are determined to weld a boiler yourself, sign up for a welding class (or several) at your community college. Read every article on welding miniature boilers that have appeared recently in the hobby magazines. Get some good textbooks and learn about welding by reading and doing. If you feel uneasy about the actual welding, prepare the pieces and have a professional do the welding.

Most important, pay attention to safety warning regarding welding hazards. Don't risk injury.

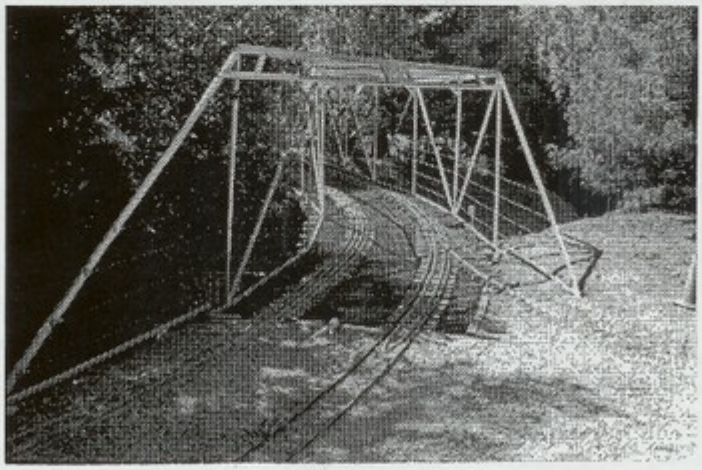
Arrange the weld sequence so the backside of joints can be welded. Welds that have to be made only from one side need a different preparation to ensure full penetration. If for some reason, you can't be certain of making a full penetration weld, consider giving the welding job to a professional.

First, fit and weld front flue sheet into barrel. Then machine for the smokebox connection. Next, layout and cut for dome, firebox and drill for drypipes. Install drypipes and dome. Weld throat sheet and firebox outer plates.

The firebox inner wrapper could be built up from pieces with a lot of welding, but it's preferable to have an iron shop bend it up to fit a template. Wide fireboxes can be done in one piece. Remember to bring extra pieces for practice bends. Narrow fireboxes can be bent from one piece twice as long as needed then cut and welded down center top.

Assemble firebox separately including girders. On wide firebox boilers the backhead can now be installed and the firebox slipped in the bottom. Remember to attach the mudrings first. Narrow fireboxes must be installed from rear followed by the backhead and door ring. Staybolt holes can be drilled through once the location of the firebox is set. Remove chips. After the staybolts are welded, the firetubes can be installed.

Thanks to John for preparing a very informative talk. His wide technical experience, particularly welding boilers, was evident in his explanations and illustrations regarding boiler design and construction.



The bridge with completed superstructure.