Shay Operation

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Initial: 04/29/04 Last Revised: 06/03/2004

On the first run there was a problem with the blower --- the blower holes plugged. The holes were enlarged to minimize future plugging. The operation was significantly different with these larger blower holes; the burner heat range increased significantly and the maximum possible heat appeared to be at least double than previously. A number of tests on the test stand were run over several days to determine and document the optimum settings. Also, the check list at the end of the page was developed to remind myself what should be done before, during, and after each run.

Burner Operation: I understand that the heat output of the coal fired locomotive is controlled by the draft. After once started, the fire of a sitting locomotive can be turned down by merely reducing or turning off the blower. After sitting for an extended period, the fire will heat up quickly if the blower is increased. No one in the area has an operating propane burner so I can't comment on it. The oil burner seems at first glance to be a little more complicated than the coal burner. However, after one becomes familiar with the operation and builds confidence, it works great --- without ashes.

I spent a number of hours over several days lighting and relighting the burner and running it up to full pressure to determine optimum settings for the following situations:

- Initially lighting cold burner
- Setting the mixture
- Switching the atomizer from air to steam
- Relighting hot burner
- Keeping pressure when sitting.

Burner Lighter: I was never able to light the cold burner with the igniter. Also, the igniter frequently won't light the burner if it's been off for more than a few minutes. Previously I had used a propane torch when the igniter wouldn't light it. However, the propane torch won't fit in the engineer's pocket and I really didn't want to build a bracket to haul it with me. (Of course I could pull another car to carry the torch --- could even carry a large propane tank too.) The little butane units in the photo meet the needs and fit in a shirt pocket. The torch unit on the right is from the local hardware store and shoots a flame about two inches. The unit on the left is from Lowe's and is sold as a wind resistant fire source. The combination work well even on breezy days.

I've had limited success lighting the burner through the firebox door with this little torch. However, it always works if pointed through the hole at the front end of the fire pan.

Lighting the Cold Burner: Compressed air is required to get the burner started; 20 psi is adequate. (One could probably used an electric blower on the top of the stack to generate draft and only use the air for the atomizer. In that case, a tank of air or the spare tire might provide an adequate supply.)

I shut the valve between the blower/atomizer manifold and the steam turret so I can watch the steam pressure build on the gauge. I then set the blower and atomizer both for 8 psi ------- these are not that critical but I like to run the atomizer regulator at 8 psi so might as well start that way. I then light the little torch and point it in the front of the fire pan and slowly open the fuel valve. The burner lights at about 1/4 turn. I then turn off the torch and put it in my pocket. There is considerable white smoke initially and then it becomes cleaner after a few seconds. The blower and fuel valve can then be adjusted for a stable flame with no smoke.

Setting the Mixture: The key points about the mixture are:

A too lean mixture will cause the fire to flutter and possibly go out.

A too rich mixture will cause the fire to smoke and possibly go out.

The mixture can be controlled by both the fuel valve and the blower valve:

Opening the fuel valve makes the mixture richer; closing it makes it leaner.

Opening the blower valve makes the mixture leaner; closing it makes it richer.

A too rich mixture that is smoking will cause soot buildup in the tubes (bad).

The optimum setting is just leaner of the point where smoke is noticeable.

For my particular setup, a relatively low setting is with the blower at 10 psi and the fuel valve open about a quarter turn. A high setting is with the blower at 30 to 40 psi and the fuel valve opened one half turn or so with a full fuel tank.

Switching the atomizer from air to steam: Once the steam pressure is at 20 to 30 psi, the air line can be disconnected and steam used for the blower and atomizer. The easy way to do this is to use a regulator on the air input line and set the air pressure to just below the pressure at which you want to switch to steam. Once the steam pressure is above the value of the air regulator output pressure, the valve between the steam turret and the atomizer manifold can be opened. The higher steam pressure will cause the check valve in the air input line to close The burner usually sputters as water is cleared from the steam lines and then evens out in a few seconds. If the fire goes out, it should relight easily with the igniter.

If a regulator is not available in the air line, the air line valve can be gradually closed while opening the steam input valve to the atomizer manifold.

Note that the boiler comes to operating pressure quickest using compressed air at a pressure of 50 psi or greater and not switching to steam for the blower and atomizer until after operating pressure is reached..

Relighting a hot burner: If the fire goes out because it is too lean or too rich, it always seems to relight by pushing the igniter switch. If the fire has been out for more than about 30 seconds with the fuel on, it's probably wise to shut off the fuel for about 30 seconds to let the excess clear out and then push the igniter switch while opening the fuel valve until it relights.

If the burner won't relight using the igniter, I get out my little torch and use the cold burner procedure.

Keeping Pressure when sitting: The minimum heat output of the burner is such that if you stop and sit for a while, the pressure will build and the safety valves will release, which can be distracting if you just stopped to chat for a few minutes. One technique is to add water using the steam powered pump. The added water cools the boiler causing the pressure to drop. The burner can then be used to heat extra water when you're sitting --- storing energy.

There is no problem with shutting the burner off for a while; just remember that your need about 20 psi to get the burner going again. All steam valves should be closed to minimize steam pressure loss when sitting. If the burner is off for more than a few minutes, then the torch will likely be required to relight it.

Operation on the track: The only track I've run the Shay on is Mill Creek Central Railroad. Very little of that track

is flat, most is on a grade with some nice long stretches of ~ 3% grade --- ideal for a shay. So when running you are either working to keep pressure when going uphill or trying to slow it down when going downhill.

On the first couple runs I tried to juggle the throttle and steam brake to regulate the speed. That proved to be too much effort so I started to use the reverse lever to slow down when going downhill. That worked much better than the brake.

Initially I tried to adjust the blower in relationship to the throttle ---- open throttle --- reduce blower and vice versa. That also was too much effort. I ended up setting the blower for 20 to 30 psi and adjusting the fuel for no smoke. If the throttle is opened really wide, the fuel must be increased to accommodate the extra draft. If going really slow or stopped, the blower can be turned down to about 10 psi and the fuel reduced to keep from smoking

The axel pump seems to match well with the water consumption. On the last run hauling a couple cars the pump supplied more water than was being used so the return valve was opened slightly. With very heavy loads it's expected that the steam powered pump will be needed from time-to- time. to augment the axel pump.

Check List - Before Operating

Lubrication: If one can concentrate on the job, the locomotive can be lubricated when steam is building. However, I'm easily distracted so, at least for now, I lubricate everything before lighting the burner.

ISO 46 (turbine oil) is used on:

- Drive shaft bearings
- Universal bearings
- Crank main bearings
- Crank rod bearings
- Rod wrist pin
- Eccentric straps
- Reversing link
- Axel pump rod (don't forget the axel pump)

ISO 62 (way oil) is used on:

- Valve stem guides
- Crosshead guides
- Drive shaft slip joints

The lubricator is topped off with steam oil.

Fuel:

I've been using diesel fuel. A few bucks can be saved if purchased for off the road use such as for agriculture use. I add a capful of Red Devil Soot Remover to each 5 gallons of fuel.

Water: I've been using the local water at home and at the track with no problem so far. I add about an oz of LSB 8000 to the boiler when initially filling and another oz to the tender tank. If used a second day without draining I add another oz to the tender tank.

Check List - During Operation

Fluid Consumption: I haven't recorded these data accurately so will come back and update this in area in a few weeks. However, preliminary indications are that the shay consumes about one tender tank of water per 8 scale miles (will vary with

load). One fuel tank is good for about 3 water tank fill ups. At this point I'm topping the fuel off every second tender fill-up.

Lubrication when operating: At this point I'm topping lubricating all bearings at the same time I top off the fuel.

Blowdown: I do a 30 second blowdown every couple hours to clean anything that has collected in the mud ring. I've blown the steam into a bucket several times to see if there is any crap coming out. So far it looks pretty clean---maybe the LSB 8000 is working.

Check List - After Operating

If the locomotive is going to be operated the next day, I just shut it down. If however it's going to be sitting for a few days or longer I do the following:

Boiler: Before the boiler is cooled I open the blowdown and drain all water. I then connect compressed air and try to blow out any remaining moisture.

Tender: I open the tender drain valve.

Cylinders: I remove the plugs in the upper cylinder heads and give a good squirt of WD40 into each cylinder. I then move the locomotive back and forth a few feet to work the WD40 over the cylinder walls.

Fuel: I leave any remaining fuel in the fuel tank.

Shay Project
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