

1 1/4" Crayford Focuser

3D Printed Focuser

I wanted to use a 1 1/4" focuser for an 8" Newtonian telescope I was making. But most commercial crayford focusers are designed for 2" eyepieces which are a bit large for an 8" telescope. So I decided to make use of my 3D printer and create my own 1 1/4" crayford focuser. My design fits a 10" diameter tube, but one could easily modify the design if a flat base is needed.

My focuser works just like any other crayford focuser. Turn the knob and the drawtube smoothly, with no backlash, moves up or down until a stop is reached. The drawtube friction is adjusted using the two tensioning grub screws on the focuser back. Also on the back is an optional M4 threaded hole to add a brake if using heavier accessories. My heaviest eyepiece is a 24mm Televue Panoptic eyepiece which works fine without the brake.

Here are a few of the key focuser design attributes (with a 2mm thick curved base added):

- Drawtube inside diameter = 1 1/4"
- Minimum racked-in height = 40mm
- Maximum racked-out height = 70mm
- Drawtube travel = 30mm
- Maximum drawtube extension below base = 23mm
- Weight = 200g
- 3D print material = PLA
- Curved base mounting holes: 48mm x 63mm
- Base dimensions: 68mm x 77mm

Want to build your own focuser? You can either download my STL files and start printing. Or download my 3D model CAD files and create your own customized version.

These instructions include the following:

1. 1 1/4" crayford focuser example (See above photo).
2. Construction Tips
3. Parts List + Exploded View
4. Downloadable Files (LeisureNotes.com)
 1. Instructions (pdf file)
 2. 3D CAD Models
 1. STEP (zip)
 2. STP (zip)
 3. OBJ (zip)
 4. STL (zip; also available at Thingiverse)

Please note that this 3D printed focuser design has also been shared on the Thingiverse website. Simply click this Thingiverse link or search for Thingiverse project # ??????.

Construction Tips

First, my disclaimer. I rate myself as a novice 3D printer user. So please don't hesitate to modify my design to better suit your 3D printing capabilities.

Here are the 3D printer settings I used:

- Printer: Prusa MK3S+
- Slicer app: PrusaSlicer
- Filament: Prusament PLA
- Nozzle temperature: 215
- Bed temperature: 60
- Layer height: 0.20mm
- Supports:
 - Drawtube — none
 - Printed with top end on platter
 - Base — everywhere
 - Note: Rookie mistake here. I had support material everywhere. In hindsight, I suspect the base can be printed with very little support material. The most likely spots are the two pinion rod pressure rods.
 - Printed with focuser base on printer platter
- Perimeters: 6
- Solid layers (top and bottom): 8
- Minimum shell thickness (top and bottom): 0.7mm

So you now have the settings that worked for me. Again, I'm a novice using my 3D printer and I suspect some of my perimeter and layer settings might be overkill.

Also please make sure you compare your printer tolerances with my mine. The inside hole diameters printed using my printer average 0.2mm smaller than the CAD diameter setting. So my 3D models have holes that are intentionally 0.2mm diameter larger so the final, printed hole sizes will be very close to the required size. For example, if I need a 3mm hole diameter for a M3 screw, my 3D model will have a 3.2mm diameter hole.

Build Steps

Drawtube

1. 3D print the drawtube.
2. Lightly sand the three drawtube rail recesses used for the pinion aluminum rail and two brass bearing rails.
3. Cut the metal rails to length, check the fit, clean and rough up both sides with sandpaper, and then glue the metal rails to the drawtube. I used the JB Weld original epoxy which I highly recommend. Make sure you clamp the rails to the drawtube for a strong glue joint. For clamps, I place a small piece of scrap wood on top of each metal rail and then used rubber bands as 'clamps' to press the metal strips against the drawtube.
4. Install the heat set brass inserts for the eyepiece retainer screw and the two drawtube stops in the bottom end. Note that my example focuser has M3 screws for the stops, but I recommend M2 screws. The design (and CAD files) have been revised to use the recommended M2 screws.

Focuser Base

1. 3D print the base. Remember, I used 'everything' setting for my support material. I don't recommend this setting since every hole in my focuser base had support material which was difficult to remove. If I build another one, I'll use the PrusaSlicer tool to selectively add support material to the few necessary areas such as the two holes for the pinion pressure rods.
2. Install into the base the four heat set inserts for the base back plate and the one insert for the optional brake. Next I installed the two pressure grub screws into the base back plate. Note that I installed the two grub screw inserts from the backside of the back plate which increases the holding strength. I also went ahead and installed the heat inserts into the two knobs.
3. Install the four drawtube pressure bearings that fit against the drawtube brass rails. Don't forget the flat washers which act as spacers between the bearings and the base.
4. Next I did a quick fit check for the pinion shaft which should turn freely. My holes were a little small so I carefully used a drill bit to slightly enlarge the holes. Making these holes slightly larger might be a nice design improvement if I ever do another revision.
5. Time to install the pinion pressure rods. First, I cleaned out the holes in the base where the pressure rods are inserted. These two holes needed some minor cleaning/rounding (especially the seam along the top). Then I did a trial fit of the pressure rods which needed a light sanding for a snug fit. I wanted these rods to fit with no 'slop' since once the pressure is set no further rod movement is needed.
6. Next, I inserted the pinion rod and checked the fit to ensure I had a close tolerance fit and smooth turning. Then I did a push-pull of the pinion rod to check that the pressure rods would also move in-out correctly.
7. Now that main moving parts seemed to be working, I installed the base back using four M3 screws. Then I added the two grub screws used to push the pinion rod against the drawtube.
8. Before tightening the pressure grub screws, I added the drawtube.
9. Next I installed the two knobs.
10. Now I carefully tightened the pressure grub screws (needed very little pressure) until the drawtube had enough pressure to operate smoothly plus held my eyepiece in position.
11. Finally, I added the two drawtube stops and the drawtube M4 nylon screw used to capture the eyepiece in the drawtube.

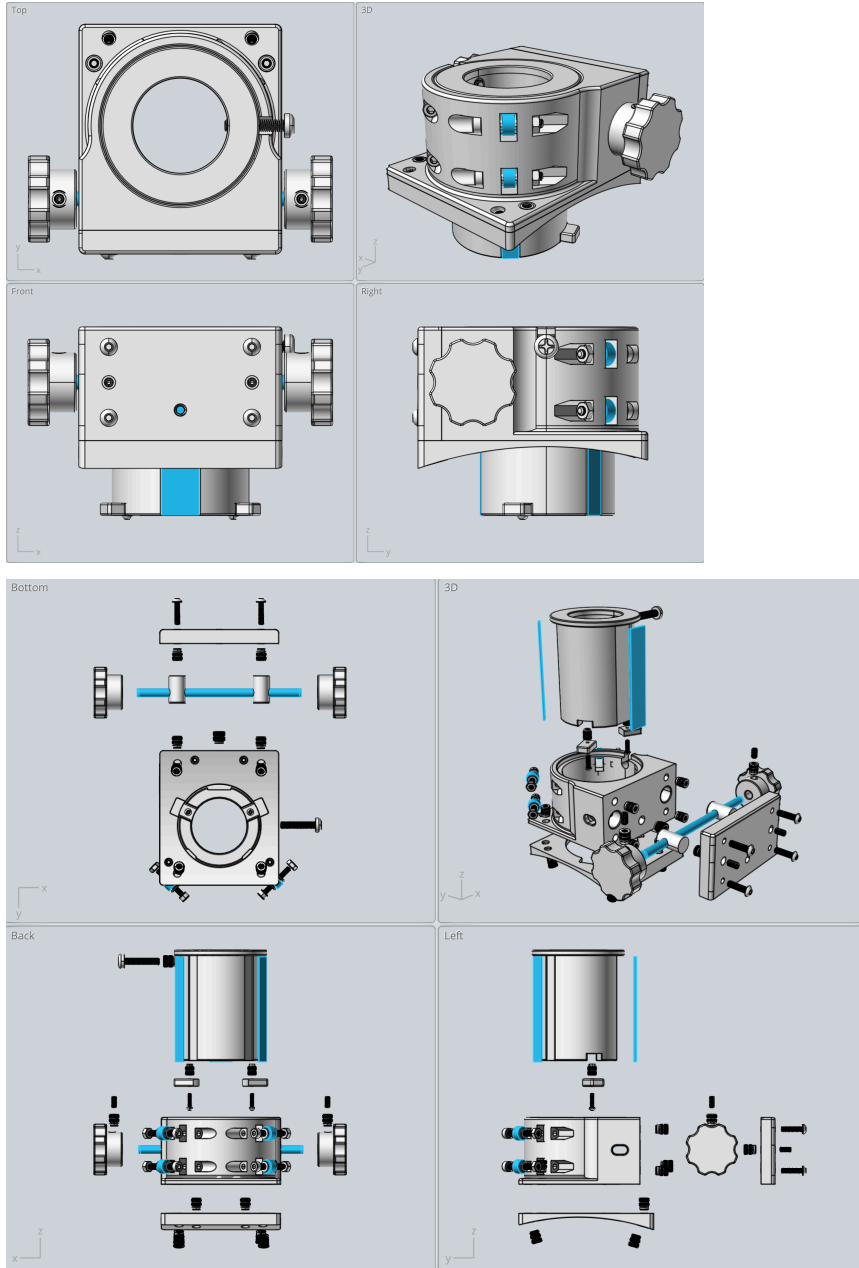
All done! ...almost...

Please note that my focuser mounts to a 10.25" OD telescope tube. So I printed and glued a curved base to the bottom of my focuser (adds 2mm to the focuser base height). I then added

the heat set inserts for the four mounting screws which are inserted from inside the telescope tube (bottom of focuser). Next I added the inserts for the four alignment grub screws which are installed and accessed from the focuser side of the telescope tube.

Parts

The parts I used are all easily located online. I purchased most of my parts from Amazon. I also highly recommend McMaster-Carr as an excellent online supplier. You can use the following exploded views along with the parts list to help you visualize the focuser design. Of course using a 3D model file viewer or CAD program is highly recommended.



Parts List

ID	Part	Dimensions	Material	Qty	Notes
1	Drawtube	Ref. Drawing	PLA	1	
2	Base	Ref. Drawing	PLA	1	
3	Curved base	Ref. Drawing	PLA	1	Fits 10.25" OD tube
4	Pinion pressure rod	Ref. Drawing	PLA	2	
5	Base back	Ref. Drawing	PLA	1	
6	Knob	Ref. Drawing	PLA	2	
7	Drawtube stop	Ref. Drawing	PLA	2	
8	Drawtube bearing rail	1mm x 6mm x 60mm	Brass	2	
9	Drawtube pinion rail	1/16" x 1/2" x 60mm	Aluminum	1	
10	M4 Philips head screw	4mm x 20mm	Nylon	1	Drawtube eyepiece capture screw
11	M3 button head hex drive screw	3mm x 12mm	Stainless	4 4	Base back Curved base mounting screws
12	Pinion rod	5mm dia x 96mm	Stainless	1	
13	Bearings	8mm OD x 3mm ID x 4mm	Stainless	4	
14	M3 cap head hex screw	3mm x 20mm	Stainless	4	Bearing shafts
15	M3 flat washers	3mm	Stainless	8	Bearing shaft washers
16	M3 hex nuts	3mm	Stainless	4	Bearing shaft nuts
17	M3 heat set inserts	3mm x 6mm L	Brass	4 2 4	Base back Knobs Curved base
18	M4 heat set inserts	4mm x 6mm L	Brass	2	Eyepiece capture screw insert Optional brake screw insert
19	M3 grub screws	3mm x 6mm L	Stainless	2 2 4	Knobs Pinion pressure screws Curved base alignment
20	M2 button head hex drive screw	2mm x 8mm	Stainless	2	Drawtube stops
21	M2 heat set inserts	2mm x 6mm	Brass	2	Drawtube stop inserts