Plumbing Part IV - Axel Pump

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The axel pump is the primary source of feed water to the boiler when the locomotive is moving. It is mounted on the middle truck and driven by an eccentric on the rear axel of that truck. The eccentric was installed on the axel when the axel was fabricated months ago. The pump itself and the rod connecting the eccentric to the mump must be fabricated to complete the axel pump system. I'm following Kenneth's design for the axel pump.

Rod: The rod looked to be the most difficult and least interesting piece so it was fabricated first. The first step was the rough cut the two pieces from 5/16" thick 1.5" wide CRS.

The mill was then used to finish the mating surfaces and the area around the screws that hold the two pieces together.

The next step was to drill and tap the screw holes. After the two pieces were screwed together, the center for the two holes were located and the outside edges marked off. A starting 3/8" hole was then drilled in the center of the large hole.

The piece was then mounted in the four jaw chuck centered on the 3/8" hole. A piece of 3/8" rod was inserted in the hole and the indicator used to position the piece. The hole was then drilled 1" (Silver & Deming) and then bored to 1.5"

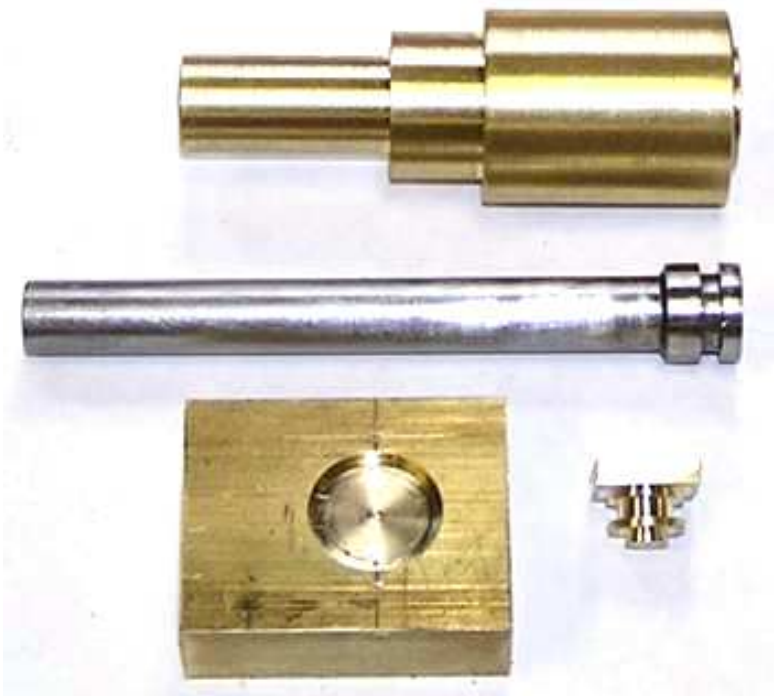
The next step was to drill the 1/4" hole at the little end and then rough saw the outside. The photo at the right shows the rod at this point.

The rounded ends were then smoothed with a file and the long straight edges finished on the mill.

The last steps were to mill the small end to a thickness of 1/8", insert the little bronze bush and drill a 1/16" oil hole. This photo shows the rod on the eccentric (truck is upside down). The truck was reinstalled on the locomotive, the end of the rod secured with a piece of wire and the engine driven with compressed air to allow the rod/eccentric to smooth out any rough spots.

This piece went very quickly -- only a couple hours (better than cutting the grass on a hot afternoon). Also, it was interesting -- maybe because only one piece is required.

Tolerances: The tolerances were checked before staring on the pump. The cylinder bore is 1.12" long. The eccentric throw is 5/8" so the piston stroke is also 5/8". The piston height is 3/8" so the piston height plus stoke is 1.0" This means there is a total margin of 0.12". I don't think the position of the axel were the eccentric is mounted and the position of the lower spring plank where pump mounts were controlled that well. Besides, these dimensions can change as the truck flexes and parts move when the springs compress and expand. I decided to modify the design by making the cylinder 1/8" longer. Since the water is essentially non compressible, the pump operation won't be affected by the longer cylinder. Also, the stem on the piston was made extra long. The end of the stem will be finished to the required length measured after the pump has been mounted in the spring plank.



Pump: The next step was to do the lathe work for the four pieces shown here. Nothing unusual except 1/2" square stock rather than 5/8" round stock was used for the plug ---- figured it would be easier to mark off the location of the four screw holes.

Even though clearances of 0.002 were provided between the piston and cylinder, the fit was pretty tight. To smooth it out, the bore was lubricated, the piston inserted, the small end of the piston chucked in the lathe, and the cylinder grasped with the hand and slid back and forth as the piston rotated. Worked out the rough spots in a few minutes. Now is very smooth.

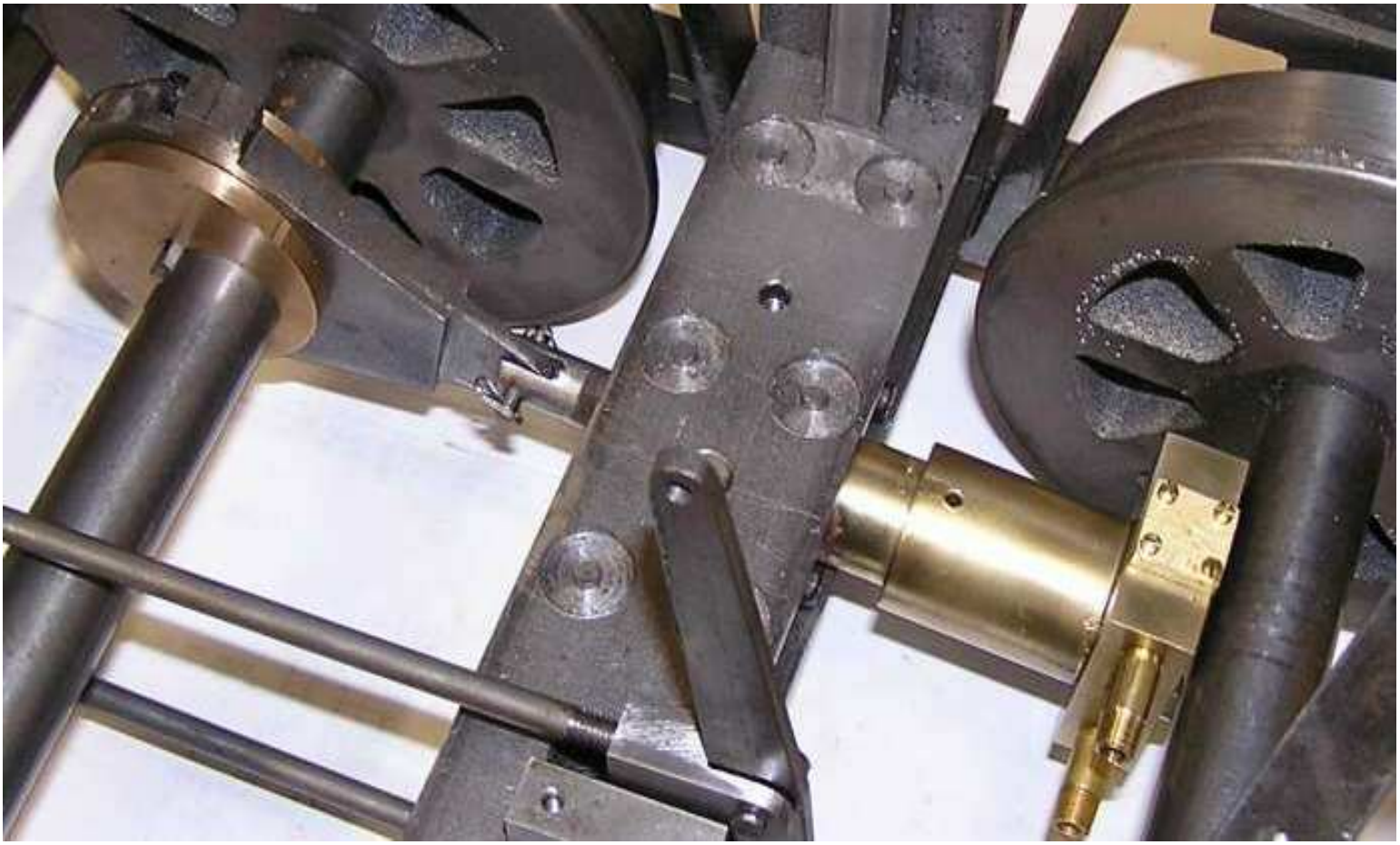
Cutting the 5 degree slope on the wedge was easy since the milling head can be tilted. First thought was to leave the mill straight and shim the one side the wedge up 5 degrees by slipping the correct size drill under one side. However, the calculator and computer were both upstairs and I wasn't about to try to compute the shim height using an old slide rule.

These are all the pump parts (except the balls) ready for assembly. Note the O rings are installed on the piston and plug. The pin on the lower right that blocks the small ball from going up into the upper chamber is different than Kenneth's design. He used a 3/32 brass pin and a 1/8" MTP plug. I didn't have a 1/8" plug so I turned the pin shown from 3/16" stainless steel hex stock. The threads are 1/8" MTP.

The next step was to silver solder the wedge to the pump body. It was decided to drill the hole in the spring plank first and test fit everything before doing the soldering. The drill press feature of the mill was used to drill the hole at 5 degrees. However, before drilling the hole, the surface was faced with an end mill to get a surface perpendicular to the drill so it wouldn't wander when starting. After the hole was drilled the pump was assembled in the hole and everything fit fine. The wedge was then silver soldered to the pump body. The pump body and wedge were then used as a pattern to drill and tap the holes that hold the pump to the spring plank.

The final task was to inset the piston and determine where to put the the hole to connect the rod. The longer cylinder gave a little more margin so a point midway between the possible extremes was picked for the hole. Turns out it was within a few thousands of the point Ken specified on the drawing ---- right on!

Finished Pump: The next photo shows the finished pump mounted on the truck. The top spring plank is off giving a better view of the pump. The only thing remaining is to connect 1/4" ID hoses to the nipples on the side of the pump --- and of course, reassemble the truck.



A neat thing about the pump that was suspected and now confirmed is that the pump can be removed without disassembling the truck. Maintenance on the check valves can be performed merely by removing the screws holding the valve body and then lifting the valve body off. The piston will slide out after the valve body and pin to connecting the piston to the rod have been removed. The body will also slide out if the valve body and pin between the rod and piston have been removed. A neat design!

Update - Test: The pump was tested before finishing the project. The locomotive was run on the test stand with the engine powered by compressed air. The first test was at low pressure with the output hose emptying back into the tender tank. Next, the steam pressure gauge was connected to the output and the engine turned by hand. The hose connections leaked some that limited the pressure. Was able to run the engine at very low speed and run a pressure of well over 100 psi. The pump should work fine. Some work is needed on the hose connections. Also, need stronger hose --- the hose used for the test got much fatter as the pressure increased.

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