Cone Pulley Design

By R. G. Sparber

02/10/2008

Why?

Why would you make your own cone pulley when they are so easily found in stores? Well, I have three reasons. First, they can be found in stores but it is against the law to take them home without handing over a fair amount of money. Secondly, they are rarely the exact size desired. And thirdly, making pulleys is amazingly easy and fun.

I learned these lesson when I made my Gingery drill press. Some kind sole gave me a cast iron cone pulley. One cone pulley is necessary but a second is needed to be useful. After a lot of searching I came to the conclusion that I could not buy another pulley like this one so was forced to investigate making my own. The experience was very enlightening.

The Power Train

Before I can design the cone pulleys, the overall power train must be designed. Through the generous help of many on the gingery_machines Yahoo group, I was able to piece together the important parameters.

Power Train

R. G. Sparber
02/07/08

		RPM	second cone pulley	cone ratio	RPM of small sprocket	RPM of large sprocket	RPM delta
motor RPM	1725	1725					
motor pulley	1.5	1725					
outboard pulley	7.6	340.46					
cone pulley:							
Step 1	2.625	340.46	3.88	0.68	230.63	57.66	15.3
Step 2	3.000	340.46	3.5	0.86	291.82	72.96	26.35
Step 3	3.500	340.46	3	1.17	397.2	99.3	26.35
Step 4	3.875	340.46	2.63	1.48	502.58	125.65	
small sprocket	10						
large sprocket	40						

Cutting Speed in Feet/Min

ram cycles/min ->		57.66	72.96	99.3	125.65
length of stroke	1	*8*	*10*	*14*	*17*
	2	*16*	*20*	*28*	*35*
	3	*24*	*30*	*41*	*52*
	4	*32*	*41*	*55*	*70*
	5	*40*	*51*	*69*	*87*
	6	*48*	*61*	*83*	*105*

cast iron	60	Feet/Min
machine steel	80	Feet/Min
carbon steel	50	Feet/Min
brass	160	Feet/Min

Cone pulley calculations	Step 1	Step 2	Step 3	Step 4	
distance between pulley centers: C =	**10.000**	**10.015**	**10.015**	**10.000**	independent variables
dia. of 1st sheaves: d1, d2, d3, d4	**2.63**	**3**	**3.5**	**3.88**	from above
dia. of 2nd sheaves: D1, D2, D3, D4	3.88	3.5	3	2.63	dependent variables
resulting belt length: L =	30.24	30.24	30.24	30.24	dependent variables
d/D =	1.48	1.17	0.86	0.68	dependent variables

The key output of the above calculation is that I get the outboard pulley diameter and the cone pulley diameters. The outboard pulley is specified by Gingery to be 8" but since I plan to make my own, can tweak it a little.

I started with advice from "JohnW" saying that the best range of speeds for the ram is 50 to 120 strokes per minute. That puts the center of the range at 85 SPM. With the cone pulley diameters set to give a 1:1 speed ratio, it was easy to adjust the outboard pulley such that the RPM of the large chain sprocket to be 85. This is the same as the SPM of the ram.

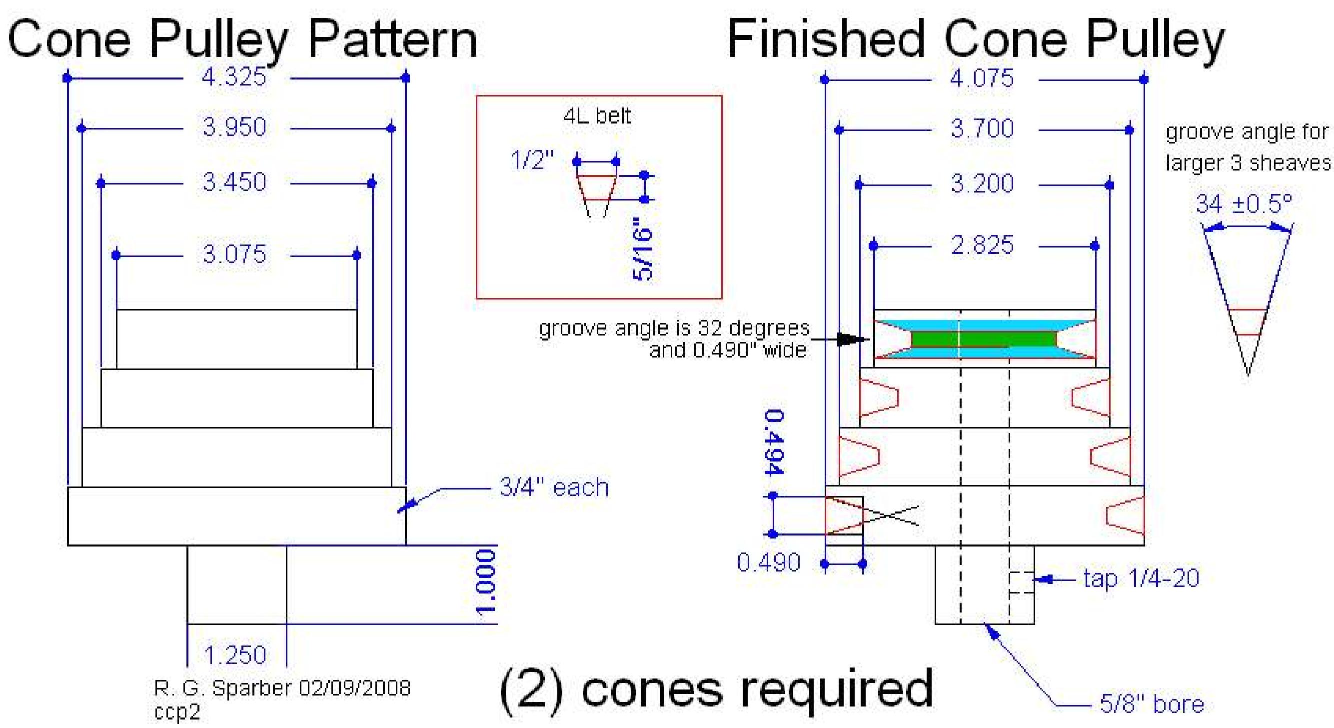
Next came finding the best diameters of the cone pulleys. Sadly, this was more cut and try plus listening to advice on line from "CT2" rather than any scientific, closed form equation, approach. No matter, I got usable results. The trick is to get speeds that are equally spaced across the range of speeds plus be sure that the needed center to center distance of the cone pulleys does not vary much. Note near the bottom of the spreadsheet that there is only a 0.015" shift in center to center distance as we move through the speeds. This means that we can change speeds and not have to adjust the center to center distance or, even worse, change the length of the belt.

Pulley Design

There are few "gotta have" books in our hobby but one of them is the Machinery's Handbook. I frequently use about 0.01% of it and on rare occasion venture out into new, uncharted pages. One of these adventures was the section on "V-Belts and Sheaves". This section was not helpful in the choosing of the best diameters for a cone pulley, but was invaluable on finding the belt length and center to center distance, used in the above spreadsheet, plus the geometry of a sheave.

Do you see that the finished cone diameters, below, do not match the values given in the spreadsheet above? This is because the handbook says to add 0.2" to the speed diameter to get the sheave diameter. For example, the spreadsheet calls out for 3.875" for the largest sheave. You see 4.075" below.

This turns out to be about a 3% correction which is not much but, hey, I'm in the design stage so it is easy to make the change.



I plan to use a 4L belt so the dimensions of the groove come from the book.

The cone pulley pattern will be built from MDF I have on hand. A 3/4" thick sheaves is thicker than normal but my other choice was 1/2" and that would be too thin. I also did not worry much about shrinkage and machining allowance. I just slapped a 1/4" onto the finished diameter. Each step in the cone pattern will have about 2 degrees of draft to insure easy extraction from the sand.

I have yet to drawn up the outboard sheave with its 7.6" diameter but I doubt it would be very interesting anyway. It is likely that I will cut the 1.5” motor pulley from round stock.

Rick Sparber
rgsparber@AOL.com