AWCY? Presents: The CETME 2077

(CETME-C 3DP receiver and Furniture)

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1 Acknowledgements

Guide by NotMyRealName1 & The_Gun_Dwarf

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Thanks to everyone else that contributed advice, models, or other assistance, this project has been a long time in development and has been touched in one way or another by so many people I cannot mention everyone individually here.

Lastly, I have to thank all of the folks over at WeaponsGuild. The CETME C guides over there are the basis for all of the semi-automatic compliance steps in this guide.

2 Description

This is a printed CETME Model C receiver to allow for the completion of the roller delayed 7.62x51mm (.308 Winchester) battle rifle parts kit. This rifle is a predecessor to the Heckler & Koch G3 family of rifles, and with the advent of this printed receiver is the first full powered battle rifle that can be 3D printed. Through the use of a steel understructure, a fully captured front trunnion and cocking handle assembly, and a semi-automatic shelf this receiver is complete and reliable. Individual builds have been tested to a service life exceeding 1000 rounds. **Be aware that without the completion of the fire control group component modification outlined below you are likely in possession of an NFA item and could be prosecuted as such. It is highly recommended that you accomplish this work prior to the printing of the receiver.**

3 Materials Required

- Approximately 800 grams of PLA+ or Nylon ○ Extensive testing has been done with:
    - ESUN PLA+
    - ZIRO PLA PRO
    - Overture PLA+
    - Duramic PLA+
    - Overture Easy Nylon (annealed)
    - NylonX (annealed)
    - Polymaker PLA+ or Nylons
    - Coex GF Nylon
- CETME Model C parts kit
    - Example kit: Sources for these kits are far and wide. The biggest item to look out for is a cut receiver stub, intact as imported, as this is required for the build.
        - https://www.apexgunparts.com/cetme-model-c-parts-kit-308-7-62mm- bndl.html
- CETME Model C barrel ○ Preferred barrel:
    - https://www.apexgunparts.com/cetme-c-barrel-7-62-x-51-18inch-fluted-5-8x24-threaded-us-made.html
    - https://www.sarcoinc.com/cetme-c-308-barrel/ ○ A G3 or PTR barrel can be used as well, but these require the substitution of a G3/PTR triple tree or use of the 2077 furniture that interfaces the charging handle tube. Everygunpart and Hkparts are sources for PTR or G3 barrels.
- 5/8x24 flash hider or your choice (the kit referenced above contains a metric threaded flash hider that will not the fit above barrels)
- Three (3) 1/8”x1/2”x12” mild steel bars ○ 1018 or A36 grade steel is functional (stronger material is better but not required)
- One (1) 10-24x24” threaded rod ** Weldless Struts require 10-32 rod substitution ○ Two sections of at least 12” will work as well

- Five (5) music wire compression spring ○ 1.5” x 0.48”OD x 0.396”ID ○ If you have a spare AR buffer detent spring this can be substituted for the mag catch
- Two (2) quick release pins for stock attachment ○ 1/4” diameter x 1-7/8” usable length ○ Can substitute with 1/4-20 bolts and nuts
- Four (4) 10-24 steel nuts w/ nylon insert or replace with 10-32 nuts for the weldless struts
  - ○ Nylon insert is required
- One (1) 5mm barrel pin for HK G3 or CETME rifle ○ There are oversized pins available if your build requires a larger pin for a tight fit ○ Drill rod can also be cut to length and used but a proper pin is suggested due to uncertain metallurgy in cheap offerings. You DO NOT want a single shot harpoon gun.
- One (1) 4” x 1” diameter brass rod or 1/2" brass pipe nipple (for barrel pressing) ○ There has also been success using a correctly sized socket and a sacrificial penny to minimize damage to the barrel face
- Two (2) 8D x 2” nail for joining receiver halves (not required if a one piece receiver is printed)
- One (1) small size package of two-part epoxy ○ DO NOT USE QUICK CURE IF POSSIBLE ○ JB Weld preferred
- One (1) 6-32 x 1” machine screw ○ Can be substituted with a 3x30mm metric screw
- One (1) 3' section of 1/4-20 threaded rod for the spine of the receiver/handguard ○ Needs at least two (2) 1/4-20 nuts to accompany – I like to use a jam nut in front for 3 total
- One (1) 1/4-20 x 2” front receiver bolt
- Four (4) 3x50mm Machine Screws and Four (4) 3mm heatsets for handguard nosecone attachment if using the quad rail handguard
- If using no triple frame or a G3 barrel – I prefer this method of securing the cocking tube ○ One (1) 8x50mm allen head bolt and one (1) m8 nut
- Weldless Specific Parts:
  - Two (2) 10-32 Clevis end adapters:

- Source 1: https://midwestcontrol.com/shop/BTC-187S (the L model will work if you cut and drill them)
- Source 2: https://www.mcmaster.com/2447K11/ (throw away the snap on piece)
- You can also likely find these on ebay/amazon from third party sellers ○ Two (2) 10-32 x 1" Countersunk Machine Screw (important to be countersunk)
- Example: https://www.amazon.com/Hillman-Group-44040-Stainless-15-Pack/dp/B00IZFX5 NG

○ Two (2) 10-32 steel nuts – nylock preferred but not required ○ Two (2) #10 washers and lock washers if not using nylocks

4 Tools and Equipment Required

- Fused Deposition Modeling (FDM) printer ○ Build volume of Creality Ender 3 or larger
    - CR10 or larger volume required for a single piece receiver
- Dremel tool
    - Need a few cut off wheels to complete the metal fabrication portions
    - This is used for demilling the fire control group (FCG) components to eliminate the ability of full-auto function
- Hacksaw
- Drill Press ○ A handheld drill is highly discouraged due to the high possibility of damage to trunnion, barrel, drills, reamers, and wrists... but this method is completely possible. Proceed at your own risk if you elect to go this route. A broken drill bit does not make a good barrel pin.
- 3/16” end mill
- #9 drill bit ○ This is used for barrel pin drilling ○ This is for use with the 5mm pin
    - The #9 drill bit ensure an interference fit of 0.001”
- 7mm or “I” letter drill bit
    - This is used for the drilling of holes in the strut rails
- #7 drill bit
- #10 drill bit (3/16th) ○ This is for the weldless version only. Used to secure the clevis adapters.
- Welder
    - This is only required for fabrication of the welded version of the receiver struts. Not required if you use the clevis adapters for the stock attachment plates.
- 12+ ton hydraulic press ○ This is required for barrel to trunnion pressing and triple tree onto barrel pressing ○ If desperate can be substituted with a 1” X 18”+ black iron pipe and a small sledge hammer

- Hammer - good to have a variety of sizes
- Rubber faced hammer
- Punch
- Screwdrivers
- Hex keys
- Propane or butane torch suggested
- Needle nose pliers
- 11/16” Inner Diameter (ID) pipe
- Bull nose cutters

5 Print Settings

All components should be printed at a 50% or lower layer height to nozzle opening ratio to maintain proper bonding between layers. Example:

0.4 nozzle – 0.2 layer height
0.6 nozzle – 0.3 layer height

Wall count: 8+
Infill: 25% or higher
Top and bottom thickness: 2.0mm

These settings have been tested quite successfully. The steel in the assembly is the primary mode of force transfer within the receiver. Up to a 1mm nozzle has been successfully used to print this design. Feel free to increase the infill and/or wall count to your preference. Greater infill will increase weight but will also increase heat capacity. Everything is a trade-off.

See Appendix “Print Orientation” for suggested orientation of parts on the print bed.

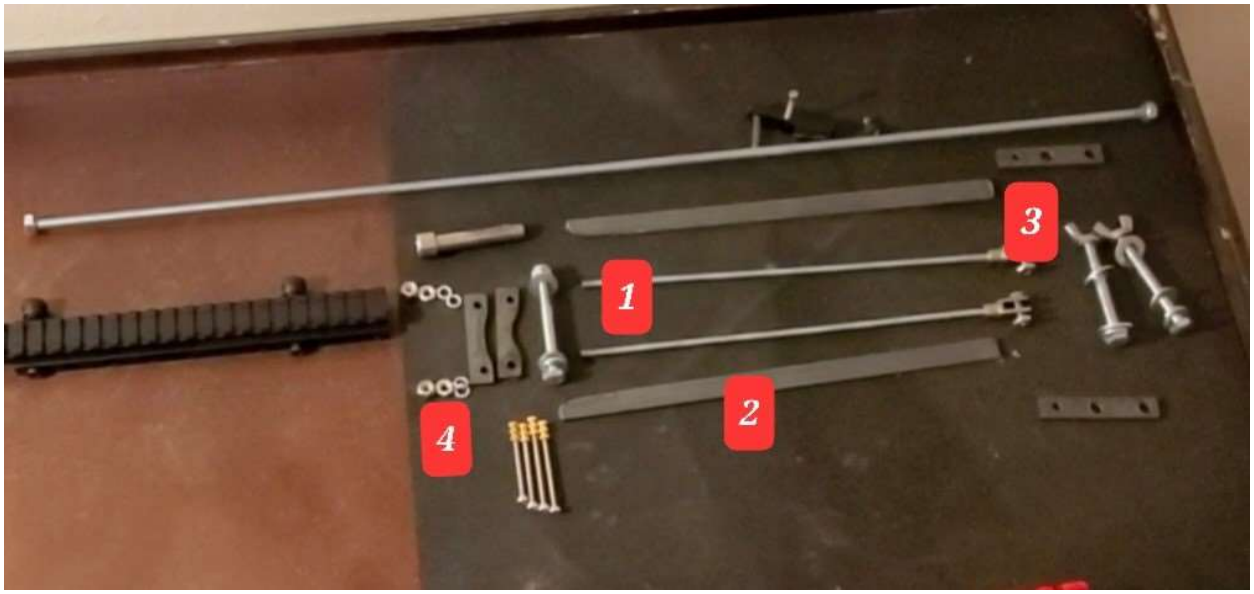
6 Printed Parts

- One (1) front receiver section
- One (1) rear receiver section
- One (1) strut rail cutting and drill guide (optional – receiver can be used to mark the plates)
- One (1) front receiver plate cutting and drill guide
- One (1) magazine catch
- One (1) barrel pin pressing jig
- One (1) handguard assembly – 5 pieces in smallest volume format
- One (1) Filler/Spacer ring for the trunnion to handguard interface
- One (1) ACR stock assembly (Optional but best due to spine threaded rod interface)

7 Metal Fabricated Parts

- One (1) right side strut ○ One (1) clevis piece, one (1) 10-32 countersunk machine screw, and one (1) 10-32 nut required per weldless strut
    - One (1) 10-24 x 9.842” (250mm) threaded rod (cut and ground) ○ One (1) strut rail (cut and drilled)
        - 1/8” x 1/2” 2.325” (59mm) (cut to length and drill using the “strut rail cutting and drill guide receiver for jig”)
- One (1) left side strut ○ One (1) clevis piece, one (1) 10-32 countersunk machine screw, and one (1) 10-32 nut required per weldless strut
    - One (1) 10-24 x 9.842” (250mm) threaded rod (cut and ground) ○ One (1) strut rail (cut and drilled)
        - 1/8” x 1/2" x 2.325” (59mm) (cut to length and drill using the “strut rail cutting and drill guide or receiver for jig”)
- One (1) left side rail
    - 1/8” x 1/2" x 9.527” (242mm) (cut and deburred), length is approximate and will be determined when fitting your rifle
- One (1) right side rail
    - 1/8” x 1/2" x 9.527” (242mm) (cut and deburred, length is approximate and will be determined when fitting your rifle
- Two (2) front receiver crush rail
    - 1/8” x 1/2"x 2” (50.8mm) (cut to length and drill using the “front receiver plate cutting and drill guide”)
    - Doubling these plates up or using 1/4” stock is required for long term durability of this piece
- Two (2) washers that fit securely around a #10 threaded rod
- One (1) cut 8D nail for receiver pin ○ 1” long, trimmed after insertion
- One (1) front receiver bolt ○ 1/4-20 x 2”
    - This clamps the receiver around the stub as well as secures the handguard

8 Metal Part Fabrication



Weldless hardware set shown above. Welded struts are shown in the image below. Note that the use of the clevis adapters allow for this build to be completed with no welding required. This version of the receiver was also tested in the 1000+ round gauntlet and is known to be a secure. Note that the geometry of the grip frame as well as the use of countersunk screws prevents the weldless assembly from being able to separate even if the nuts were to fall off. See the appendix section 13 for additional pictures and clarification on the weldless version.

8.1 Threaded section of the strut (Labeled 1 in image at start of section)

Step	Description

1)	Use a hacksaw, grinder, or Dremel to cut the 24” #10-32 (or 24 for welded) threaded rod into two pieces with an approximate length of 250mm.
2)	Clean up any burrs present on the opposite end of the flat section of the threaded rod that may have occurred during cutting. This is only needed if you must use the cut end on the threaded end of the rail.
3)	Welded rod version only: Grind one end of each rod flat approximately halfway through the diameter of the rod and 20-23mm in length. This is to allow for a flat surface to interface the strut rails when welding.

8.2 Flat Strut Rail (**Required for weldless rails) (Labeled 2 in image at start of section)

Step	Description
1)	Place the printed strut rail cutting and drilling guide over one end of a 1/8” x 1/2” x 12” mild steel bar so that the bar rests in the pocket of the guide. It is also possible to simply use your receiver as the guide to ensure that every cut is exactly where it needs to be for your build.
2)	Mark the end to be cut off at the end of the guide as well as the hole locations with a marker, pencil, or scribe. Confirm with your receiver after marking if using the jigs.
3)	Repeat the marking process for the other end of the rail.
4)	Align the printed cutting and drilling guide and the mild steel bar into the vice of your drill press.
5)	Drill 2 holes through the guide holes using the 7mm or “I” letter drill bit. A third hole of size 3/16th is required for the weldless version in order to secure the flat bar to the clevis adapter.
6)	Flip the bar and repeat the drilling process on the other end.
7)	Once the bar has two holes on each end drilled, cut the bar off at the marked cutoff line on each end.

8.3 Strut Weldment (**Not Required for Weldless)

See Appendices Strut Weldment for illustration.

Step	Description
1)	Align the center of the strut rail with the flat section of the threaded rod. The tip of the threaded rod should NOT be closer than 1/2" to the closest large hole.
2)	Weld the strut rail to the threaded rod with a weld down each side.
3)	Repeat steps 1 and 2 for oppose side.

8.4 Front Receiver Crush Rail (Labeled 4 in image at start of section)

Step	Description
1)	Place the printed front receiver plate cutting and drilling guide over one end of a 1/8” x 1/2” x 12” mild steel bar so that the bar rests in the pocket of the guide.
2)	Mark the end to be cut off at the end of the guide with a marker, pencil, or scribe.
3)	Repeat the marking process for the other end of the rail.
4)	Align the printed front receiver plate cutting and drilling guide and the mild steel bar into the vice of your drill press.
5)	Drill two holes through the guide holes using the 7mm or “I” letter drill bit.
6)	Grind the front receiver crush rail to fit in the space from the bottom of the trunnion to just short of the magazine well.

	 Note that 1/4” bar stock is used here and will need to be doubled up if using the 1/8” rail stock material

8.5 Weldless Strut Plate (Labeled 3 in image at start of section – plate is above number)

Step	Description

1)	Insert the undrilled end of the strut plate into the clevis until it stops. This entire assembly should be installed into your receiver as well to confirm hole alignment. The clevis pieces are manufactured with somewhat loose length tolerances so you may have to grind them a bit on one end for everything to fit perfectly.
2)	Using a sharpie mark the hole of the clevis onto the strut plate
3)	Repeat for the second plate
4)	Using a 3/16 Drill bit drill the two plates on the markings for the weldless strut connection

8.6 Flat Rail Notching

Step	Description
1)	Line up one end of the rail stock with the notch in the receiver stub and mark the end of the stub.
2)	Using a hacksaw or grinder create a notch in the rail to allow the rail to make contact with both the front groove in the receiver stub and the rear of the groove at the cut end of the stub.
3)	Repeat the process above for the second rail on the opposite side of the receiver stub The point of this step is to allow the inner rails to pass between the oem rails on the stub and the receiver print with the rails coming to rest on the trunnion. This notch should minimize any steps from the bar stock to the stub.
	

	
	Shown above is how the rail will interface the stub & stock assemblies when installed. Doing this with your kit will give you an idea of how much you need to notch your flats in order to fit between the stub and the inner wall of your printed receiver. Try to match the contour of the trunnion with your notch and be careful to not remove too much material. You want there to be no steps from the rail into the stub as the rollers may get hung up here.

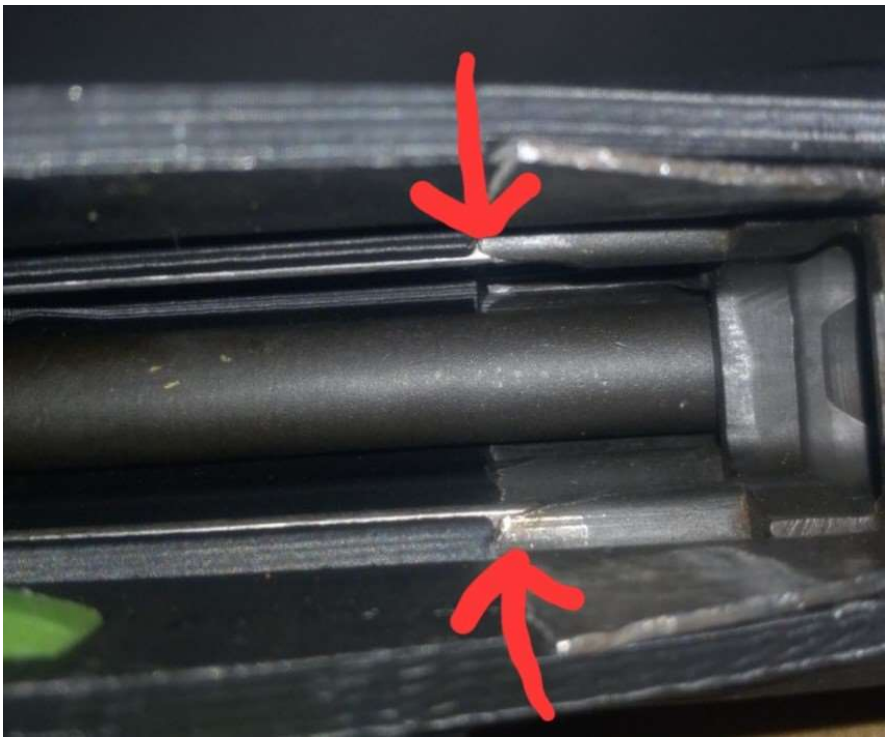
9 Kit Component Alteration

Nothing in this guide shall be interpreted as legal advice. Consult a lawyer that specializes in firearms for legal advice.

9.1 Receiver Stub Preparation

Unlike the traditional metal build, the trunnion and cocking tube are not demilled from the receiver stub to start the build. The receiver stub that accompanies the parts kit is left in its current state with one minor alteration. This allows the printed receiver and the adjoining steel components to interact in a way that maintains a much more robust connection than simply placing the trunnion in a plastic body as well as providing better temperature management. The prep that is needed for the receiver stub prior to barrel pressing (covered in detail further in this guide) is relatively simple.

A heavy edge break grind must be done on the inner edge of the stub factory receiver rails. This will allow the rollers pass over this edge and into the trunnion, from the homemade rails, without snagging. Please see the image below for clarification.



9.2 Trigger Pack Modification

The basis for the trigger pack modification is the Bureau of Alcohol Tobacco and Firearms (ATF) acceptance of the PTR/Century Arms semi-automatic conversion.

This conversion features the removal of Fully Automatic specific components, the grinding and reshaping of a few specific trigger pack components, and the cutting of the trigger box itself to disallow the reinstallation of the auto-sear component.

9.2.1 Trigger Pack Disassembly

Step	Description

1)	Remove the selector from the grip assembly and remove the trigger pack by rotating the selector past the “T” position at the top until it is at the 12-noon position and inward on the back of the back of the selector. If aligned properly, the selector will pop out of the grip frame. 
2)	Remove the trigger pack by pressing upward on the bottom of the trigger while also applying upward pressure on the ejector.

3) Once removed press out the 3 dowel pins in the pack that hold the components into place. This is most easily done from the left side of the trigger pack, starting with the trigger, then the hammer and lastly the auto sear. Every time I have taken apart a trigger pack, the ejector pin has basically fallen out. If this is not the case in your experience, press the pin out of the trigger pack from the left side, as it is a headed pin and cannot be pressed out from the other direction.

Parts shown above will require demill in accordance with the following instructions.

9.2.2 Hammer Demill

In order to demill this component remove the step from the round surface at the bottom of the hammer, closest to the pin hole. This surface should go from a surface that can catch, to a completely smooth rounded surface.

9.2.3 Sear Demill

The next component in the pack that will be demilled is the sear assembly. The pin does not need to be removed from the sear assembly, as the modification should be done without taking it apart. For this modification remove the additional material on the part of the sear that rotates. You are not removing the spring ears, you are removing the little tab that comes off of the center.

9.2.4 Trigger Side Plate Demill

Remove the hook as shown below in order to complete demill of this component. Cut off and smooth the remaining tab in line with the rest of the top surface.

9.2.5 Trigger Box Demill

Step	Description
1)	Hold the trigger pack with the front facing to the left. The ejector will be on the closest side of the trigger box.
2)	Mark the box so the top and bottom edges are connecting to the tangent of the large hole at the bottom left corner. 
3)	Transfer the upper line to the front of the trigger box and around to the right side of the trigger box.
4)	Add the additional vertical line to the right side of the trigger box.
5)	Use a Dremel or die grinder to cut at the line. The goal is to cut off the front bottom of the trigger box to allow for the mating of the front shelf of the receiver. You will need to then weld or epoxy a sheet of metal across the resulting gap for additional shelf reinforcement as well as blocking the installation of NFA components.

Left: Cut Trigger Box

Right: Uncut Trigger Box

9.2.6 Grip Frame Demill

The grip frame is the fifth and final component in the trigger pack that will be demilled. There are two options available for the demilling process:

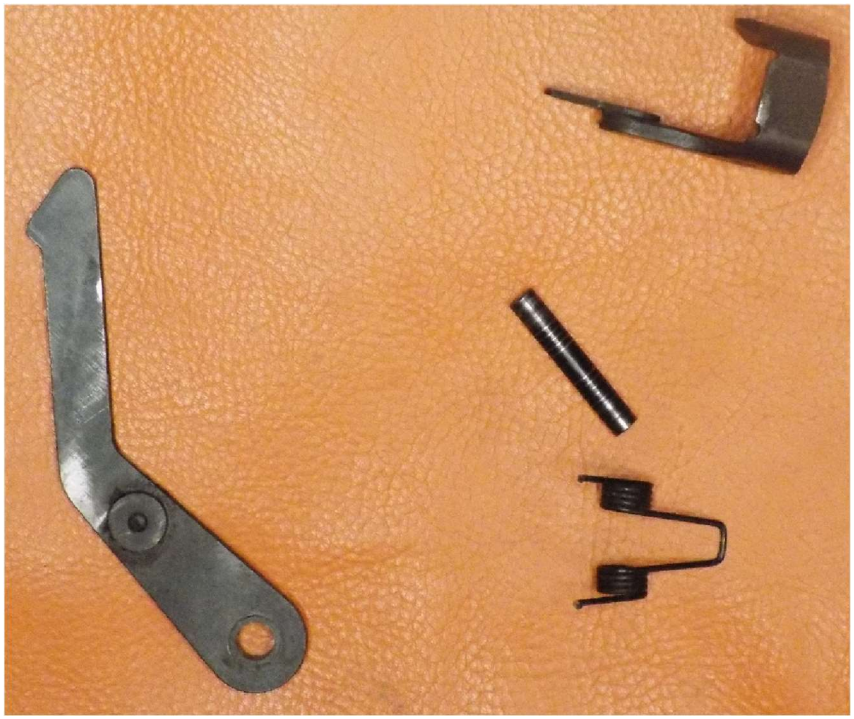
1. Completely remove the front ears of the grip frame. This guide outlines the removal method which is simpler and more common.
2. Widen the space between the forward pin hole bosses to the full width of the opening in the front of the grip frame. To find further information on this method, search for “Clipping and Pinning” on a G3 grip frame.

Step	
1)	Cut off both forward ears from the grip frame itself.
2)	Grind or sand the previous ear locations on face of the grip frame completely flush.
3)	Measure and mark 1/2" from the rear of the grip on the rear tab of the grip frame.
4)	Use a Dremel or die grinder to remove the excess tab, ensuring not to remove too much material as you will need to carefully grind material during the final fitting of the receiver.

5) Remove the following components from the FCG and reassemble:

- Full auto trip lever
- Auto sear
- Auto sear spring
- Auto sear pin

Note: Because the trigger group has been demilled and can no longer being to used to make a full-auto weapon, you can begin printing of the receiver components.



Above: Full auto trip lever, auto sear, auto sear spring, and auto sear pin

Above from left to right (and smallest to largest): auto sear pin, trigger pin, and hammer pin.

Below Left: reassembled trigger Below Right: Hammer with spring in correct position

6)

If completed correctly, the safety selector now has the following functions:

- Upper: Semi-auto
- Middle: Safe
- Lower: Semi-auto

Note: The upper 'T' position is not usable in this receiver design. Completed trigger pack and grip assemblies shown below.

10 Rifle Assembly

Now that the metal component fabrication steps have been completed, the kit component alteration, and the printing portion of the build, you can begin the real fun.

10.1 Barrel Pressing

This process requires the receiver stub, barrel, and bolt assembly. Outlined below is how to achieve this using a 12-ton press. However, this step can be performed with a hammer and a 1x18" black iron pipe. The pipe will fit around the barrel into the recess on the front of the trunnion and act as an anvil for you to pound the barrel into place. This method is tested and works but it is strongly suggested that you invest in a press. Harbor freight will get the job done.

Step	Description
1)	Place the receiver stub in your 12-ton press with the cocking tube facing downward through the press. It is recommended to clean up your barrel and trunnion with some light sanding to remove any burrs – not enough to remove any significant material.
2)	Slide the barrel into the receiver stub so the taper at the front in the shank section of the barrel seats into the trunnion.
3)	Apply a small amount of anti-seize on the barrel shank to assist with the barrel pressing process. To avoid damaging the barrel face it is recommended that you utilize a piece of brass rod 1" in diameter to press the barrel into the trunnion and receiver stub. ***Note: Brass is suggested because it is softer than the barrel and will deform to match the barrel instead of damaging the barrel.***
4)	Once the barrel has seated just short of the inside face of the trunnion stop pressing and check the bolt gap. It is critical that you do not press the barrel in past the seat in the trunnion. The barrel face should always have a step above the trunnion inside face – you can check this with a pick or screwdriver. Repeat above steps until your bolt gap is measuring just over 1mm when the bolt is inserted into the trunnion. ***Note: If small chips appear around the barrel face this is normal. The barrels are slightly oversized to ensure they fit the widest margin of trunnions. Remove any metal chips carefully with a pick.***
5)	Disassemble the bolt, remove the firing pin, and reassemble the bolt ***without*** the firing pin. The bolt will be used press the barrel the rest of the way. Damage would occur if the firing pin were to remain in the bolt. You can also elect to whack the bolt with a rubber mallet if you're impatient but this is really only recommended for the last bit of adjustment.
6)	Use a feeler gauge in the gap to help set the distance and give a stopping point while pressing. 0.1-0.5mm is HK spec but you should shoot for around .3-.4 on a new build as the gap will close over time. This could be substantial in the first few hundred rounds as things settle. If you go too far you can use a rubber mallet and block of wood to drive the barrel back slightly. If you overshoot pressing the barrel by a significant margin you should go ahead and press the barrel all the way through the trunnion and start over. Always apply firm, even pressure to the rear of the bolt carrier as well as the front of the trunnion or barrel when measuring gap. Be careful not to push the carrier in any direction other than inline with the barrel in order to ensure that you correctly measure the gap. A light drag on the feeler gauge is what you are going for. Do not force things.

	Note: Less gap gives more delay so the upper end of the spectrum is not great either. If you have too much gap you run the risk of beating your gun apart or unlocking while pressure is still at an unsafe level. Running zero gap could potentially result in unsupported case material which could lead to a catastrophic failure. While forgiving, it is critical to get the bolt gap correct when building your rifle. I highly recommend watching some videos on checking the gap as explanation through text alone may not be sufficient for all.
7)	The following is taken directly from the WeaponsGuild Tutorial: *Once the barrel is close to being in correct position remove the guide rod and put in the bolt carrier group. This must be fully assembled. At first there will be a huge gap between bolt carrier and bolt. As it is pressed downward the gap will close. The gap gets less as parts wear so we aim for the high side. Stop when it pinches the 0.45mm (0.018") feeler gauge stop. Release the pressure from press and check gap. If more than 0.45mm then use thinner gauge and repeat. Normal range is between 0.25mm and 0.45mm (.010" and .018").*

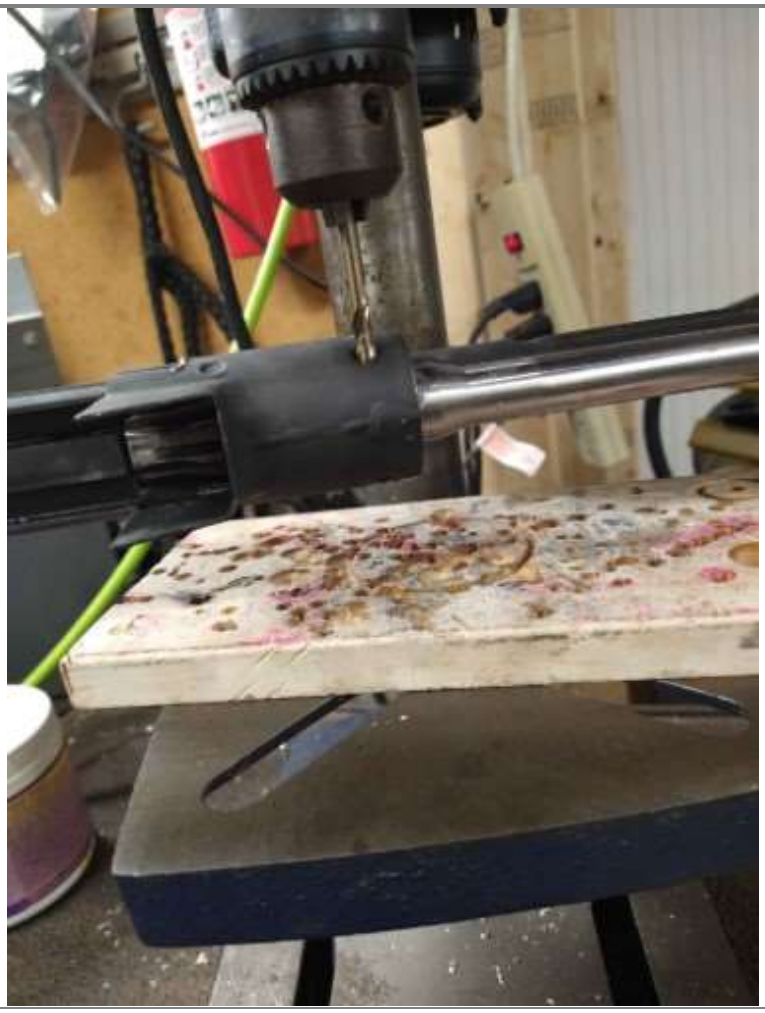
10.2 Barrel Drilling and Pinning

After the barrel has been pressed and the bolt gap set the barrel must be pinned to ensure it does not move from the current position. This is accomplished by using a drill press, a 3/16" end mill, and a #9 drill bit used as a finish reamer.

It is completely possible to do this with a hand drill but, much like hammering the barrel in, this should only be done for a desperate khyber pass style build. You are much more likely to break a drill bit off in the trunnion than successfully drill the pin hole. Proceed with this method at your own risk and consider investing in a drill press. Again harbor freight will get the job done for this application.

NOTE: This results in a matched set of barrel and bolt carrier group that are not readily interchangeable with other assemblies due to the nature of used parts kits. Always check bolt gap if you replace any bolt components or swap barreled assemblies.

Step	Description
1)	Clamp the receiver stub in the drill press on the left-hand side.
2)	Use the 3/16" end mill to bore downward through the barrel pin hold in the trunnion to begin creating a round keyway in the barrel material while using the trunnion hole as a guide. Take care to not alter the shape or size of the trunnion holes, only use them as a guide to create the keyway. ***NOTE: Ensure the receiver stub is not cocked vertically in the drill press vice and do NOT force the receiver stub into the end mill.***
3)	Once the hole is bored with the 3/16" end mill, change the bit to the #9 drill bit and repeat the boring process. A higher spindle speed is desired when using the #9 drill bit.
Step	**Description**

	
4)	Assemble the barrel pinning fixture around the receiver stub at the trunnion, ensuing the barrel pin hole lines up with the hole on the jig.
5)	Apply anti-seize to the pin and start the pin with a hammer to ensure the pin remains straight and perpendicular to the barrel.
6)	Use the 12-ton press to insert the pin into the trunnion and barrel assembly until they are equal distances inserted on either end of the receiver stub.

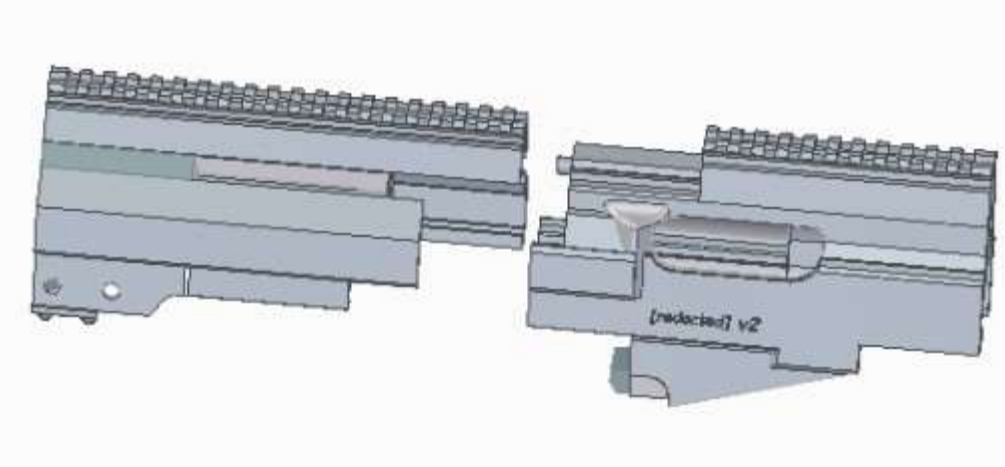
10.3 Triple Tree Pressing

After the barrel pinning is complete the triple tree will need to be pressed on to have a front sight a fully supported front end. This step is intentionally completed after barrel pinning to prevent alteration of the bolt gap. This step can be skipped entirely if you plan to use the 2077 furniture with nose piece that interacts with the cocking tube. I have personally found that this adds to the stability of the stub as well as allows the barrel to be free floated.

Step	Description
1)	Place the receiver stub into 12-ton press in the vertical position with the barrel facing up.
2)	If utilizing a barrel block, place it under the barrel to minimize potential bolt gap impact.
3)	Using the 12-ton press and an 11/16”ID pipe apply downward force onto the triple tree

	while ensuring the cocking tube is aligned with the cocking tube hole in the tree. ***Note: Do <u>NOT</u> overdrive the triple tree. This will cause damage to the cocking tube and receiver stub.***
4)	Remove the receiver stub from the press and bolt it into a vice horizontally with the sight of the triple tree on top. (e.g. the in-use position)
5)	Tie a string to the top of the triple tree. Pull the string back tightly to the center of the receiver stub. Ensure the string remains centered on the triple tree.
6)	Use a rubber faced hammer to tap the triple tree into vertical position. The string is used as a guide to assist in making the triple tree straight.

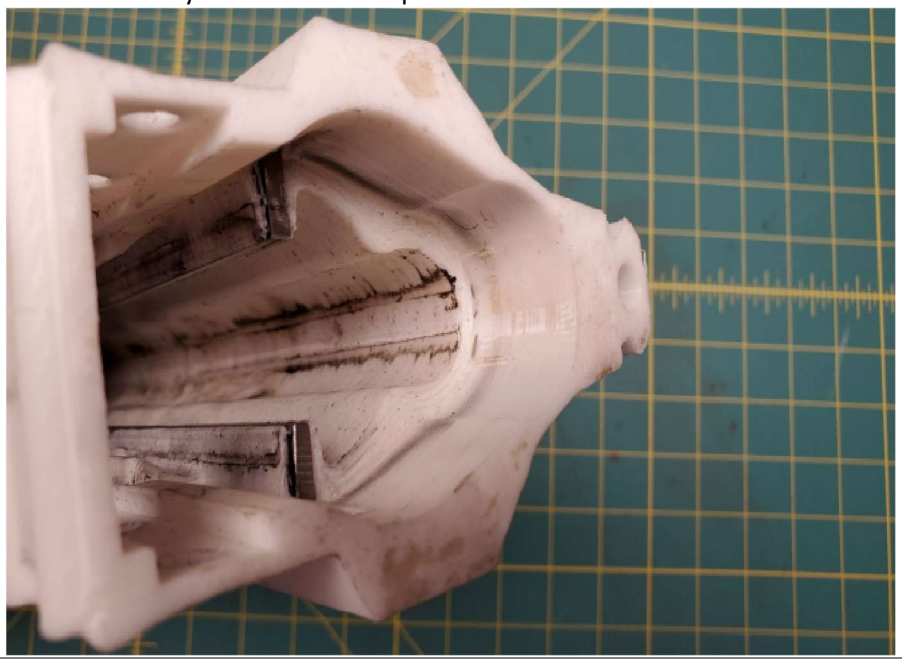
10.4 Receiver Assembly

Step	Description
1)	Clean up supports from the printed receiver parts.
2)	Slight the two components together firmly and tightly. **Note: The front and rear sections are keyed together at the top of the receiver. Skip steps 2-9 if you printed your receiver as one piece.** 
3)	Hold the cut 8D nail in needle nose pliers and use a blow torch to heat the nail red-hot.
4)	Insert the red-hot cut 8D nail deeply into the front receiver divot in the optic rail. This nail will be left in the receiver to create a strong mechanical bond between the receiver halves.
5)	Take an uncut 8D nail with the pliers and heat to red-hot with the blow torch.
6)	Insert the red-hot nail into the second (rear) divot on the optic rail and remove it.
7)	Reheat the 8D nail to red-hot and insert into and remove from on the front of the two divots on the left side of the receiver.

Step	Description

	
8)	Ensure the blow torch is off and place the torch and the hot nail in a safe place away from anything flammable.
9)	Once the nail is cool, use end cutting pliers and remove the remaining section of the nail that was left in the receiver. NOTE: Do NOT pull while cutting. The pin is left in the receiver and only cut as flush as possible to the receiver.
10)	Unlock the bolt, insert it into the receiver stub, and lock the bolt.
11)	Slide the receiver stub and barrel assembly into the front of the printed receiver with the cocking tube on the top, and the barrel facing forward. You can now place a G3 mag into the mag well and press until the mag is snug but not overly tight. You want to be able to still remove the magazines with minimal effort. Make note of the insertion depth of the stub as this will be your target depth for assembly. The shelf inside is recessed on the large side of how these kits are cut but there is a chance you may need to trim your stub if the magazine is loose at full insertion into the printed receiver. See the image below for clarification on the stub before and after insertion.

Step	Description

	 
12)	Slide the roughly notched rails into the receiver slots and press them forward into the receiver stub by hand. This may require some light tapping with a small hammer and punch if your print is particularly tight. **NOTE: The goal is to do light tweaking to the notches in the recoil rails that is needed to keep the receiver stub straight and true in the receiver. While also setting the insertion depth of the stub for a tight magazine well fitment. The rails should be making solid contact with the trunnion on the stub.**
13)	Check that the rails line up with one another at the rear of the receiver. If they are drastically different in length, grind away material in the notch to get them lined up. Double check that your stub is pressed in firmly against the rails and that your mag well is snug. Once complete the rear rails should look similar to the image below. Check fitment with your stock to ensure that contact is made between the rails and the shell of the recoil assembly. If the stock does not fully insert you may need to grind some additional material from the rear face of the rails. See the AWCY? Release on the ACR stock for detailed information on assembly of the stock components. 
14)	Go ahead and install your handguard and the trunnion filler ring at this point along with the

Step	Description
	cross bolt that secures it to the printed receiver. This should just be hand tight. You may need to shave the filler ring to fit your exact build since the cuts on the stubs lead to varied insertion depths. This should ideally be nylon or slathered up in red/grey RTV.
15)	Insert the threaded rod for each strut into the holes on the receiver. For the welded struts this will be the entire assembly while the weldless design requires some additional steps. Push the threaded rod all the way in until it touches the receiver 'ears' in front. At this point you should drop the clevis adapters into the slots in the receiver. Thread the rods in the clevis adapters until the rods are level with the inner flat surface of the clevis. Insert your stock attachment plates and secure to the clevis with the 10-32x1” countersunk screw and a retaining nut on the outside of the receiver. Your struts should now be fully installed.
16)	Add the receiver crush plate(s) and put the threaded rods through the holes. Whether this is one or two plates depends on whether you used the 1/8” rail materiel to create your crush plate or opted for 1/4” bar stock specifically for this part.
17)	Place a washer and nut on each threaded rod so they cannot fall out of the assembly. If the front of the mag well protrudes past the printed walls on either side use washers to shim complete contact with the crush/squeeze plate. 

Step	Description
18)	You are now ready to install the 1/4-20x36” threaded rod that run down the spine of the rifle. This helps to clamp not only the components together but layers as well. This is is critical component to having a solid rifle. 
19)	Slide the stock assembly into the rear of the receiver while allowing the threaded rod spine to pass through it. Press it forward until it stops. Align the holes in the struts with the holes in the receiver and stock and insert the two quick release pins or bolts. Depending on how much of your ACR stock is assembled you may need to trim the spin threaded rod as you insert the stock into place. If not this is also a good time to mark and cut it such that you can install a nut to clamp the stock to the receiver but not have it poke you in the face.
20)	Tighten down the strut nuts, onto the crush plate, ensuring that both the stock and receiver stub/barrel are straight and true to one another. If they are not, loosen the nuts, remove the pins and stock, and grind the rail notches as needed to obtain proper alignment.
21)	Remove the stock and place the FCG into the receiver and onto the semi-auto shelf.
22)	Replace the stock using it to hold the FCG in place, and install the pins/bolts.
23)	Insert a magazine into the mag well and tighten the nuts on the struts to achieve full contact of the recoil rails from the receiver stub at the front of the stock socket in the rear until the magazine is snug but not tight. Tighten the bolt securing the handguard to the receiver. This should be just tight enough to crush a lock washer. Be careful as over tightening either the cross bolt or the struts can cause stress cracking in the plastic. Add jam nuts where possible. **NOTE: It is this metal structure that makes the design as robust as it is.**
24)	Stare in awe at your creation. After testing things out and making sure that your rifle functions you can achieve greater accuracy by disassembling everything and applying liberal amounts of your favorite epoxy to the metal parts interfacing the printed receiver. I applied epoxy to the stub, inner rails, cocking tube/handguard interface, and around the crush plate plus nuts on a rifle that I was able to hit 1 moa groups with. Take a look at the heat mitigation tips at the end before performing this operation.

25)	Ensure the cocking handle is interfacing correctly with the bolt carrier assembly by cocking and releasing the bolt carrier. If there is binding you may need to: □ Oil the bolt

Step	Description
	• Tweak the tension on the struts • Look for burs on the receiver stub cut edge • Verify the front stub is square to the receiver • Rack it a few times to get it sliding and to wear in the plastic (come on… you didn't need an excuse to do the HK slap 100 times in your living room) □ Or just shoot the thing to break it in
26)	Ensure the trigger is working and resetting when the bolt is cocked.

10.5 Magazine Catch Assembly

Step	Description
1)	Place one end of the spring on the magazine catch and using JB Weld, attach one end of the spring to the mag catch itself. Torsional spring can be substituted with an AR15 buffer detent spring if you have one of those laying around. There is a recess in the receiver for this method.
2)	Let the JB Weld fully cure.
3)	After the magazine catch to spring interface has cured, apply epoxy to the end of the spring. **NOTE: If desired, a hot glue gun can be used in place of the epoxy.**
4)	Align the hole in the magazine catch with the appropriate bosses of the side of the receiver.
5)	Using the 6-32 machine screw (3x30mm metric substitution), attach the magazine catch to the receiver body, ensuring the wet epoxy on the other end of the spring is getting all over everything. See Appendices Magazine Catch Assembly for illustration.
6)	Align the flat end of the spring against the receiver body so the epoxy may bond the two.
7)	Allow the JB Weld to cure.
8)	Once the epoxy is cured, check the magazine fitment using either a G3 magazine or a CETME Model C magazine. Original CETME mags suck in comparison to the aluminum G3 mags so only use these for the memes. G3 mags are also cheaper so its a no brainer.

10.6 Optional - No triple frame handguard

Step	Description
1)	If you choose to use no triple sight frame you will need to use the quad rail handguard as well as a specific handguard end cap. This cap will fit around the cocking tube and interference fit with the handguard to create a secure hold on the cocking tube. For additional reinforcement I suggest welding or epoxying an m8 nut into the end of the cocking tube (where the cleaning kit goes) and using an m8 allen head bolt to clamp the nose onto the tube. Four (4) 3x50mm machine screws and heat sets should also be used to secure the nosecone to the upper and lower handguard portions. I actually prefer this method of retaining the cocking tube as it also retains handguard alignment.

11 Final Thoughts and Common Issues

Do not shoot this rifle in your hands until you have completed a remotely fired test. This is a fullpowered rifle cartridge and an experimental plastic receiver. Please use your best judgment to ensure that you are maintaining safe operation of the rifle.

Inspect the receiver before and after each shooting session. **If at any point you find a crack, separation, or delamination *STOP* using the rifle until the issue can be corrected.** Check bolt gap often in the first few times firing and after approximately every 200 rounds thereafter. Failing to check gap could result in a potentially unsafe rifle, so do not skip this as a regular maintenance check. Oversized rollers are commonly available to increase gap back to ideal levels once the parts begin to wear. The general rule of thumb is that each +1 will give you 0.1mm of additional bolt gap but in practice it often amounts to less than that. Buy a few sets for peace of mind that you can keep your gun in top shape for many thousands of rounds to come.

This design has been tested to well over 1000 rounds and if assembled with care should last for at least around this number. Use your judgment but small cracks can be repaired with a soldering iron. The most rounds fired continuously to date was 242 over about 10 minutes, with 100 degree ambient temperature, using a receiver printed in overture easy nylon. This caused the barrel to start to droop and shooting was aborted. I will note that this is not the most temperature resistant nylon so there may be some juice left to squeeze. For the sake of reliability do not exceed 120-150 rounds on a nylon print or 80-100 on a PLA+ print. Test the waters on your print and never try to shoot this much on your first outing. Incrementally work your way up as you check for any failures. There are some notes in the appendix on increasing the heat tolerance of your rifle.

While this rifle design does everything possible to allow for a reuse of the parts kit on a full metal build, there will be limited damage to the stock socket caused by the recoil forces being transferred into the edge of the steel. This is easily cleaned up and the stock assembly is ready to be used in a folded receiver as well. If this concerns you I would suggest buying a replacement stock or recoil assembly as these are still cheap and pretty widely available.

Congratulations! You now have a main battle rifle!

Some Common Issues

Bolt drags excessively or gets stuck at rear

This can be caused by a couple issues. The simplest being that your receiver is just tight and needs to be broken in a bit through manual cycling or firing. Your receiver is likely okay if you can drop your bolt into the rear, with the stock removed and grip frame removed, and it locks into the trunnion without significant drag. If the bolt gets stuck you need to check that your prints are not warped and your receiver halves are mated perfectly inline. You may need to sand printed surfaces or calibrate your printer if you are still having issues. Make sure your charging handle is not dragging on your 2077 handguard. Due to variations in tube rotation you may need to file the slot in the handguard a bit.

If your bolt locks into the trunnion when drop tested you'll want to check the ejector-carrier clearance next. Re-install the grip frame and stock. Charge your bolt to the rear and check whether the ejector

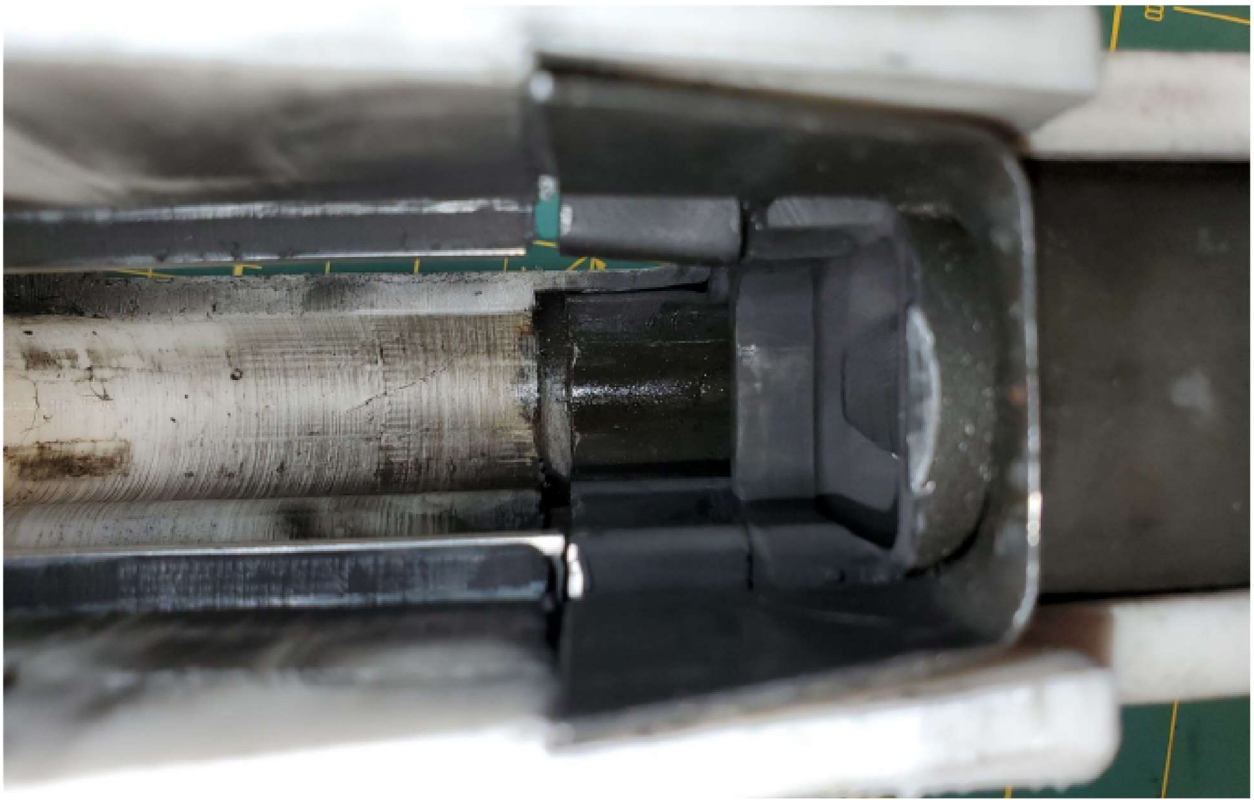
arm is dragging excessively on the bottom of your bolt. If this is the case check that your semi-auto shelf has all support material removed as the interface of the trigger box and this shelf will set the height of the ejector in front. If your shelf is clean double check that you cut enough material off of your trigger box and didn't add too much material when attaching your shelf plate to the box. The large round hole in the side of the box should have all curvature removed. Lastly check that the rear of your grip frame is properly retained between your recoil assembly insert and the stock retaining pins/bolts.

If you are still having issues with drag after these checks you may need to shave a small portion of the ejector arm with a dremel for clearance. Be careful as you want this to still make good contact with casings for positive ejection. As you charge the bolt to the rear you should be able to see the ejector peak through the bolt face to get a good idea of when to stop.

Once you have ensured that your receiver is not the issue and your ejector to carrier clearance is acceptable the final habitual offender is the recoil guide rod. These can be bent or warped causing the excessive drag on your bolt. This rod is fixed in place as your carrier reciprocates on it. If your prints are out of spec and your receiver is too long the carrier might get hung up on the front of the rod causing extremely hard charging. Luckily these recoil assemblies are cheap so buying a replacement should not be a major issue. Avoid G3 assemblies as they are shaped a bit different and do not work with the 2077.

Bolt gets caught before going into battery

Make sure that the edge break is smooth for the transition from the rail inserts to the metal receiver stub. Ensure proper contact is made and that you do not have a gap in your rails. See above section for more information on setting or checking the ejector-carrier drag if your rails are smooth. If this is a failure to feed check that you have properly set your magazine well clearance according to the stub insertion instructions in the receiver assembly section. Check that your magazines themselves are not over inserted and your catch is working. **NOTE:** this should be impossible at the front due to the metal stub interfering – don't cut this.



Ejection Issues

The most common cause of ejection issues on HK style rifles is a worn or loose extractor spring. This is the little bent wire on the side of your bolt face. This should provide some tension on your extractor and should be replaced if loose. Ideally you'll have spares for this spring as they tend to be the first wear item. The gauntlet rifle had issues with the extractor spring on the factory kit getting soft after 5-600 rounds. This should be the first check if you ever start to have ejection issues.

The next most likely cause is that your ejector is not making enough contact with the back of spent cases. Charge the rifle and check to see where in the bolt face the ejector protrudes. If it is significantly low you may have cut too much material from your trigger box or have an out of spec print. If you cut too much material the fix is just adding a thicker filler shelf or applying some epoxy to the semi-auto shelf on your receiver to set the ejector height.

Issues with optic zero

Make sure all of the metal structures are tight. If you are using a very large optic consider adding a metal pic riser for a large contact patch with the plastic pic rail. If you have an excessively heavy optic it could deform a rail with minimal contact over time. If you still have issues take everything apart and bed your metal bits with epoxy.

A Note on Heat Mitigation

The steps described below add little cost to your rifle but will significantly increase its ability to withstand heat. The gauntlet rifle had these actions taken and, based on my anecdotal experience, added to the longevity. Part of the mitigation is inherent to the design as will be discussed below.

The design of this rifle has multiple aspects that give it superb heat mitigation. As we pump heat into our barrel by firing there are two primary factors that will determine how long the plastic receiver will endure. The first factor is total heat capacity of the metal plus plastic and the second is the rate at which that heat is transferred into the plastic. The total heat capacity of this design is maximized by retaining the stub and cocking tube. All of this extra mass of material is additional heat sink for this thermal energy to flow to. Take a look at the thermal image below for an idea of how all of this mass is helping to distribute thermal energy after mag dumps.

To understand the second factor we need to briefly talk about modes of heat transfer. For our purposes we need to worry about conduction and convection – whether heat transfer is by contact or by a gaseous medium like air respectively. Heat energy flows much more readily by conduction than by convection. This is why a nice air gap goes a long way and also why trying to air cool before pumping heat into the receiver is a difficult task. In order to retain a trunnion for maximum accuracy you need to have solid contact over the entire surface which is a bad situation for heat transfer into the plastic. Fortunately there are means to mitigate conductive heat transfer.

The methods employed in this design include increasing the number of interfaces and by using materials with low thermal conductivity. When you place a hot object against a cooler object the amount of heat transfer across that interface behaves like a capacitor with no transfer initially followed by an exponential growth to steady state. This steady state being determined by relative temperatures and

the thermal conductivity of the materials which we can consider constants. This is why mag dumping fast will get you to higher round counts. This design maximizes interfaces by retaining the old receiver shell. We want this to be like an onion with many layers. It has nothing to do with dissimilar metals or any of that malarkey.

The next layer in our heat transfer mitigation onion is some red or grey RTV slathered generously inside the receiver wherever metal from the stub is touching. RTV is a type of polysiloxane which is a polymer of silicon and oxygen with methyl branches. As such it will not melt or decompose like most carbon based polymers we are familiar with and will instead only break back down into primarily the cyclic siloxane functional groups when exposed to extreme temperatures. It also has very low thermal conductivity which makes it a great material to use as a final layer between the hot stub and the receiver.

Retention of the entire stub also helps to reduce concentration of heat energy in a small volume of plastic by maintaining a very large contact area with the receiver. This helps to reduce the actual temperature of the plastic per unit of heat energy coming from the barrel. The large areas of the stub that are in contact with the air in the mag well and along the cocking tube will help to radiate some of that heat away from the plastic.

The next action is making a heat shield for your handguard. This is actually quite easy if you have an hour to kill. For the stock material I used a steel gutter shield that is meant to keep leaves and detritus out of gutters on your roof. The material is perforated steel sheet of fairly thin gauge. This perforation helps to keep as much heat from transferring into your handguard. I found this at my local hardware store. Cut an approximate section to fill your lower handguard and you can also wrap between the cocking tube as long as you do not obstruct the cocking handle.

You can use some angled bar stock to start a bend. This stuff is not very tough and will take a shape quite easily. After getting an initial central bend going down your piece go ahead and insert into the lower handguard and use a hammer/punch to form it. Take your time and make a quality shield to keep your parts intact for the long haul. I recommend sliding the shield out and giving the backside a good coating in red or grey RTV before replacing permanently.

12 Appendices

12.1 Shopping Checklist

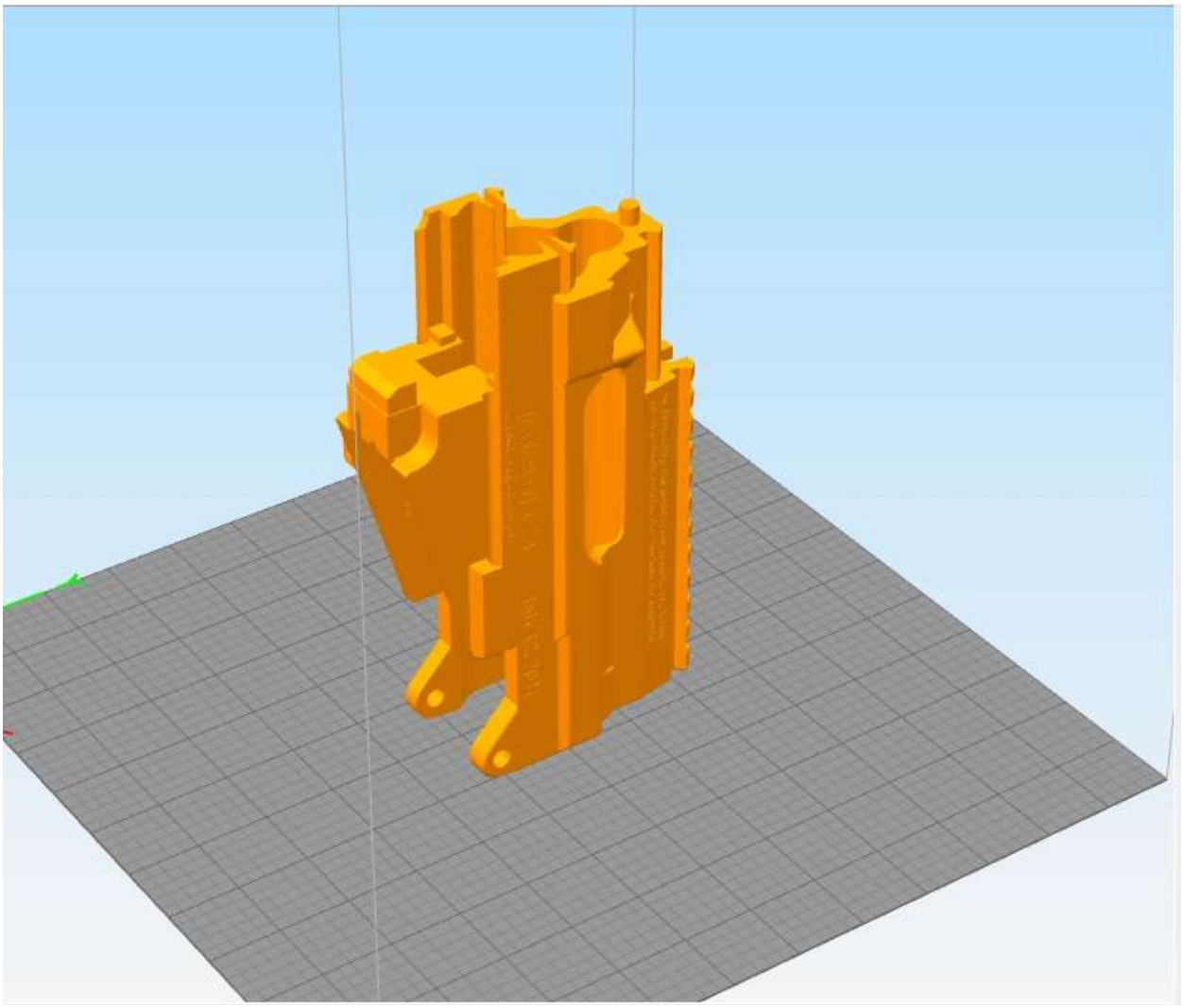
Item	Obtained?
At least 800 grams of PLA+ or Nylon	
CETME Model C Parts Kit	
CETME Model C Barrel (or G3 or PTR)	
5/8x24 Flash Hider	
Three (3) 1/8”x1/2”x12” mild steel bars (1018, A36, or better grade steel preferred)	
One (1) 10-32x24” threaded rod	
Five (5) music wire compression spring (1.5” x 0.48” OD x 0.396” ID)	
Two (2) quick release pins (1/4” diameter x 1-7/8” usable length) – 1/4-20x2” bolts work	
Six (6) 10-32 steel nuts w/ nylon insert (Nylon insert is required) – Only 4 for welded	
One (1) 5mm barrel pin for HK G3 or CETME rifle – oversize as needed	
One (1) 4” x 1” diameter brass rod or 1/2" brass pipe nipple	

Two (2) 8D x 2” nail – Not required for a one piece receiver print	
One (1) two-part epoxy	
One (1) 6-32 x 1” machine screw or 3x30mm metric size	
One (1) 36” section of 1/4-20 threaded rod	
One (1) 1/4-20x2” bolt	
Four (4) 3x50mm machine screws (quad rail handguard only)	
One (1) M8x50 allen head bolt and M8 nut (no triple sight frame build)	
Two (2) 10-32 Clevis Adapter (Weldless Only. Midwest: BTC187S------Mcmaster: 2447K11)	
Two (2) Countersunk 10-32 machine screws (Weldless Only)	
One (1) Small package of #10 washers or lock washers (Good to have both and spares)	
One (1) Small package of 1/4-20 nuts (Good to have spares and nylock is nice)	
One (1) Small package of ¼ washers or lock washers (Good to have both and spares)	
See the AWCY? Release on the ACR stock for detailed information on assembly of the stock.	
FDM Printer	
Dremel Tool	
Hacksaw	
Drill Press	
3/16” End Mill	
#9 Drill Bit	
7mm or “I” letter drill bit	
#7 Drill Bit	
Welder	
12+ Ton Hydraulic Press	
Propane or Butane Torch	
Hammer	
Rubber faced Hammer	
Punch	

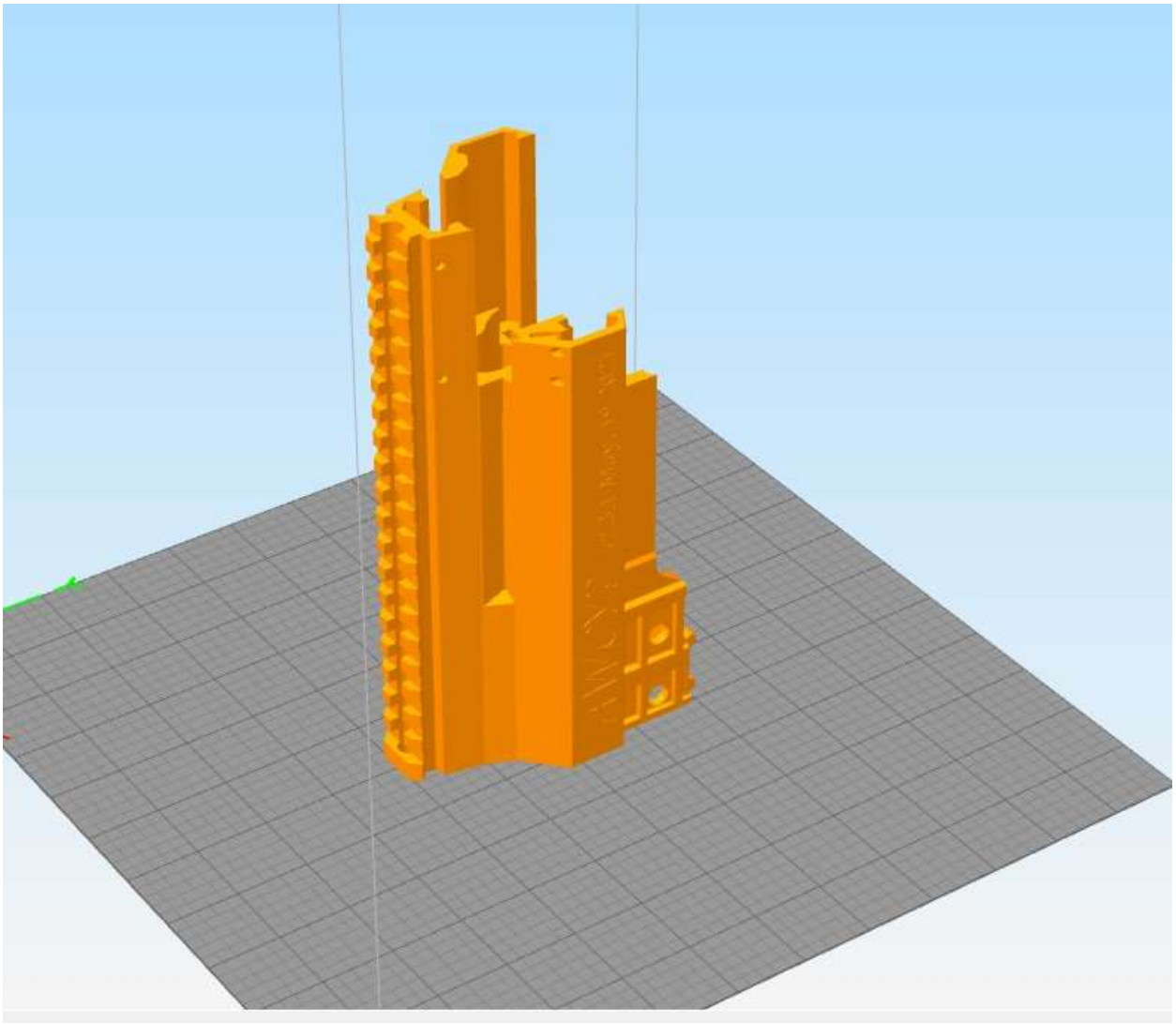
Screwdriver	
Hex Keys	
Needle Nose Pliers	
Bull Nose Cutters	

12.2 Print Orientation

12.2.1 Front

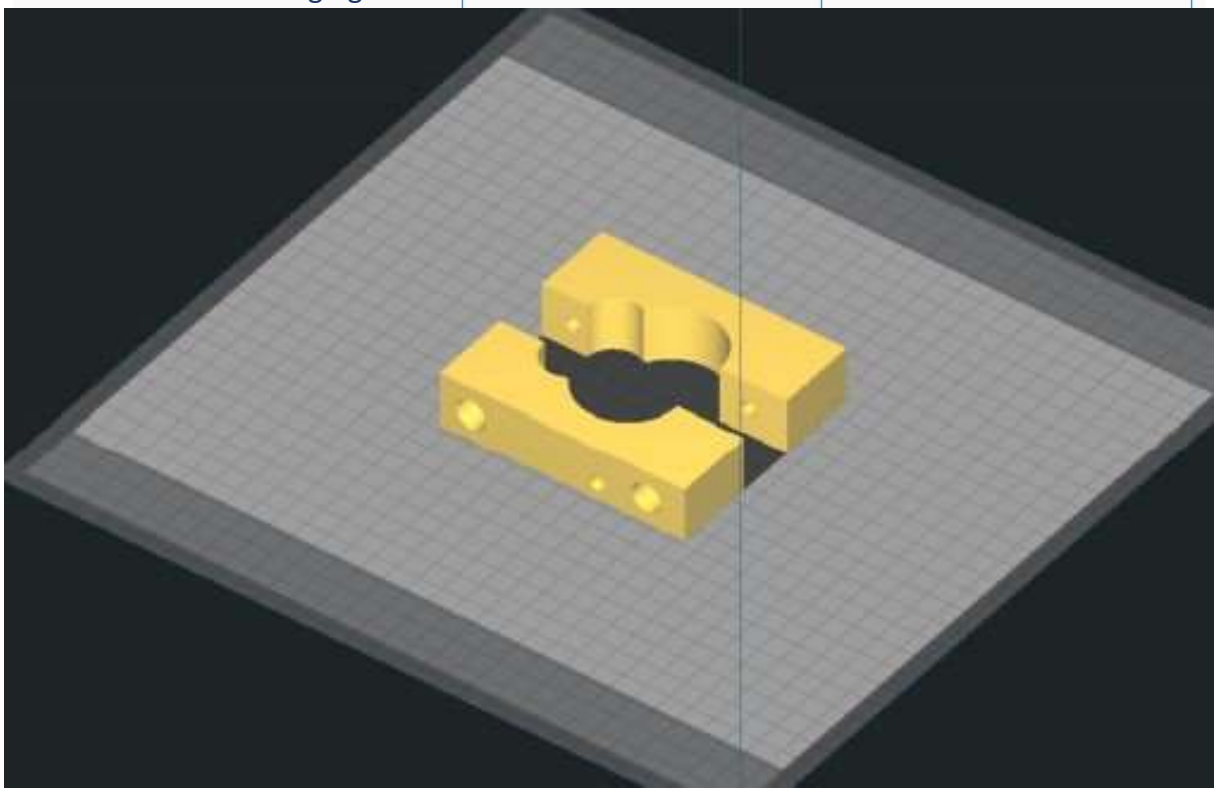


12.2.2 Rear

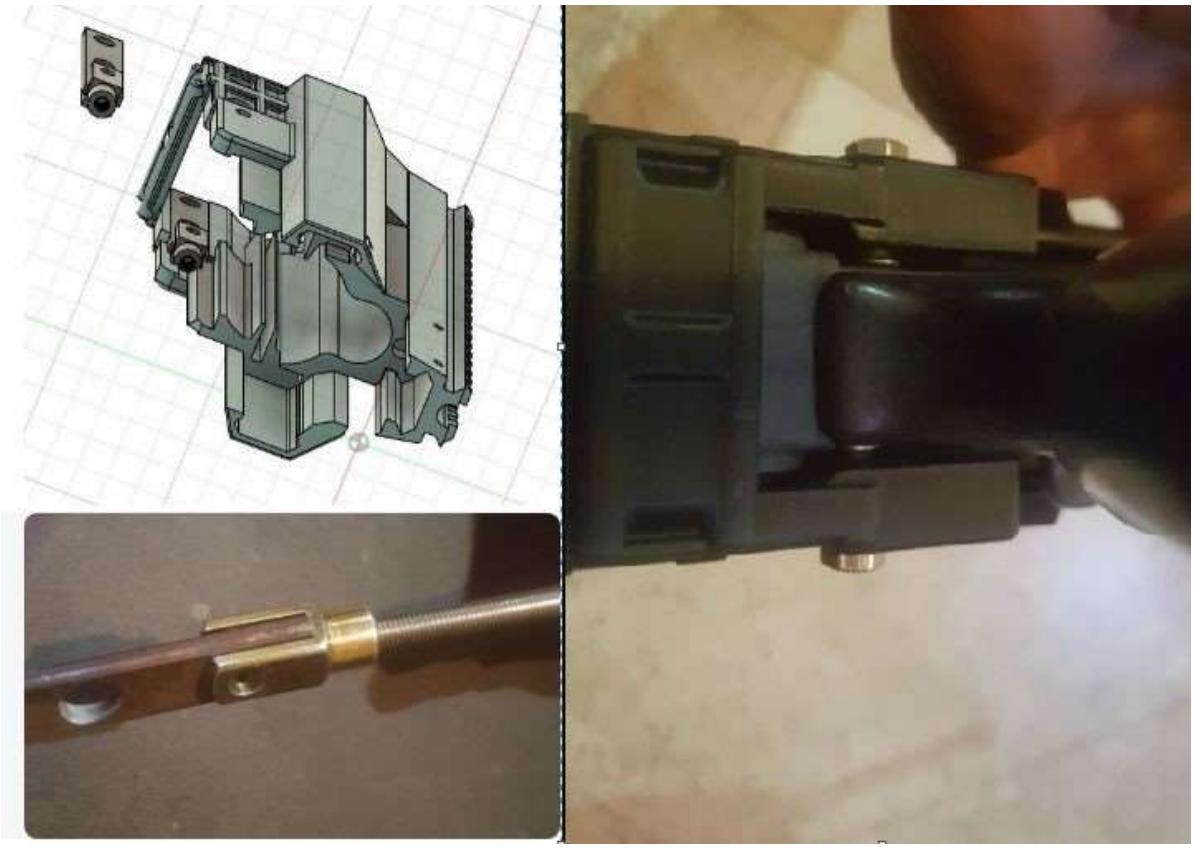


12.2.3 Magazine Latch, Trunnion Wedge (only non-2077 builds), Cutting and Drilling Jigs

12.2.4 Barrel Pin Pressing Jig

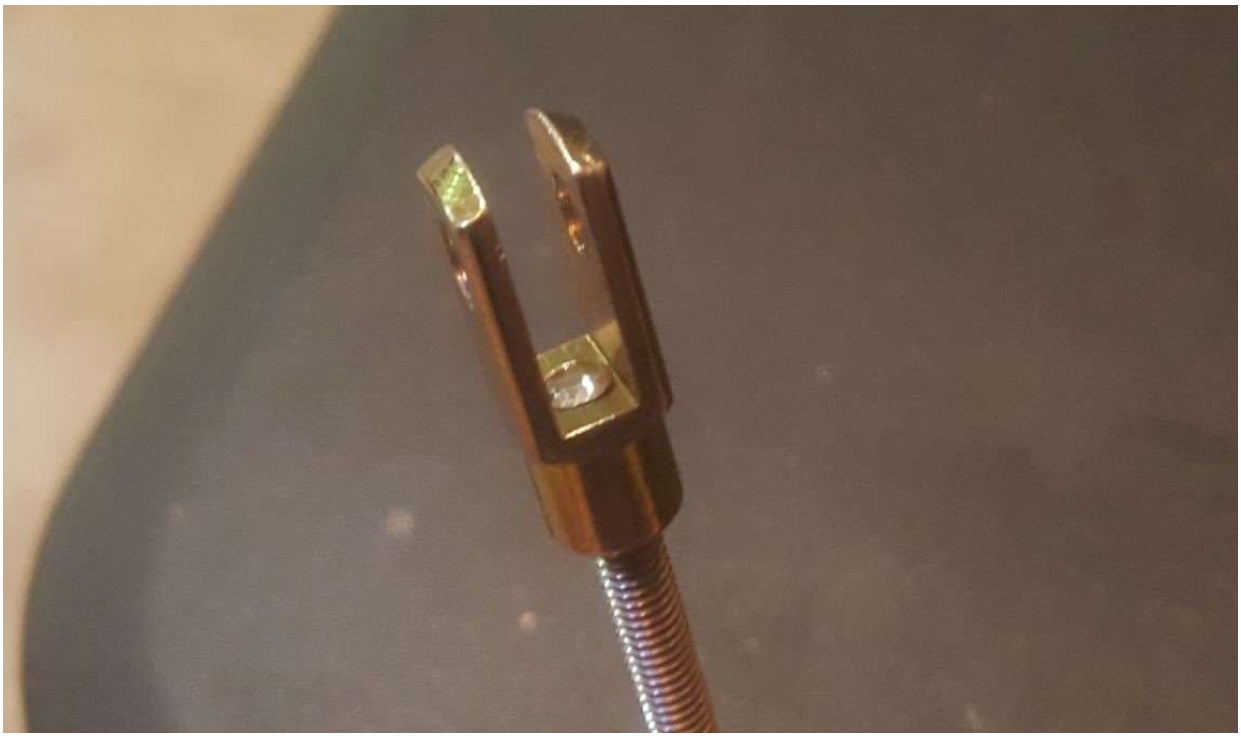


13. Weldless Details:



Above images should clarify how the weldless design is securing the receiver strut rods to the stock attachment plates by means of the clevis adapter. When installed correctly this is a strong connection and has been proven to last over 1000 rounds with no issues. The image at the right illustrates the importance of the countersunk screws for the safety for this design. If you use this attachment method the screws cannot fall out of the receiver as long as your grip frame is in place.

This means that you are ensured to have a solid connection, even if the nuts were to fall off, at any time you can also fire the rifle. The next image below shows that you should ensure that the threaded rod is fully inserted into the clevis adapter such that it bottoms out on the stock attachment plate. The additional images after that are visual aids to understand exactly where all of the listed parts are going to end up.




PUSH
MAIN
PULL
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