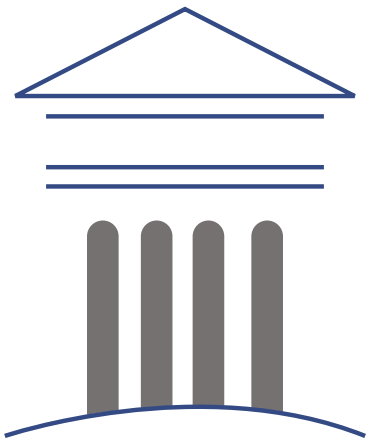
Design and Layout
Lesson: 2186

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Objectives

After completing this lesson, you should

1. Know the different measurements of a custom stock.
2. Understand why these measurements are important.
3. Know the difference between the various types of drawing that you might encounter as a gunsmith.
3. Be familiar with the different types of lines on the drawings an what they mean.

Introduction

A *rifle stock*, in the most basic terms, is an attachment, usually constructed of wood, which provides a comfortable means of holding the barrel, receiver, and action. If installed correctly, a properly designed stock will help absorb recoil. It will also provide shooting accuracy if properly bedded.

A gunstock should exhibit a pleasing blend of wood and metal, achieved by flowing and tapered lines. The gunstock must also conform to certain basic principles to provide strength, comfort, and ease of handling for the shooter. When a stock possesses all these qualities, it can be considered a work of art.

Comfortable fit and attractive design are important to the gunmaker who desires the best. The gunstocker must first know what the customer wants, and then be able to visualize the finished stock — with perfect fit, beauty, and symmetry — in the rough wood blank. The experienced gunstocker knows that such a stock lies beneath the surface of the rough wood, and merely removes the excess wood to highlight its beauty.

Choosing the shape and style of a gunstock is a matter of personal taste. Some shooters tend to stick to classic lines, while others want the ultramodern, laminated, fiberglass, or thumbhole stocks.

This lesson is designed to teach you all the necessary stocking terms and types of stocks, as well as how to choose a shape and style of gunstock to suit anyone's need or fancy.

Wood for Gunstocks

Most of the early firearms used in the United States had stocks with a steep drop at the heel. This design permitted shooters to hold their heads erect and their eyes on the target while bringing the barrel into the proper aiming position. This trend in stock design carried over into the twentieth century on some arms — especially single-shot and side-by-side double shotguns. This type of stock design worked fine with the light-recoil charges of the time, but if you fire a modern, high-velocity shot in one of these firearms, the recoil is so severe that not even seasoned shooters can take the pounding of the stock against cheek and shoulder.

As shoulder arms became more powerful — and consequently produced more recoil — the design of the stock had to be changed to offer more comfort to the shooter. It was quickly discovered that, in most cases, the straighter the stock, the less obvious the recoil. Therefore, modern rifles and shotguns normally have much straighter stocks than the sporting arms of the last century. Drop at heel is only one of the many factors governing stock fit, recoil, and accuracy. Drop at comb, trigger pull length, pitch, metal-to-wood fit, and length of the foreend all enter into the picture. Since all of these factors are extremely important, let us discuss each one briefly to obtain a better understanding of each.

Drop at Heel. This is the measurement of the slope (drop) of the top of the buttstock (at heel) from the line of sight, as shown in Figure l. Some drop is necessary to bring the sight to eye level.

Drop at Comb. This measurement is similar to drop at heel, except the measurement is taken at the top of the comb from the line of sight, as shown in Figure 2.

Pitch. Pitch is established by the angle at which the butt is cut and is determined by measuring the angle from the heel of the comb to the toe of the stock, as shown in Figure 3. One simple method of measuring pitch is to set the gun butt on the floor with the top of the receiver touching the wall. Pitch is the distance between the muzzle and the wall; it is expressed in the United States as inches.

Length of Trigger Pull. Trigger pull is the distance from the trigger to the butt of the stock, as shown by measurement D in Figure 4. The pull on most American firearms is about 14", which is about right for the average male. However, tall people (more than 6' high) will usually require a longer pull, while most women and youths will require a shorter pull. A gun with proper trigger pull for the shooter is a gun that comes up to the shoulder easily and fits solidly against the shoulder, without getting caught in the armpit or on clothing, while allowing the finger to hook easily around the trigger.

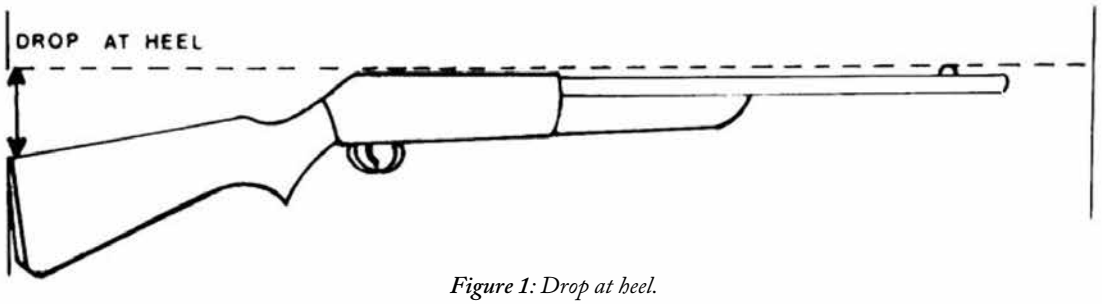


Figure 1: Drop at heel.

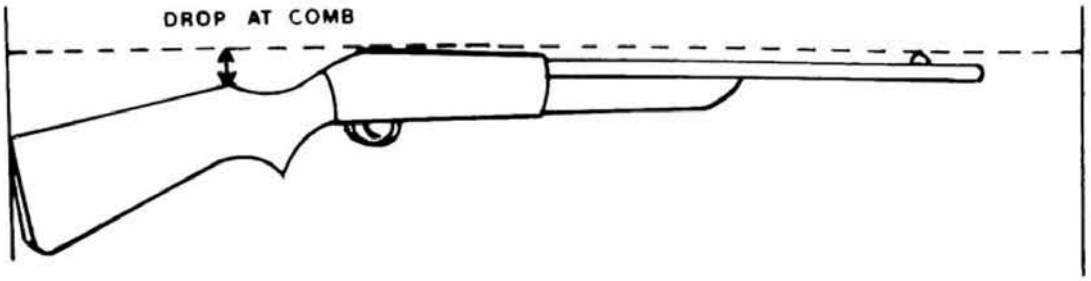


Figure 2: Drop at comb.

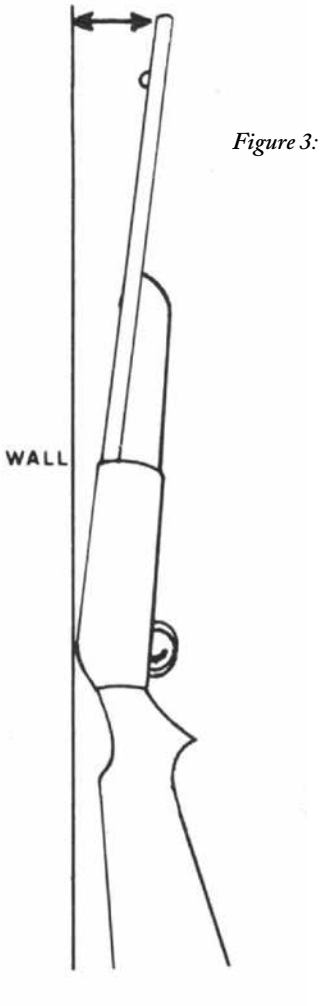


Figure 3: Method of determining pitch

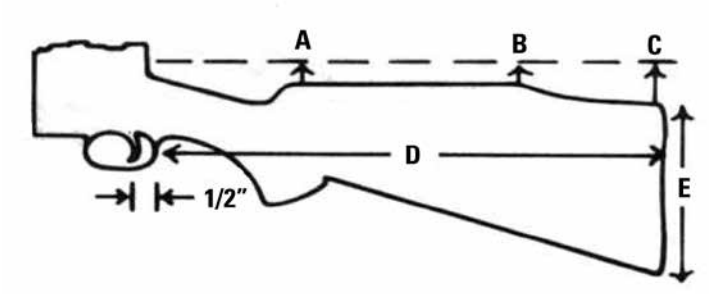


Figure 4: Length of pull. Amount of drop: (A) point of comb, (B) Monte Carlo, (C) heel, (D) length of pull plus $^{1}/_{2}$", and (E) depth of butt.

Cast-off and Cast-on. These two terms refer, respectively, to the butt of the stock being offset to the right and to the left of the sighting plane down the barrel. Figure 5 shows a plain stock where the center of the stock is in line with the sight line. Figure 6 illustrates cast-off (A) and cast-on (B). In theory, cast-off positions the buttstock to the right of the sighting plane, enabling better aim for the right-handed shooter. Cast-on accomplishes the same advantage for the left-handed shooter. Most offhand shooters (those who shoot without a prop or stabilizer for the gun) will do best with a stock having about $^{3}/_{16}$" cast-off at the heel and about $^{5}/_{32}$" at the toe. This is equivalent to moving the front sight nearly an inch to the right on most rifles and twisting the butt slightly to conform better to the curve of the shoulder. With a stock correctly cheeked for a quick shot, the eye usually tends to look a bit to the right of the centerline. Cast-off compensates for this.

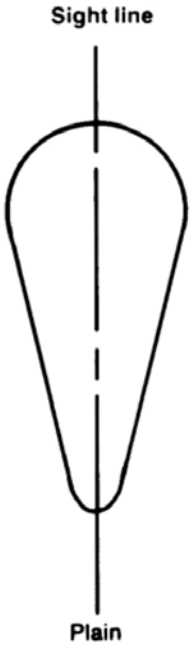


Figure 5: Plain stock with no cast-off or cast-on.

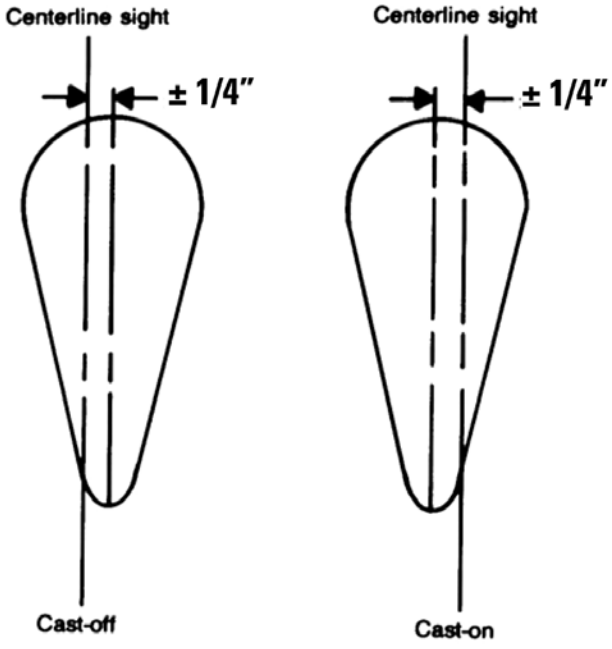


Figure 6: (A) Cast-off and (B) cast-on.



Figure 7: Brownells Pull and Drop gauge.

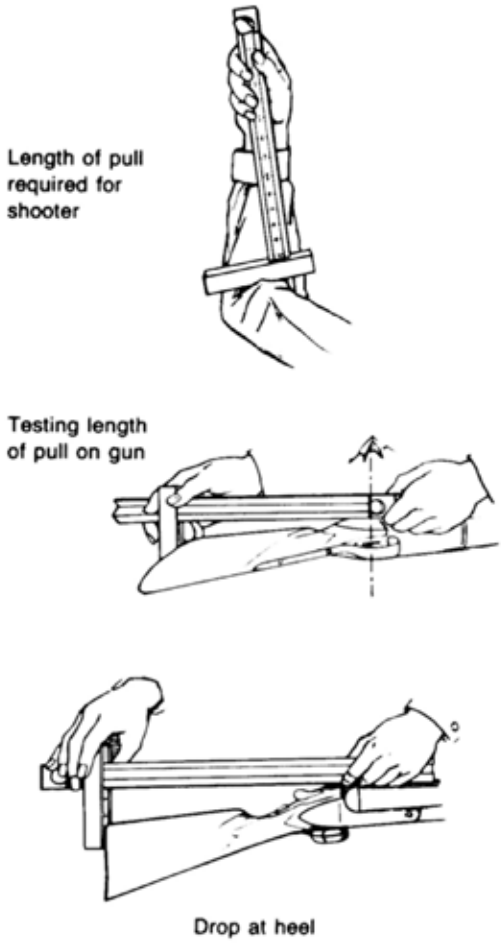


Figure 8: Steps in using the Brownells Pull and Drop gauge.

Grips. Except for exotic stock designs, the types of grips may be divided into three classes: the straight grip, semi-pistol grip, and pistol grip. Grips are classified by the way the grip area is curved. If the stock is straight from the trigger guard to the toe of the stock, it is called a straight stock. A stock with a slight curve is considered to have a semi-pistol grip. A stock with a steep curve has a full pistol grip.

Fore-ends. Moving from the butt towards the muzzle, we find the fore-end. This may be an area on a one-piece stock where the off hand (the one not pulling the trigger) grasps the stock, or it may be a separate piece of wood designed for the same purpose, as in two-piece stocks for lever-and slide-action rifles and almost all shotguns.

There are really no hard and fast rules for fitting a gunstock to the shooter, because each individual is different in stature and/or shooting style. Consequently, proper measurements will vary for each person. In many cases, only a slight modification of one or more of the above factors will improve a shooter's ability. In fitting an individual to a gunstock, the gunsmith should use a certain procedure; the following sequence is the generally accepted:

- Check trigger pull
- Check pitch
- Check comb height
- Check drop

One tool that will simplify measuring most required gunstock dimensions is the Brownells Pull and Drop Gauge, shown in Figure 7. This gauge will enable you to accurately, easily, and quickly measure the pull and drop of any gunstock. These steps are shown in Figure 8.



***Figure 9**: An adjustable try-stock is designed to perfectly fit a gunstock to a shooter. This type of gunstock is available from Fajen, Inc.*

TRY-STOCKS

Most professional gunstockers use a "try-stock" to fit customers to a gunstock that suits them the best (Figure 9). With such a stock, the comb height or length of pull can be set, then tried in actual shooting, and adjustments can be made until the stock fits exactly. Dimensions can then be specified for a stock to be built for the shooter.

In general, a try-stock is designed so that the length of pull, drop at comb, drop at heel, and angle of recoil pad can be set and precisely adjusted so that the gun can automatically be lined up with the shooter's vision and can be fired in comfort.

First, set the length of trigger pull. This can be done in ¼" stages. Pull should be long enough that recoil does not jam the shooter's nose into the thumb of the trigger hand, but the pull must be short enough that the gun can be smoothly and comfortably put into shooting position. Be sure the Allen set screws are located firmly in the ¼" spaced holes in the two steel extension rods. This locks the length of pull in place during recoil.

Adjust the comb up or down so that the shooter sees the desired sight bead picture. The try-stock's comb can also be adjusted from side to side to simulate a thick or thin comb so that the line of sight coincides laterally with the front and rear sight, or the center of a telescope sight.

With the gun in the shooting position, determine the drop at heel. Locate the recoil pad up or down so that the hard heel or the top of the pad is just above the shooter's shoulder. This locates the central soft part of the pad against the shoulder, where the recoil is taken. If the hard heel is below the top of the shoulder, it will transfer the recoil thrust, perhaps painfully, to the shoulder rather than the soft part of the pad. If the drop at heel is too high, then the pointed toe of the butt pad or plate will transfer the recoil thrust to the body. If you have a full chest, you may need to angle the toe (only) of the pad as much as an inch away from the fullness to prevent the hard toe from digging into the chest. This cast of toe also might be needed to facilitate automatic placing and to hold the gun in a vertical shooting position. Casting only the toe to fit the natural hollow between the shoulder and the chest also eliminates the need for other than 0 to 1" pitch down.

Most try-stocks also have an adjustable trigger hand locator, which permits locating the trigger finger automatically and uniformly in the same position for each shot. The various dimensions can be refined and adjusted as called for depending on the type of clothing the shooter is wearing, the type of shooting being done, etc.

The best stock is one that conforms exactly to the shooter's body and preferences. This is one of the advantages of custom-made gunstocks: you get a stock exactly as you want it, not as the manufacturer dictates.

If a try-stock is not available, you may want to try out a number of rifles or shotguns with varying sizes and shapes of stocks until you find one that seems to fit right and that points easily and naturally, aligning the sights exactly on the target without any adjustment. However, this method can be impractical, because a wide variety of different stocks might not be readily available. The following dimensions usually suit the average person of average build:

- Length, as measured from middle of trigger to middle of buttplate: 13½"
- Drop at comb from line of sight: $1^{7}/_{8}$"
- Drop at heel from line of sight: $3^{1}/_{8}$"

Of course, these dimensions will have to be altered for each person, depending on his or her build, particularly for stout or thin people and for people with longer-or shorter-than-average necks or arms. These dimensions are more suited to offhand shooting. For target rifles, which are used for prone shooting, the above dimensions should be changed as follows:

- Length, as measured from middle of trigger to middle of buttplate: 13¼"
- Drop at comb from line of sight: 1¾"
- Drop at heel from line of sight: 2½"

A person with a long neck requires a greater drop at heel; some people require as much as 4" at the heel, but usually not any more than this. People of short stature and with short arms require shorter stocks, but almost never less than 13 inches. Stout people also require shorter stocks.

However, stature has little affect on the drop at the comb. This measurement depends largely on the conformation of the cheek and cheekbone. People with lean faces require thicker combs than those with full faces. If shooters have high cheekbones, they should experiment a little with a rough stock to find the correct shape and height to give support and lead the eye quickly and surely into the line of sight, yet not hit the cheekbone every time the rifle recoils.

A drop at comb of 1¾" to $1^{7}/_{8}$" should be about right for all types of stocks for the average person using metallic sights. Since most modern rifles use telescopic sights, modern stocks usually have a higher comb to compensate for the higher sight line. Many also utilize a cheekpiece. This type of stock has become known as the Monte Carlo design.

Most of the better stockmakers require exact dimensions when building a gun for an individual. If the shooter cannot be measured on the premises, a form is normally mailed out for the shooter to fill in the required information. If these measurements are correctly supplied, the experienced gunstocker will almost always supply a finished stock that fits the shooter exactly. Such a stock not only pleases the shooter, but also gives good publicity to the gunsmith.

SELF-TEST QUESTIONS

Please check your answers on page 17.

1. ***True or False*. A right-handed shooter normally requires a stock with cast-on for proper sighting.**
2. **What is the proper drop at comb from line of sight for the average shooter?**
3. **What is the average length of pull for the average shooter?**
4. **What is the name given to the adjustable stock from which dimensions are taken to build a custom stock?**
5. **What is the name given to the type of stock that utilizes a higher comb for use with telescopic sights?**
6. ***True or False*. In general, the greater the drop at heel, the greater the recoil felt.**
7. **Name the three basic types of stock grips.**
8. **When measuring a shooter for a custom stock, what are the four main areas to cover?**

Gunstock Design Considerations

The problem of fit should be considered foremost when designing a stock for an individual, In most cases— especially in hunting rifles and shotguns— aiming must become an almost unconscious act, and this cannot be done unless the stock fits the shooter almost perfectly. When a stockmaker takes a client to the range and has him or her shoot with a gun equipped with a try-stock, the professional will know that if the shooter shoots high, either the stock is too straight or else the comb is too high. If shooting low is the case, the stock has too much drop. Shooting to the left or right signifies the need for cast-off or cast-on. Required length of pull will also be apparent to the stockmaker by observing the ease or difficulty with which the gun is shouldered.

For a hunting rifle to be used in the field, instinctive correct aiming should be the goal. Strict attention should also be paid to the proper *balance* of the gun when the stock is designed and constructed. When a gun balances well, it is not only easier to handle and carry, but it also will shoot more accurately. Balance also gives a gunstock a feel of quality, making the gun a pleasure to carry and fire.

Stock inletting is covered in a later lesson, but it is worth mentioning here also. If the stock is not fitted to the receiver perfectly, the resulting openings will be exaggerated in appearance and accuracy will be impaired. All metal parts must be in close alignment with the wood, yet allow easy removal or insertion.

To design a stock for an individual properly, you will first need the measurements discussed in the previous chapter. Then, with drawing paper, straight-edges, French curves, and templates, you will be able to start sketching your design.

The basic measuring points for both rifle and shotgunstocks are shown in Figure 10. The first measurement to consider is the trigger pull length (dimension A on the rifle stock and C on the shotgunstock). The stock should be long enough that the thumb and nose are from 1" to 1¼" apart when the rifle is in the firing position. Pitch will be somewhere in the neighborhood of 2", but this again will depend on the shooter.

The distance between the front of the comb and the tang of the receiver (dimension M on the rifle stock) is critical, because this distance determines the length of the pistol grip and the ease with which the shooter can grip the gun and reach the trigger. This distance varies from 2¾" for shooters with small hands to a little over 3" for those with large hands.

The *drop at the front of the comb* (dimension G on the rifle stock and A on the shotgunstock) is another important dimension, because the comb must be low enough to permit the bolt to clear when it is drawn fully to the rear. This, of course, applies only to bolt-action and some lever-action rifles. Rifles and shotguns with concealed actions, such as semi-automatics and slide-action repeaters, will not have this problem. However, bolt-action rifles and most lever-action rifles have projecting bolts when the action is activated. The comb should be high

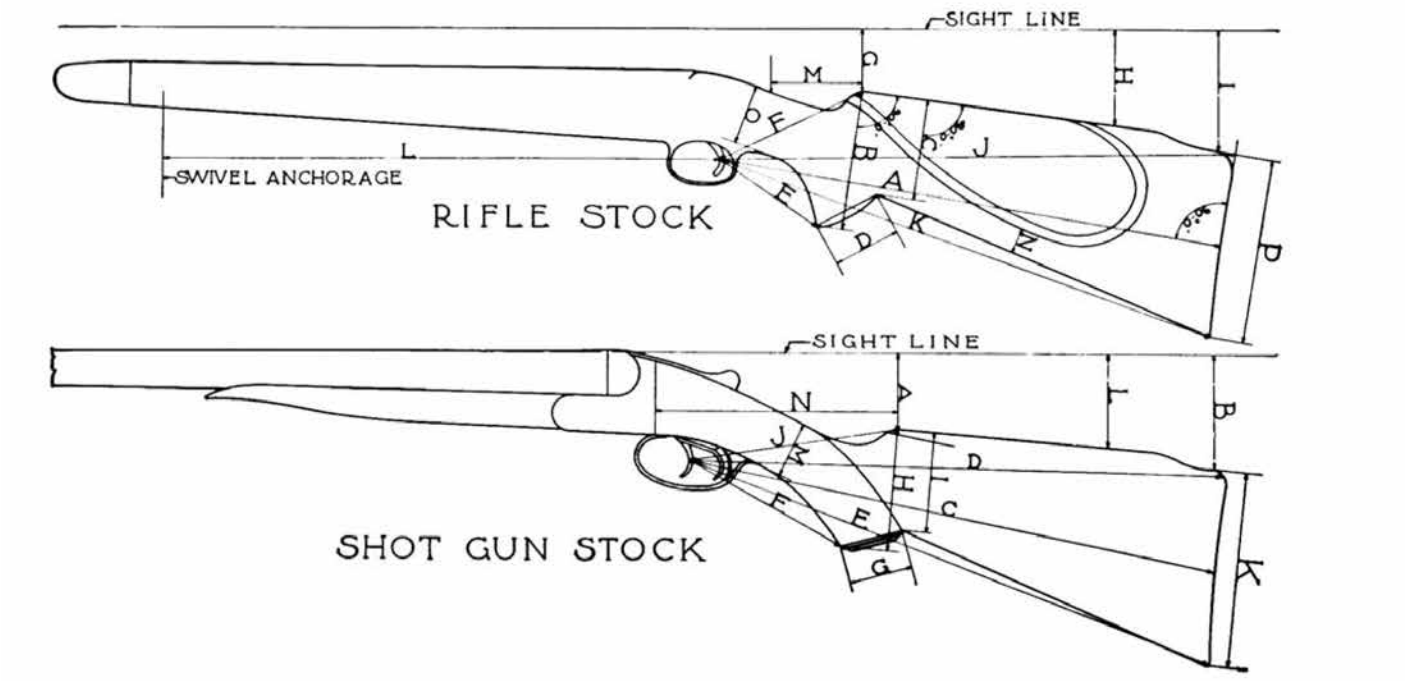


***Figure 10**: Critical measuring points for rifle and shotgun stocks. These dimensions will vary depending on the shooter's build and shooting habits.*



Figure 11: *Most professional stockmakers stick to the classic designs, except when a customer wants something special.*

enough to touch the cheek of the shooter and provide some support. Naturally, a scope sight requires a higher comb than does a rifle using only iron or open sights. A hard-kicking rifle, such as those chambered for the big-bore magnums, needs a lower comb that slopes forward and away from the cheek to prevent bruising.

Drop at heel (dimension I on the rifle stock and B on the shotgunstock) is usually slightly more than the drop at the front of the comb. The less variation between the two measurements, the straighter the stock and the less the recoil felt. Many custom rifles have been built for the .458 Winchester Magnum that had good, straight stocks that reduced the recoil to that of a conventional .30-06 cartridge. It can be done with the proper stock design.

Many seasoned shooters do not fully realize the importance of a good stock fit — or, if they do, are unfamiliar with the reasons why it is important. When a rifle is fired, vibrations occur in the barrel. If the metal-to-wood fit is not precise, these vibrations will vary from shot to shot, causing erratic accuracy. On the other hand, if a good inletting job is done on the stock, these vibrations will be kept nearly the same for each shot, maintaining the best accuracy possible when all other conditions are considered. The pressure exerted will be different on each shot if the metal parts are fitted loosely in the wood, or if these same metal parts are bound too tightly by the wood. In other words, the metal parts of a firearm should fit snugly into the wood with no gaps, yet loosely enough that they can be removed easily.



Figure 12: *Some customers will want something different, like this U.S. M-1 carbine stocked with a Mannlicher-type stock and handguard. Note the fancy carvings ansd soft, hand-rubbed linseed oil finish.*



Figure 13: *Many silhouette shooters are choosing the thumbhole-type gunstock.*

The outside of the stock is also important. The stock must fit the shooter comfortably, have appealing lines, and add to the beauty of the firearm itself. Of course, what is beautiful to one shooter may be ugly to another, so personal taste enters the picture at this point. However, in most cases, the stock outlines should be composed of straight lines, like the stock in Figure 11, or parts of a circle (arcs). Bulges and sags should be avoided if at all possible. The top line of the comb undercut and the lower lines of the cheekpiece are usually cut parallel with the bottom line of the buttstock. The curve of the pistol grip touches an extension of the bottom line of the buttstock. The center of the pistol grip cap is vertically in line with the nose of the comb. These are the very basic rules. At least one of them is broken almost every time a stock is built, but we must begin by considering some guidelines. Sometimes, you will be asked to build a custom stock like the ones shown in Figures 12 and 13.

STOCK LAYOUT

To begin the design of a rifle stock, first consider the purpose for which the rifle is to be used, in what caliber the rifle is chambered, and the amount of recoil the cartridge produces. The assembled barrel and receiver should be drawn on drafting paper first, taking the dimensions directly from the barreled action. If at all possible, full-size dimensions should be used. However, if this is not possible or practical, the drawing can be drawn to a smaller scale. When several stocks are to be made for the same type of action, many gunsmiths like to make brass templates for use in laying out the stock, as shown in Figure 14.

Once the assembled barrel and receiver have been measured and reproduced accurately on a drawing sheet (using a 6H or lighter lead pencil), the line of sight and then the outline of the stock around the barreled action are drawn. The stock designer either uses dimensions according to data received from the shooter or else takes the measurements directly from an existing stock. However, certain dimensions, such as length of pull, suit the stature of the person the stock is being built for. These dimensions are a practical place to start, and they can be indicated on the drawing with very light lines. Then the lines forming the outline of the stock itself can be laid out with a heavier, darker lead.

Hidden lines, such as those indicating the cutout for the magazine, should be indicated on the drawing as dotted or broken lines.

When beginning to draw the outline of the stock, the critical points should be drawn first — that is, the length of pull, drop at comb, drop at heel, etc. The pitch can then be decided upon and drawn in. You will recall that the pitch of the stock is the angle of the buttplate in relation to the line of sight. A 3½" pitch is quite common among classic style stocks.

Once the critical points have been carefully plotted on the drawing, they are then connected with straight and circular lines where possible. During this process, you will probably erase and redraw certain parts several times until they meet with your approval. The lower line of the stock is drawn straight from the end of the trigger guard rear tang to the point of the fore-end. Make this initial line light, so that it can be modified. Then, this baseline can be used to make modifications. The top line of the fore-end is drawn along the line of the bore. The lines around the cutouts in the receiver complete the outline. The cheekpiece (if any), comb undercut, buttplate, and grip cap are drawn last.

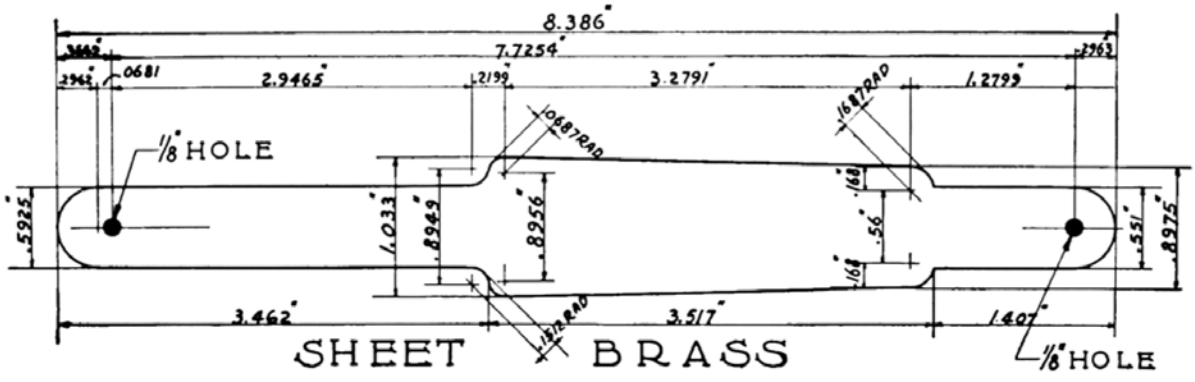


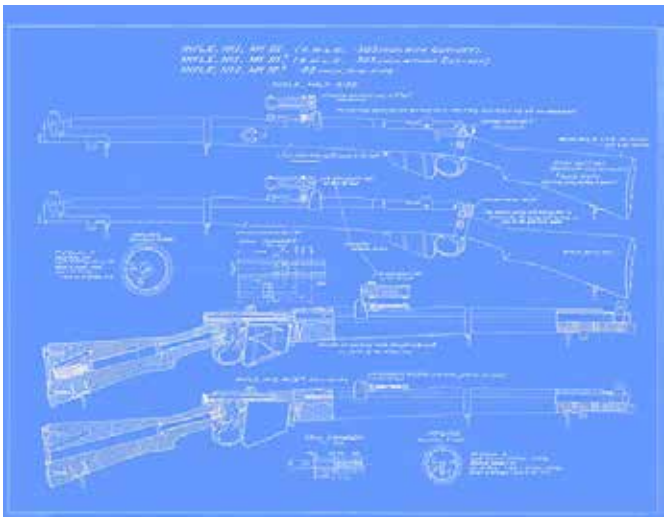
Figure 14: *Brass template made for laying out the floorplate of a Springfield bolt-action rifle on a gunstock blank.*

For best results, the gunstock layout process just described requires some drafting instruments: a T-square, a drawing board, templates, lead holders, French curves — and skill in their use. Therefore, gunsmiths must know how to read working drawings, sometimes called blueprint reading, and how to transfer measurements from a gun part to a drawing or vice versa. Therefore, the next section in this lesson will cover reading blueprints and taking measurements.

SELF-TEST QUESTIONS

Please check your answers on page 17.

9. **What is the main objective of a hunting rifle that is to be used in the field?**
10. **Name two stock faults that could cause a shooter to constantly shoot too high.**
11. **When laying out a stock design, what is usually the first measurement to be considered?**
12. **For shooters with large hands, how many inches should the distance from the front of the buttstock comb and the receiver tang on a rifle usually be?**
13. **For shooters with small hands, how many inches should the distance from the front of the buttstock comb and the receiver tang on a rifle usually be?**
14. **When you begin to draw the outline of a custom stock, should you draw the critical points first or last?**



Blueprint Reading

A *blueprint* is an exact copy or reproduction of an original drawing, consisting of lines, symbols, dimensions, and notations to convey a thought or design accurately.

A firearm drawing, therefore, is an abbreviated way to convey a large amount of exact, detailed information, which would otherwise take many pages of manuscript or hours of verbal instruction to convey.

In every branch of gunsmithing work, there is often the occasion to use a drawing of some type. In general repair work, for example, an exploded drawing of a firearm, along with an identification of each part, helps tremendously when disassembling the weapon. Furthermore, the drawing will help the gunsmith determine whether any parts are missing or broken. Finally — and probably most importantly — the drawing will help when you reassemble the gun.

When ordering parts for a certain firearm, a drawing showing all the parts in relation to each other, as well as a schedule listing the name and catalog number of each part, is invaluable.

Should the gunsmith have to make a part from scratch, with no model part available for a guide, the drawing will at least give the gunsmith some idea of how the part is shaped. Often times, an experienced worker can duplicate the part — using trial and error for fit — until a good substitute part is reproduced.

Nearly all stockmakers use patterns to shape their stocks, and the better ones will have full-size patterns for every type of action they are likely to encounter. They will have made drawings of inletting details, so that some of the work can be roughed out — probably with power tools — prior to the final, precise inletting with chisels and inletting black.

Firearms manufacturers must make working drawings for each part that goes into a firearm prior to tooling up for production. Even some Old World gunmakers, who made the highest-quality arms on an individual basis, first sketched out the design, then made calculations, modifications, and drawings of other construction details before hand-fitting each part in its appropriate position.

The ideal drawing should show in a clear, concise manner exactly what is intended to be conveyed to those who have use for it. The amount of data shown on such a drawing should be sufficient, but not overdone. This means that a complete set of working drawings used in the firearm industry could consist of only one small sheet of paper, as in the case of a section view of a trigger mechanism, to several dozen sheets, depending on the complexity of the project.

DRAWING SYMBOLS

Drawings used in the firearms industry are usually drawn full-size and show the object in its true perspective. Therefore, very few symbols are used. However, there are some that you should be familiar with, such as the ones in Figure 15.

Most designers and drafters use drawing symbols adopted by the United States of America Standards Institute (USASI). You will frequently find these symbols modified to suit a particular need. For this reason, many drawings — especially those prepared for workers in a plant — will include a symbol list, or legend, showing all the symbols used on the drawing, and their definitions.



***Figure 15**: Types of cross-hatching used on firearm drawings.*

TYPES OF DRAWINGS

Pictorial Drawings. In these drawings, an object is shown in one view only. Three-dimensional effects are simulated on the flat plane of drawing paper by drawing several faces of an object in a single view. Such drawings are used to convey information to people who are not trained in blueprint reading, or they are used to supplement the conventional *orthographic*, or flat, drawings in more complex designs.

The pictorial drawings most often found in plans used in the firearms industry include:

- Exploded views (Figure 16)
- Isometric or oblique drawings (Figure 17)
- Orthographic projection (Figure 18)
- Perspective drawings (Figure 19)

The exploded view will be found most often. This drawing shows each part used in the firearm and its relationship to the other parts. The main disadvantages of exploded view drawings are that small parts cannot be pictured clearly and that sizes are difficult to depict accurately.

Orthographic projection drawings are used more than any other type of drawing in firearm manufacturing plants. These drawings show how each part of a gun is to be constructed. Orthographic projection drawings generally give all plan views, elevation views, dimensions, and other details necessary to construct a project or object.

Diagrams. Diagrams are drawings that are intended to show components and their related connections. Such drawings are seldom drawn to scale, and usually show only the working association of the different components. Symbols are used extensively in diagrams to represent the various pieces of equipment or components. Lines are used to connect these symbols.

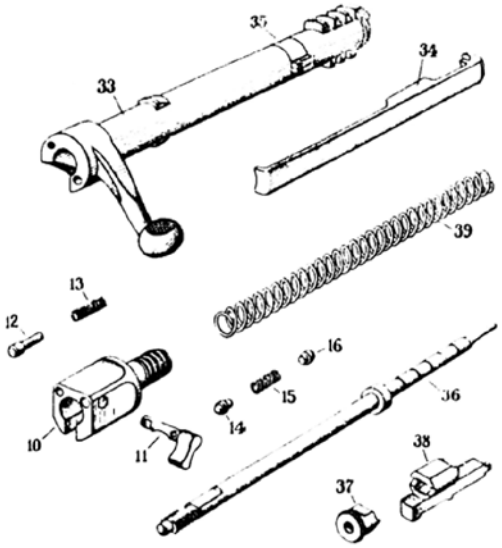


***Figure 16**: Exploded view of the components making up a bolt assembly for a bolt-action rifle. This the type of drawing that gunsmiths will encounter the most.*

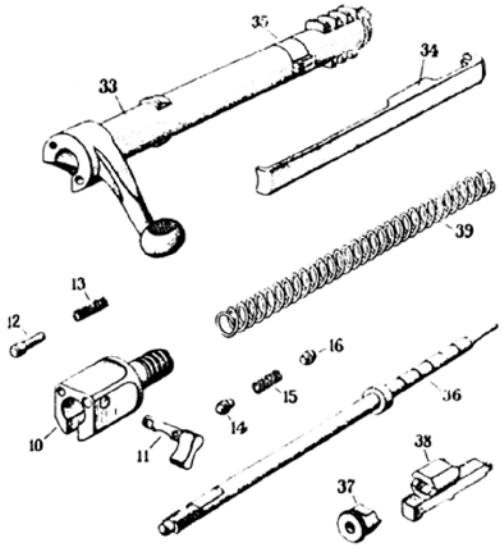


***Figure 18**: Orthographic view of a block. This view shows the shape of the block's surface.*

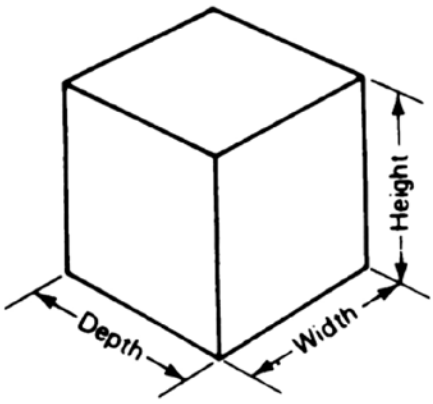


***Figure 17**: Isometric view of the block shown in Figure 18.*

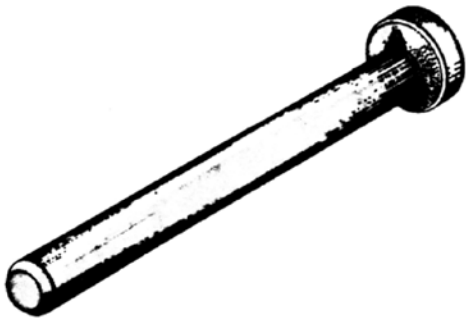


***Figure 19**: A perspective drawing of a mainspring plunger.*

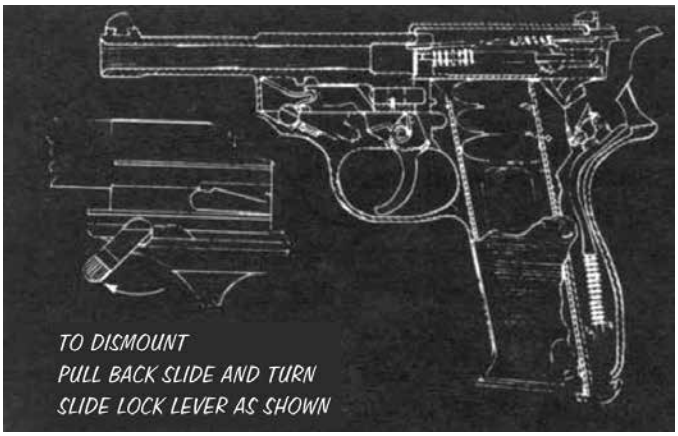


***Figure 20**: Full section of a handgun.*

Diagrams are seldom used in the firearms industry, except for wiring diagrams for power tools and other equipment.

Sectional Drawings. A *section* of an object — as applied to working drawings — is what could be seen if the object were sliced or sawed into two parts at the point from which the section was taken. For example, if you wanted to see how a golf ball was constructed, you could place the ball in a vise and cut it in half with a hacksaw. When the two parts were separated, you could easily see how the ball was constructed, or you would at least have a view of its internal construction. The point where the ball was cut is called the *cutting plane*.

You must use a considerable amount of visualization in dealing with sections. There are no given rules for determining what a section will look like.

Sectional lining, or *cross-hatching*, is used in sectional views to indicate the various construction materials. For common metal, such as the steel used in gun parts, the lining is made with fine lines, usually drawn at angles of 45°, as illustrated in Figure 15, on page 11.

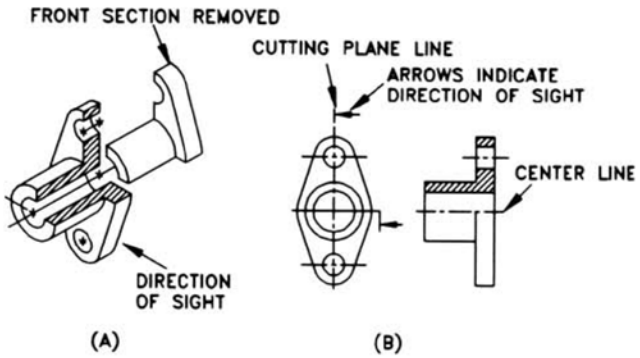


***Figure 21**: (A) Half-section view. (B) Rotated-section view.*

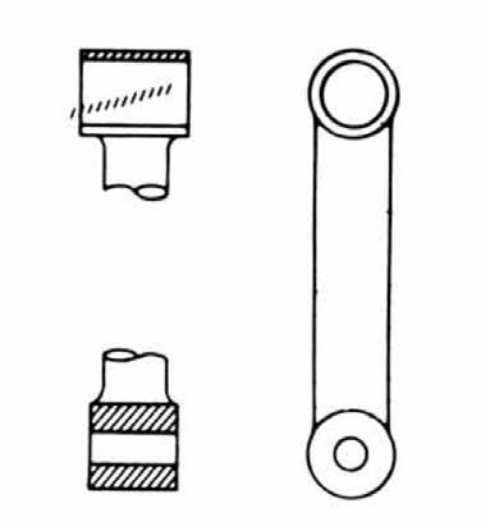


***Figure 22**: A removed section.*

Sectional views are classified as:

- *Full section*. A full section is a view in which the cutting plane is assumed to pass entirely through the object; a full section produces a view like the one in Figure 20.
- *Half section*. A half section is a view in which the cutting plane passes halfway through the object, as shown in Figure 21 (A).
- *Revolved section*. A revolved, or rotated, section is a cross section where the area of the cut has been rotated 90°, as shown in Figure 21 (B). It is used to show the true shape of the cross sections of such items as bars and other elongated parts.
- *Removed section*. A removed, or detail, section is a cross section that has been removed from its original position to a convenient space near the original view. As you can see in Figure 22, a section has been removed and drawn at the side. The areas of the cut have been rotated to show detail.
- *Aligned section*. An aligned section is a sectional view in which a sloping part is rotated parallel to the cutting plane, to show its true shape, as shown in Figure 23.
- *Assembly section.* Assembly drawings often are redrawn in section form to show how the interior parts are fitted together. Parts that lie in the path of the cutting plane, such as pins and screws, are not usually drawn in the section, as you can see in Figure 24.

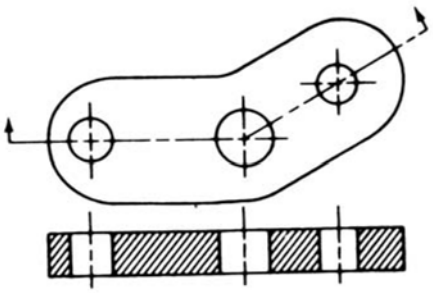


Figure 23: An aligned section of a bolt link for a lever-action rifle.

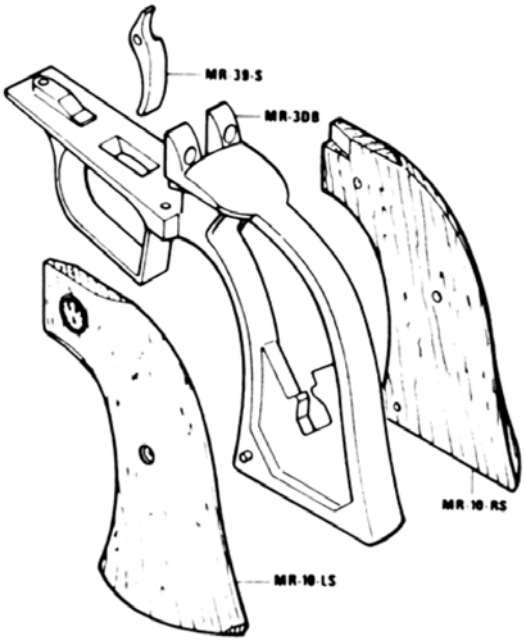


Figure 24: An assembly section.

SCHEDULES

A schedule, as used on a working drawing, is a systematic method of presenting notes or materials lists and components on a drawing that is in the form of a table. When properly organized and thoroughly understood, schedules are great time-saving devices for those preparing the drawings, as well as for those using them.

DRAWING DIMENSIONS

A drawing is expected to convey exact information regarding every detail so that an object can be created according to its specifications. It would be impossible to achieve successful results without definite dimensions, or sizes, on a drawing. A drawing dimension, like the ones shown in Figure 25, is a numerical value expressed in units, such as feet and inches or metric units. The dimensions are indicated on drawings in conjunction with lines, symbols, and notes to define the geometrical characteristics of an object. Dimensions are usually shown between points, lines, or surfaces that have a necessary and specific relation to each other or that control the location of other components. Dimensions are shown only once on a drawing, so as not to confuse people reading the drawings. Only enough measurements are given that the intended sizes, shapes, and locations can be determined.

SELF-TEST QUESTIONS

Please check your answers on page 17.

15. **What size patterns do professional gunstockers normally use?**
16. **A drawing of an object showing the interior parts of the object is called a _____**
17. **A _____ is a time-saving device that is used on drawings to present notes.**
18. **Numerical values shown on drawings next to objects are known as drawing_____.**

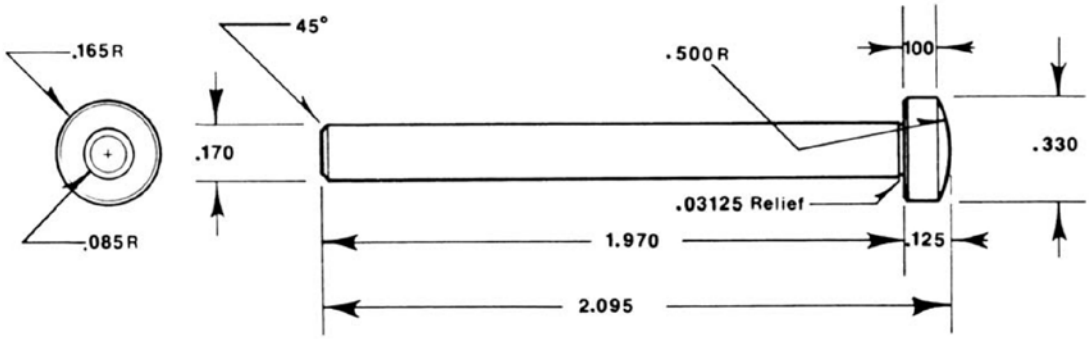


Figure 25: An orthographic view of a magazine plunger with sufficient dimensions to construct the part.

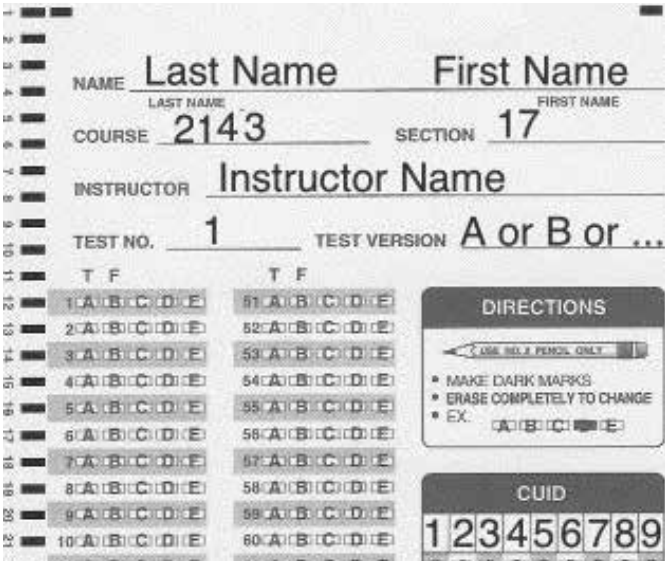
Answers to Self-Test Questions

1. False. A right-handed shooter requires cast-off.
2. 1¾"to $1^{7}/_{8}$ inch.
3. 14 inches.
4. Try-stock.
5. Monte Carlo.
6. True.
7. Straight, semi-pistol grip, and pistol grip.
8. Trigger pull, pitch, comb height, and drop.
9. Instinctive, correct aiming.
10. Either the stock is too straight or the comb is too high.
11. The trigger pull length.
12. 3 inches.
13. 2¾ inches.
14. Critical points should be drawn first.
15. Full-size patterns.
16. Section.
17. Schedule.
18. Dimensions.

Lesson Questions

THIS IS LESSON NUMBER 2186.

Make sure you print your name, student number, and lesson number in the space provided on the Lesson Answer Form. Be sure to fill in the circles beneath your student number and lesson number.



REMINDER: A properly completed Lesson Answer Form allows us to evaluate your answers and send the results and additional study material to you. Do not hold your Lesson Answer Forms to send several at one time. You may run out of study material if you do not send your answers for evaluation promptly.

You may also complete your exam online at www.sdi.edu, click on the *online exams* tab.

1. **Why is some drop at heel necessary in all gunstocks?**
   a. To make the gun kick.
   b. To bring the sight to eye level.
   c. To prevent the gun from kicking.
   d. It makes loading quicker.

2. **What is cast-off?**
   a. Offsetting the butt stock to the right of the sighting plane down the barrel.
   b. Offsetting the buttstock to the left of the sighting plane down the barrel.
   c. Lowering the drop at heel.
   d. Removing the rear sight for a better sight picture.

3. **A try-stock is designed to precisely adjust**
   a. Telescopic sights.
   b. Cast-on and cast-off of the gunstock.
   c. The stock's grip.
   d. Length of pull, drop at heel, drop at comb, and angle of the recoil pad.

4. **The Brownell Pull and Drop Gauge is designed to quickly measure**
   a. The shooter's arm length and chest size.
   b. Weight of trigger pull.
   c. Length of trigger pull, drop at comb, and drop at heel.
   d. The gun's pitch.

5. **How long should the trigger pull on a target rifle that will be used in the prone position be compared to trigger pulls on hunting rifles?**
   a. The target rifle's pull should be shorter.
   b. The target rifle's pull should be longer.
   c. Both should be the same.
   d. The target rifle's pull should be much heavier.

6. **How does a rifle stock that is designed for use with telescopic sights compare to one for use with iron sights only?**
   a. The one designed for use with telescopic sights should have a greater drop at heel.
   b. The one designed for use with telescopic sights should have a lesser drop at heel.
   c. The one designed for use with telescopic sights should have a lower comb.
   d. The one designed for use with telescopic sights should have a higher comb.

7. **When a shooter constantly shoots to the left, this indicates that the stock should have**
   a. A greater drop at heel.
   b. Cast-on or cast-off.
   c. A shorter trigger pull.
   d. A longer trigger pull.

8. **The drop at heel, in comparison with the drop at comb, is usually**

   a. Exactly the same.

   b. Slightly more than the drop at comb.

   c. Slightly less than the drop at comb.

   d. Considerably less than the drop at comb.

9. **Hidden lines on a stock drawing should be made using**

   a. Heavy solid lines.

   b. Light solid lines.

   c. Lines of different colors.

   d. Dotted or broken lines.

10. **A full-section drawing is one where the cutting plane**

   a. Passes halfway through the object.

   b. Passes entirely through the object.

   c. Is rotated to a sloping part.

   d. Is omitted.