Shay Line Shafts, Universals & Drive Shafts

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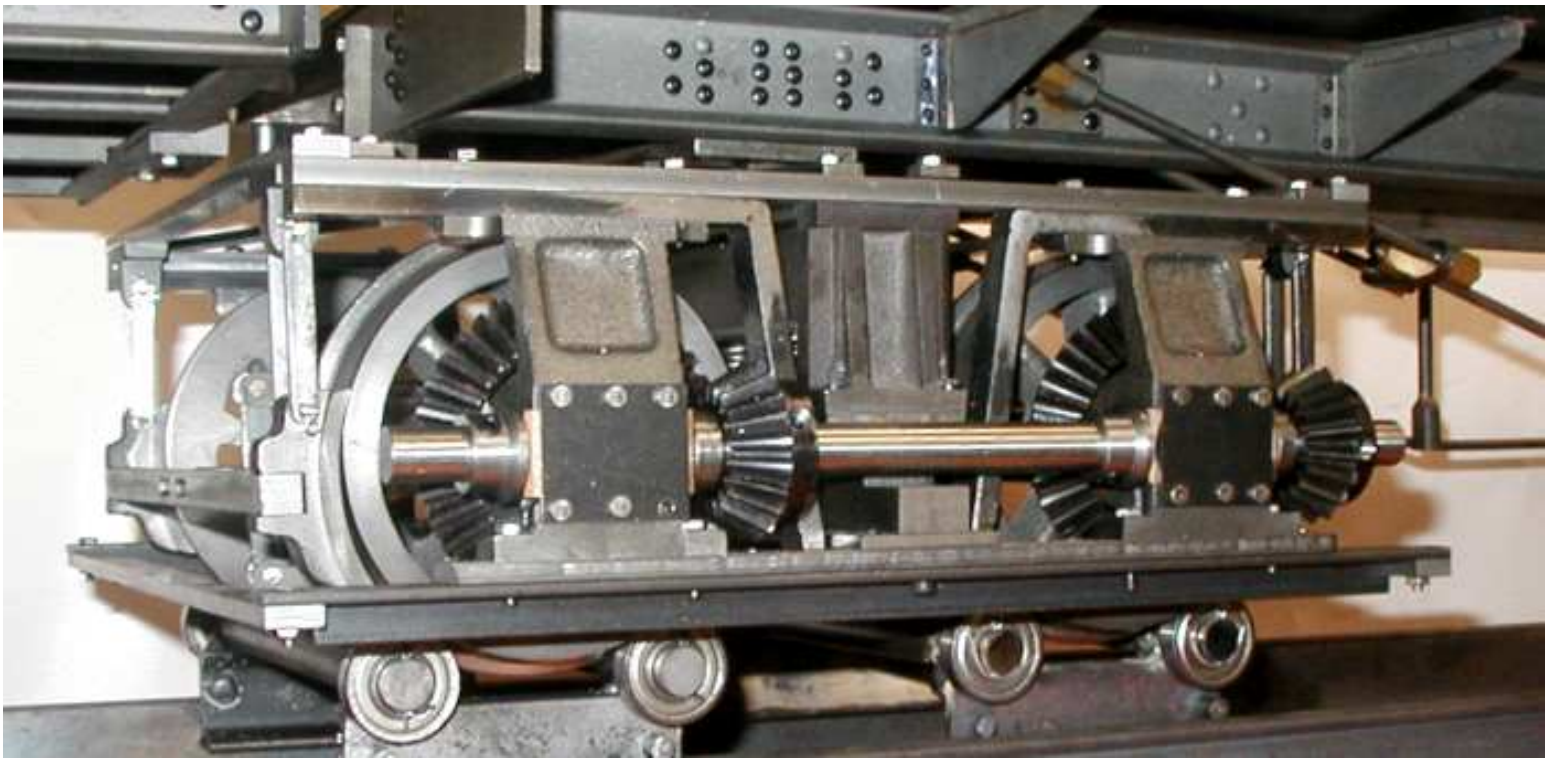
The new lathe drive belt finally arrived so I was able to finish and document this part before I have to shelve the project for a few weeks.

Line Shafts: A line shaft subsystem consisting of bearings, line shaft, bevel gears, collars and spacers is located on the right side of each truck. The subsystem for the middle truck is shown below. The truck is setting on the test fixture. (I see I left one of the screws off the rear bearing cover plate.)



This shows the second attempt at assembling the line shafts. The first time I used 3/16" diameter expansion pins to hold the pinion gears and collars to the line shaft. The pieces must have slipped when I drilled the holes and the result was unsatisfactory. Before redoing the shaft I checked everything very carefully to make sure I wouldn't have to do it the third time. It was at that point I discovered that I had mounted the pinion gears behind the axel. Dumb! **The pinion gears go in front of the axels as shown in the photo.** That made the redo less painful since I had to fix two problems.

I decided to use set screws in the redo. Since I had already drilled 3/16": holes through the gears and collars, the minimum size set screw I could use was 1/4" diameter. I chose 1/4"-28 dog point set screws for the bevel gears and 1/4"-28 hollow set screws for the collars. The dog point is ~ 3/16" diameter so it should have the same holding force as the expansion pin. With the two set screws, I can tighten one to hold the gear and drill the 1/8" deep hole for the dog point of the other set screw --- then inset that set screw, remove the first set screw and drill the hole for that dog point. The forces on the collars are less so I'm hoping the hollow point set screws will hold them in place.

The photo above shows the assembled line shaft removed from the middle truck. There is a pinion gear, spacer, bronze bearing and collar for each axel. The spacer between the bearing and the gear controls the amount the pinion meshes with the gear on the wheel. The collar on the other side of each bearing holds the pinion gear and spacer against the the bearing. The bearing rides in a slot in the right side journal boxes as shown in the photo on the right. The bearing is not a tight fit --- there is a small amount of float. The plate holds the bearing in the journal box. Each bearing has a round stub on the side that fits in the axel hole in the journal. This novel design permits the bearing to rotate slightly as necessary when the axel moves up and down over variations in the track while preventing the bearing moving to the front or rear.

Universals: I examined the universals very carefully on my visit to Cass this spring. One of these universals is shown on the right. The visible part is a single casting. There are bronze sleeve bearings (not visible) on the ends of the drive shafts. The eight bolts hold a split removal disk on the other side of the universal. When the bolts are removed, the universals can be removed from the truck and the bearings accessed.

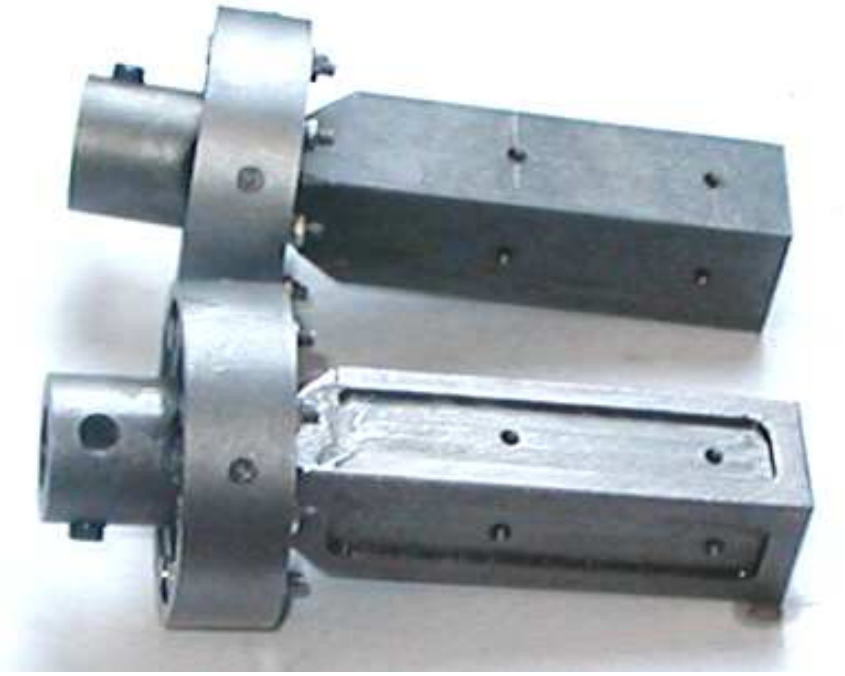
The three photos below show one of my universals. The split disk is removed in the left photo to expose the bearings. It's pretty close match to the full size universal. Once it's been in use for a few hours and dirt mixes in with the dripping oil, it'll be indistinguishable from the real thing.

My universal is a little larger diameter than Kenneth's (but smaller than the prototype) necessitating that the truck bottom tie bar be mounted under the angles.



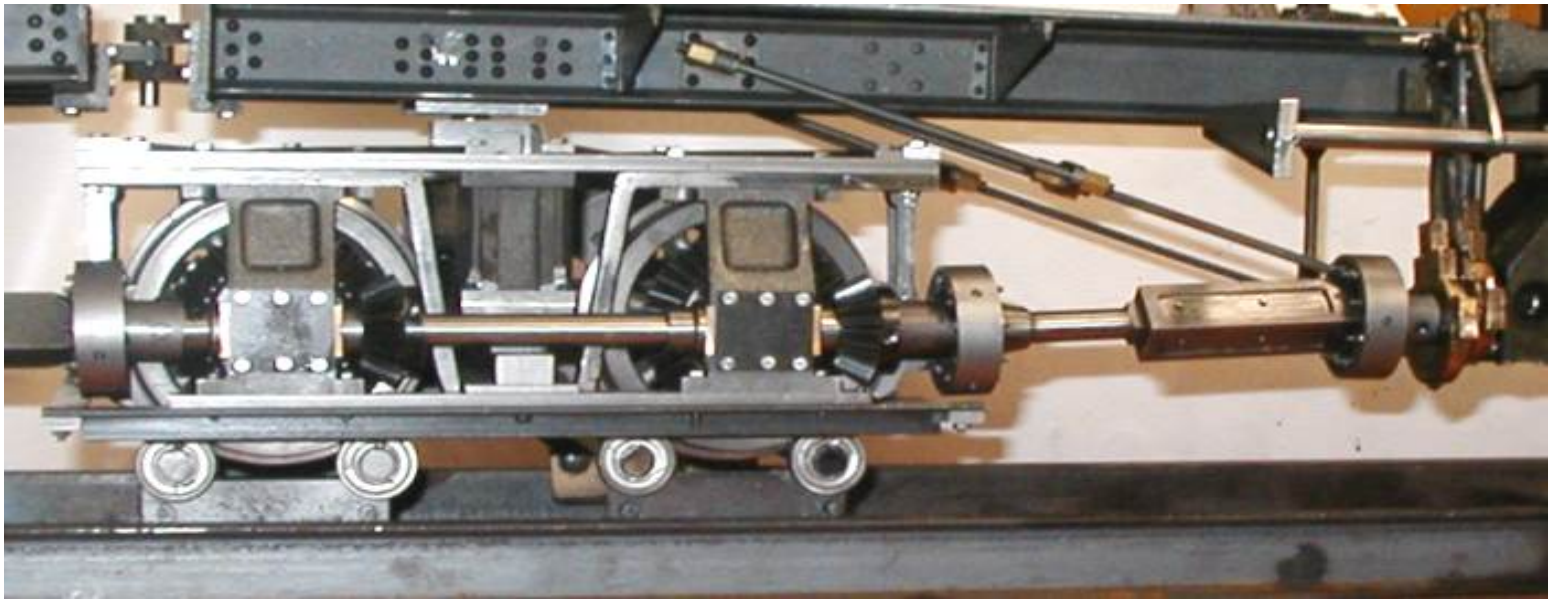
Drive Shafts: The drive shafts are made up a male and a female slip joint as shown below. All the female parts are the same length whereas the male parts of have different lengths as required. The longest male part for between the middle and rear truck is shown below. Kenneth used brass for the male part. I used steel like the prototype.

Female Slip Joint: A few months ago Mark Mihalyi showed me his female slip joints. He had milled a recess in each side much like the recess in the prototype shown on the right. The photos accompanying Kenneth's drawings showed similar recesses in his drive shafts. I was unhappy with my female slip joints --- they seemed huge.



This photo shows one of my female slip joints after recesses were milled in the sides and the corners rounded. It looks much more delicate and interesting that the plain one above it. (This is probably the same principle as a woman's corset.)

The combined line shaft - universal - drive shaft is shown in photo below. That's the middle truck with the engine on the right.



The installation of the line and drive shafts made it possible to run the locomotive on compressed air. It ran slick --- can't wait to get it on a track.

Some of the techniques used to fabricate the line shafts, universals and drive shafts are described in the accompanying notes.

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