Shay Drive Shafts & Universal Fabrication

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The following describes how I machined the universal rings and drive shafts.

Universal Rings: As mentioned elsewhere, I used a different universal ring design than Kenneth. My design uses three rings, a 5/8" thick 2" OD/1.75" ID outer ring and two 1/4' thick 1.75" OD/1.25" ID inner rings.

The rings are cut from tubing. I cut some by using a parting tool in the lathe. I found it was much quicker to cut over-thick slices with an abrasive cutoff saw and then true up the ends in the lathe. It's often difficult to mount thin disks in the chuck. The face of my chuck is true so I position a spacer between the piece and the chuck face, then tighten the chuck followed by removing the spacer. The photo shows a spacer behind an outer ring.

There are eight bolt holes through the inner rings. I made a drilling template on the rotary table. In fact, I made it twice; the first time the hole pattern wasn't concentric. The photo shows the pattern, note the extra eight hole markings. I also cut a 1/2" thick piece of the outer tube to hold the inner rings for drilling. The OD of the inner rings is about 0.015" smaller then the ID of the outer ring. The three brass strips are shims to hold the inner rings concentric to the outer ring. If both inner rings are positioned the same, they are aligned with each other. I drilled two holes through the target ring, inserted a couple screws to hold them in position and then just drilled the other six holes deep enough to mark the target piece.

The next step was to remove the pattern and use the target piece drilled and marked above as a pattern to drill the second inner ring.

This photo shows the rings for the six universal rings.

The next step was to drill the four holes in the inner rings for the sleeve bearings.   The sleeve bearings are 1/4" long 5/16" OD 1/4" ID oil impregnated bronze -- McMaster-Carr part # 6391K126 at 23 cents each.   The two inner rings were first bolted together and then the location of the bearing holes marked. The marks were center punched and then a center drill used to deepen the mark. The four holes were then dilled with a 1/8" drill. The 1/8 drill in the drill press was then used to align opposing holes. After the pair of holes were aligned, the drill press vise was tightened to hold the rings in position. The 1/8" drill was then removed and a 5/16" drill used to enlarge the the two aligned holes. This process was repeated for the other pair of bearing holes in the pair of inner rings

The next step was to silver solder one of the inner rings inside the outer ring. The two pieces were cleaned in the pickling solution and then fluxed. Four pieces of flat silver solder were then inserted between the inner and outer ring. The strips were positioned midway between the holes for the bearings so the solder didn't flow into the bearing holes. A length of 5/16" hex rod was used as a spacer under the inner ring when the pieces were heated.

The soldered pieces were then cleaned in the pickling solution and four 1/8" oil holes drilled in the outer ring.   The other inner ring was sawed in half. The completed ring with bearings is shown on the right. I was unable to make the bearing holes identical in all the pieces. Therefore, each of the split rings is marked so that it can be associated with the correct mate. (No worry, auto engine bearing caps and connecting rod bearing caps are also not interchangeable and marked in a similar way.)

This shows the partially assembled ring ----- the shafts and eight bolts must be added to complete the assembly.

Female Slip Joints: I pretty much followed Kenneth's design on the female slip joints. I started with 7/8" bar stock. The bar was cut to the proper length and then chucked in the lathe where the ends were finished and then the inside drilled 1/2". The next step was to mill a slot in the end for the pin that interfaces with the universal ring. Here is a place where I deviated from Kenneth's design, I ran the pin across the diagonal rather than the flat side.

The 1/2" round hole through the center has to be squared to accept the 1/2" square male shaft. This is done by removing 3/16" from one side and then squaring the hole with the end mill. The side is then covered with a 3/16" plate. Rather than milling off the 3/16", most the thickness was sawed off and then finished with the end mill. That is the operation shown on the right. The next step was to square up the round hole with the end mill.

This photo shows the three pieces after the milling operation and prepared for soldering cover plates over the open sides. The white flux is visible on the pieces. Those brass colored strips on the edges of the upper pieces are silver solder. The cover plates are 1" wide and are trimmed after the soldering.

This out-of-focus photo shows the three pieces after the soldering. Scrap blocks of steel were used to hold the plates in position

After the soldering the excess width of the cover plates was milled off.

The next step was to solder in the pins on the end.

The pins were then cut with a hack saw. This is a procedure very similar to the U Joint stub discussed in the line shaft note.

The end was finished with a 1/3'" end mill.

The sides of the end near the pin were milled to a tapered shape. After this step, two oil holes were drilled in each side.

Later I went back and milled 1 /16" deep recesses in the four sides.

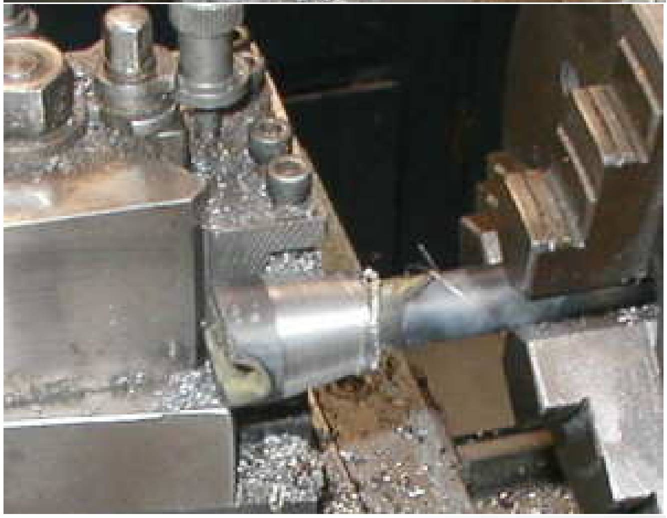
Male Slip Joint: Kenneth made his male slip joints from brass. I chose to use 1/2" square steel stock and the end from 7/8" diameter rod ----- nearly identical to the U joint stub. The end of the rod that fits in the stub was turned to 7/16" diameter. This made it easy to position the two pieces when they were soldered.

The very end is turned down to 7/16" and the remainder to to 1/2". The male slip joints between the engine and the first two trucks are fairly short and the rounded part can be turned with the piece held in the 4 jaw chuck. I used the tailstock to steady the longer male slip joint between the second and third truck as shown on the right.

The two pieces were machined with a .004" clearance so that solder could flow between the two. The photo shows the two pieces after the soldering.

The end was sawed off before mounting in the lathe where the end was finished.

A taper was then turned in the sides of the stub end.



This is the nearly complete male slip joint.

This shows the end all prepared for heating to solder the pin to the end. The pieces had been cleaned in pickling solution. The white flux is clearly visible as are the flat strips of silver solder.

That's the still red hot end

Next, the center of the pin was sawed out.

The inside of the end was finished with a 1/2" mill. Then the sides were thinned. The final step was to reduce the top of the pins and round the inside edge of the pins on the grinder.

What's next?   The shay project is shelved for a few weeks while I'm off to West Africa for a month.

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