

## How To Replace Factory Original Nylon Azimuth Bearing Balls

After 2 years of service from my CPC 1100 I began having problems with tracking and go-to accuracy when set up for wedge mounted astrophotography. The problem became so severe that my PHD auto-guiding setup was unable to cope.

When looking through the eyepiece I would attempt to slew (slow speed) but the stars were not moving even though I could hear the motors turning. Eventually the scope would lurch.

I had the same problem 6 months earlier and I was able to correct it by increasing the spring tension adjustment on the azimuth worm gear assembly. But now, the amount of force needed to rotate the scope by hand (when the clutch knob was released) was way too much.

I read a web posting that mentioned that the CPC scopes used nylon bearings and it occurred to me that this could be the cause of my problems.. It's predecessor, NexStar GPS used steel bearings.

The CPC 1100, WO 110mm refractor, cameras, dove-tail plate, dew shield, counter weights add up to approx. 100 lbs. When you look at the angle the scope is sitting (leverage), it is not surprising that nylon bearings may not be up to the task.



Sure enough, when I dismantled the scope the nylon bearings (122 in all) had worn to the point where flat spots were noticeable.

My solution was to replace the nylon bearings with steel bearings. This article shows the steps required to dismantle the scope and replace the bearings.

Before I begin, credit goes to my friend Dave Yates (cpc1100scoper) who is my "Obewan" with all things mechanical and electrical. It is a wonderful collaboration. I determine the requirement, he figures out how to do it, and we curse, grunt and swear in his garage until it's done. We have done numerous and major modifications to our CPC 1100's to the point where we now own a metal lathe, milling machine, metal band saw and countless other tools needed to work with aluminum. As soon as we can decide on an appropriate name for a Company, we hope to offer some of our solutions for sale. One of our potential Retailers thinks it should be named "Pimp My Scope". I am not sure if he was kidding.

OK, on to the "how to" part.

You will be replacing the 122 ¼" (0.25") nylon bearing balls with Chrome/Stainless steel bearing balls. These sit in a channel (groove) in the bottom base plate (the part that bolts to the tripod/wedge). This channel is not what I would call smooth which certainly accounts for the excessive wear on the bearings. The task here is to lift the fork assembly away from the base to get at the bearing balls.

## Before You Begin

### NOTES:

1. This is a fairly easy project (2 hours at most) for anyone with a least some “do it yourself” experience. On the other hand, if your tool collection is limited to a hammer, vice-grips, and a combination screw driver, this project may not be for you.
2. This is also an inexpensive project. Well under \$ 50.00 unless you need to buy metric tools (Hex/Allen wrenches)
3. I know of a few inconsistencies in the fasteners (screws, bolts) that Celestron uses during construction. For example, my scope uses Phillips head screws (5) for the plastic base cover. My friend’s scope (6 months newer) uses socket head (hex/Allen) screws.
4. I cannot be certain if CPC 800 and 925 Models are built the same as the 1100 model. I assume they are, but I am unsure.

## Supplies and Tools Required

### Supplies:

1. Chrome Steel or Stainless Steel Bearings. ¼” (0.25”) diameter. There are 122 on a CPC 1100. They typically come in bags of 100. Make sure you get a few extras because you WILL drop a few and won’t find them until 6 months from now when you step on one in the dark.
  - a. I used Chrome Steel bearing balls because they were a stock item locally, but I may replace them with stainless steel. Chrome Steel is the most wear resistant (hard as hell) but the least rust resistant.
  - b. Stainless Steel grades 304,316, and 440C are a softer metal but resist corrosion. 440C is ideal. Harder than 304/316 and corrosion resistant. The Chrome steel with a coating of lubricant will last a long time. Replacing them periodically is cheap and gives you the opportunity to clean and re-lube everything to assure a lifetime of smooth action.
  - c. EBay is a good source. Do a search for “Stainless Steel Bearing Balls” and you will find plenty.
2. Light weight oil. 3-in-1 machine oils works fine
3. Synthetic silicon based grease. You may as well replace the cheap Chinese stuff while it’s all apart.
4. Removable, medium strength thread locker such as Loctite 242 or Permabond MM115 (usually blue in colour)
5. Rags, paper towels

### Tools

- Metric Hex/Allen wrenches: 2mm, 2.5mm, 5mm
- Phillips screw driver
- Large channel-lock pliers (or a 45mm wrench if you have one).

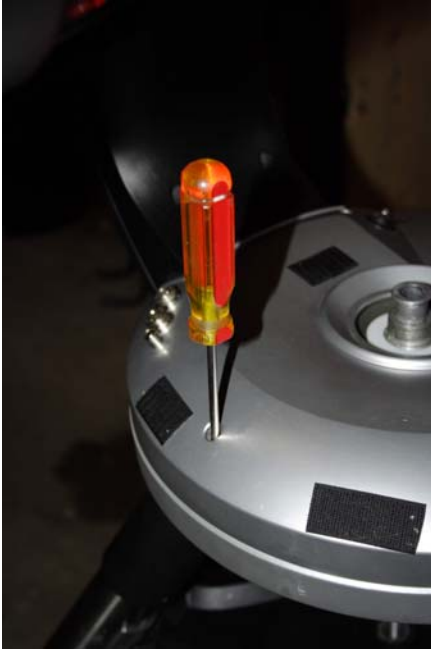
### Step 1:

Start by bolting you scope to the tripod (not a wedge)

Loosen the clutch knob set screw so that the knob can be removed. You will need a 2mm allen wrench.

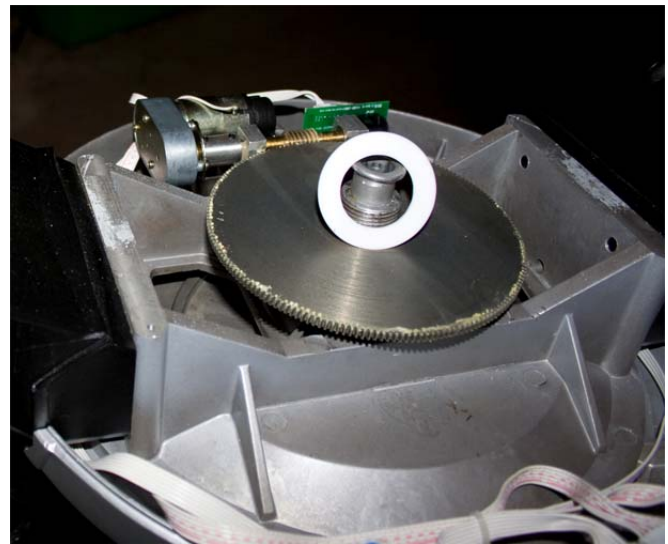


Remove the 5 screws from the plastic base cover and pop the cover off. Then disconnect the 5 cable straps. You may want to label them to make sure you reconnect them properly later on.



Next, remove the plastic clutch washer and lift up on the main gear to remove it. You may need to release the tension from the worm gear assembly. Just push against it to compress the spring and then lift the main gear.

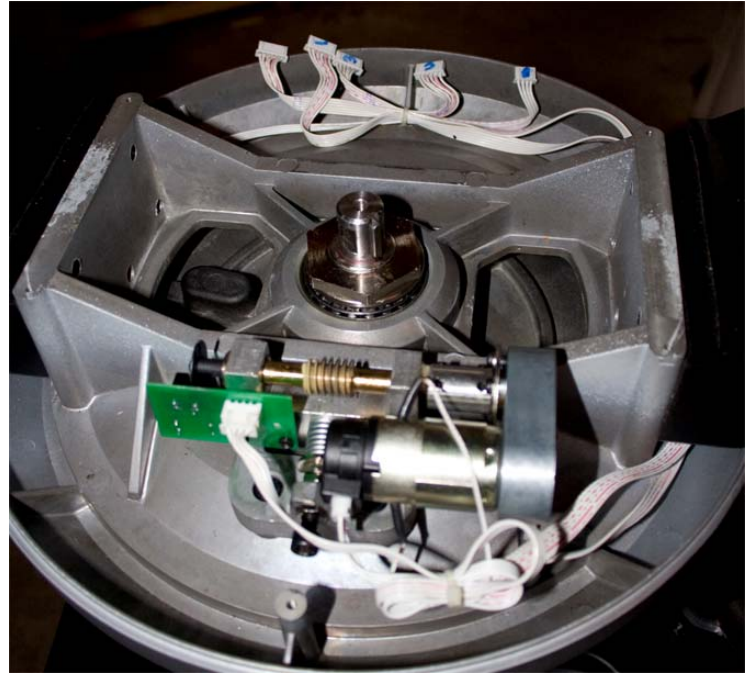
Be careful not to get and grease on the clutch washer or the center of the main gear. I took the opportunity to clean off the old grease. Hot water (really hot) and some soap does nicely. I used some liquid hand cleaner that has a bit of grit and got an old toothbrush to clean out the gear teeth. Give a really good rinse to get the soap off. Dry it off right away to prevent rust.



Next, remove the clutch plate. There are 2 set screws (2.5mm), on either side and a bolt (5mm) with a lock washer. Remove them and Peel off any traces of Loctite and set them aside.

Then lift up on the friction plate to remove it from the main shaft.

You will also need to remove the "key" from the slot. Take note how it is positioned as you will need to reinstall the same way.



Next, remove the nut and washer using a 45mm wrench (if you have one) or channel lock pliers. Peel off any Loctite from the nut and set aside.



Now it's time to lift the fork assembly and reveal the nylon bearing balls.

DO NOT attempt to pry off the main shaft bearing. Simply lift the fork assembly and the bearing will come with it. You may need to "rock" the assembly in all directions to coax the main bearing to lift off the shaft.

Set the fork assembly in a safe place. This would also be a good time to remove the old grease from the main bearing and shaft. No soap or water here. Just wipe it with a clean cloth.

And there they are. 122 nylon bearing balls (more like ovals now). The balls sit in a groove that is not terribly smooth. I ran my finger in the groove and it felt like fine sand paper. This would explain the excessive wear.



A few days earlier I attempted to fix my problem with some lubricant with the existing nylon bearings. It did reduce roll resistance but did not make the problem go away.

This is the bottom of the fork assembly. It is basically an inverted cone. The arrow in the photo points to the point where the bearing balls touch the fork assembly. It is not a groove, just the marks made by the bearing balls.



Next, remove the base plate from the tripod and set it down on a towel, blanket, or what ever. These balls are slippery suckers and you will drop a few. If you drop then on the floor you will not likely find them again.

Remove the nylon bearings from the channel. You may want to keep the olds ones (you never know).

Give the channel a good wipe down and then apply a thin coating of lubricant. I used 3-in-1 machine oil applied with a Q-tip.



Now it's time to prepare the steel bearing balls. I dumped a bag of 100 into a container and then counted out 22 more from the other bag. I did not count to see if there were really 100 in the 1<sup>st</sup> bag but I am assuming that there were a few more than 100 because I had 4 left over after filling the channel.

I added ¼ teaspoon of machine oil and mixed them to evenly coat the bearings with lubricant. You don't want oil to be dripping wet. Just a nice light coating. I rolled each one with my fingers to remove the excess. Now just drop them in the channel.

In the photo you can see that they are a snug fit with no gaps. I ended up removing 1 because they were a bit too snug. You do want some play.

Now it's time to reassemble everything.

Start by putting the base plate back onto the tripod. Bolt it down good and tight. This is important because later you will be trying to determine how much torque is needed on the 45mm nut.

Now would be a good time to grease the main bearings and shaft. Don't over do it. You just want a thin coating. I used a synthetic silicone based grease that maintains viscosity from -45°F to over 400°F.



Insert the bearing back into the fork assembly. Now it's time to grunt.

Lift the fork assembly and place back onto the base plate. Use the shaft as your guide to getting things lined up before making contact.

Once settled you will need to gently urge the main bearing to seat itself down on the shaft. I used a plastic plumbing fitting and tapped on it with a hammer.





Apply a few drops of Loctite to the nut and install the large washer and nut.



Now it's time to tighten the nut.

It does not take much torque on the nut. Surprisingly little in fact. If you tighten too much the fork assembly will be difficult to turn.

Once I got close I pushed on a fork arm, back and forth, to see if there was any play between the main bearing and the shaft. I slowly tightened until the play stopped. Keep in mind that the tripod is not known for its rigidity and the shaft itself will also appear to move. What you want to see is that the main bearing and the shaft remain 90 degrees to each other. If in doubt, back off on the torque.



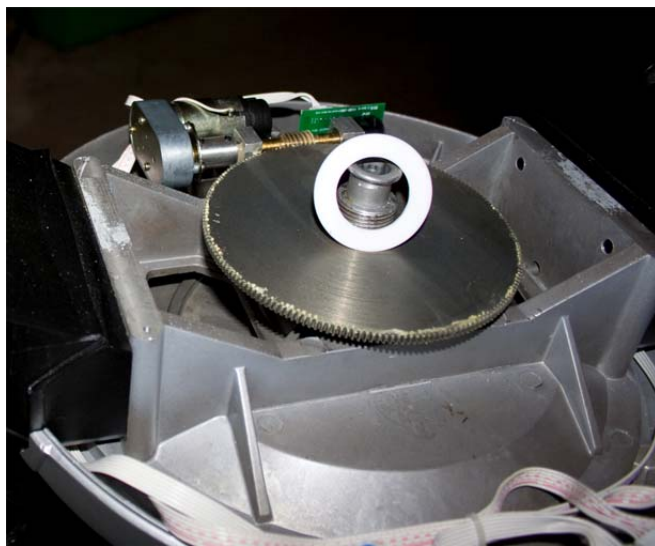
The rest is pretty simple. Just put the rest of the parts back in place. Put a bit of Loctite on the 2 set screws and bolt.

Don't forget to install the key in the shaft slot!



Put a bit of synthetic grease on the main gear teeth. Not too much! Then place the gear over the shaft. You will need to push the worm gear & motor assembly back to allow the main gear to seat itself against the friction plate.

Be careful not to get any grease in the center portion of the gear (top and bottom). Otherwise the clutch will slip!



All that remains now is to reconnect the wires, install the base cover and clutch knob.

Before you put in the screws for the base cover, plug your scope in and slew the scope at high speed in both directions. Let it spin around a few times. Spinning it around will ensure that the bearing is properly seated.

Then recheck to ensure that there is no play between the main bearing and the shaft. Do this by rocking the fork assembly (grab an arm and shake) in all directions. You may need to put some extra torque on the 45mm nut.

The result? Like Butter !. This has solved my tracking and go-to accuracy problems. And it was an easy project too.

Good luck!

Gary Bennett  
Toronto, Canada  
gary@bendun.net