Shay Truck Machining III
Flat Bars & Assembly

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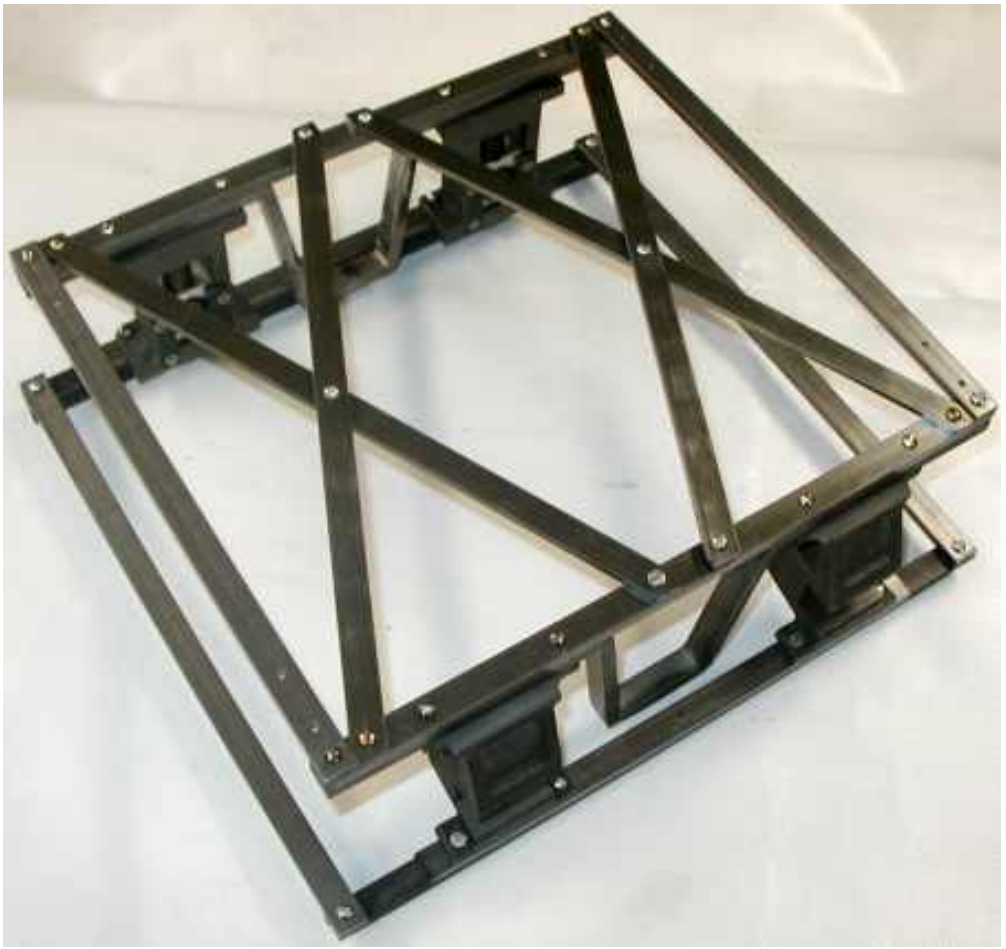
Initial: 2/28/03 Last Revised: 06/05/2004

The Flat Bars:

The photo shows the assembled flat bars for one truck. A total of 16 bars, consisting of 12 flat bars, 2 bent flat bars (side bar hangers) and 2 angles are required for each truck. Kenneth's drawings call for Hot Rolled Steel. I decided to use Cold Finished Steel stock for all except the angles which are available only in HRS. The CFS has a much smoother surface and squarer cross section.

There are a total of 9 different lengths and/or drilling patterns in each truck. Since I was making three trucks I decided to make a pattern for each of the 9 bar variations. The accuracy of the lengths of the bars and the hole patterns have a significant impact on the quality of the finished truck so I was very critical of the patterns and in fact redid several

until I had a satisfactory set.



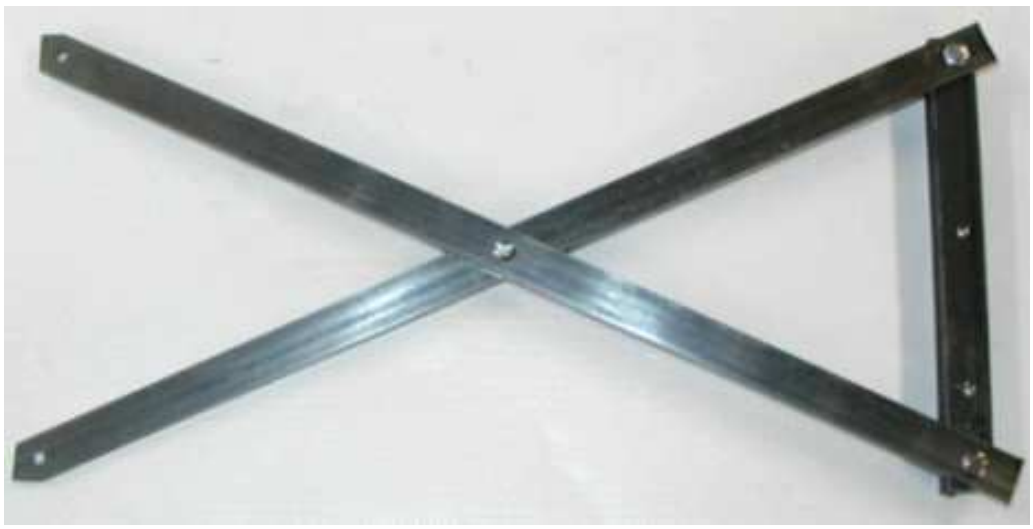
I was very concerned about my ability to fabricate satisfactory side bar hangers ---- the part with the bends. The hanger is made from 1/4" X 1/2" flat bar stock. The drawings suggest that the bar be sawed halfway through at each bend point, heated red hot at that point and then bent. This procedure worked very well. The photo below shows the first attempt. The bent hanger is attached the top strap to make sure the length of the hanger is correct. (The top strap appears to be slightly bowed in the photo. This is probably do to positioning the camera too close to the object.) The angles on the two sides of the strap were adjusted until they were equal.

The drawings indicate that the gaps at the bend points be filled by brazing. My gas welding tanks were empty and the weather was bad so I decided to use my little flux-core wire welder to fill the gaps. (I used a propane burner to heat the bars for bending.) The flux core welding made a mess but produced very strong joints. I had to do 2 or 3 passes on each joint to get a satisfactory buildup.. The joints were ground flat and cleaned between each pass. The final finishing was done with a file.

I was very relieved when I had the 6 bars shown on the right completed.

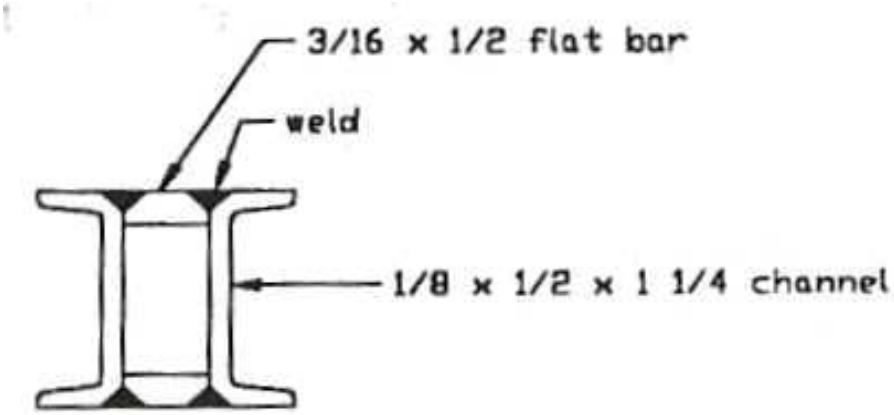
The condition of the ends of the bars have a major impact on the overall truck appearance. Sloppy ends look really bad. I'm unable to saw bars with smooth square ends and correct lengths. What works for me is to saw the bars about 1/8" longer than required on my 14" abrasive cutoff saw ($60 from Harbor Freight) and then finish the ends to make them square and the bars the correct length. I finished some ends in the lathe and some in the mill. The mill is probably the quickest. I was able to put up to about 8 bars together in the milling vise so the operation is fairly quick. I had purchased a four fluted doubled ended 1/2" diameter Chinese end mill from Enco for $3.49 (probably about $5 when S&H included). I was able to finish all the bar and spring plank ends for the three trucks using one end of the double ended end mill. It's getting pretty dull now so will start using the other end when I work on the frame.

The ends of the cross braces are cut at 24.5 degrees and 65.5 degrees. I spent considerable time on my afternoon walks thinking about how to do a good job of finishing these ends. I have a rotary table that I can mount on the mill, but it is a big pain. It finally dawned on me that the ends are square and at right angles with respect to the truck side frames. It was then a simple matter to make a fixture from scrap 1/2" angle with two holes the same distance apart as the cross brace mounting holes in the side frames. The left photo below show a pair of cross braces mounted to the fixture. I rough sawed the excess length from the ends when attached to the fixture (this allowed fairly accurate rough cuts) and then did the finish cut in the mill as shown on the right. That's the $3.49 end mill at work.

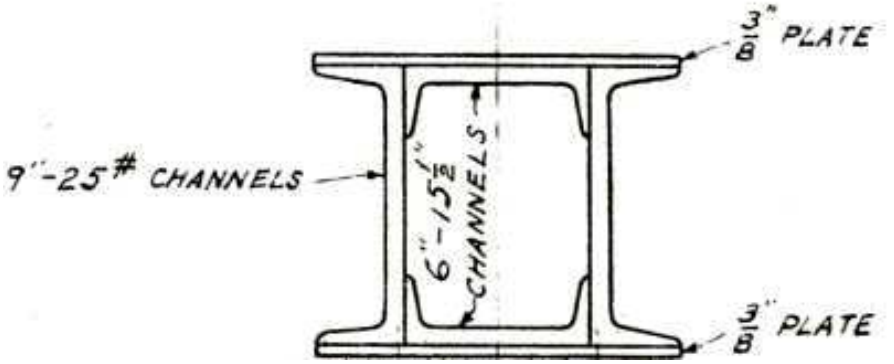


The Spring Planks:

Kenneth's drawings call for the spring planks to be made by welding two channels and two flat bars together as shown on the top right. After the welding the top and bottom are to be smoothed by machining or grinding. I'm not much of a welder so that didn't seem like such a good idea to me.



I had purchased a set of Lima Locomotive Works drawings from Kenneth so I thought I'd take a look at the prototype. The spring plank is show on a 1923 blueprint. I was able to scan part of that blueprint and "process" the image to get the lower part of the sketch on the right. Note that they welded the 3/8" plates on the top and bottom to get smooth surfaces. Kenneth must be complimented on a design that very closely approximates the prototype profile from readily available stock.



In spite of the nice profile of the welded channels/flat bars I decided to use CFS stock to make my spring planks. The top and bottom are 1/8" X 1 1/2" flat bars and the center part is a 3/4" X 1" bar. The rough cut stock for one top and one bottom spring plank are shown on the right.

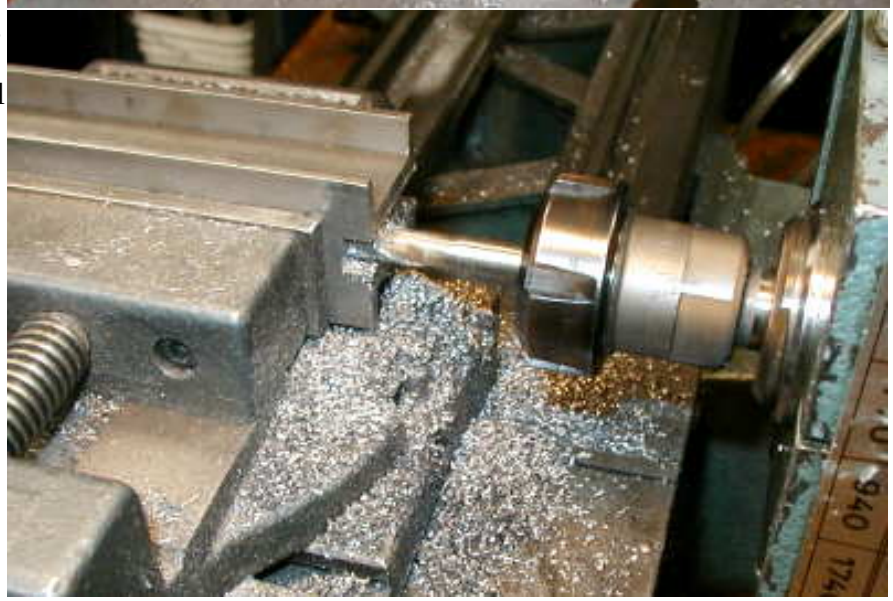
Update: Some time after I finished the trucks, I visited Mike Mihalyi who is building a pair of Shays. He used a different spring plank design based on Ken's earlier drawings. He used a pair of 1" X 1/2" X 1/8" channels instead of the 3/4" X 1" solid bars I used. He screwed the 1/8" X 1 1/2" bars to the top and bottom of these channels. This is like the Lima drawing without the two 6"-15 1/2" channels on the inside. If I make another Shay I'll use that design.

The next step was to locate and drill a 1/2' hole in each piece. (This is the hole that provides access to the lower screw in the pivot block.) A bolt though this hole was used to hold everything together and aligned while other holes are drilled for flat head screws to hold everything together.

The ends were finished to the correct dimensions after everything was screwed together. The photo on the right shows finishing the right end of the bottom spring plank. The notch provides clearance for the line shaft. In this case most of the material was removed for the notch by sawing. The end mill provided the final finished surface. That's the $3.49 end mill at work. The socket head cap screw is in the hole that will later be used for one of the screws that limits the upward motion of the top spring plank.

The bottom of the pedestals are attached to the top of the bottom spring plank. Rather than marking off and drilling both the pedestal and spring plank and hoping they fit together, I drilled the holes in the bottom spring plank and then used it as a template to drill the pedestal as shown in the photo. This enabled the pedestals to be positioned and all dimensions verified before the castings were drilled. This operation worked very well.

Once the pedestals were mounted on the bottom spring plank, it was possible to finish the ends of the top spring plank including the slot that rides in the pedestal rib. The photo at right shows milling the slot. And, that's not the $3.49 end mill. That's a single ended 5/16" end mill which cost $1.99. The slot is about 3/8" wide. Two cuts were required. The mill height was adjusted slightly above the centerline of the spring plank. After a first cut, the spring plank was turned over and a second cut taken. This technique assured that the slot centerline was on the spring plank centerline.



The top of the bottom spring plank and the bottom of the top spring plank each require 12 spot faces for the springs. The spot faces are 1/2" diameter and 1/16" deep. I used a counter bore with the pilot removed to do the facing and used a drilling template as sown on the right to to position the spots. The same template was used on all six spring planks to make sure the spot faces on each end of the springs lined up. I chose a counter bore because the smooth sides wouldn't cut the template. If I had it to do over I'd probably try to use that $3.49 end mill --- the counter bore cost more than $10.

The finished pieces of the two spring planks for one truck are shown on the right. The spring planks were disassembled to remove the burrs from the machined edges and holes.

That's the cleaned and assembled pair of spring planks. I was really pleased with these.

This shows the the springs in position

There are a pair of screws between the two spring planks that limit the separation of the two planks so that the springs are retained even with no external pressure.

I was very concerned that the journal boxes be assembled in the side frames such that the axel holes are perpendicular to the side frames and the axels have the correct spacing and are positioned correctly with respect to the spring planks. To this end I made the assembly jig shown on the right. It has two axels with the correct separation and held parallel by the bars welded between them. This photo shows positioning the lower angle on the RH Journal Boxes to mark the Journal Box mounting holes. The previously marked mounting hole centers were very close to those found by this technique so the jig might be overkill.

In this photo the jig is being used to hold everything together for drilling the mounting holes in the top of the journal boxes.

The end result was three trucks that are square and rigid and operate extremely smoothly.

All the patterns, templates, jigs, etc used to fabricate the trucks are shown on the right. This technique requires extra material but allows one to spend extra energy on the pattern and then duplicate the pattern quickly.

It's on to the frame next.

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