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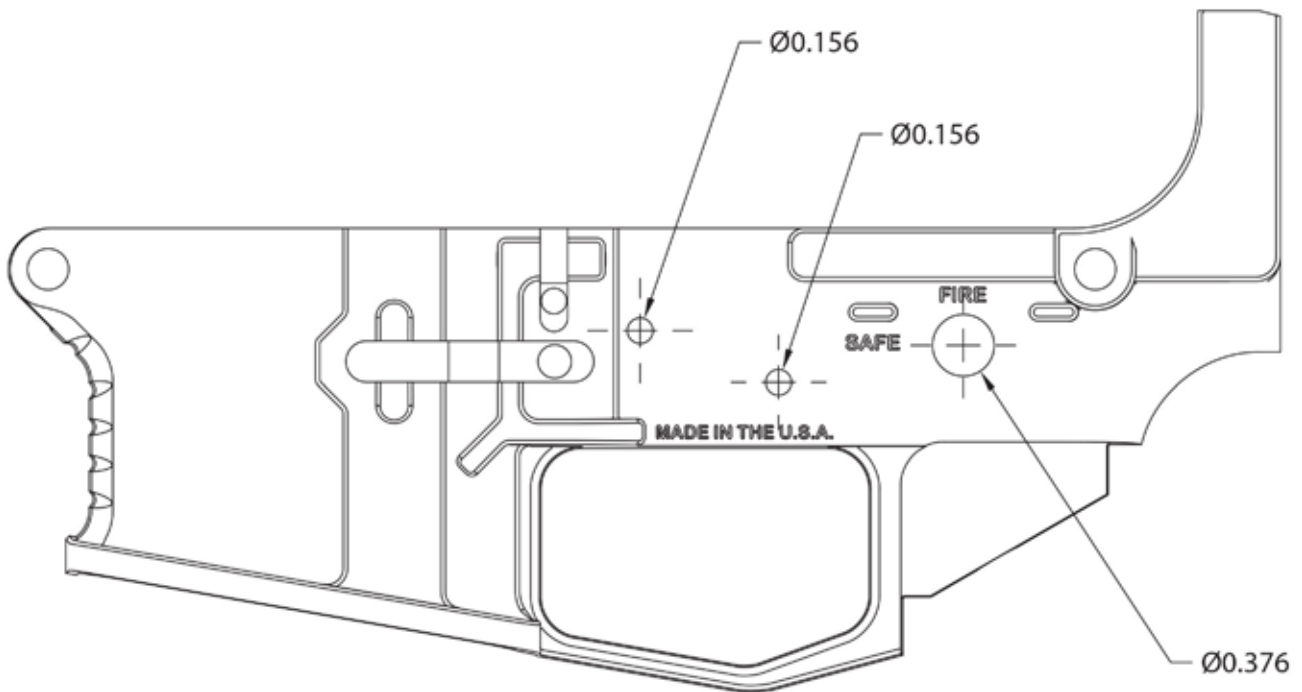
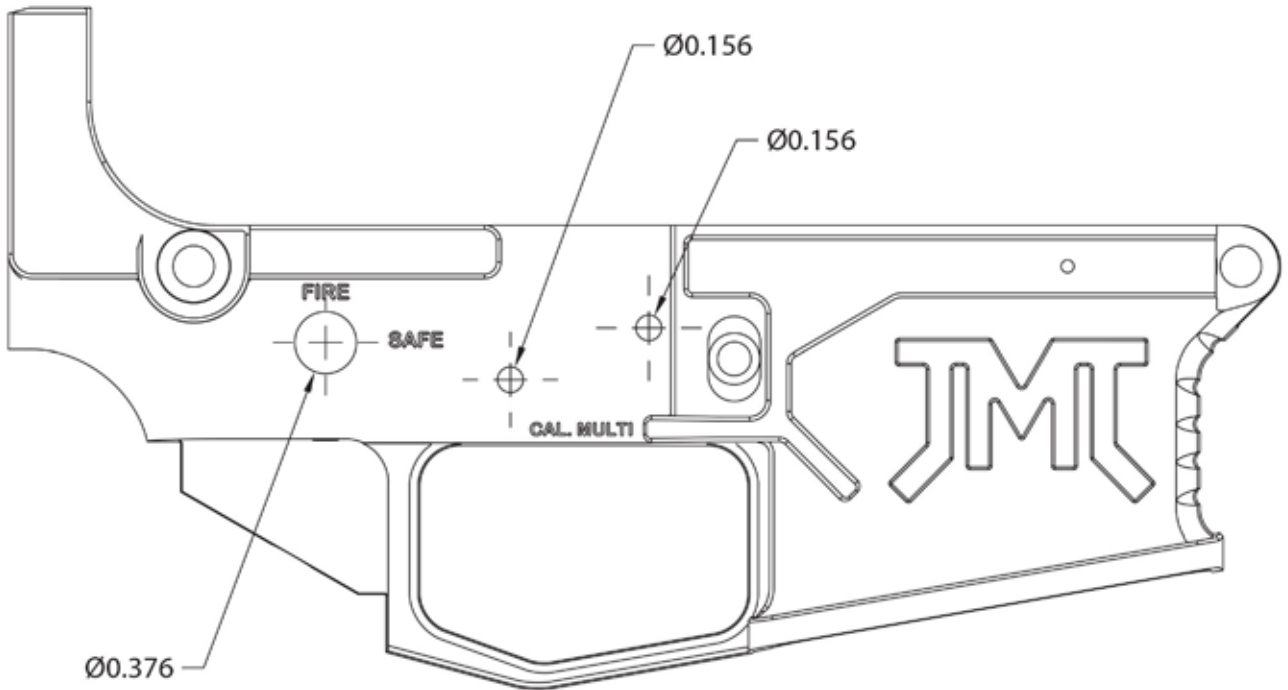
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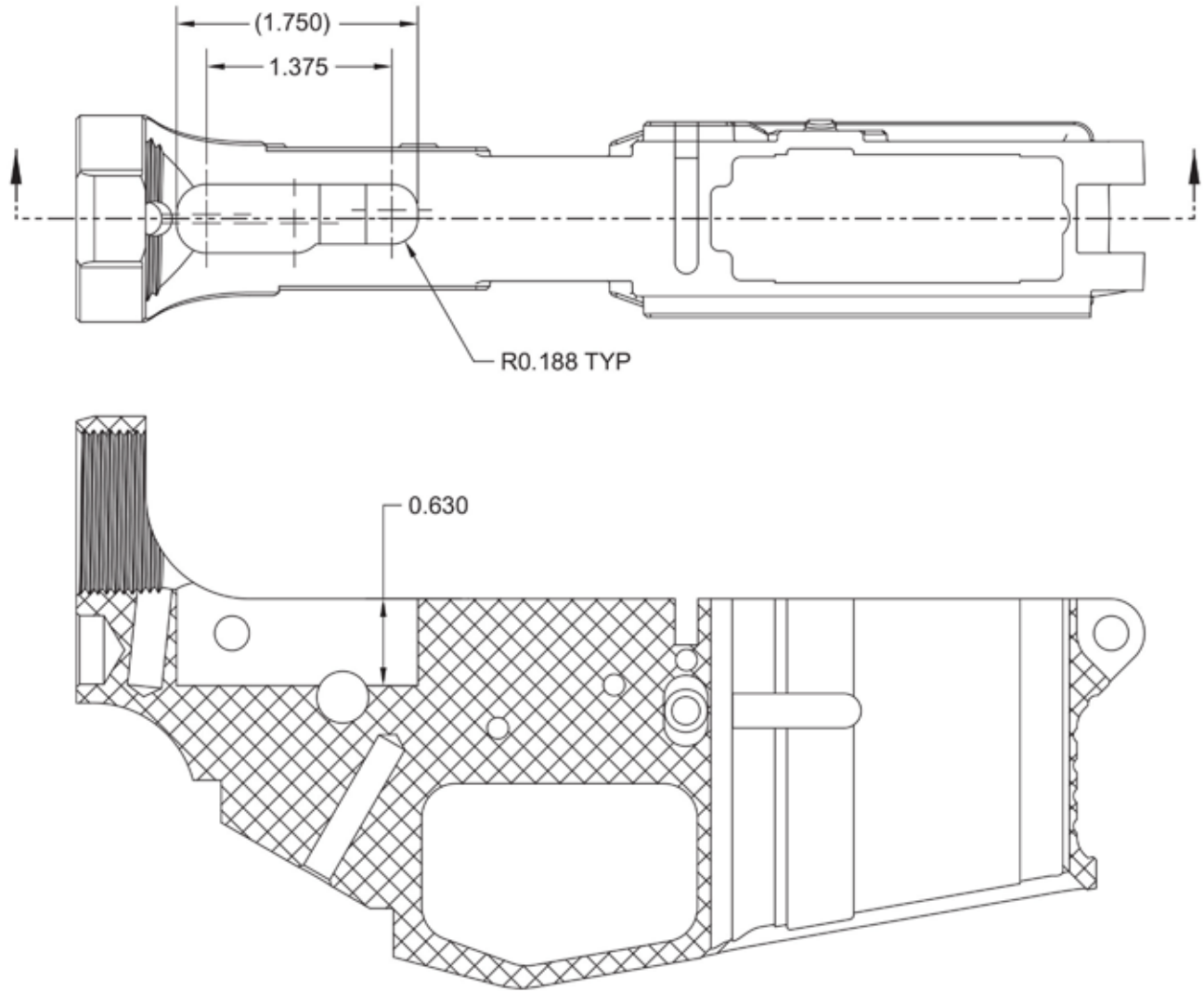


Appendix 1

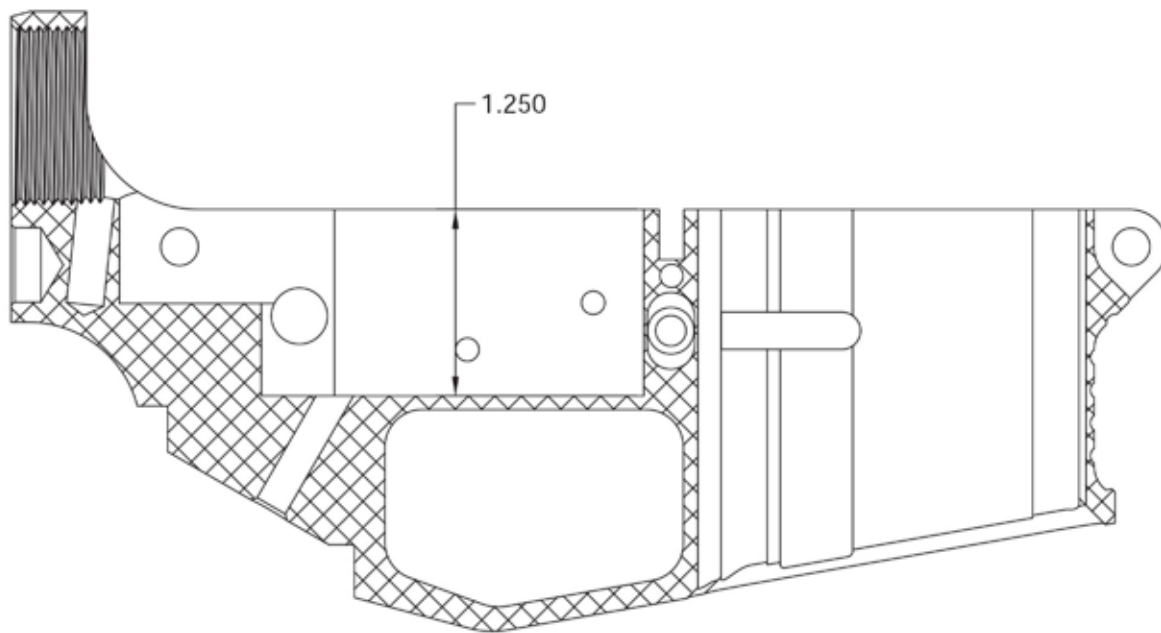
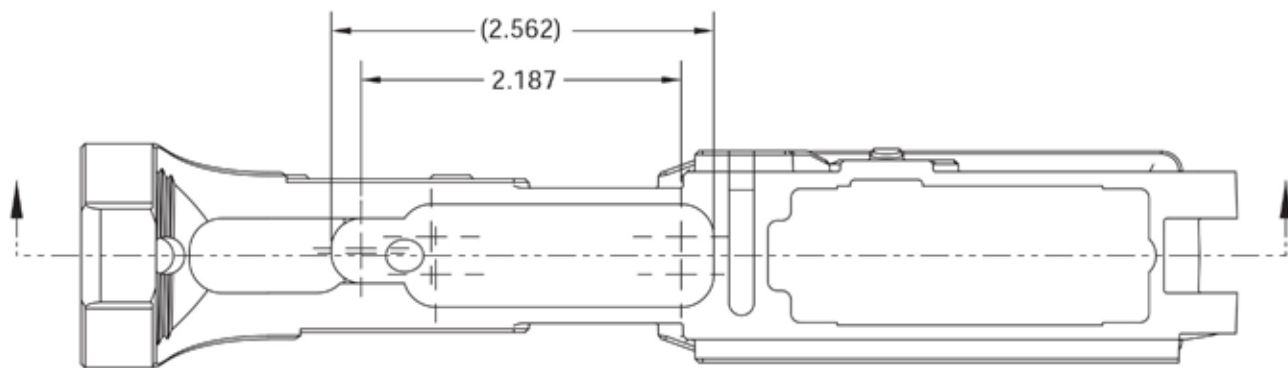
Schematics for AR-15-Type Firearms



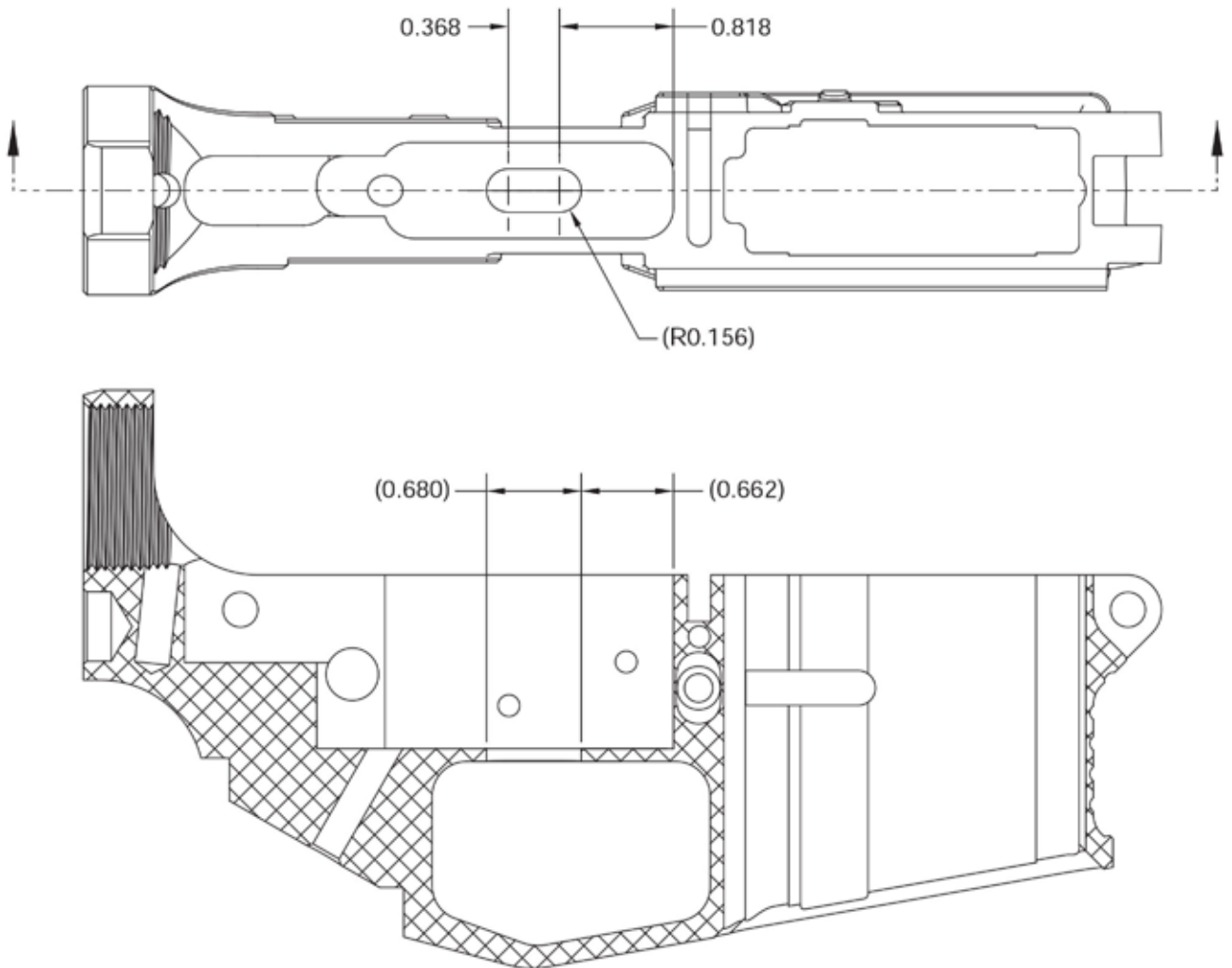
Schematics for AR-15-Type Firearms



Schematics for AR-15-Type Firearms



Schematics for AR-15-Type Firearms



Appendix 2

ZERO AN M16A2 RIFLE

From Army Manual STP 21-1-SMCT "Soldier's Manual Of Common Tasks" Skill Level 1 October 1987

CONDITIONS: On a 25-meter range, given an M16A2 rifle, 18 rounds of 5.56-mm ammunition, a 300-meter zero target, and sandbags for support.

STANDARDS: Using 18 rounds or less, the soldier must battlesight zero his rifle by achieving five out of six rounds in two consecutive shot groups within the 4-centimeter circle. Bullets that break the line of the 4-centimeter circle will be used in evaluating the soldier's performance.

TRAINING AND EVALUATION

1. The M16A2 rifle has **two adjustable sights** -- front and rear. Elevation adjustments are made using the front sight, and elevation changes and windage adjustments are made using the rear sight.
 2. **The sight systems.**
 - a. The rear sight has an elevation knob with range indicators from 300 to 800 meters and two apertures for range. One aperture is marked 0-2 for short range from 0-200 meters and an unmarked aperture for normal range from 300 to 800 meters.
 - (1) The 0-2 (large) aperture is used for short range (Figure 104). This aperture is used only when the rear sight is all the way down.
 - (2) The unmarked (small) aperture (Figure 105) is used for normal range. This aperture is used for most firing situations. It is used in conjunction with the elevation knob for 300- to 800-meter targets.
 - b. The rear sight also consists of a windage knob on the rear side of the sight (Figure 106).
 - (1) Each click of the windage knob will move the strike on the round from 1/8 inch (.3 centimeters) at 25 meters to 4 inches (10 centimeters) at 800 meters.
 - (2) A windage scale is on the rear of the sight and the windage knob pointer is on the windage knob.
 - c. The front sight consists of a rotating sight post with a spring-loaded detent (Figure 107).

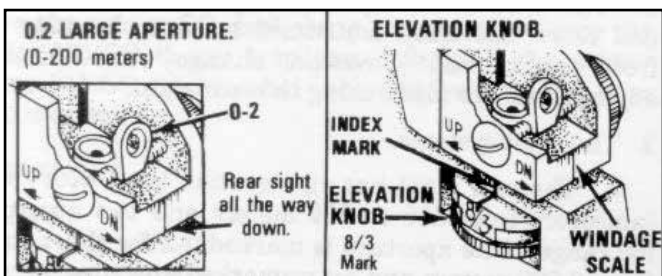


Figure 104. Rear sight.

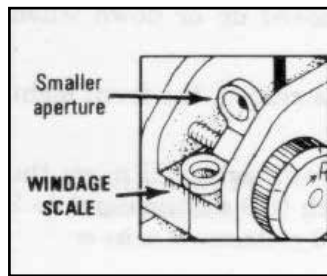


Figure 105. Unmarked aperture.

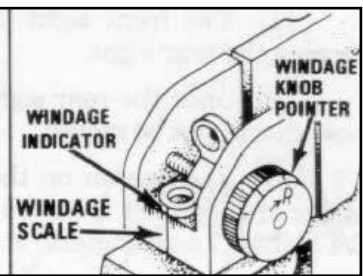


Figure 106. Windage knob.

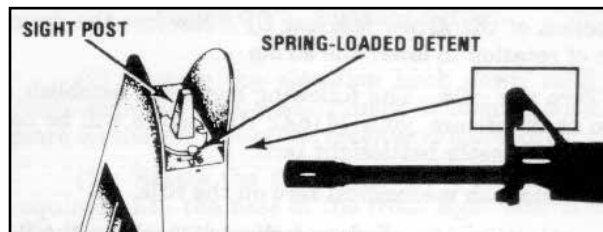


Figure 107. Front sight.

- (1) The front sight is moved up or down when zeroing the rear sight.
- (2) Once the rear sight is zeroed, the front sight post should not be moved.
- (3) Each notch on the front sight will move the strike of the bullet from 3/8 inch (0.9 centimeters) to 2 3/4 inches (7 cm) at 200 meters.

3. Sight adjustments.

a. Rear sight.

- (1) To adjust windage or move the strike of the round, turn the windage knob counterclockwise to move the strike to the left and clockwise to move the strike to the right (Figure 106).
- (2) To adjust elevation, turn the elevation knob until the desired range is indexed at the index mark on the left side on the sight (Figure 104).

- b. **Front sight.** To adjust elevation, depress the detent and rotate the sight post (Figure 108). To raise the strike of the round, rotate the sight post in the direction of the arrow marked UP. Reverse the direction of rotation to lower the strike.

4. Zero the rifle. The following steps will establish a zero at 25 meters, your M16A2 rifle sights will be set with a 300-meter battlesight zero.

a. Establish mechanical zero on the rifle.

- (1) Align the windage indicator mark on the 0-2 aperture with the center line of the windage scale (the unmarked aperture is up) (Figure 106).
- (2) Rotate the elevation knob down until the range scale 8/3 (300-meter) mark is aligned with the mark on the left side of the receiver (Figure 104).
- (3) Rotate the front sight post up or down as required until the base of the front sight post is flush with the top of the sight post well.

b. Zero at 25 meters.

- (1) After setting the front and rear sights to mechanical zero, the elevation knob is rotated up (clockwise) one click past the 8/3 (300-meter) mark. The elevation knob will remain in this position until the battlesight zeroing has been completed.

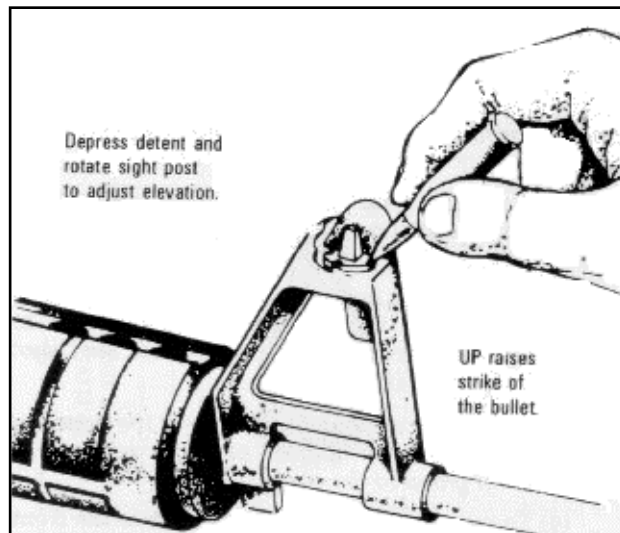


Figure 108. Depress detent.

Note: Any changes in elevation required during the zeroing procedures will be made using the front sight post only

- (2) Carefully aim and fire each shot of a three-shot group at the circle on the silhouette (Figure 109).
- (3) If your shot group is not within the circle on the silhouette, use the squares on the target to determine the required clicks to move your next shot group into the circle (Figure 109).

Note: The squares are numbered around the edges of the target to equal the number of clicks required to move the shot group to the circle.

- (4) To raise your next shot group, rotate the front sight post UP (clockwise). To lower your next shot group, rotate the front sight post DOWN (clockwise). One click will move the strike of the round one square on the target.
- (5) To move the shot group to the left, turn the windage knob counterclockwise. To move the shot group to the right, turn the windage knob clockwise. Three clicks of the windage knob will move the strike of the round one square on the target.

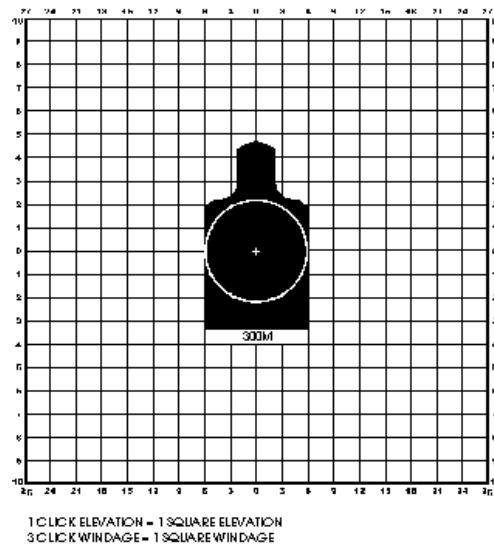


Figure 109. 25-meter zero target

Full size of target is 8-11/16 x 11-5/8 inches, grid is 7-3/16" wide

- (6) Continue to fire three-round shot groups and make corrections until you have a tight shot group in the circle on the silhouette
- (7) If your shot group is within the circle, your rifle is now "calibrated."

(8) To place your 300-meter zero on the rifle, you must rotate the elevation knob one click counterclockwise. The 8/3 (300-meter) mark on the elevation knob should now be aligned with the index mark on the left side of the sight.

Notes: 1. *There are clicks between the range numbers as you turn the elevation knob. Use these clicks if you need more elevation past a certain range number to hit a target.*

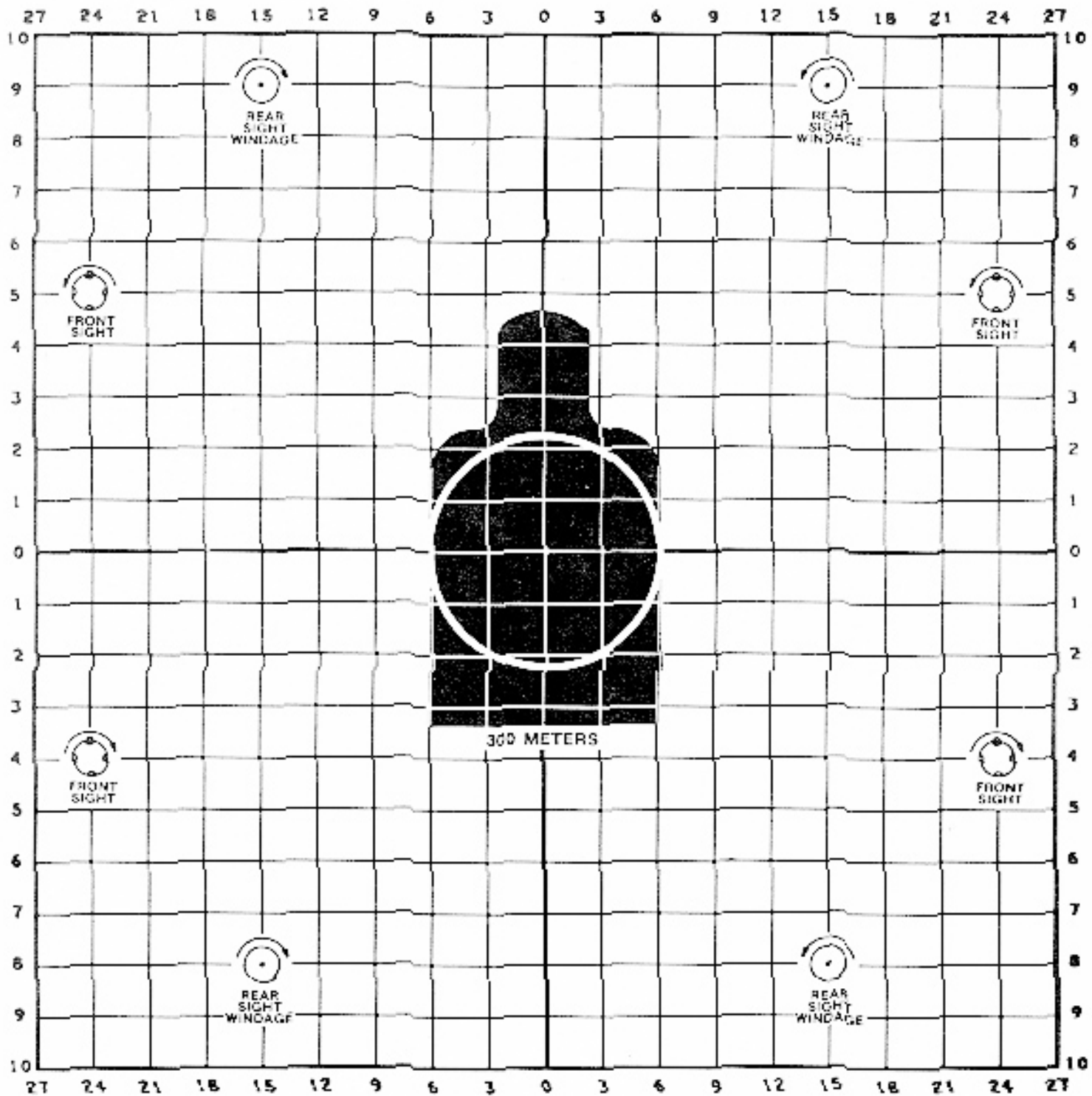
2. *The unmarked aperture is automatically zeroed to 200 meters. Use the 0-2 aperture when shooting at night or at close ranges; for example, in an urban environment or in dense jungle.*

5. **Sight setting.** Your rifle sights should be kept set to a combat zero of 300 meters. If you are told to engage a target at a longer range; for example, 500 meters:

- a. Rotate the elevation knob so that the desired range mark is aligned with the index mark on the left side of the sight.
- b. Engage the target.
- c. When the engagement is over, return the sight to the 300-meter setting.

Note: When the rifle has been zeroed to 300 meters, all other ranges on the elevation knob are also zeroed.

25 METERS ZEROING TARGET M16A2



Appendix 3

ZERO AN M16A1 RIFLE

From Army Manual STP 21-1-SMCT "Soldier's Manual Of Common Tasks" Skill Level 1 October 1987

CONDITIONS: On a 25-meter firing range, given an M16A1 rifle, 18 rounds of 5.56-mm ammunition, a 250-meter zero target, and sandbags for support.

STANDARDS: Using 18 rounds or less, the you must battlesight zero his rifle by achieving five out of six rounds in two consecutive shot groups within the 4-centimeter circle. Bullets that break the line of the 4-centimeter circle will be used in evaluating the soldier's performance.

TRAINING AND EVALUATION

1. The M16A1 rifle has **two adjustable sights**. Elevation adjustments are made on the front sight, and windage adjustments are made on the rear sight.
2. The **standard sight system** (Figure 100).
 - a. The rear sight has two parts: an aperture marked "L" for ranges beyond 300 meters and an unmarked aperture for ranges from 0 to 300 meters (when zeroing with the standard sight, use the aperture marked "L"), and a windage drum for windage adjustments.
 - b. The front sight consists of a rotating sight post with a spring-loaded detent.
3. **Adjust sights** (Figure 101).
 - a. **Rear sight.** To adjust windage, depress detent and rotate drum to desired direction. To move point of impact to right, turn drum clockwise in direction of arrow and letter R. To move left, move drum counterclockwise. Each graduation (notch) moves the point of impact of bullet as indicated in Table 4.

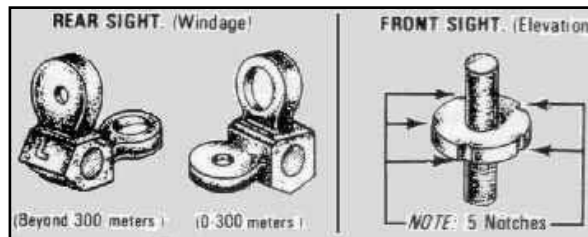


Figure 100. Standard daylight sight system.

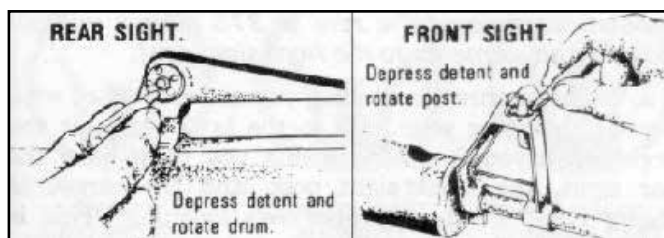


Figure 101. Rear sight detent and front sight detent.

CHANGE ON IMPACT	DISTANCE
<i>Standard Sights</i>	
0.7 cm (17/64 in)	25 meters
2.8 cm (1 3/32 in)	100 meters
5.56 cm (2 13/64 in)	200 meters

Table 4. Change of impact table.

- b. **Front sight.** To adjust elevation, depress detent and rotate post. To raise strike of bullet, rotate post in the direction of arrow marked UP. Reverse the direction of rotation to lower strike of bullet.

4. Battlesight zero the weapon.

NOTE: The "L" marked aperture is used to zero the M16A1 rifle on the 25-meter range. Once the zeroing is complete, flipping the sight to the unmarked aperture will cause the sights to be zeroed for 250 meters. Flipping the sight back to the "L" marked aperture will automatically extend the zero to 375 meters without additional adjustments to the front sight post.

a. **Sight picture.** In aiming, you are concerned with correctly pointing your rifle so the bullet will hit the target when you fire. To do this, you must have the rear sight, the front sight post, and the target or aiming point in their proper relationship. This is known as sight picture. A correct sight picture is obtained when the sights are aligned and the aiming point (target) is in the correct relationship to the front sight post (Figure 102B). Sight picture includes two basic elements: sight alignment and placement of the aiming point.

b. **Sight alignment.** To obtain correct sight alignment, align the sights as shown in Figure 102A. Notice that the top center of the front sight post is in the center of the rear sight aperture. If an imaginary horizontal line were drawn through the center of the rear sight aperture, the top of the front sight post would touch this line. If an imaginary vertical line were drawn through the center of the rear sight aperture, the line would bisect the front sight post. You ensure that you have sight alignment by concentrating your attention and focusing your eye on the top of the front sight post through the blurred rear sight aperture. By doing this, you can detect and correct any errors in sight alignment.

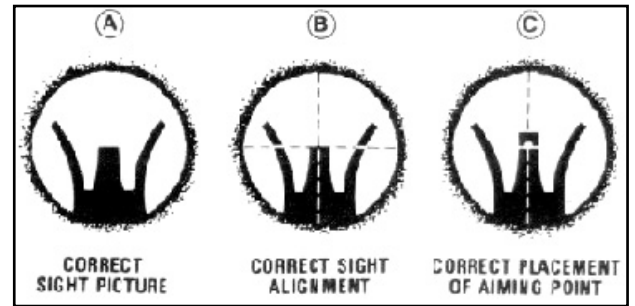


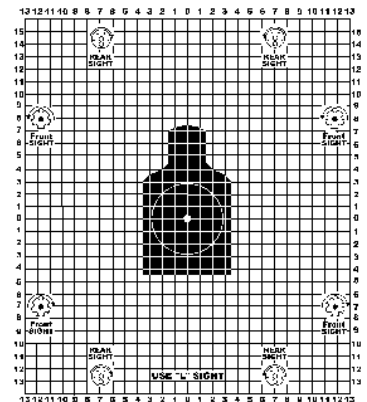
Figure 102. Sight pictures.

c. **Placement of the aiming point.** The aiming point (target on which the firer has aligned his rifle sights) is correctly placed when it is on center of mass of the 250-meter scaled silhouette of the 25-meter target (Figure 102C). If the aiming point is correctly positioned, an imaginary vertical line drawn through the center of the front sight post will appear to split the aiming point.

d. **Battlesight zero target.** Use the standard 25-meter target (Figure 103) when determining the battlesight zero for the M16A1 rifle. Vertical and horizontal lines are printed on the target with a number value given to each. It also has pictures of front and rear sights with a direction arrow to show which direction to turn the given sight when making adjustments. When firing at this target, aim center of mass and adjust sights to bring the shot groups to the center of the silhouette and within the 4-centimeter circle.

e. **Sight adjustments.** If the battlesight zero has not been previously determined, place the M16A1 sights in the starting position.

- (1) Set the front sight post so that the base of the post is flush with the top of the front sight post well, then go clockwise for 11 clicks.
- (2) Center the rear sight aperture within the rear sight housing by moving the rear sight all the way to the left, then moving it 17 clicks to the right.
- (3) With the sights in the starting position, fire a three-round shot group. Once a shot group of 4 centimeters or less is achieved, adjust the sights to move the shot group to within the zero circle.
- (4) Find the horizontal (right-to-left) line nearest the center of the shot group. Follow the line left or right to the nearest edge of the target. Move your front sight by number of clicks marked on that target line by turning the front sight in the direction of the arrow in the front sight figure nearest the center of the shot group.
- (5) Find the vertical (up-and-down) line nearest the center of the shot group. Follow that line to the top or bottom of the target, whichever is nearest. Move the sight by number of clicks marked on that target line by turning the rear sight drum in the direction of the arrow in the rear sight figure nearest the center of the shot group.



Standard zero target (available in supplemental materials)
Full size of target is 8.5 x 11 inches

f. **Determine the battlesight zero.** Determine the 250-meter battlesight zero by firing a series of three-round shot groups at the 25-meter target. Aim at the center mass of the 250-meter scaled silhouette and adjust your sights until the center of this acceptable shot group is within the 4-centimeter circle that appears on the target.

5. Upon completion of zeroing, the battlesight setting should be determined and recorded. There are two methods that can be used to determine how many clicks up or down and left or right the sights were moved from the base settings.

CAUTION

After the initial determination of sight setting, the following procedures for determining the battlesight zero settings for the front and rear sights of the m16a1 rifle will be done only when doubt exists as to whether the sights are properly set. Continual changing of the sights may cause damage.

- a. **Record as changes are made.** To do this, the firer starts with both sights set at zero (base settings). A three-round shot group is fired, and the sights are changed as indicated by the numbers and pictures on the target. These changes are recorded on a piece of paper as they are made. This procedure continues until a good battlesight zero is obtained.

EXAMPLE: The firer has recorded the following corrections:

<u>Rear Sight</u>	<u>Front Sight</u>
L8	UP 5
R2	UP 3
L1	DOWN 2

By adding all the RIGHT corrections and all LEFT corrections, then subtracting the smaller number from the larger number will give the proper correction.

L8R	L9
+ L1	=- R2
<hr/>	
L9	L7

Where L7 is the rear sight correction.

The same procedure is repeated for the front sight by adding all the UP corrections and all the DOWN corrections and subtracting the smaller from the larger number.

UP 5	DOWN 1
UP 8+ UP 3	=- DOWN 1
<hr/>	
UP 8	UP 7

Where UP 7 is the front sight correction.

NOTE: When subtracting LEFTs and RIGHTs, and UPs and DOWNs, the remainder will carry the sign of the larger number.

b. **Determine changes after zero.** The firer will complete the battlesight zero, making changes as required after each shot group is fired. Upon completion of zeroing, the firer must determine the number of clicks he moved the sight.

- (1) To do this, he looks at the rear sight and determines which way he must move the rear sight to place it back on center. After looking at the rear sight, the firer determines the rear sight is to the left of center. In order to bring it back to center, he must move it to the right. He carefully moves the sight to the right one click at a time, keeping track of the number of clicks to bring it to center.

EXAMPLE: The rear sight was moved five clicks to the right to bring it back to center. The zero for the rear sight is, therefore, "left five clicks".

- (2) To determine the zero for the front sight, use the same procedure: determine which way the sight post must be turned to bring it back to even (base setting). Carefully turn the front sight post one click at a time until the base is even with the top of the sight post well.

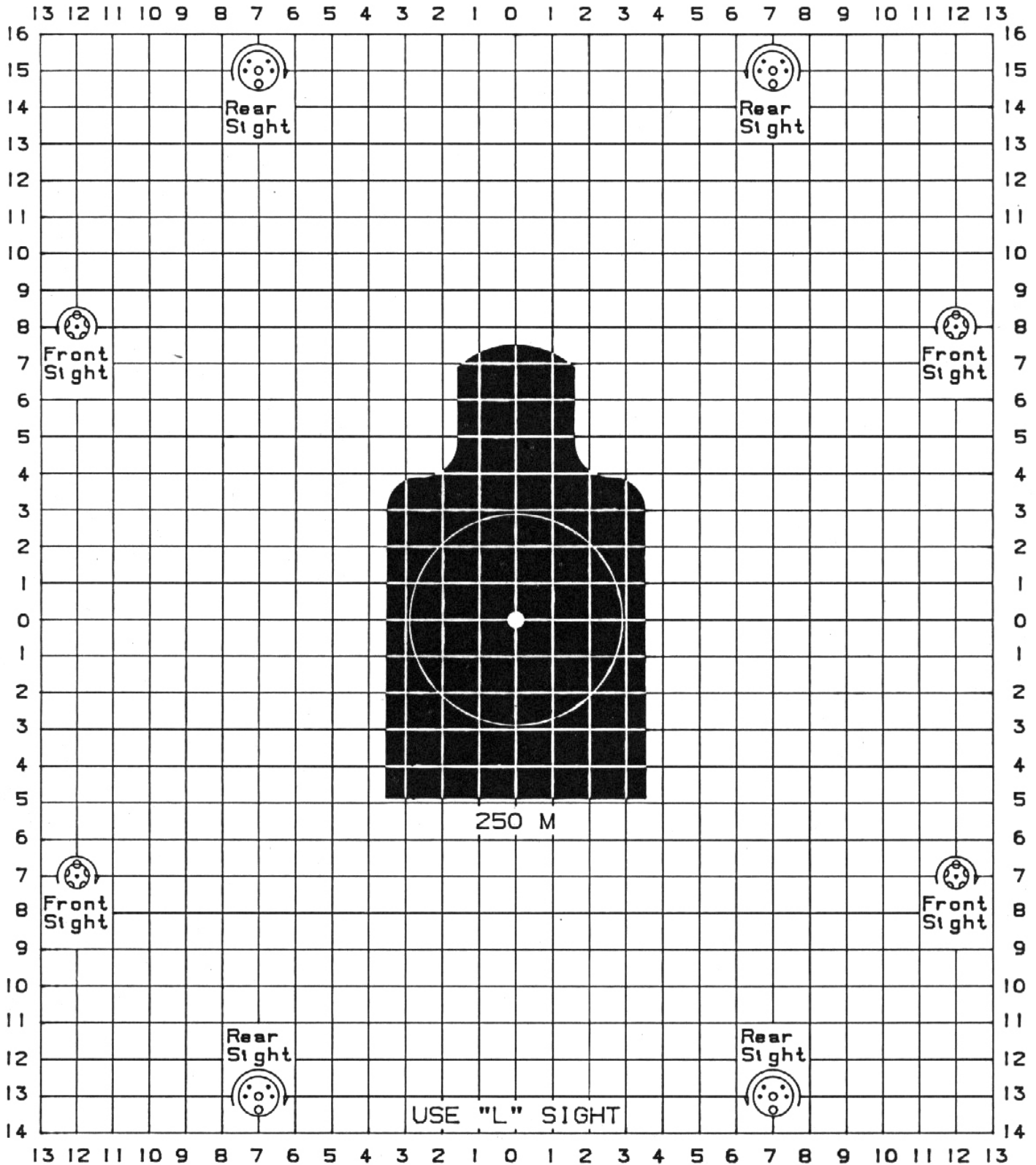
EXAMPLE: The sight post base is above the top of the sight post well. Since the sight post has a right-hand thread, the sight post must be turned to the right to lower the sight.

The sight post was lowered four clicks; therefore, the zero is "up 4 clicks".

The battlesight zero for this rifle is "left 5 clicks" and "up 4 clicks".

6. Upon obtaining the battlesight zero, the firer should record the data on a piece of tape and secure it to the rifle. By doing this, should the sights be changed during cleaning, the sights can be returned to the battlesight setting.

M16A1 SERIES TARGET
 25-METER ZERO TARGET
 (STANDARD SIGHTS)



1. AIM AT TARGET CENTER. ADJUST SIGHTS TO MOVE SHOT GROUP CENTER AS CLOSE AS POSSIBLE TO WHITE DOT.

2. AT COMPLETION OF ZERO, ROTATE REAR SIGHT TO UNMARKED APERTURE AND WEAPON WILL BE BATTLESIGHT ZERO FOR 250M.

Appendix 4

Drilling and Milling an AR-15 80% Aluminum Lower Receiver

Overview

Welcome to the AR-15 Certified Armorer Lab: *Finishing an AR-15 80% Lower Receiver*. In this lab, you will complete the milling of an 80% lower aluminum receiver and learn how to install a lower receiver parts kit (not included). While this process can be greatly simplified through the use of expensive, high-end milling equipment, this lab is designed for the gunsmith or enthusiast on a budget.

For this reason, the lab assumes the use of the following tools:

- Drill press
- Milling vise
- Variety of drill and mill bits
- Set of calipers
- Cross-head and flat-head screwdrivers
- Safety glasses
- Cutting fluid
- Jig designed for this lab
- AR-15 80% lower aluminum receiver



Figure 1: AR-15 80% aluminum receiver.

Other tools and equipment that will be helpful:

- Shop vac
- Pivot pin installation tool
- Buffer retaining spring installation tool
- Vise
- Vise block
- Armorer's wrench

Before moving into the steps for milling out the 80% lower receiver, you first need to identify and prepare your tools and components.

Note: Some photos in this lab show a slightly different jig; primarily the color, the plates and concept are the same.

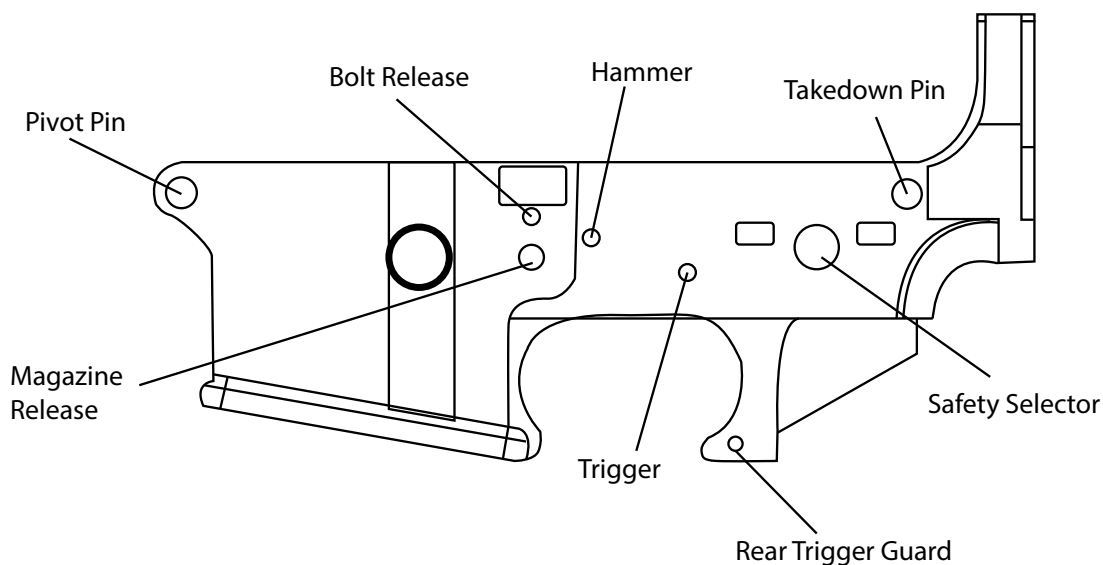


Figure 1A: Shown is the left or "port" side of the receiver. Labels indicate various points where pins or parts are inserted prior to operation.

Components and Tools

THE DRILL PRESS

The drill press is one of the most critical tools necessary to complete this lab. Pairing this tool with a number of high-speed steel (HSS) drill bits and end mills and the jig, you will be able to finish an 80% lower receiver. The drill presses shown (Table 1 and Figure 2, 2A) are basically the floor and bench versions of the same drill press. If you can afford a high quality drill press and are planning on drilling and milling several rifles, it may be worth the money to purchase a higher-end drill press.

TABLE 1 - SPECIFICATIONS FOR DRILL PRESS		
Name	13" 16-Speed Floor Drill Press	13" 16-Speed Bench Drill Press
SKU	43378	38142
Brand	Central Machinery	Central Machinery
Amperage	8	8
Horsepower	3/4	3/4
Max. speed	3600 RPM	3600 RPM
Min. Speed	220 RPM	220 RPM
Number of speeds	16	16
Voltage	120	120
Product Height	63-1/4 in.	41-3/4 in.
Table dimensions	11-3/4 in. diameter	11-1/2 in. diameter



Figure 2: 13", 16-speed floor drill press.



Figure 2A: 13", 16-speed bench drill press.



Figure 3: Drill bit set.

Drill bits (Figure 3) can be purchased inexpensively online and at hardware stores. End mills are more difficult to locate, but can be purchased online. A good end mill (Figure 3A) will cost more than the bits, but you should be able to purchase two quality end mills for approximately \$50.00.

It is recommended that when using a drill press with high-strength aluminum, you choose a revolutions per minute (RPM) speed at the spindle that is a good compromise for cutting speed and tool/bit life. One of the challenges with tooling aluminum is that a high RPM setting can cause sufficient friction to melt the aluminum onto the bits and mills. For this reason, we recommend an RPM setting lower than what the manufacturer of your drill press recommends in their chart (Table 2).

It is recommended to use some sort of cutting oil when drilling and cutting the aluminum receiver. While it is not ideal, you can always use WD-40 if you do not have a true cutting oil available. Additionally, you should keep a shop vac handy



Figure 3A: End mill bit.

to clear and clean up metal shavings. This process will produce an amazing quantity of aluminum shavings, and you will find that they will begin to bind your bit as you work. For this reason, it is *important to vacuum the shavings out of the receiver as you work.*

IDENTIFYING THE PARTS OF THE JIG

A picture of the AR-15 lower receiver jig designed for this lab is shown in Figure 4. The left side and right sideplates of the jig have posts that will fit precisely into the takedown and pivot pin holes of the 80% lower receiver (Figure 5), aligning the holes in the jig with the areas on the lower receiver that need to be drilled. These posts fit snugly, so you may have to work the plates into place, taking care not to place undue pressure on the lower receiver.

The drill plate mounts on the top of the jig, using four short screws to secure it in place. The drill plate is one of three plates

TABLE 2 - RPM SPEEDS											
	Diameter	1/16"	1/8"	3/16"	1/4"	5/16"	3/8"	1/2"	5/8"	3/4"	1"
Aluminum	RPM	10,000	6000	4000	3000	2400	2000	1500	1200	1000	750
	HP	.01	.07	.10	.20	.28	.28	.67	1.00	1.37	2.30
	Feed	.001	.003	.005	.007	.008	.009	.012	.014	.016	.018
	Thrust	6	25	50	80	100	125	200	260	335	450

(* NOTE : A typical drill press often has an RPM limitation of between 2000-3600 RPM. If the chart above specifies a higher RPM than your machine is capable of, it should not cause a problem to run at a lower RPM. For instance, many people drill 1/16" holes at less than 10,000 RPM with no problems.)

to be used as guides for drilling and milling the fire control pocket of the lower receiver and opening up the trigger slot. The drilling and milling plates screw into place with the four short screws, and the screw holes are positioned in such a way that the inserts can only be secured in the correct position. The plate with three larger ($\frac{5}{8}$ "") and three smaller ($\frac{3}{8}$ "") holes is what allows you to use a drill press for this project, avoiding the cost of renting or purchasing a milling machine. By drilling out the majority of the material in the fire control pocket, then "plunge-milling" out even more material with the end mill ($\frac{3}{8}$ ""), you can accomplish the milling portion by "walking" the end mill across the fire control pocket using the milling vise for slow, fine movement, and the more open inserts for guides. The plate with the small slot is used as a guide to open the trigger slot through the bottom of the receiver. This plate can be secured from the top or bottom of the receiver. Finally, the trigger pin, hammer pin, and selector holes are drilled using the guide holes in the sideplates of the jig.



Figure 5: Aluminum lower receiver from your kit.

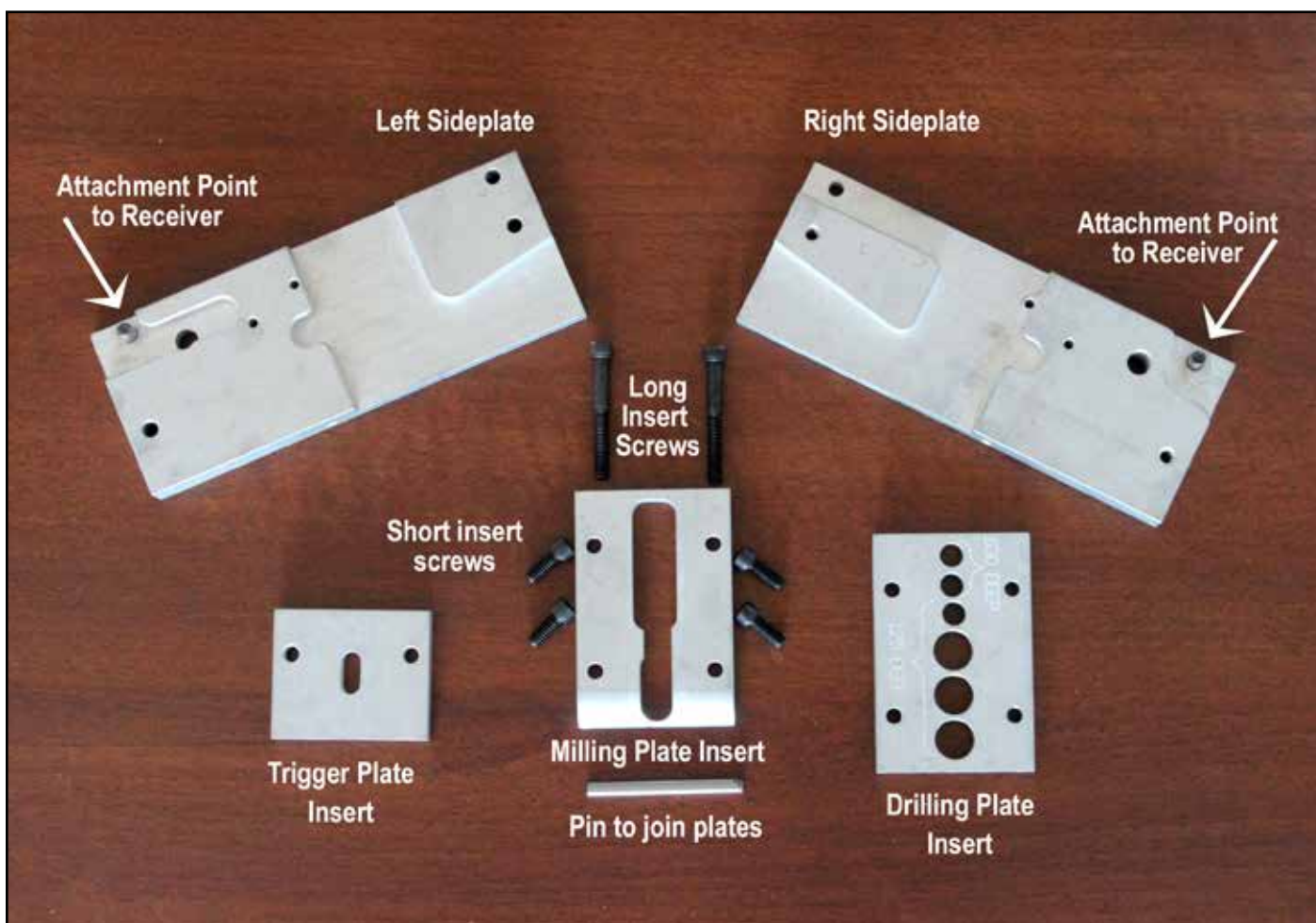


Figure 4: Jig plates for an AR-15-style lower receiver.

MOUNTING THE JIG TO THE 80% LOWER RECEIVER

The jig sideplates are secured to the receiver using a long pin which slides through the plate, receiver, and second plate to provide stability to the assembly while you drill and mill your 80% lower receiver. The short screws are used to secure the plates to the top of the receiver.

See Figures 6 – 8 to properly mount the jig to your 80% lower receiver with the first insert.

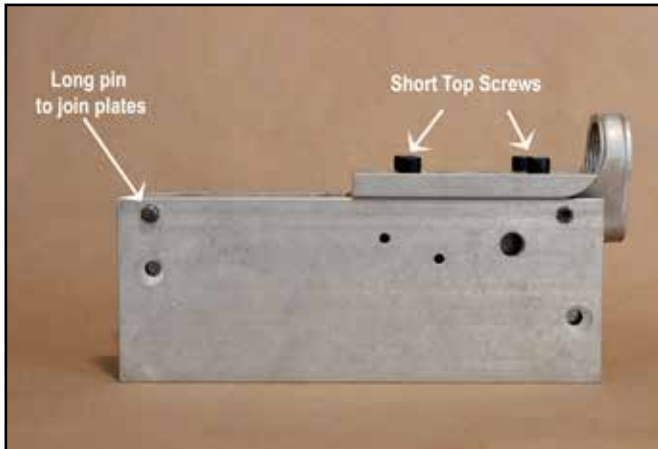


Figure 6: Sideplates attach to the lower receiver using the long pin included in your kit.

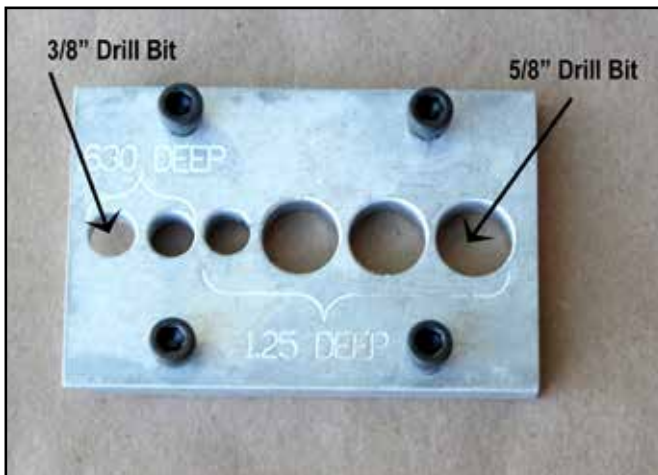


Figure 7: The drill plate attaches to the sideplates with the short screws included in your kit. The depth for each drill hole is indicated on the top.

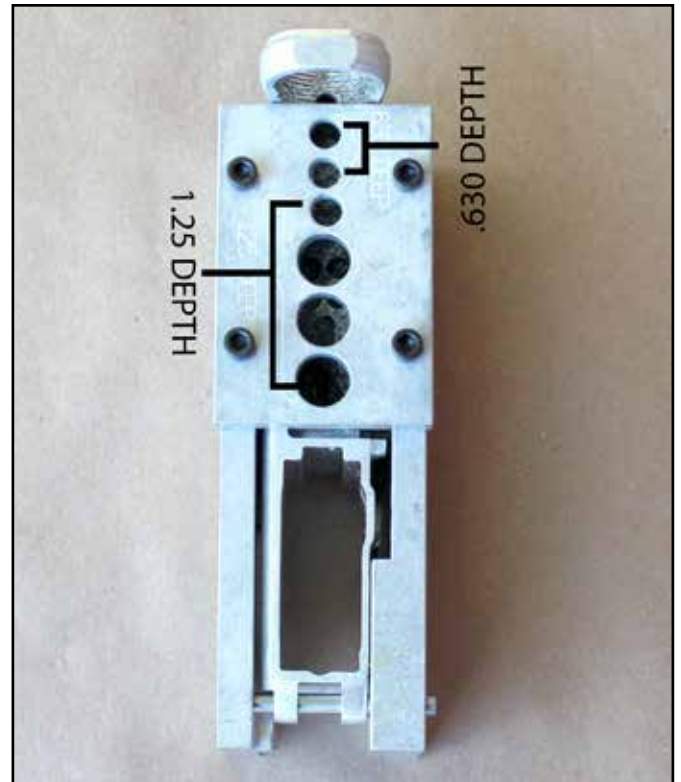


Figure 8: Shown above is the jig completely assembled with the drilling plate installed. Note the different drilling depths.



SAFETY REMINDER! Wear Safety Goggles AT ALL TIMES when running the drill press and drilling/milling the 80% lower receiver! Make sure you are not wearing loose-fitting clothing or items that can get tangled in the moving parts of the drill press!

Setup for Drilling/Milling

Before beginning milling and drilling, prepare your work area, making certain critical tools you will need for the upcoming tasks are within reach and the area is free of clutter. You will want to have your calipers, cutting fluid, drill bits and end mills, screw drivers, shop vac, and possibly a parts cleaning brush (to brush away aluminum shavings and bits) all within easy reach. A magnetic parts bowl is a handy way to keep your bits, mills, chuck, and extra screws all handy.

Using a digital caliper (Figure 10) to measure drilling/milling depths is highly recommended. Although drill presses typically have throw-depth scales, these are sometimes not as accurate as one would like. You will want to measure from the **top of the receiver** to the depth of the cut on the bit itself. With drill bits, be sure to take into account the depth all the way to the tip.

While measurement with the graduated scale is not recommended due to the previously mentioned inaccuracy, the depth stop collar is a must for making certain you do not drill too deep into your 80% lower receiver.

With your drill bit inserted into the chuck (well-centered) and evenly tightened into place from all three points, perform the following steps:

1. Verify that power is off (and preferably that the press is unplugged).
2. Verify that the jig and 80% lower receiver are safely secured in the milling vise (not so tight as to cause excessive pressure on the lower receiver, but tight enough that the jig assembly is firmly secured and will not vibrate loose).
3. Adjust the position of the milling vise and lower the press, so the drill bit is alongside the sideplate of the jig assembly.
4. Loosen the locking screw on the depth stop collar (Figure 11) and make certain the collar is rotated so that the pointer (yellow on the example drill press) is at the “zero” point.



Figure 11: Depth stop collar will help prevent drilling too deep.

5. Use the digital calipers to measure the appropriate depth on the sideplate (measuring from the seam between the top plate and the sideplate, so you are measuring from the top edge of the receiver), moving the drill bit into place (again be certain to take the nose of the bit into account for the depth).
6. Holding the drill bit in position, verify that the collar is still at the “zero” point and tighten the locking screw. (If you have someone to assist with this process, it is quite helpful, because it is difficult to hold to measure, position, and tighten the locking screw without shifting the depth of the bit while setting the calipers down to free a hand for tightening.)
7. Now that the drill bit is locked into place, use the calipers again to measure the depth alongside the jig assembly, verifying that the bit stops in the correct position. You may wish to mark the side of the plates with a sharpie to make quick measuring faster.



Figure 9: Dial-style caliper.



Figure 10: Digital-style caliper.

ROUGH DRILLING THE FIRE CONTROL POCKET

To begin rough drilling the fire control pocket, you will use the jig with the drilling plate insert that has the hole drilling guides to drill six holes using two different size drill bits. First, you will drill three holes with a $\frac{5}{8}$ " bit, then you will drill three holes with a $\frac{3}{8}$ " bit. These holes will roughly outline the fire control pocket of the receiver (Figure 12). The goal here is to remove as much material from the fire control pocket with the drill bits. Drilling will be followed by milling. You want to minimize the amount of material that needs to be milled because a drill press is not designed for the lateral stresses of the milling process.

Go slowly when drilling. As you drill, it is recommended to drill down in short incremental thrusts (perhaps $\frac{1}{16}$ " per thrust). Raise the bit to clear away aluminum chips and curls, apply more cutting oil, and work progressively deeper until you've reached the desired depth. Watch out for aluminum build-up on your bit, as it will bind up in the receiver. You will likely need to use a shop vac and some compressed air to clear the shavings that are trapped below the insert plate. In a pinch, you can remove the plate to clear shavings, then reinstall, but this is not recommended because it is sometimes difficult to perfectly clear the shavings so they don't interfere with cleanly reinstalling the insert plate.

Between drilling holes, it is important to verify that the chuck is still tightened evenly on the bit. It is also wise to occasionally verify that your arbor is still well seated (hasn't vibrated loose). Regularly check that the stop collar is still stopping the

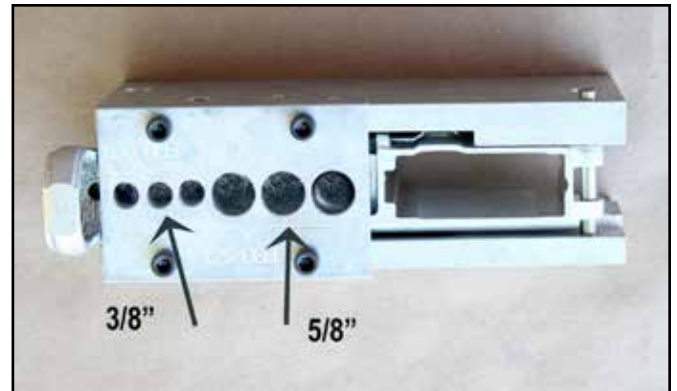


Figure 12: Holes sizes to drill the fire control pocket.

drill bit at the appropriate depth. Also, be sure to verify that the jig plates are still secure and the milling vise is still securely holding the jig. Tighten components as necessary (you will most likely need to tighten the screws holding the insert plate in place).

With all of these things in mind, it is now time to drill the first three holes. Make certain that the table of your drill press is level in all directions, and the milling vise is secured tightly to it and squared up, so that the movement along the y-axis will produce a straight cut parallel to the long edge of the jig assembly. Secure the jig assembly in the milling vise so it is secure and will not move, but not squeezed so tightly that the aluminum receiver can be crushed (Figure 13).

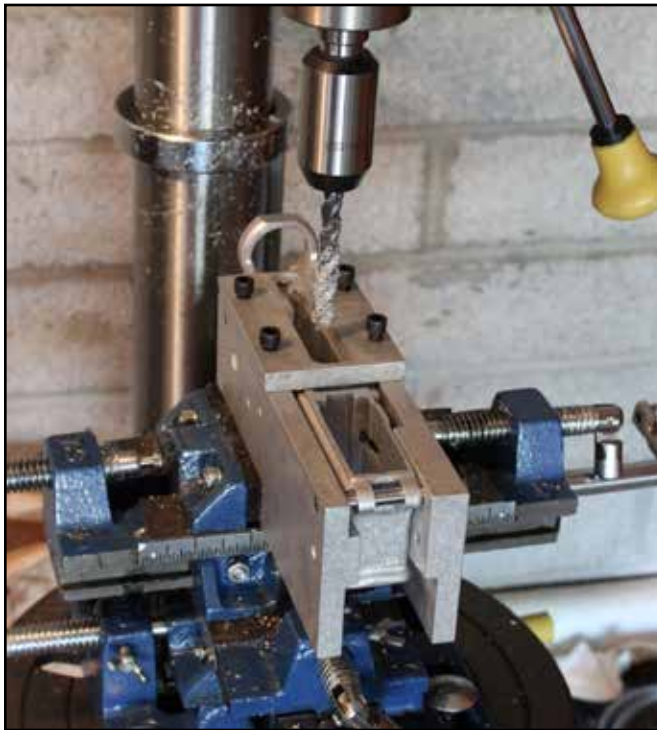


Figure 13: Jig assembly in milling vise.



Figure 14: Drill bit in place with drilling fluid applied.



Figure 15: Drill slowly and carefully the first set of holes.

You will need to insert the $\frac{5}{8}$ " drill bit in the press and tighten it evenly in the chuck. Set the depth to 1.25" using the method described in the previous section. Use the x/y-axis adjustments on your milling vise to move the jig assembly into place below the drill bit, lined up to drill the first $\frac{5}{8}$ " hole. Try to have the bit lined up above the center of the hole. The drill press must be on, with the bit spinning, to do the best job of verifying that the bit is centered. With the drill press on, slowly lower the bit. If the bit makes contact with the edge of the guide hole in the insert plate, back off and make small adjustments to the position of the bit with the x/y-axis adjustments on your milling vise. Try again using the same process and repeat until you have the bit centered in the hole and can press it into the aluminum of the receiver without cutting the insert plate. Keep in mind that the insert plate is also aluminum and will drill and mill as easily as the 80% lower receiver you are trying to machine.

Before you begin to thrust the bit into the aluminum of the receiver, apply a generous amount of cutting fluid to the bit and guide hole in the insert plate (Figure 14).



Figure 16: You will need to remove the excess debris from the receiver quite often to avoid bogging down the bit.

Press the bit into the receiver taking care to press hard enough to cut into the aluminum, but not so hard that the bit is forced back into the chuck (Figure 15).

As mentioned earlier, perform small cuts, backing off and re-applying cutting fluid before drilling further. When you reach the depth stop, slowly back the bit out of the hole. Turn the drill press off, then clean the drill bit.

Perform the previously mentioned checks to verify that everything is still secure and set properly, then repeat the steps in this process to drill the second and third $\frac{5}{8}$ " holes (you don't need to set the depth again unless you've discovered that it has shifted). If you feel the bit binding, be sure to use the previously mentioned method of clearing shavings. Also, pay attention to changes in the vibration and sounds of the drill press as it operates. These are often indicators to look for a problem.

Now you need to change out your drill bit to drill the three $\frac{3}{8}$ " holes. First, use the previously described methods to install and secure the $\frac{3}{8}$ " bit. Reset the stop collar to a depth of 1.25" Note the smaller hole closest to the larger holes also is drilled to a depth of 1.25". Once you have drilled the first hole, you will need to reset the stop collar to a depth of .630" and drill the next two holes. Be sure to continue to apply cutting fluid throughout the drilling process. With multiple drilling spots you will have even greater build-up of aluminum shavings and will need to use compressed air and a shop vac to clear these shavings between drillings.

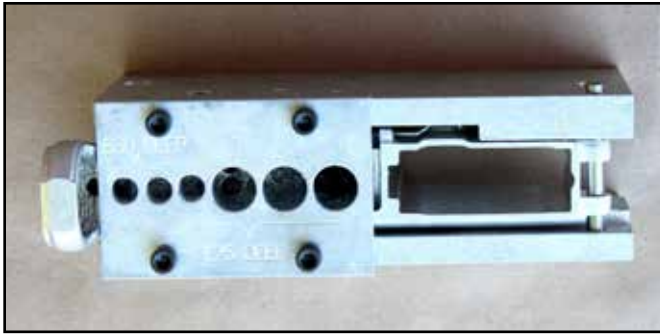


Figure 17: Completion of drilling from plate 1.

Once you've completed drilling the two $\frac{3}{8}$ " holes to a depth of .630", reset the stop collar to a depth that will allow you to drill through the bottom of the receiver. Verify that plunging through the receiver for the two holes that will act as the starting point for the trigger slot will not cause the bit to impact the milling vise. If it will, you may need to adjust the positioning of the jig assembly in the vise or even find a small piece of wood that can be placed below the jig assembly while still allowing the vise to have a firm grip on all components. Once you are certain it is safe to drill through the bottom of the receiver, spray a liberal amount of cooling fluid in the two trigger slot holes, line up the drill bit, and drill the first hole, slowly penetrating the bottom of the receiver. Slowly back the bit out, repeat for the second hole, then shut down the drill press, and clean off and remove the bit.

You can now remove the insert plate and use the shop vac and compressed air to clean out the holes. Your lower receiver should now look similar to the one in Figure 17.



Figure 18: Collet and $\frac{3}{8}$ " mill bit.

MILLING THE FIRE CONTROL POCKET

With drilling now complete and the majority of the metal in the fire control pocket removed, it is time to move on to milling. To successfully mill the lower receiver, you will need to change out the chuck and drilling arbor in your drill press for an appropriate $\frac{3}{8}$ " collet. Remove the drilling arbor, then install the $\frac{3}{8}$ " collet and the $\frac{3}{8}$ " end mill (Figure 18).

Remove the four screws for the drilling plate and install the milling plate using the same four screws. Again note the plate can only fit one way.

Milling the fire control pocket is a time-intensive process that requires a great deal of patience. It is very important that you complete this process slowly, as rushing it at all can result in snapped end mills, damage to the insert plate, or bad cuts in your lower receiver (Figure 19).

Use the x/y-axis adjustments on the milling vise to move the milling bit into place. You will want to begin your milling away from the edge of the insert plate to develop facility with the milling process and verify that your end mill is behaving properly while minimizing the likelihood of cutting into your index plate and potentially ruining your lower receiver. An opening in the corner closest to you and to your left is a good place to start. As before, verify that everything is snug and apply cutting fluid to the end mill and opening in the receiver plate.

You will be inserting the $\frac{3}{8}$ " end mill into the partially completed receiver. First, verify you are aligned with an existing opening by lowering the end mill into the opening. If you are not aligned, adjust accordingly. Turn on the press, and slowly lower the end mill into the lower receiver. Work slowly as you meet resistance and cut into the aluminum. Then, once you have reached the lowest point of your cut (.630"), slowly turn the handle for the y-axis adjustment to move the mill clockwise into the material. All milling will be clockwise and it is important that you "walk" the milling bit extremely slowly, backing off if you experience excess chatter or a change in noise, adding



Figure 19: Snapped mill bits are more likely to occur if you rush through the process.

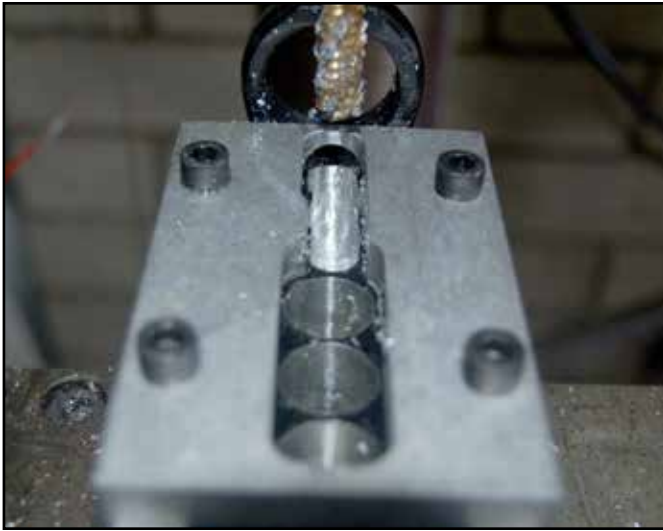


Figure 20: Remember to always mill clockwise and work extremely slowly.

cutting fluid frequently, and taking breaks occasionally to verify everything is still snug and depth is still correctly set.

Pay particular attention as you approach the edge of the milling plate. When you've cut as far as you can along the y-axis, you can either reposition the end mill for your next pass, or slowly work your way along the x-axis until you reach a point where you can return along the y-axis. Remember to always mill clockwise and work extremely slowly, keeping the bit well lubricated and cooled with cutting fluid and taking breaks as necessary. Work toward the middle, then go back to clean the edges along the milling plate, taking particular care as you work near the plate. Take small bites in multiple passes and be particularly cautious in the area where the opening narrows, noting the place where the guide juts into the opening (Figure 20).



Figure 21: The milling plate allows you to continue to mill the deeper section of the fire control pocket.

Once you have completely milled out and smoothed the edges of the fire control pocket at a depth of .630", it is time to remove the plate, clear any remaining aluminum shavings, and install the trigger plate (Figure 23). Also note that in the area that is cut to its final depth, the dimples caused during drilling have been milled flush.



Figure 22: It's a good idea to recheck your measurements prior to starting with a new plate.

Again verify that everything is tight, then set the milling depth to 1.25" with the stop collar. Repeat the prior milling process at this depth to complete the milling of the fire control pocket. Start away from the edge as you did previously, working slowly in a clockwise direction with plenty of cooling fluid. When you have finished smoothing the fire control pocket, remove the insert plate, clear any remaining aluminum shavings, then change out the $\frac{3}{8}$ " end mill for a $\frac{5}{16}$ " end mill. Set your milling depth to just penetrate the bottom of the receiver, again taking necessary precautions to make certain you won't mill into the milling vise.

Use the x/y-axis adjustment on your milling vise to align the $\frac{5}{16}$ " end mill to enter the slot in the insert plate. Start up the drill press, slowly lowering the mill and adjusting as necessary to avoid making contact with the insert plate (Figure 24). Slowly lower the mill down into the pilot hole closest to you, then use the y-axis adjustment to slowly walk the end mill

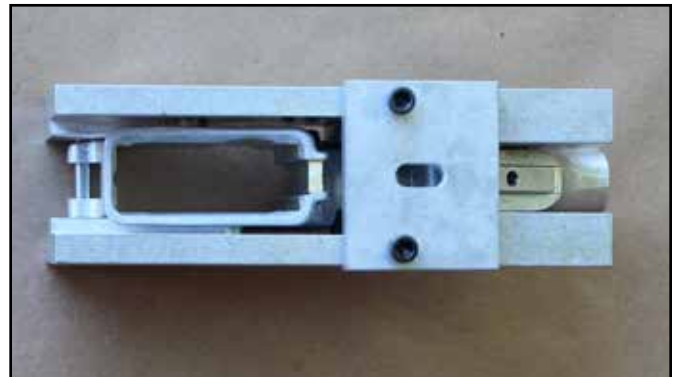


Figure 23: Third plate for drilling trigger slot.



Figure 24: Slowly lower mill to avoid making contact with the insert plate.

away from you, connecting the two pilot holes and boring them out to a full $\frac{5}{16}$ ". Take special care to not cut into the insert plate, as you are working with particularly tight tolerances here. When done, slowly back the end mill out of the opening and turn off the drill press. Remove the trigger plate and clean any remaining aluminum shavings out of the fire control pocket.

The finished fire control pocket should look similar to Figures 25 and 26. Dimples are gone and the sides and floor of the



Figure 25: Finished fire control pocket.

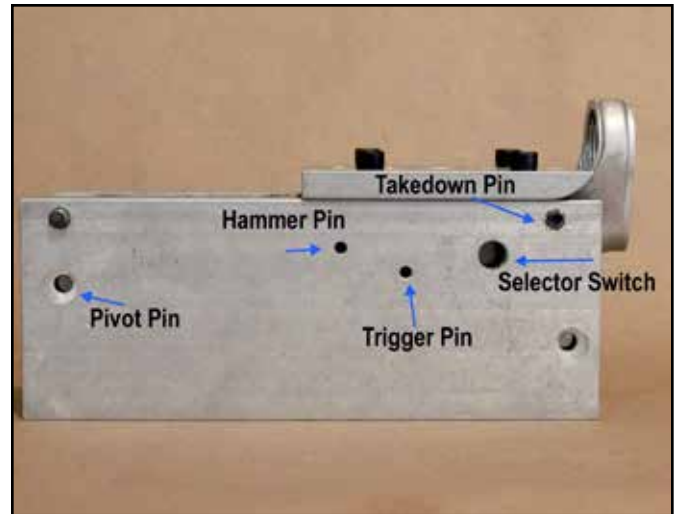


Figure 27: Labels for selector, trigger pin, and hammer pin holes.

pocket are smooth and shiny. There should also be an opening all the way through the receiver for the trigger slot.

Note that the hole in the left bottom is the existing lower grip screw hole, not a miss-drill.

You can now use a file to remove any rough edges from the trigger slot, or wait until after you have drilled the selector, trigger pin, and hammer pin holes and removed the jig before performing this task.



Figure 26: Bottom view of finished fire control pocket.



Figure 28: Receiver with milling and drilling completed.



Figure 29: Back side of receiver with milling and drilling completed.

DRILLING THE SELECTOR, TRIGGER PIN, AND HAMMER PIN HOLES

To drill the selector, trigger pin, and hammer pin holes, you must first remove the jig assembly from the milling vise, change the collet and end mill back to the arbor and chuck, and insert and tighten the $\frac{3}{8}$ " drill bit. Next, you need to secure the jig assembly in the milling vise with one of the sideplates facing the drill bit. Drilling these holes will be easier at this point in the process because the fire control pocket is now open. Using the $\frac{3}{8}$ " guide hole in the jig sideplate and the drilling techniques established earlier, drill through the top side of the receiver into the fire control pocket (Figure 27).

Change the drill bit out for the $\frac{5}{32}$ " drill bit, then use the same process to drill the trigger pin and hammer pin holes, using the guide holes in the jig sideplate and drilling into the fire control pocket. Next, remove the jig assembly from the milling vise, rotate it 180°, then reinstall it in the milling vise.

Use the $\frac{5}{32}$ " drill bit to drill the trigger pin and hammer pin holes on the other side of the receiver, then change the bit out for the $\frac{3}{8}$ " bit and drill the selector hole in this side of the receiver.

You are now done with drilling and milling your 80% lower receiver and it is now a 100% lower receiver. Gently remove the lower receiver from the jig, clean and pack up the jig components for a future project, then clean your lower receiver which should now look like Figures 28 and 29.

The following video link may be helpful in completing the drilling and milling process.

<https://vimeo.com/sdigunsmithing/videos>



Figure 30: Lower parts kit *SHOULD* contain these parts. Check your kit carefully to assure you have all the parts before beginning.

Installing the Lower Parts Kit

Lower parts kits (LPKs) for AR-15 lower receivers can be purchased from a broad range of vendors. Prices vary and can start as low as \$65. When selecting a kit, be certain that it contains all of the necessary parts as shown in Figure 30.

When unpacking your parts, be sure to set up a clean work area with some means of holding and organizing the parts. Many of the parts are very small and can easily be lost or nest into a groove on another part. Before beginning your build, verify that all parts are accounted for and appear to be undamaged. Also, be aware that you will be working with small parts and springs, making it all but inevitable that you will launch a spring across the room, or drop and have to search for a detent at some point during the installation process.

There are many ways to assemble your lower receiver. The following steps represent one method utilizing a minimum of specialized tools. If you plan to assemble more than one lower receiver, you will eventually develop a methodology that works best for you.

One very specialized tool that you will need is an M4 stock wrench. This wrench is designed to tighten the castle nut without damaging the nut, threads, or buffer tube and is shown in Figure 31 below.

The following are other tools you need for installing the LPK:

- Needle-nose pliers
- Roll pin insertion tool (optional)
- Long-shank screwdriver(s) for the lower pistol grip
- Brass/polymer gunsmithing hammer
- A multi-tool (Leatherman, Gerber, SOG, etc.)
- Masking tape to protect the finish of receiver when tapping pins, etc.



Figure 31: M4 Stock wrench.

INSTALLING THE MAGAZINE CATCH AND CATCH BUTTON

Find the magazine catch, button, and spring. The spring will go over the magazine catch shank. The catch fits into the magazine catch channel as shown in Figures 32 and 33.

Start the magazine catch button onto the threaded end of the magazine catch shank where it protrudes from the side of the receiver opposite the one where you inserted the catch. Once you have a few turns of the shank into the button, push the button into the receiver as far as you can press (spring pressure will make this difficult). This will allow you to spin/screw the magazine catch into the button.



Figure 32: Magazine catch button.

Remember, push the button in as far as you can — and be careful not to scratch the side of your receiver with the catch. Keep turning until the end of the catch shank is almost flush with the top of the button. You will have just enough clearance to do this. Once you have it screwed in, the catch and button should be seated nicely into their respective niche.



Figure 33: Magazine catch installation.



Figure 34: Bolt catch roll pin.

INSTALLING THE BOLT CATCH ASSEMBLY

Find the bolt catch roll pin. Because there is some risk that you might scratch the surface of your receiver by a misplaced stroke of your hammer, you should place a small amount of masking tape on the receiver around the area where you will be tapping in the pin. Now, start the bolt catch roll pin into the catch mount as shown in Figure 34.

Next, insert the bolt catch spring and buffer into the hole just below the mount. *Put the spring in first, with the buffer facing out.* Push the bolt catch into its slot (there is only one way to install this part). You will notice some spring tension as you push this part into place. Align the roll pin with the hole in the bolt catch/release and gently tap the pin in place with the polymer side of the gunsmithing hammer. Be careful not to tap too hard, as the roll pin might slip out or be damaged. Once the pin is positioned, a few taps will put the pin in place.

INSTALLING THE PIVOT PIN, SPRING, AND DETENT

This installation has the greatest risk of launching and potentially losing the detent and spring. Now, insert the pivot pin spring into the detent hole. Place the small detent onto the spring and push it in as far as it will go. You will start to feel spring pressure immediately. Note that the pivot pin has



Figure 35: Installed detent, spring, and pin.

a groove and indentations for the detent milled into its shank. Also, the head of this pin is milled flat on one side.

The pivot pin is inserted with the flat part of the pin head facing the detent. A thin, flat, rigid metal tool will work for pushing the spring and detent into the detent hole and holding them there while starting the insertion of the pivot pin. You may be able to use one of the tools in your multi-tool. Figure 35 shows the installed detent, spring, and pin.

INSTALLING THE TRIGGER GUARD

This part of the installation is pretty straightforward. The trigger guard has a spring-loaded detent that will fit into the magazine side of the receiver as shown in Figure 36.



Figure 36: Trigger guard.

Next, find the trigger guard roll pin, align the openings on each end of the trigger guard with mounting holes on the receiver, then tap the roll pin into one of the two holes at the ends of the trigger guard. Be gentle when tapping in the roll pin, taking care to support the trigger guard, so you do not bend or break one of the ends. Verify the alignment of the holes on the other end of the trigger guard, then repeat the previous procedure to complete your installation as shown in Figure 37. *(If the pin will not fit, do not force it, as the pin or holes may be out of specification.)*



Figure 37: Trigger guard installed.

INSTALLING THE TRIGGER/HAMMER ASSEMBLY

Depending on your parts kit, your trigger, trigger spring, disconnecter, disconnecter spring, hammer, and hammer spring may have already come assembled. If they did not, you can use Figure 38 as a guide for assembly.



Figure 38: Trigger and hammer assembly.

Insert the trigger assembly (verify that the disconnecter spring is installed and properly oriented - with the large end of the spring oriented down and touching the trigger) and the disconnecter into the trigger slot of the receiver as shown in Figure 39.

The trigger spring's "arms" will rest on the bottom of the fire control pocket, facing toward the magazine. Insert the hammer/trigger pin (hammer and trigger pins are interchangeable in semi-automatic AR-15s) into the trigger pin hole, pushing down on the trigger assembly (spring pressure will make this difficult) to align the holes. The trigger pin can then be pushed into place. Take care not to force it.

The hammer spring's "arms" will now be set to rest on the trigger pin and "in" the trigger pin groove as shown in Figure 41.



Figure 39A: Shown is the disconnecter spring in place. Photo courtesy of creampuff.

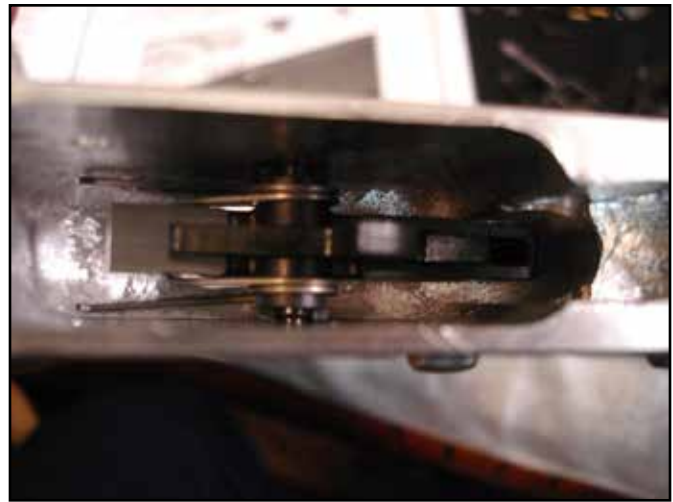


Figure 39: Trigger assembly and disconnecter placed into slot of receiver.



Figure 40: Trigger pin.

The hammer spring will be under some tension. As you press the hammer group with the disconnecter into the fire control pocket, align the holes, and insert the hammer pin. Remember, you are aligning the holes for the hammer and the disconnecter — all holes must align. The pin should insert with light force. If it does not, do not force it. Check alignment and try again.

Once the hammer assembly is installed, cock the hammer back. **Do not release the hammer!** Doing so may cause damage to the hammer, bolt catch, or fire control pocket wall.



Figure 41: Hammer assembly installed.



Figure 42: Safety selector switch has 3 parts.

INSTALLING THE SAFETY SELECTOR SWITCH

The safety selector switch is comprised of three parts: spring, selector detent, and switch, as shown in Figure 42. If your detent does not look like the one in Figure 42, do not install it, as it will not allow you to switch/turn the selector switch. It is possible that you incorrectly installed it in place of another detent.

The detent and spring are installed into the detent spring hole under the pistol grip. The detent is inserted first into the detent hole — point first. The spring will have a tendency to pinch if you are not careful. Slip the pistol grip over the tang of the receiver, then ease the spring into the spring hole in the pistol grip. Slide the pistol grip flush on the tang and tighten the grip screw and lock washer inside the grip as shown in Figure 43.



Figure 43: Selector spring installation.



Figure 44: Buffer stop pin and spring.

INSTALLING THE BUFFER RETAINER AND REAR TAKEDOWN PIN

This portion of the installation will be much easier if you secure the lower receiver in some way. A lower receiver vise block is a good option for this. Regardless of the option you choose, be certain the receiver is securely held and will not be crushed in any way. The detent and spring will be held in place by the stock plate. Place the castle nut and stock plate in place over the threaded end of the buffer tube, then slowly thread the buffer tube onto the receiver. Continue threading the buffer tube onto the receiver. Stop just before the threaded end of the buffer tube covers any portion of the buffer retainer hole. Insert the buffer retainer and spring as shown in Figure 44.

Holding the buffer retainer down in the hole with your index finger, continue to thread the buffer tube onto the receiver until it holds the buffer retainer in place. Ensure that the buffer tube does not bind on the center pin of the buffer retainer.

Place the takedown pin halfway into its hole, with the groove in the pin facing toward the buffer tube. Place the takedown pin detent into the hole in the back of the receiver, followed by the spring. Press the buffer tube plate into place, taking care to be certain that the plate lines up with the indentation on the receiver and does not bend the spring. Hand tighten the castle nut until it holds the plate in place and prevents the spring from slipping out. Once the castle nut is hand-tight, use the M4 stock wrench to further tighten the nut. Tighten it and slightly back off a few times to make certain you are



Figure 45: Castle nut installation.

not binding on the threads; then tighten it to 40 ft/lbs if you have access to a torque wrench. If not, just make certain it is solidly secure. The preferred method to secure the castle nut to prevent it from loosening is called “staking.” This consists of using a center punch topeen some of the metal on the plate into a few of the grooves in the castle nut. If this is not feasible for you, another option would be Blue Loctite®. Your lower receiver and buffer tube should now look like Figure 45.

Now, follow the manufacturer’s instructions to install the adjustable stock onto the buffer tube (this differs between stock, but is most commonly just gripping the adjustment handle tightly and inserting the stock over the buffer tube) and you have a completed lower receiver as shown in Figure 46.

The following video links may be helpful in completing the lower parts kit installation.

Part 1: www.youtube.com/watch?v=-WWZxdO2LXQ

Part 2: www.youtube.com/watch?v=dBM7rE3V7PA



Figure 46: Completed lower receiver.

Using the Rotary-Tool For Optional Fitting of Lower to Upper Receiver

(only if required)

Upon assembly of the AR-15 upper, there may be a bit of Rotary-Tool or file work that will be needed to ensure proper fit of the upper to the lower. If fitting is necessary, it will primarily be in the area of the takedown pin shelf. The AR-15 upper has a flange and hole that mate with the lower receiver takedown pin holes, the shelf, and the takedown pin.



Figure 47: Upper and lower receiver not quite mating up.



Figure 48: Another view of upper and lower receiver not quite mating up.



Figure 49: Third view of upper and lower receiver not quite mating up.

When attaching the upper to the lower, secure the upper using the pivot pin. Swing the upper to the lower and see how the flange and takedown pin shelf mate up. If the shelf is not cut completely, the flange will bind on the lower shelf cut (Figures 47 – 49).

Once you determine that some final finishing needs to be done, your easiest and safest bet is to get a Rotary-Tool kit with the sanding and grinding tools (Figure 50).



Figure 50: You can use the Rotary-Tool kit you received in a previous lab or purchase your own.



Figure 51: Chose a small sanding/grinding tip that fits into the pocket.

When determining what sanding/grinding tool to use, find the tool that fits. You cannot remove metal from the shelf pocket at the same time, so the tool **must** fit in the pocket, which will allow you to take small amounts of metal from the pocket (Figures 51 and 52).

Once you have found the tool that fits the pocket, install it into your Rotary-Tool and start taking metal from the takedown pin shelf walls. Go slowly, as you do not want to take out too much or sand out your takedown detent and spring channel — you are dealing with hundredths of an inch. Too much can ruin your project!

Keep fitting your upper to the lower, seeing how much more needs to be sanded out of the shelf area.



Figure 52: Be sure to choose the correct tool to fit IN the pocket.



Figure 53: Check the fit of the upper and lower receivers to determine how much more is necessary to sand or grind.

Continue sanding out more metal and fitting the upper until the upper and lower mate precisely (Figure 54).

Keep fitting the upper to the lower until the upper seats firmly and the flange and lower receiver takedown pin holes line up precisely.

Insert the takedown pin to ensure proper alignment (Figure 54).

Once you have verified the proper fit of your lower receiver to your upper receiver, you are ready to begin installing or re-installing your lower parts kit.

You can complete your AR-15 by installing the lower parts kit and completing upper build as described in Lesson 2220.



Figure 54: Insert takedown pin to ensure proper alignment.

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ACKNOWLEDGEMENT OF THE RISK: I fully recognize that there are dangers and risks to which I and others may be exposed to arising out of the handling and repair of firearms as part of the course of instruction provided by Trade Training Company, LLC dba Sonoran Desert Institute. The following is a description and examples of specific, significant, non-obvious dangers and risks associated with this activity: inadvertent discharge, unauthorized use of firearms, and improper repair. **RELEASE AND WAIVER OF LIABILITY:** I, on behalf of myself, my personal representatives, heirs, executors, administrators, agents, and assigns, **HEREBY RELEASE, WAIVE, DISCHARGE, AND COVENANT NOT TO SUE** the Trade Training Company, LLC dba Sonoran Desert Institute, including its governing board, directors, officers, employees, agents, volunteers, and any students, hereinafter referred to as "Releasees" for any and all liability, including any and all claims, demands, causes of action (known or unknown), suits, or judgments of any and every kind (including attorneys' fees), arising from any injury, property damage or death that I may suffer as a result of my participating and/or receiving instruction from Trade Training Company, LLC dba Sonoran Desert Institute and the handling and repair of firearms as part of such instruction **REGARDLESS OF WHETHER THE INJURY, DAMAGE OR DEATH IS CAUSED BY THE RELEASEES.** I further agree that the Releasees are not in any way responsible for any injury or damage that I sustain as a result of my own negligent acts. **INDEMNITY:** I, on behalf of myself, my personal representatives, heirs, executors, administrators, agents, and assigns, agree to hold harmless, defend and indemnify the Releasees from any and all liability, including any and all claims, demands, causes of action (known or unknown), suits, or judgments of any and every kind (including attorneys' fees), arising from any injury, property damage or death that I or any third party may suffer as a result of my participating and/or receiving instruction from Trade Training Company, LLC dba Sonoran Desert Institute and the handling and repair of firearms as part of such instruction, **REGARDLESS OF WHETHER THE INJURY, DAMAGE OR DEATH IS CAUSED BY THE RELEASEES OR OTHERWISE.**