



Super Safety

3D Printed Active Trigger System

1 INTRODUCTION

The Super Safety is a mechanism that actively resets the trigger of a firearm to allow the operator to fire again, quickly, and efficiently.

The Super Safety has been designed to operate with AR-15 pattern firearms that use a mil-spec bolt carrier and fire control group.

Two versions of the cam are included, the single mode cam and the dual mode cam. The single mode cam has two positions, safe and active reset. The dual mode cam has three positions, safe, active reset, and passive reset. Each has its own advantages, which will be explained.

When 3D printed in PA12-CF the Super Safety can last several hundred rounds. Optimally it is manufactured from a wear resistant steel.

This document contains the information needed to manufacture the Super Safety, as well as understand it's function.

Several companion documents are referenced from this document. They can be found in the same folder as this document.



Figure 1 17-4 SS Dual Mode Cam.

2 CONTENTS

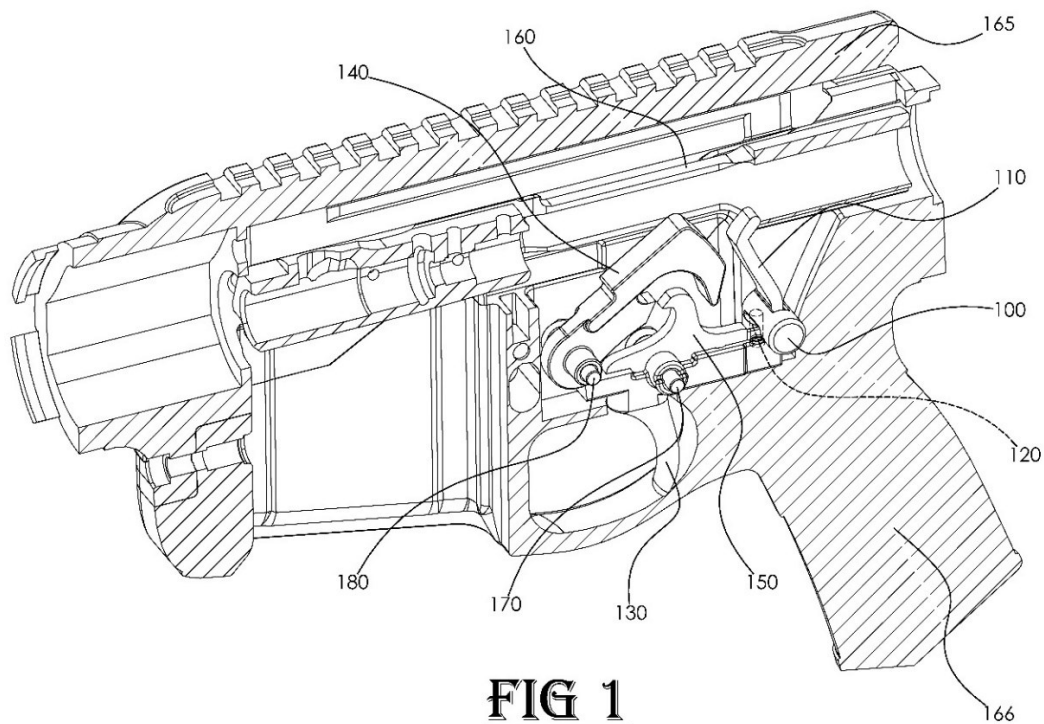
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3 HOW IT WORKS

The detailed description below was taken from a provisional patent, hence the rather general language used. Reference numbers are used to reference a part, feature, or assembly shown in one or more of the supplemental figures. The basic function will be described first, and then the safety and dual mode mechanisms will be described. Note that the figures illustrate the single mode version.

3.1 FIGURES

See the included document “Figures.pdf.” for the remaining figures 1 through 13.



3.2 BASIC FUNCTION

In FIG 1, an assembled AR-15 fire control group is shown along with the mechanism. The cam **100** is installed into the receiver **166** in the place of a standard safety. The lever **110** is fastened to the cam **100** by a dovetail **330** and **250**. The trigger **130** and disconnecter **150**, are pivotally mounted to the receiver **166** by a transverse pin **170** and biased forward by a spring (not shown). The hammer **140** is pivotally mounted to the receiver **166** by a transverse pin **180** and biased forward by a spring (not shown). The detent **120** is contained in a passage within the

receiver **166** and is biased against the cam **100** by a spring (not shown). The bolt carrier **160** reciprocates within the upper receiver **165**.

In FIG 2 the fire control group and the mechanism are shown in the ready state. This is when the hammer **140** is cocked and the trigger **130** is forward, in the reset position. The firearm is ready to fire. When the trigger bow **390** is pulled to the rear by the operator, the trigger sear **410** releases the hammer sear **430**, allowing the hammer **140** to swing forward under spring pressure. The striking surface of the hammer **450** strikes the firing pin (not shown) which then fires the weapon. As the trigger bow **390** is pulled, the tail of the trigger **380** moves up into the cam **100**. The cam follower **270** slides against the cam surface **190**, rotating the cam **100** forward until the upper surface of the trigger **200** is resting in the relief area **210**. The disconnecter **150** is pivoted forward about its pivot **480** congruent with the motion of the trigger.

In FIG 3 the fire control group and mechanism are in the fired state. This is when the hammer **140** is fallen and the trigger bow **390** is pulled. As the bolt carrier **160** moves to the rear under gas pressure, the hammer cam point **520** pivotally displaces the hammer **140** back down into the former ready state. The tail of the hammer **460** may push the lever **110** out of its path as it swings back, this is not critical to the operation of the mechanism. The disconnecter sear on the hammer **460** snaps past and may engage with the disconnecter sear **500**. The hammer **140** is held down by the hammer cam surface **530** as the bolt carrier **160** continues to move rearward. As the bolt carrier continues to move rearward the hammer cam point **520** presses against the reset surface of the lever **340**, rotating the lever **110** rearward. As the lever **110** rotates rearward it transfers torque to the cam **100** via the dovetail joint **330**. As the cam **100** rotates the cam surface **190** slides against the cam follower **270**, moving the tail of the trigger **380** down, rotating the trigger **130** back into the former ready position. The trigger sear **410** can now engage the hammer sear **430**. The disconnecter **150** pivots back rearward about its pivot **480** congruent with the motion of the trigger **130**. The disconnecter sear on the hammer **460** may no longer engage with the disconnecter sear **500**.

In FIG 4 the fire control group and mechanism are in the reset position. The bolt carrier **160** is in its most rearward position, the lever **110** is held to the rear by the hammer cam surface **530** and the cam is rotated so that the neutral surface **260** is against the top surface of the trigger tail **200**. The trigger **130** is held in the reset position by the cam **100** and cannot be pulled by the operator as the neutral surface **260** is blocking the triggers tail **380** from moving up. As the bolt carrier **160** moves forward again under spring pressure, the hammer **140** is released by the hammer cam surface **530** and the hammer sear **430** engages the trigger sear **410**, preventing the hammer **140** from falling. As the bolt carrier **160** moves forward the rear surface of the bolt carrier **510** presses against the tip of the lever **350** rotating the lever **110** forward. The dovetail joint does not immediately transfer torque from the lever to the cam. The lever **110** pivots in the cam **100** until the void **220** is filled. Once the void is filled the hammer can transfer torque to the cam via the upper and lower contact surfaces **240** and **230**. Note that the void **220**, the lower contact surface **240**, and the upper contact surface **230**, are shown on arbitrary sides of the dovetail **330**, these features may be on either side of the dovetail **330** depending on which direction the lever **110** is moving. The amount that the lever **110** rotates in the dovetail **330** before transferring torque to the cam **100** is such that as the bolt carrier **160** completes its forward movement, the cam **100** rotates the neutral surface **260** away from the cam follower **270** and to a point where the cam follower **270** begins to slide against the cam surface **190**.

Once the cam **100** moves into this position the trigger bow **390** can be pulled again by the operator as previously described.

3.3 SAFETY

In FIG 6 a cut away view of the cam **100**, trigger **130**, and detent **120** are shown from the rear. The detent head **310** slides against the detent track **280**. The detent **120** and detent track **280** serve two purposes, preventing the cam **100** from rotating out of its intended range of motion, and selecting different cam profiles that engage with the cam follower **270**. In this example two cam profiles are implemented, the active cam profile consisting of the surfaces **210**, **190**, and **260**, and the safety cam profile **300**. The safety cam **300** is of a round and neutral profile. If the left side of the cam **290** is pressed by the operator, the cam **100** will transversely shift to the right and be held in the right position by the detent track **280** and detent **120**. In this example when the cam **100** is resting to the right the active surface of the cam can engage with the cam follower **270** and the mechanism will function as described previously. If the right side of the cam **320** is pressed by the operator, the cam **100** will transversely shift to the left and be held in this position by the detent track **280** and the detent **120**. In this example when the cam **100** is resting to the left the safety cam profile **300** engages with the cam follower **270** and prevents the trigger **130** from being pulled regardless of what position the cam is rotated to. In other words, by pressing the right side **320** or the left side **290** the manual safety can be engaged or disengaged. When the cam **100** is transversely shifted to the right or left, the lever **110** is held approximately in the center of the firearm by the walls of the receiver **166**. The cam can move transversely in the firearm independent of the lever, as the dovetail on the lever **250** can move transversely within the dovetail slot on the cam **330**.

3.4 DUAL MODE

The cam **100** can be expanded to support more cam profiles. The detent track **280** would be widened to support another position, and another cam profile would be added to the cam **100** alongside, or in between the current profiles, **300** and **210**, **190**, and **260**. An example of this would be to add a second neutral profile similar to the safety profile **300**, but of a smaller diameter. If this profile was selected by transversely sliding the cam **100** to the proper position, it would be of a small enough diameter to not engage the cam follower **270** regardless of what position the cam was rotated to. This would result in the fire control group functioning as before, but without the cam **100** actively resetting the trigger **130**. This would allow the operator to fire precise single shots more effectively. Because of geometric constraints on the AR platform, the tail of the trigger **380** and the cam follower **270** would need to be made narrower.

4 REQUIRED RESOURCES

All parts, tools, and materials will be described here. It is important to source all of the needed resources to ensure that the project is successful.

4.1 PARTS

A complete, functioning, AR-15 with a mil-spec bolt carrier and fire control group will be required. Keep in mind that the trigger and safety detent will be irreversibly modified. You may want to obtain spares of these parts.

The cam and lever will need to be obtained as well, presumably you will be 3D printing these.

The printed parts, as well as the modified trigger and detent, may be available in kit form.

4.2 FILAMENT

The filament required must have specific properties. High stiffness, excellent abrasion resistance, and preferably the ability to print via a 0.25 mm nozzle without clogging. The only material found to meet these properties is the Polymaker PA12-CF. This filament is highly recommended.

PLA+, PC, ABS, PETG, and other more common filament lack the required abrasion resistance. PA6 filaments lack the needed stiffness. Many carbon fiber filaments will clog when printing with the small 0.25 mm nozzle.

4.3 TOOLS

A 3D printer with an all metal hot end capable of printing the PA12-CF. A small nozzle is highly recommended to ensure the required level of detail. A 0.25 mm hardened nozzle is optimal. A 0.4 mm nozzle will work, but more hand fitting will be required.

A computer with slicing software. Prusa Slicer is highly recommended.

A Dremel tool with grinding wheels for modifying the trigger and detent.

Fine sanding and polishing paper for finishing the trigger and detent, as well as fitting the Cam and Lever. 320, 600, and 1500 grit paper are good choices. Leather or cardboard with polishing compound is also helpful for the final touch.

Miscellaneous punches and tools for disassembling and reassembling the firearm.



5 MAKING THE PRINTED PARTS

This is where you will have to decide whether you will print the single or dual mode cam. The dual mode cam is selectable between standard spring reset, same as any mil-spec fire control group, and active reset, allowing fast and efficient firing. The single mode cam has a much wider bearing surface, and will last longer before wearing out. In practice, when printed in PA12-CF, the single mode cam will last around 500 cycles, and the dual mode cam will last about 100. Optimally the dual mode cam should be made from steel. If you are printing the cam in PA12-CF, then the single mode cam would be the best option.

5.1 GENERAL PRINT SETTINGS

The same basic print settings are used for the cam and the lever:

0.25 mm nozzle:

- 0.10 mm layer height.
- 0.25 mm external perimeter line width.
- 0.20 mm top layer line width
- 0.30 mm for all other widths.
- 50% triangle infill.
- Four top and bottom layers.
- Very low print speeds. Less than 1 mm³/s flow rate.

0.4 mm nozzle:

- 0.10 mm layer height.
- 0.40 mm external perimeter line width.
- 0.40 mm top layer line width
- 0.45 mm for all other widths.
- 50% triangle infill.
- Four top and bottom layers.
- Very low print speeds. Less than 1 mm³/s flow rate.

If you are using a different nozzle size, such as 0.2 mm or 0.35 mm, the above line widths may need to be slightly modified.

Filament Settings:

- Manufacturer recommended temperatures.
- As little cooling as possible. Start with 0% and only increase if needed.

Using a bed adhesive, such as Magigoo, is highly recommended to prevent print failure.

5.2 PRINT ORIENTATION

Both parts come pre-orientated. The cam should be printed on its end with the markings facing up. The lever should be printed on one of its sides.

5.3 SUPPORT MATERIAL

Only the cam will require support material. A support enforcer STL is included with each cam. They act in the same way as paint on supports. The areas of the part that the enforcers overlap with are supported, other areas are not. This ensures that the minimal amount of support is added.

5.3.1 How to Use Support Enforcers

In Prusa Slicer (and Bambu Studio) enforcers are added by right clicking on the part > Add Support Enforcer > Load. Then you will select the file for the enforcer, included in the same folder as the part. After this is done select “Support for Enforcers Only” in Prusa or one of the “Manuel” support modes in Bambu.

In Cura you will import the enforcers same as the part, and then under the “Per Model Settings” select “Print as Support”. After this is done, you can select the modifiers and part and merge them together by right clicking and selecting “Merge Models”.

5.3.2 Support Settings

- Organic or Tree support.
- Two interface layers.
- 0.10 mm interface pattern spacing.
- 0.07 mm Z separation.
- 0.25 mm XY separation.

5.4 CAM SETTINGS

- The cam should be printed on a raft using the same interface settings as the support.
- Four walls should be used with a 0.25 mm nozzle.
- Three walls should be used with a 0.4 mm nozzle.
- Use paint on seams to ensure that no seams are in the dovetail groove. They will interfere with fit and function. Seams should be placed on the outside diameter, in places where they will not affect strength, such as the edge of the dovetail groove. If paint on seams are not available, use random seam position.

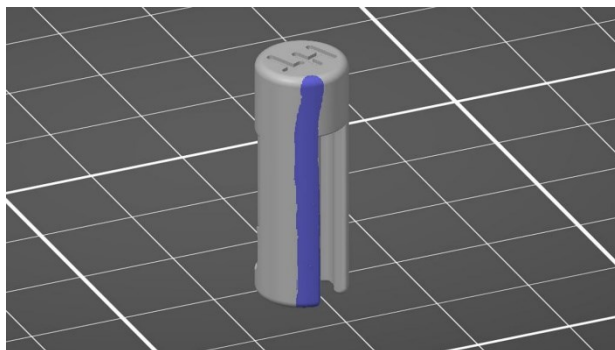


Figure 5. Proper use of the paint on seam with the cam.

5.5 LEVER SETTINGS

- The lever should be printed on a raft using the same interface settings as the support.
- Six walls should be used with a 0.25 mm nozzle.
- Four walls should be used with a 0.4 mm nozzle.
- Use paint on seams to ensure that no seam is on the dovetail. Seams should be placed along the back surface of the lever. If paint on seams is not available, use random seam position.

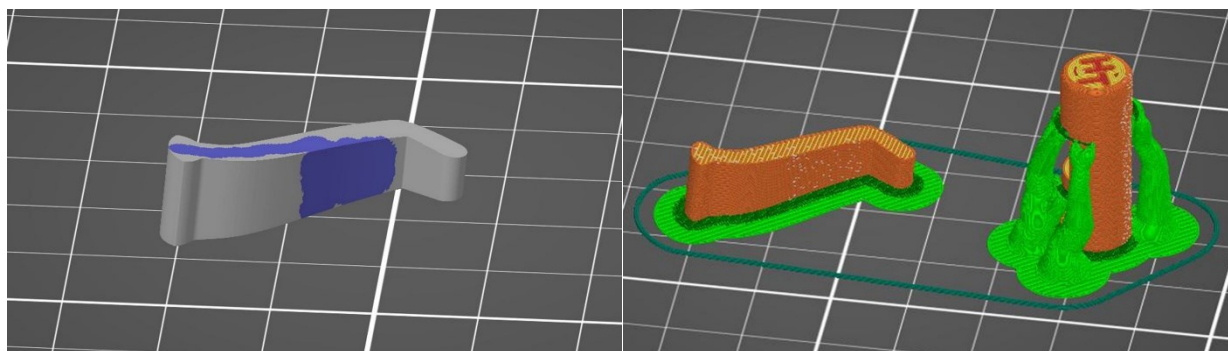


Figure 6 and 7. Proper use of paint on seam with the lever. Parts properly sliced.

6 MAKING THE MODIFIED PARTS

The extent of the modifications to the trigger will depend on whether or not the single or dual mode cam is used. When using the single cam, fine sandpaper is all that is needed to form the profile on the triggers tail. When using the dual cam, the Dremel tool will be needed to remove the right side of the tail completely. Decide on the cam, and then move forward with trigger modification.

If you have not already done so, remove the fire control group and safety group from the AR-15 lower.

6.1 TRIGGER

Lay out your sand paper on a flat hard surface.

6.1.1 Single Mode

Starting with the 320 grit paper, use a stroking motion to round the end of the trigger. The goal is to create a small radius, and then a curved drop off.

Achieving the proper profile is important to ensure that excessive force is not required to reset the trigger, and so that the cam can properly lock the trigger when the bolt carrier is out of battery. If the curve is cut too far forward, the cam may slip when trying to lock the trigger. If the curve is too small, excessive force will be required, possibly resulting in a failure of the lever.

Some triggers already have a drop off from the factory, this will make your job easier.

Be sure to hold the trigger with its center plane perpendicular to the surface, so that both sides of the triggers tail are ground evenly.

Once the desired shape is achieved, use the 600 and 1500 grit paper to smooth and polish the surface. If desired, you can complete this with the leather and polishing compound for a mirror finish. The smoother the surface, the less it will wear down the cam.



Figure 8 and 9. Proper sanding technique. Completed single mode trigger.

See the included drawing “Single Mode Trigger.pdf.”

6.1.2 Dual Mode

To make the dual mode trigger, we will start with an already modified single mode trigger. Follow the above steps to create one.

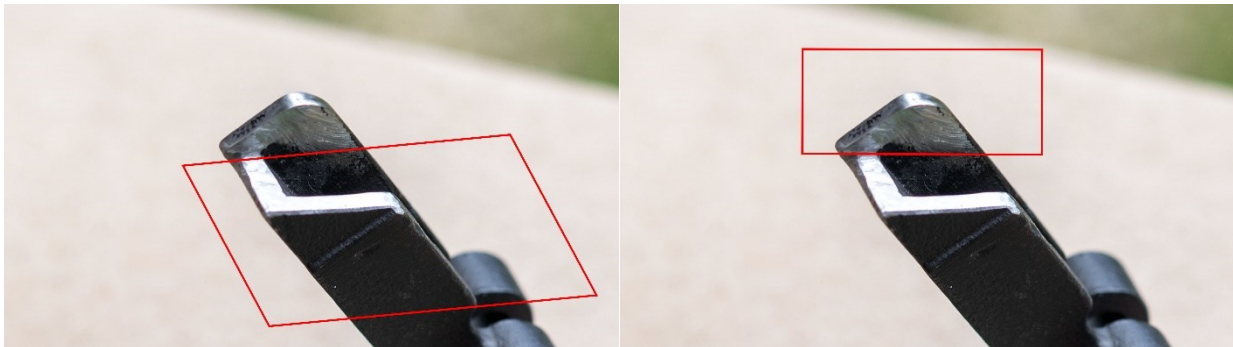


Figure 10 and 11. First cut from side. Second cut from top.

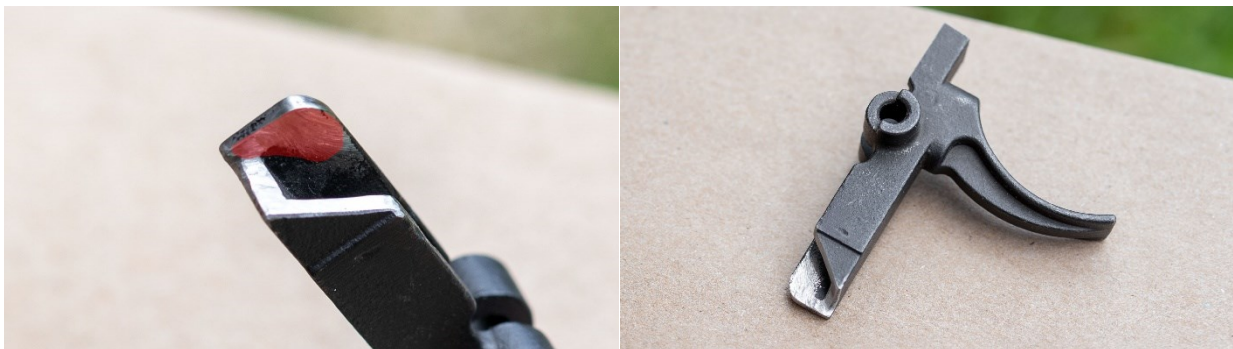


Figure 12 and 13. Final adjustment grind. Completed trigger.

Using the Dremel tool, cut away the right side of the trigger tail. The left 0.080" or so should be left untouched. Frequently cooling the trigger in water is important to prevent loss of the triggers temper.

It is best to start cutting from the right side of the trigger, and then finish from the top and rear. Some extra material should be left on the left side, and this should be removed through careful grinding, this ensures you don't over cut.

The above figures illustrate where to cut. The most important part is to not effect the cam surface you created when doing the single mode grinding.

See the included drawing "Dual Mode Trigger.pdf."

6.2 DETENT

Use the Dremel tool to remove the sharp tip from the detent. Then proceed with the 320 grit paper to round the top off more. Be careful not to remove too much material, you only want to convert the conical surface to a spherical surface, not shorten the detent.

Once the basic shape is formed, proceed with the 600 grit paper to create a smooth and uniform surface. Be sure not to blunt the edges where the spherical surface meets the parallel walls of the detent, this edge should remain sharp.

Once the surface is smooth and uniform, use the 1500 grit paper to polish it to a shine. If desired, you can complete this with the leather and polishing compound for a mirror finish.



Figure 14. Completed detent.

See the included drawing "Detent.pdf."

7 ASSEMBLY

Reinstall the fire control group, using the now modified trigger. The parts should be installed as they would on any other AR, including the disconnecter and disconnecter spring.

7.1 FITTING THE PARTS

Before proceeding with the assembly, the cam and lever must be test fitted. The cam must run smoothly in the safety hole in the lower, and the lever must move freely within the cam.

If the cam is too tight in the lower, it should be sanded on all of its outside diameter surfaces until it fits smoothly.

The dovetail on the lever should slide into the dovetail groove on the cam with only slight friction. The lever should be able to turn forward and backwards within the cam by 10 to 15 degrees. If the lever is tight, or can not turn within the cam, it should be sanded to fit. This is easier said than done.

Before sanding the lever, try running it back and forth a number of times along the length of the groove. This removes burrs and may be enough to create the proper fit. When doing this, hold pressure first to one side of the lever, and then the other. This ensures both sides are equally smoothed. The procedure should always be used when test fitting.

Sandpaper should be bent over the corner of a table or wooden block to form a tight bend. This can be used to remove small amounts of material from the sides of the lever. The curved bottom of the cam should also be sanded. Frequently test the fit to insure that the sanding is not over done.

Another option is to reprint the lever with slightly adjusted XY Size Compensation. This is a setting within Prusa Slicer that shrinks back the walls of an object. A small negative number should be used to do this, such as -0.025 mm.



Figure 15. Test fitting the lever in the cam.

7.2 FINAL ASSEMBLY

The hammer should be cocked back during this process.

Slide the cam in from the left side of the lower, as you do so, hold the lever inside of the lower above where the cam is inserted. The dovetail groove on the cam should slide over the dovetail on the lever, locking the two together. Be sure to hold the cam in the proper orientation, with the crook at the end facing to the rear.

Hold the cam in as you install the detent and detent spring. Once the detent is in place, and under spring force, the installation is complete. Steel cams should be lubricated with oil prior to use, otherwise galling against the trigger is a possibility. PA12-CF cams do not require lubrication.



Figure 16. Super Safety installed in a lower.

7.3 TESTING

Conduct a basic function test prior to installing the upper. With the hammer cocked, move the lever forward, then pull the trigger, being sure to catch the hammer in it's fall. Continue holding the trigger down as you pull the hammer back into the cocked position, it should catch on the disconnecter. As you continue to hold the trigger, move the lever to the rear, simulating the action of the bolt carrier. The trigger should be forced back forward into the reset position, and the hammer should be released from the disconnecter. With the lever all the way to the rear, attempt to pull the trigger, it should be locked. Continue pulling the trigger as you move the lever back forward, as the cam unlocks, the trigger should move to the rear, releasing the hammer. Be sure to catch the hammer in it's fall.

If the system does not function as described above, investigate why before continuing. Section eight has troubleshooting details on each possible issue. However, best way to troubleshoot is to understand in detail how the system works. Read section three.

After the basic test, install the upper and test again by pulling the trigger and racking the bolt carrier. The trigger should be reset each time the carrier moves to the rear, and unlocked each time the bolt moves into battery. Once all dry fire testing is passed, then you may test fire the system.

8 TROUBLESHOOTING

There are several malfunctions that can manifest. These are addressed here.

8.1 FAILURE TO FIRE

This normally occurs after a string of fire. The hammer has fallen, but the primer was not ignited. A light primer strike is typical. This is due to hammer follow, or in other words, the hammer being dropped before the bolt is into battery.

There are two modes of malfunction that will cause a failure to fire.

The most common is the cam being rotated out of the locked position prior to the bolt moving into battery. This is caused by the lever not having enough movement within the cam. The bottom of the lever should be sanded until it has more play.

The second cause is the locked position being too small. In other words, the cam is rotated at the right time, but the hammer rides the cam down into the fired position too soon. This is caused by a worn cam or improperly ground trigger. Inspect the cam, and reevaluate the profile of the trigger tail.

8.2 FAILURE TO RESET

The trigger is not actively reset when the active cam is engaged. The spring reset will continue to function as if the passive mode is selected. This is caused by the cam not resetting the trigger far enough to move the disconnecter away from the hammer. The disconnecter continues to hold the hammer back throughout the cycle.

There are two modes of malfunction that will cause a failure to reset.

The first is when the cam is not rotated far enough to the rear. In other words, the cam is not rotated into the locked position. The result is that the trigger will not be sufficiently reset to allow the hammer to be released from the disconnecter. This can be caused by an overly flexible or broken lever, or too much play between the lever and the cam.

The second is when the cam is worn, or the lower is out of spec. The cam is rotated fully to the rear locked position, but fails to reset the trigger. If the locking surface on the cam is worn down, it will not have sufficient diameter to depress the tail of the trigger by the required amount. The same goes for the lower, if the selector switch hole on the lower is too large, the cam can shift upwards and fail to move the tail of the trigger down sufficiently.

8.3 BROKEN LEVER OR CAM

The lever may break, resulting in a failure to actively reset the trigger, or even a jammed firearm. The edges of the dovetail groove on the cam may also fail for the same reason. The cause of this is typically excessive force on the lever due to an improperly ground trigger. A lack of lubrication when using a steel cam can also result in excessive force.

9 LEGAL

The Super Safety is not a machine gun. The Super Safety cannot be used to convert a firearm to a machine gun.

A “Machinegun” is defined in Federal Law as:

“...Any weapon which shoots, is designed to shoot, or can be readily restored to shoot, automatically more than one shot, without manual reloading, by a single function of the trigger.”

The Super Safety requires two functions of the trigger for every round fired:

1. The trigger must be pulled by the operator. A round is fired.
2. The trigger is reset by the cam. The trigger can now be pulled again by the operator.

The Super Safety does not meet the requirements needed for it to be a machine gun.

For a more detailed technical analysis written by Dan O’Kelly, see the included document “Legal Brief.pdf.”