

Heavy Duty Shapers

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Foreward

The Delta and Powermatic style shapers are wonderful machines with much versatility. It is rare that I find a machine that is as rewarding to use as my shaper. It has done what other machines have only promised to do. While Heavy Duty shapers won't do everything, they were never designed to do everything either. What they do accomplish, they do with higher precision than any other machine in its class. Some may talk of routing to a precision of .001". The HD shaper attains that level of precision so easily and routinely that it is rarely mentioned.

This document is the result of observations and my experiences. It also summarizes the gathering of empirical evidence detailing the Delta Heavy Duty and to a smaller extent, the Powermatic 25 and 26 shapers. I have tried to apply good scientific methodology to arrive at conclusions. Things like sufficient sample sizes as a data set and the conclusions drawn by using both positive and negative testing were used. It is still possible that I have missed an detail

which could make my conclusions wrong, but I have no one to my knowledge is available to collaborate with. As a result, no one else has spent any significant amount of time researching the Delta and Powermatic spindle designs. As new facts are discovered regarding details of the Delta and Powermatic shapers, I will revise this document.

History

The Delta Heavy Duty Shaper first appeared in the 1938 Delta Tools catalog. It has, for the most part, remained unchanged since that time. Certain minor improvements have been made over the years in certain areas, but it is still the same basic shaper. It was first offered as a 8500 RPM machine. Later, the spindle pulley size was reduced thus raising the spindle speed to a nominal 10,000 RPM. As time went on Delta then changed pulleys to a two step pulley system thus permitting an operator the choice of either 8500 RPM or 10,000 RPM. Due to changes in technology, a more modern approach can be applied to spindle speeds thus almost eliminating the need for belt changes to change speeds.

Other design changes Delta made over the years are:

- Larger table opening allowing larger cutters to be used.
- Bronze threaded insert for the elevation screw
- Addition of a spindle indexing pin
- Adjusting screw for the hex stop rod
- Wear blocks for the hex stop rod.
- Modifications to the motor mounting plate allowing NEMA 56 frame motors to be used and additional clearance added for two speed spindle pulleys.
- Addition of a quick release and tension system for the drive belt.

In the 1980s, Delta decided to create the Platinum series of shapers. These shapers feature a different spindle design. Finding new spindles for these shapers is difficult. If you are contemplating the purchase of a Platinum series shaper, I recommend that you check on the availability and cost of spindles before you buy it.

Features

There is one feature that the Delta and Powermatic 25 shapers has that really makes them perform far and above other shapers and that is the precision spindle cartridge.. This high precision assembly makes for very low runout and axial play which results in

a superior finish.

Delta, in its wisdom, decided that the default ball bearing clearances were too great for a high precision shaper. The only way to get the precision they wanted and at a low cost was to preload common bearings. This is accomplished through the use of a pair of precision inter-bearing spacers which are located inside the spindle cartridge. Realizing the benefits of a preloaded bearing design, Powermatic duplicated Delta's cartridge for their model 25 shaper.

Chapter 2 Design Specifics and Notes

Spindles

The spindle for the Delta Heavy Duty shaper is a fairly common design. The spindle consists of three sections. The shank, the taper and the body. The Grizzly 3 hp shaper spindle, the Delta, and the Powermatic all feature the same body and taper. The shank diameter and drawbar threads are different for each however. The drawbar threads for example are either 5/16"-NF or 3/8"-NF depending on manufacturer. The shanks are different diameters as well. The shank diameters are as follows:

Delta HD - .566"

Grizzly 3hp - .610"

Powermatic - .625"

There are a few different spindles that were made for the Delta HD shaper. These are:

5/16"

1/2"

3/4"

1"

stub

router bit

Third party 1/2", 3/4", 1". and router bit spindles are available.

Drawbars and Nuts

Replacement drawbars are easily made from threaded rod. I use stainless steel threaded rod for tie-bars or drawbars. Stainless is a bit of overkill, but it holds up better because it has nearly twice the tensile strength of steel and is corrosion resistant.

Replacement drawbar nuts are easily made if you have a metal lathe, an appropriate tap, and some 5/8" hex stock. The taper angle is 30 degrees.



Delta Drawbar Nut

Cartridges

The Delta and Powermatic 25 cartridges are identical in design. They both require a precise preload (endplay) of .001 to .0015.

The Powermatic 26 has no preload so bearing replacement requires no special considerations. A set of snap ring pliers is mandatory when replacing bearings in the Powermatic 26 spindle cartridge.

The Delta spindle cartridges have had a few minor changes over the years. There are two basic types however. An early version that is equipped with WC88504 bearings and a later one that is equipped with 6204 bearings. This also means that the length of the inter-bearing spacers are different as well as a change in arbor design.

The reason for the change in bearings from WC88504 to 6204 is because New Departure, the makers of good extended race bearings, went out of business. Since that time others have attempted to make good WC88604 bearings and some had succeeded.

Sadly all of the companies that made good WC88504 bearings have quit making them. As a result, there are no good WC88504 bearings made today. As a result of this, Delta chose to use 6204 bearings. They are still used today.

Early Delta cartridges featured a hardened arbor. While this makes for durable seat that is very resistant to damage, it also makes it prone to cracking as illustrated below, There is no repair possible for these cracks.



Cracked seat end of arbor



Cracked pulley end of Arbor

The one question I get most often is “How can I tell if the cartridge bearings are bad?”. If you hold the cartridge in your hand and spin the pulley you should feel nothing. No roughness, binding, or scraping. In short, all you should feel is grease which has no feel. While this is not a 100% test, it is a fairly accurate test with zero false positives (felt rough but bearings were good) There is a possibility of a few false negatives (felt good but bearings were bad). To reduce the false negatives, running the cartridge and listening to the bearings should remove all doubt .

Solid Spindle Cartridges

Besides the regular replaceable spindle cartridges, Delta also made solid spindle cartridges. These cartridges have a permanently mounted spindle in them that is slightly longer than the replaceable spindles. There were three different 3/ 4” spindles and one 1” spindle.

They were:

3 /4” LH direction only

3 /4” RH direction only

3 /4” bidirectional

1 “ bidirectional

The mono-directional spindles are easy to spot. The upper spindle threads are normal V threads. Bi-directional spindles have a square or acme style thread.

Below is a picture of all of the cartridges that Delta made.



A Spindle Parade

From left to right: Standard, 3 /4 RH only, 3 /4” LH only, 3 /4” bidirectional, 1” bidirectional

All of these cartridges feature preloaded bearings for maximum accuracy and precision.



RH Only Solid Spindle Cartridge Detail

Cartridge Bearing Preload

Delta has stated in it's scant documentation that the cartridge bearings are preloaded and that the preload is set at the factory. Additionally, if the bearings require replacement, the owner is instructed to send the cartridge in to be rebuilt or to purchase a replacement. At the time of this writing a new spindle cartridge has a price of nearly \$200.00 . Delta does not rebuild cartridges and hasn't for years. Just because Delta doesn't rebuild them doesn't mean that it can't be done.

What I have discovered is that the preload Delta refers to is more accurately described as negative preload. Preloading is, by definition, the act of placing pressure on two bearings in such a manner as to remove all end play and a little bit more. This is best illustrated on automotive differential bearings. In the case of the Delta and Powermatic 25 bearings, the preload is actually negative preload or more commonly, end play. You can measure the amount of endplay by clamping the cartridge pulley in a

wise and using a test indicator, lightly pulling and pushing on the body. The total amount of end play should be .001 to .0015.

Spindle Cartridge Bearings Rebuilding Data

Delta used New Departure extended race (WC88504) bearings in their early cartridges. After New Departure went out of business, they switched to NTN 6204 bearings and they have continued to use them. The reason for this is simple. There are no good extended race (80000 series) bearings made any more. Let me state that again. There are no good extended race bearings made anymore. I came to that conclusion after testing all of the WC88504 and 88504 bearings on the market today. As a matter of fact very few 6204 bearings are suitable for a shaper. The best bearings for high speed shaper duty are made by NTN. NTN has proven to be the most consistent and coolest running bearing on the market to date. NTN even beat SKF in my 10,000 RPM temperature tests. NTN is what Delta uses in their new cartridges. While the NTN bearings don't run as cool as the old New Departure bearings, they do run at acceptable temperatures. Acceptable is defined as 145 degrees (F.) or so at 10,000 RPM.

Below is an excerpt of a letter that I wrote to another engineer regarding the bearing and preload spacer issues. While this letter was addressing the Delta HD shaper cartridge, it also applies to the Powermatic 25. My friend Brian wanted to make his own spindle cartridge and was examining a new one so that he could model his after it.

Dear Brian,

That is a brand new cartridge that you are examining. I purchased it 4 months ago from Delta.

For more than 40 years those cartridge arbors were a very light press fit (push in by hand) into the bearings. In addition the bearings are new a press fit into the body. Now they are a press fit. I can see no reason for this change. Why is that significant to bearing spacer length? For example, If the arbor is a press fit it will change the diameter of the inner race. By making the inner race larger, this also reduces the clearance (fit) of the bearing. It also will change the two spacers' delta to obtain a .001 - .0015 endplay. The bearings are also a press fit in the housing, which further reduces the "fit" of the bearing further changing the required delta of the spacers. The upshot to all this is three-fold.

1 - The installed bearing clearance or "fit" is no longer C3. It is something that is smaller.

2 - Because of the decreased fit, the delta of the spacers length is a bit more (.004 or so)

3 - Because of the decreased fit of the bearing it will also run hotter (165F)

So, what this means is that while you measure .004, difference between the two spacers, if you make the parts so that the bearings are a slip fit into the housing and arbor (it is what I do), the bearing's fit is looser thus requiring the spacers' delta to be closer to .003 to .0035 to obtain .001 - .0015 endplay (negative preload).

Summary? As long as you can obtain .001 to .0015 endplay and the bearings fit (C3) is unchanged, the bearings will be happy little bearings and will run in an acceptable temperature range.

If you use NTN 6402 C3 fit bearings with no-contact seals, have the bearings be a slip fit into the parts, the bearing run temperatures will be almost exactly 145 degrees @10,000 RPM. If it is a press fit, the run temps will be about 165 degrees or so.

Angular contact bearings will run a bit cooler (130 degrees or lower). but the cost to implement is prohibitive at this time.

Here is the kicker. The New Departure felt sealed bearings ran cool. They ran at almost 110 degrees. I don't know why for certain. I have some theories but no evidence due to a lack of high precision measuring equipment. I know it is not the seal nor is it the grease.

As far as longevity of the common NTN 6402 C3 bearings go, I think it is acceptable even if they do run a bit warm. Delta has been using NTN 6204 bearings for several (20+?) years. When New Departure went out of business, they had to find something and settled on NTN. I discovered this fact after I had concluded my own bearing studies. SKF bearings run too hot as do Nachi's.

Motors, 3 phase, and Power

For the ultimate in flexibility and utility, it is tough to beat variable speed on a shaper. Properly set up, a VFD will permit any HD class (Delta HD, PM 25, PM26, etc) shaper

to run at any speed between 5000 and 14,000 RPM. With the right accessories, you can do almost any job that a shaper or a router table can do.

Thankfully there are still plenty of people out there that think that 3 phase motors are useless, so cheap 3 phase motors still exist on the used market but the availability of good, cheap, 3 phase motors is quickly drying up. If you purchase a used shaper with a 1 phase motor, you could sell the motor and take the proceeds from that and buy a 3 hp 3 ph motor and a VFD for very little cash out-of-pocket. I have used a variety of motors on my Delta shapers. I like the 3 hp the best. If you do not have electronic variable speed on your shaper, you have my condolences.

VFDs
or
Variable Frequency Drives

VFDs have been around for quite some time. The basic solid state drive first became available in the 1980s. Since that time the marketplace has realized the benefits of electronic speed controls not just as a convenience but also as a way to reduce energy costs and provide accurate process control. As the technology improved so the prices went down. Now a VFD can be purchased for under \$200.00 So what does a VFD do? For woodworking machines it's primary duty is to convert a single phase power source to 3 phase and to also control the spindle speed of the shaper. The various functions built into a VFD are:

- Phase converter
- Motor starter/contactator
- Motor overload
- Low voltage control transformer
- Soft starter
- Electronic brake
- Speed controller
- Reversing controller
- Power transformer (depending on VFD model)
- Process controller (depending on VFD model)

Variable speed on a shaper allows you more flexibility and versatility. You have the ability to run large cutters at 8,000 RPM or small router bits at 14,000 RPM.

Chapter 3 Adjustments

Squaring the Spindle

If you have never checked if your spindle is square to the table, you should. I have seen several shapers that were .050 or more out of square to the table. This can cause some cuts to be excessively wide. A 12" steel rule, a dial indicator, and a small c- clamp is all that you should need. Clamp the steel rule to the spindle using the spindle nut and some spacers. Then clamp the dial indicator to the end of the rule. Adjust spindle eight as needed and you are ready to measure. You want the indicator tip to sweep a circle roughly over the column mounting bolts. The reason is that if you measure .010" high, you add a .010" shim.

Belt Tension

Delta says this about belt tension. *“Proper belt tension is attained when there is approximately 3/32 deflection using light finger pressure (approx. 3.5 lbs.) at the center of the belt span between pulleys...”*

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Operational Notes and Tips

Accessories

One of the lesser talked about accessories is a precision height gauge. I can set cutter heights to within .001 in less than 15 seconds. An imported 6" dial type height gauge with a good heavy base costs about \$40 and makes duplicating setups quick, easy, and accurate. I haven't found anything better for duplicating setups. At the time of this writing, Grizzly is one supplier and is model G9618. Other importers such as Shars.com also sell the same thing. Digital height gauges are also available.



6" Dial Height Gauge

Fences

While the original stock fence works, it does leave a lot to be desired in the dust collection department. There are a couple of fences that Delta made that are much better than the early open style fence for dust collection. The 43-812 is the only fence available new for the Delta shapers. It is rather expensive. The older 43-830 usually sells for about \$150 used and is one that I recommend.

Dust Collection

There is a significant gap between the cabinet and the table of the Delta HD shaper. I had a partial roll of sill gasket left over from a construction job. I folded strips of it and pushed them in the gap. The improvement in dust collection performance was substantial.

Bolts and Torque

There are two bolts that require you to use less than normal torque. The first is the cartridge retaining or pinch bolt. This bolt should be torqued to 7-10 ft. lbs. This equates to tightening the bolt until the lock washer is flat. I have seen broken castings due to excessive torque being placed on this bolt. One Delta engineer told me that he

has seen crushed cartridges.

The second bolt is the tie bar or drawbar bolt. Make it tight but don't try to attain maximum torque. Something like 15 ft. lbs should be more than sufficient.

Rebuilding Notes

There is one bearing in the shaper not including the motor. It is the elevation screw bearing. This should be changed if you are rebuilding the shaper. There are some rubber bushings and a rubber bumper that should be changed as well. Other than that there is nothing else that needs to be changed.

I hope this document helps.

All the best.

Richard