MP120TC Assembly Instructions

Mostly **P**rinted **120** **T**echnical **C**amera

August 2023

Introduction

In Summer 2021 I decided to build a Goodman Axis technical camera, having found it online. I began printing the files provided and quickly noticed that the camera's design had flaws, some of which would completely prevent the camera from being usable. Due to these issues, I determined that the amount of time involved in modifying the design was not worth the effort and that I would start my own design from scratch.

I was inspired by the Mostly Printed CNC (MPCNC), where as many parts as possible are 3D printed, augmented by off-the-shelf hardware and parts where needed. I decided that I would follow this design philosophy and make a Mostly Printed 120 Technical Camera (MP120TC).

After about a year of work and refinements, the MP120TC was working and ready for the world. In this document you will find instructions on how to assemble one for yourself.

Format

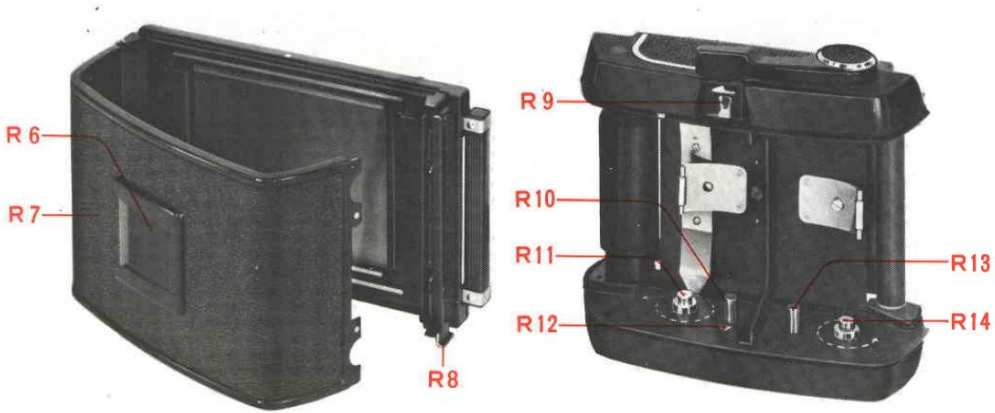
The default format, which is also the recommended format, is 6x7cm on 120 film (6x9 is possible*). This was selected over 4x5 inches for several reasons.

- 120 film is much more convenient to work with.
- 120 film is also considerably less expensive to purchase and easier to find labs to process.
- If you process the film yourself, 120 film is considerably easier to work with.
- Once developed, 120 film is also easier to get scans from when working in an analog/digital hybrid workflow.
- The cost overall is at least ¼ that of 4x5 film and image quality is comparable at most common print sizes.

*Files for 6x9-capable film backs are included if you want to use them, but 6x7 is recommended.

Film Backs

This camera is compatible with Graflok 23 style film backs, primarily Graflex RH10 and Mamiya RB-67 backs. The sliders that secure the backs will catch the darkslide release on Mamiya Pro-S and Pro-SD backs, so any RB 6x7 film back should work. 6x9 backs can be used provided you use the rear frame, repositionable plate, and ground glass holder parts designed for 6x9. Other Graflok 23 backs such as Horseman and Linhof should work, but they have not been tested. Additionally, you may use Graflok 23 compatible cut film holders, should you happen to have them and don't mind the inconvenience!



Lenses

Any lens over 75mm in focal length in a #00, #0, or #1 shutter that covers 6x7cm can be used. The most common lenses are those designed for 4x5 inch large format cameras in a #0 shutter. The lens you choose will dictate how long of a rail, how long the gear rack will need to be, and how long of a bellows you need.

Before You Start Printing Parts

Order the 2X M8 x 20mm hollow hex-head bolts

This camera uses M8 x 20mm hollow hex-head bolts for the concentric tilt/rise/fall on both the front and rear standards, with a hole through the center sufficient to clear a M4 screw. These parts can be difficult to find, and you may end up buying them from China. If you have a buddy with machine tools, you could have some common M8 x 20mm screws bored out for a M4 screw instead.

Order the Bellows

While you could try to build one yourself, chances are you'll spend a ton of time and more money than buying a professionally made one. You could order one from China, but shipping is occasionally totally unreliable, so it is recommended that you buy your bellows from Custom Bellows UK (**http://www.custombellows.co.uk/**). Their prices are good and the quality is high. Additionally, they will get the bellows to you in a reasonable amount of time.

Outer dimensions: 100x100mm Front, 100x100mm rear
Inner dimensions: 80x80mm Front, 80x80mm rear
Length/# of pleats: this is determined by the lens you choose. For a 150mm lens a bellows with 14 pleats seems to work well and allows for good close-focusing extension.

Before You Start Printing Parts (continued)

This camera can accept plain ground glass or a bright screen. Plain ground glass will work OK, but it will be a little dim and gritty. In addition, plain ground glass will suffer from light falloff away from the center of the glass. If you really want to make your own, there are videos on YouTube that describe how to make a ground glass.

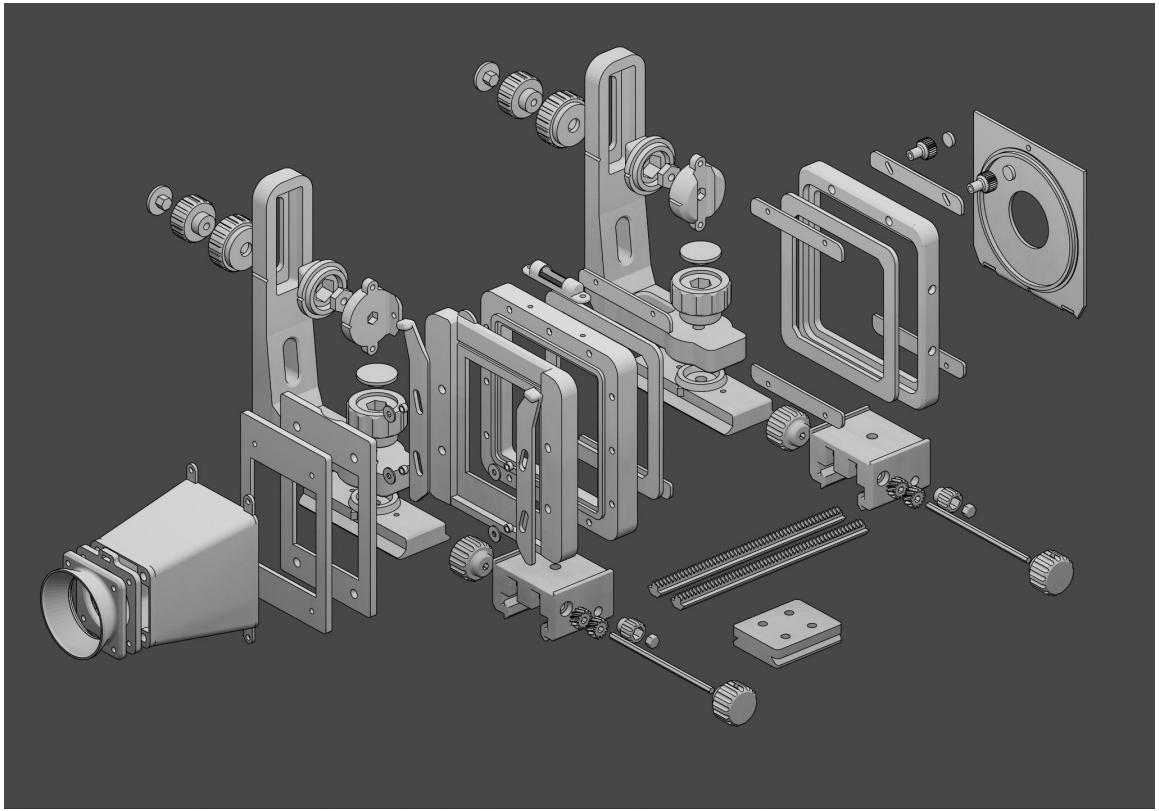
A bright screen will be more pleasant to use if you have the budget to buy one. For bright screens I recommend the Rick Oleson bright screens (**https://rickoleson-brightscreen.com/**). Other screens are available from many sources, but Rick Oleson's are the best balance of price and quality.

Format	**Ground Glass Size**
6x7 (default, recommended format)	68 x 78mm x 1.5mm
6x9	68 x 88mm x 1.5mm

Exploded View

These are all of the 3D printed parts that comprise the MP120TC. Effort was made to minimize use of supports, and heat-set threaded inserts are used on most threaded screws for durability and strength. A standard FDM type 3D printer can be used to print all of these parts. PLA+ material is sufficient, but if you have the ability to print in stronger materials, it is recommended. With PLA you may occasionally need to replace parts as they wear.

There is no specific order of assembly. Individual 3D printed parts are assembled into larger part assemblies that you can build in the order of your choosing.



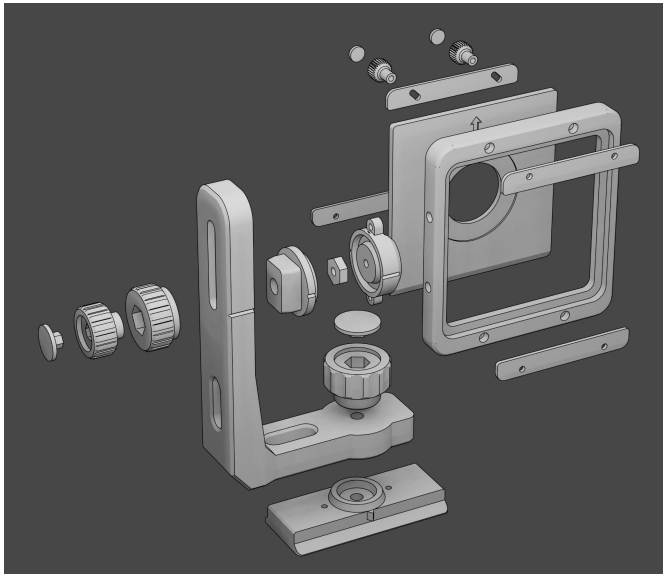
Front L-Frame and Lens Frame

3D printed parts:

- 1X Frame QR Slider
- 1X Front L arm
- 1X Front lens frame*
- 1X Lens board*
- 1X Lens board sliding plate
- 3X Bellows locking plates
- 2X M3 thumbscrews
- 2X M3 thumbscrew caps
- 1X Front tilt block
- 1X Rise/Fall block
- 1X Rise/Fall knob
- 1X Tilt knob
- 1X Tilt knob cap
- 1X M8 plug
- 1X Swing knob
- 1X Swing knob cap

Hardware:

- 1X M8 x 20mm hollow bolt (M4 hole)
- 1X M8 nut
- 1X M4 x 45mm hex head bolt
- 1X M4 nut
- 1X ¼-20 x 1.5 inch hex head bolt
- 1X ¼-20 nut
- 10X M3 brass heat-set threaded inserts
- 2X M3 x 4mm screws
- 8X M3 x 6mm screws
- 2X M3 x 16mm screws
- 2X M3 nuts
- 2X 4mm diameter, 5mm long spring ball detents with POM ball **(optional)**
- Thin Superglue



*** Note:** Several users requested that the front be modified to allow use of a Linhof Technika IV/V lens board. STL Files have been included for a Linhof lens board and an alternate Front lens frame that can accept the Linhof boards. You can decide which you wish to print.

Front L-Frame and Lens Frame

Steps

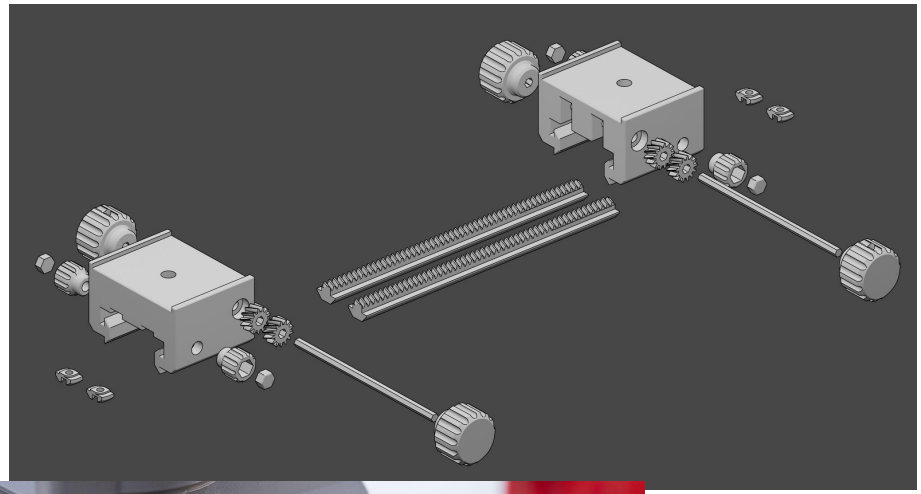
1. Install the M3 brass heat-set inserts into the front lens frame, ensuring that all are flush with the surface around them. **Note:** several holes for inserts are close to edges and you may see some deformation of the plastic when inserts are installed where the lens board and bellows are attached. If you see deformations, carefully remove them with a sharp chisel. The amount to remove is quite small, so be careful and proceed slowly to avoid slipping and damaging the front.
2. Insert the M8 hollow bolt into the rise/fall block
3. Insert the M8 plug into the remaining space in the rise/fall block and glue it, making certain that the plug is pushed in flush
4. Insert the M4 nut into the hex shaped recess on the front tilt block
5. Attach the front tilt block onto the front lens frame using two M3 screws
6. Insert the M8 nut into the rise/fall knob
7. Insert the M4 x 45mm bolt into the tilt knob
8. Insert the tilt knob cap, gluing if necessary
9. Insert the rise/fall block into the inset on the front L arm with the M8 bolt toward the outside
10. Tighten the rise/fall knob onto the protruding M8 bolt
11. Insert the tilt knob with the bolt through the center of the M8 hollow bolt and through the tilt block into the M4 nut and tighten it
12. Screw one M3 nut onto each M3 x 16mm screw, tightening it fully against the head of the screw
13. Insert each M3 x 16mm screw assembly into a thumbscrew, making certain it is in as far as possible
14. Install the thumbscrew caps onto each thumbscrew, gluing them in place
15. Install the bellows locking plate onto the bottom front of the front lens frame using M3 screws
16. Install the lens board sliding plate onto the top front of the front lens frame using the two thumbscrews
17. Insert the ¼-20 nut into the bottom of the frame QR slider
18. Install one M3 x 4mm screw into each remaining hole on the bottom of the QR slider
19. If you are using spring ball detents, insert them into the frame QR slider
20. Insert the ¼-20 bolt into the swing knob
21. Install the swing knob cap
22. Insert the swing knob and bolt through the frame QR slider and tighten

Focusing Carriages and Racks

3D Printed Parts:

- 4X - Focus Locking Knob
- 4X - Focus Locking Knob cap
- 2X - Focusing Carriage
- 4X - Focusing Knob
- 4X - Focusing Pinion
- 4X - Focusing Rack 140mm
- 2X - Hex Focusing Axle*
- 4X - M3 T Nut

* The focusing axle can be 3D printed, but a better option is to buy long 3.5mm Allen Keys and cut them down to 88mm.



Hardware:

- 4X - 684ZZ Ball Bearings (4 x 9 x 4mm)
- 4X - M3 Nut
- 4X - M3 x 8mm screws
- 4X - M4 x 16mm hex head screws
- 4X - M4 x 8mm set screws
- 4X - M4 heat set inserts
- 2X - Arca QR plates with mounting screws

Focusing Carriages and Racks

Steps:

1. Insert the bearings into the focusing carriages. They are press-fit and should snap into place.
2. Install the heat set inserts into focusing carriages.
3. Insert the hex axles (or 3.5mm Allen wrenches cut to become straight 88mm lengths) into two of the focusing knobs.
4. Insert set screws into the two focusing knobs with axles. Do not overtighten - the plastic will strip.
5. Slide the axles through the carriages, slipping them through the ball bearings and pinion gears. The pinion gears will go into the two insets on the carriages so they can mate with the racks.
6. Insert the remaining focusing knobs onto the ends of the hex axles and use the remaining two set screws to hold the assemblies together.
7. The racks provided are 140mm in length. You will need four to fit into a 300mm rail. You will need to grind the mating ends of these down so that the gears match/mesh well. The fit will be very tight in the rail, and you may need to use a scraper/chisel to alter the fit. You want them snug. If you use a shorter rail, you'll need to cut them to length.
8. Insert the M3 nuts into the 3D printed T nuts and tighten them in place at the ends of the racks. These keep the racks from slipping.
9. Insert the M4 x 16mm bolts into the focus lock knobs. Glue the focus lock knobs in place using Superglue.
10. Install the focus lock knobs into place on the carriages
11. Install the metal Arca Compatible QR plates onto the carriages. The fit will be snug and may require snapping into place
12. Install the carriages onto the rail

When printing the carriages, you should orient them with the pinion gear slots upward. No supports should be needed, but if you are worried, use Tree supports, touching the build plate only.

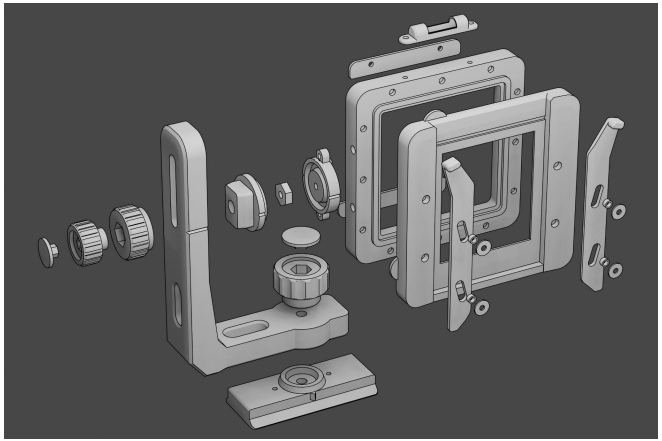
Rear L-Frame and Graflok Back

3D printed parts:

- 1X Frame QR Slider
- 1X Rear L arm
- 1X Rear frame*
- 1X Repositionable back*
- 2X Graflok sliders, 1 printed as in the STL file, the other mirrored
- 4X Graflok slider spacers
- 4X Graflok slider washers
- 2X Bellows locking plates
- 1X Bubble level holder
- 1X Rear tilt block
- 1X Rise/Fall block
- 1X Rise/Fall knob
- 1X Tilt knob
- 1X Tilt knob cap
- 1X M8 plug
- 1X Swing knob
- 1X Swing knob cap

Hardware:

- 1X M8 x 20mm hollow bolt (M4 hole)
- 1X M8 nut
- 1X M4 x 45mm hex head bolt
- 1X M4 nut
- 1X ¼-20 x 1.5 inch hex head bolt
- 1X ¼-20 nut
- 11X M3 brass heat-set threaded inserts
- 8X M3 x 6mm screws
- 2X M3 x 4mm screws
- 4X M3 metal washers
- 2X 4mm diameter, 5mm long spring ball detents with POM ball **(optional)**
- 1X 8mm x 35m vial bubble level
- 24X 4mm x 2mm neodymium disc magnets
- Thin Superglue



*** If you are using 6x9 film backs, you must use the 6x9 parts instead of the standard ones.**

Rear L-Frame and Graflok Back

Steps

1. Install the M3 brass heat-set inserts into the rear frame and repositionable frame, ensuring that all are flush with the surface around them
2. Install the magnets into the rear frame. For each magnet:
    a. Prior to installation put a small drop of super glue in the hole into which the magnet will be installed
    b. Ensure that the magnet's polarity is correct
    c. Press the magnet fully into the hole, making certain it is flush with the surface around it
3. Install the magnets into the repositionable back. For each magnet:
    a. Prior to installation put a small drop of super glue in the hole into which the magnet will be installed
    b. Ensure that the magnet's polarity is correct and that it attracts to those installed on the rear frame
    c. Press the magnet fully into the hole, making certain it is flush with the surface around it
4. Insert the M8 hollow bolt into the rise/fall block
5. Insert the M8 plug into the remaining space in the rise/fall block and glue it, making certain that the plug is pushed in flush
6. Insert the M4 nut into the hex shaped recess on the rear tilt block
7. Attach the rear tilt block onto the rear frame using three M3 screws (two on the side, one on the front)
8. Insert the M8 nut into the rise/fall knob
9. Insert the M4 x 45mm bolt into the tilt knob
10. Insert the tilt knob cap, gluing if necessary
11. Insert the rise/fall block into the inset on the front L arm with the M8 bolt toward the outside
12. Tighten the rise/fall knob onto the protruding M8 bolt
13. Insert the tilt knob with the bolt through the center of the M8 hollow bolt and through the tilt block into the M4 nut and tighten it
14. Insert the ¼-20 nut into the bottom of the frame QR slider
15. Install one M3 x 4mm screw into each remaining hole on the bottom of the QR slider
16. If you are using spring ball detents, insert them into the frame QR slider
17. Insert the ¼-20 bolt into the swing knob

Rear L-Frame and Graflok Back

18. Install the swing knob cap
19. Insert the swing knob and bolt through the frame QR slider and tighten
20. Install the 8mmx35mm vial bubble level into the bubble level holder
21. Install the bubble level holder onto the top of the rear frame with M3x6mm screws
22. Make 4 M3-6mm screws into low-profile screws. Using a drill, insert the threaded end of each M3-6mm screw into the chuck and tighten just enough to keep it in place. Run the drill and grind the head down on a piece of sandpaper until the head thickness is no more than 1.1mm. 0.9mm to 1.0mm is best.
23. Insert the Graflok spacers into each slot on the Graflok sliders, one spacer per slot
24. Install one standard metal M3 washer and then one Graflok slider washer onto each of 4 M3x6mm screws
25. Install the Graflok sliders using the M3x6mm/washers
26. Adjust the tension of the M3 screws so the sliders move sufficiently easily
27. You may need to sand down the edges that mate with your back slightly, on the edge that was in contact with your printer’s build plate. Some backs don’t seem to need this, but others do. Test-fit your back to be sure.

Attach Tripod Mount to Rail

3D Printed Parts:

- Rail tripod mount

Hardware:

- 2X Double Tee Nuts
- 4X M5 x 10mm screws

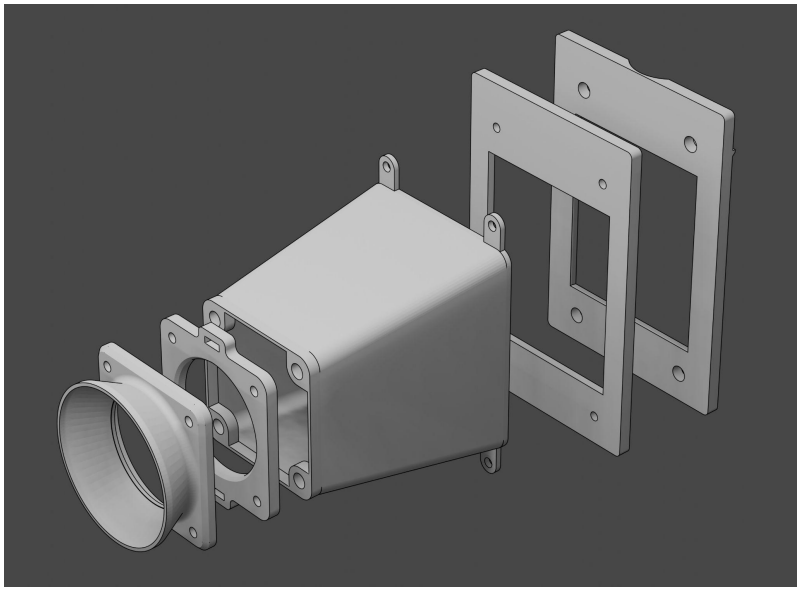
Steps

1. Insert all 4 screws through the holes on the bottom of the rail tripod mount
2. Loosely attach the double tee nuts
3. Slide the double tee nuts into the channels on the bottom of the 20x40 aluminum extrusion
4. Tighten the M5 screws

Note: if you do not wish to use the double tee nuts, you can 3D print four (4) of the T nuts described on the focusing system and use those instead. That will be a little less convenient, but would not require you to buy double tee nuts.

Assemble Ground Glass Holder

In addition to the option to use a bright screen instead of plain ground glass, you may choose to build a magnifying focusing hood that attaches to the ground glass holder. The idea of the magnifying focusing hood is to make it possible to use the camera without a darkcloth and focusing loupe.



3D Printed Parts:

- Ground glass frame - front*
- Ground glass frame - rear*
- Magnifying hood eye cup (optional)
- Magnifying hood lower lens holder (optional)
- Magnifying hood tunnel (optional)

* if you are using a 6x9 film back, you must use the 6x9 version of these parts

Hardware:

- 4X M3 brass heat-set threaded inserts for the ground glass holder
- 4X M3 brass heat-set threaded inserts for the magnifying hood (if using the hood)
- 4X M3 x 8mm screws (if using the magnifying hood)
- 4X M3 x 6mm screws (if not using the magnifying hood)
- 4X M3 x 10mm screws (if using the magnifying hood)
- 1X plano-convex lens, 100mm focal length, 50mm diameter, Eisco brand
- 1X ground glass (either plain ground glass or Oleson bright screen

Assemble Ground Glass Holder

Steps:

1. Install all four M3 heat-set inserts into the front ground glass frame
2. Clean the ground glass
3. Install the glass into the rear ground glass frame, ground side facing the front ground glass frame
4. If using the magnifying hood:
    a. Install the M3 heat-set inserts into the magnifying hood tunnel's upper surface
    b. Fasten the hood tunnel and the rear ground glass frame onto the front ground glass frame using the M3 x 8mm screws
    c. Clean the plano-convex lens
    d. Place the lens into the lower lens holder, curved side toward the ground glass
    e. Fasten the eye cup and lower lens holder with lens onto the focusing hood's outer surface using M3 x 10mm screws
5. If NOT using the magnifying hood:
    a. Fasten the rear ground glass frame onto the front ground glass frame using the M3 x 6mm screws.

Mounting Bellows to the Bellows Frames

1. Trim the fabric of the bellows right up to the edge of the outermost ribs.
2. Apply contact cement to the surfaces of the bellows frames that will contact the bellows.
3. Apply contact cement to the bellows' last ribs' surfaces on both ends.
4. Allow the glue to dry.
5. Carefully attach the bellows to the frames and press very firmly.
6. Insert the bellows frames into their locations in the camera and secure them using bellows locking plates and M3 screws.

Preparations to Interior Surfaces

As a final step, you should ensure that all exposed interior surfaces of plastic are painted matte black to reduce reflections. You may also wish to paint the surfaces of your bellows frames that face towards the lens and towards the film black as well. The interior surface of the lens board must be painted matte black.