FIREARMS DESIGN

COMMON FUNCTIONS OF RIFLE ACTIONS

The heart of any firearm is the action, consisting of the arm's moving parts and housing. The housing is usually termed the receiver, into which the barrel is threaded or otherwise locked. In all guns, regardless of the type of design and method of operation, the action accomplishes seven functions. These include:

1. **Feeding.** Introduction of the cartridge into the firing chamber. This is accomplished by hand in single-shots; in most other actions, feeding involves stripping the top cartridge from the magazine, resulting from forward motion of the bolt. (See Figure 1.)

FIGURE 1

2. **Locking** (of cartridge in chamber). Depending on design, the cartridge is locked in place, or chambered, simply by closing the lever or bolt action (see Figure 2); or, with auto-loaders, by letting the slide spring forward.

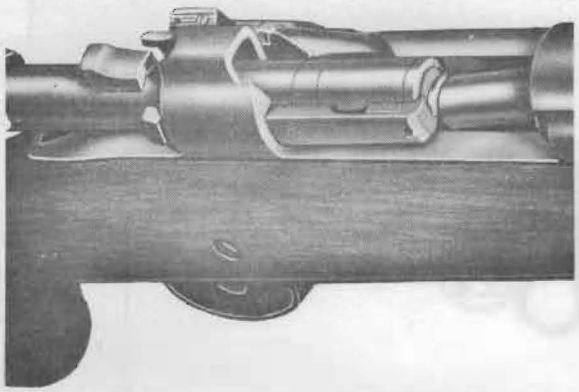


FIGURE 2

3. **Cocking.** Cocking results in compression of the firing pin spring and is accomplished by opening or closing the lever or the bolt; or automatically, by auto-loaders, on the second and following shots.

4. **Firing.** Releasing of the firing pin (striker) by trigger pressure, which detonates the primer and ignites the powder charge.

5. **Unlocking.** Unlocking is the act of opening the action partially or fully, which disconnects the striker and prevents the rifle from firing.

6. **Extraction.** The means by which the cartridge head is grasped or levered, thus drawing the case from the chamber.

7. **Ejection.** The "kicking out" of the fired case from the receiver, or removing it by hand as with some single-shots.

All guns operate within the framework of these seven functions. Various rifles perform one or more functions simultaneously,

and not necessarily in the sequence listed. The sequence is determined by whether the rifle is manually operated or is of semi-automatic design.

LEVER-ACTION RIFLES

Modern lever-actions are direct descendants of the Volcanic rifle introduced in 1855. The first Volcanic rifle was a real "pooper" that carried its powder charge in the base of a conical, hollowed-out bullet. A cardboard or cork disc kept the powder and primer in place. Because the "cartridge" had no gas seal, powder and velocity were low and the rifle passed into oblivion in 1857. See Figure 3.

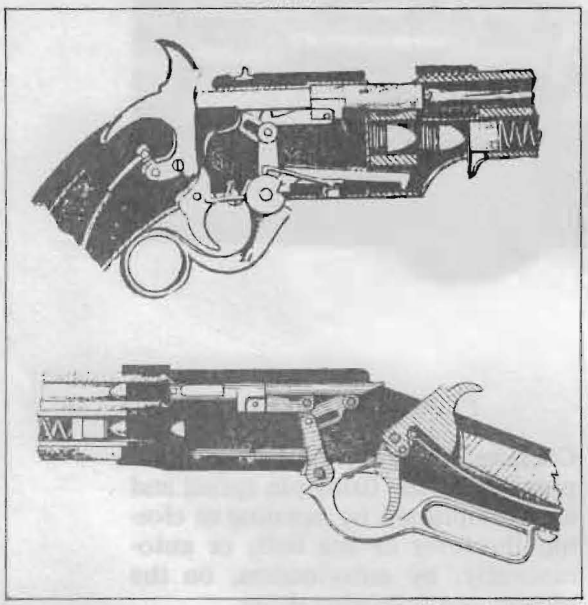


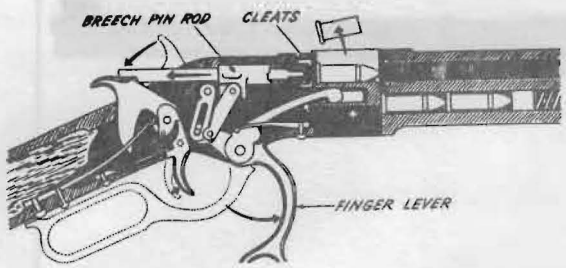
FIGURE 3 — These drawings show the Volcanic rifle (top) with its oddball cartridge, and its successor, the Henry, which fired the world's first metallic cartridge.

One of the Volcanic Company stockholders, a fellow named Oliver Winchester, purchased the company's patents. His foreman, Tyler Henry, redesigned the Volcanic and created a surprisingly modern looking rifle that fired the first metallic cartridge — a .44-caliber rim-fire, also designed by Henry. (The "H" on the head of all Winchester rim-fire cartridges is in honor of Henry.)

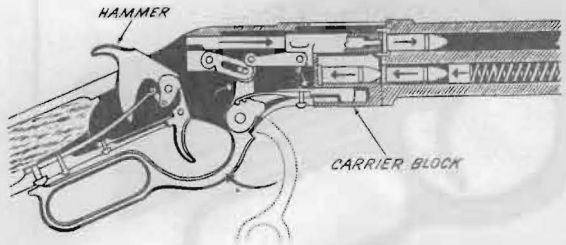
This rifle was known as the Henry Repeater and played a major role in the winning of the West.

The basic Henry model evolved into a series of famous Winchester lever-actions: the Model 66, chambered for the .44 Henry cartridge; the Model 73, for the .44/40 center-fire (see Figure 5); and the Model 76, for more powerful blackpowder center-fires such as the .45/75.

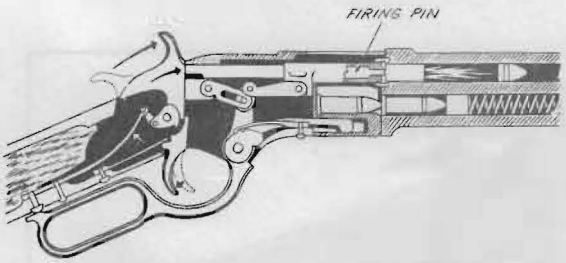
FIGURE 4 — Pioneering giants of the firearms industry. From top, Oliver P. Winchester, B. Tyler Henry, and John Moses Browning.



1. When the lever is pushed forward, the breech pin rod is pulled back and the cartridge is extracted from the chamber. The hammer is simultaneously forced back, cocking the trigger and raising the carrier block (and the next cartridge).



2. By returning the lever to the flush-with-stock position, the breech pin rod moves forward, chambering the cartridge and lowering the carrier block to accept the next cartridge.



3. Squeezing the trigger releases the hammer, causing the breech pin rod to strike the firing pin, which then moves forward and detonates the cartridge.

FIGURE 5 — Inner workings of the Winchester Model 1873. (Drawings courtesy of "Complete Book of Rifles and Shotguns" by Jack O'Connor)

In 1881 the first Marlin lever-action was introduced. It was chambered for the .45/70/405 government cartridge. Later John Moses Browning designed improved lever-actions which were sold to Winchester and introduced as the Winchester Model 1886 (the first smokeless cartridge, the .33 Win.); the Model 1894, which introduced the famous .30/30 cartridge (see Figure 6); and the Model 1895. The latter differed from its predecessors in that it incorporated a box-type rather than a tubular magazine, and was perhaps the first lever-action that could safely use pointed spitzer-type bullets (see Figure 7). The 1895 was the favorite rifle of Theodore Roosevelt and was chambered for such powerful cartridges as the .30/06; it was discontinued in 1931.

Other early manufacturers of U.S. lever-actions were Spencer, Marlin, and Savage. Of these, the Winchester 94, Savage 99, and the Marlin in its original form plus a new short-action design, are still in production and chambered for center-fire cartridges.

Most lever-actions utilize a tubular magazine feeding either through the buttstock for .22 rim-fire rounds or from a tube mounted under the barrel for center-fire cartridges. Others, using relatively powerful center-fire cartridges, employ a box-type magazine. These include the Winchester 88, Sako Finnwolf, and Savage 99.

Sequence of the Seven Functions in Popular Lever-Action Rifles

The Winchester 94 and Marlin 336 (most often chambered for the .30/30 or .32 Special) and the Savage 99 (offered in several relatively high-powered cartridges) are the most popular center-fire, lever-action rifles in use today.

Winchester 94 and Marlin 336. Now let's relate the seven functions of rifle actions to the operation of the Winchester 94 and Marlin 336. In these rifles, the rifle (1) UNLOCKS as the lever is pushed down. If a cartridge is in the chamber, it is (2) EXTRACTED and (3) EJECTED. While the breech bolt moves backward, it simultaneously cams the hammer back and down until the hammer sears engage the trigger, thus (4) COCKING the rifle on the *opening* of the action.

Also, as the lever moves down, a cartridge is fed from the tubular magazine by spring compression onto the lifter or "carrier" platform.

When the lever is raised, the bolt moves forward, strips the cartridge off the lifter, and carries it up into the chamber — thus accomplishing (5) FEEDING. After the lever is fully raised and flush with the receiver, the action is (6) LOCKED and the trigger can be pulled, thus (7) FIRING the rifle.

Savage 99. In the Savage 99 (see Figures 9 and 10), the operation sequence of the seven functions varies only in that the Savage is cocked on the *closing* of the action, while the Winchester and Marlin cock on *opening*.

The only other difference is that, with the Savage 99, the bolt moving forward strips a cartridge off a spool magazine (or box-type, depending on the model) rather than a "lifter" such as is incorporated in the Winchester 94 and Marlin 336.

FIGURE 6 — The famous Winchester Model 1894. Cutaway view shows the rifle loaded, with the hammer in the "safe" or uncocked position.

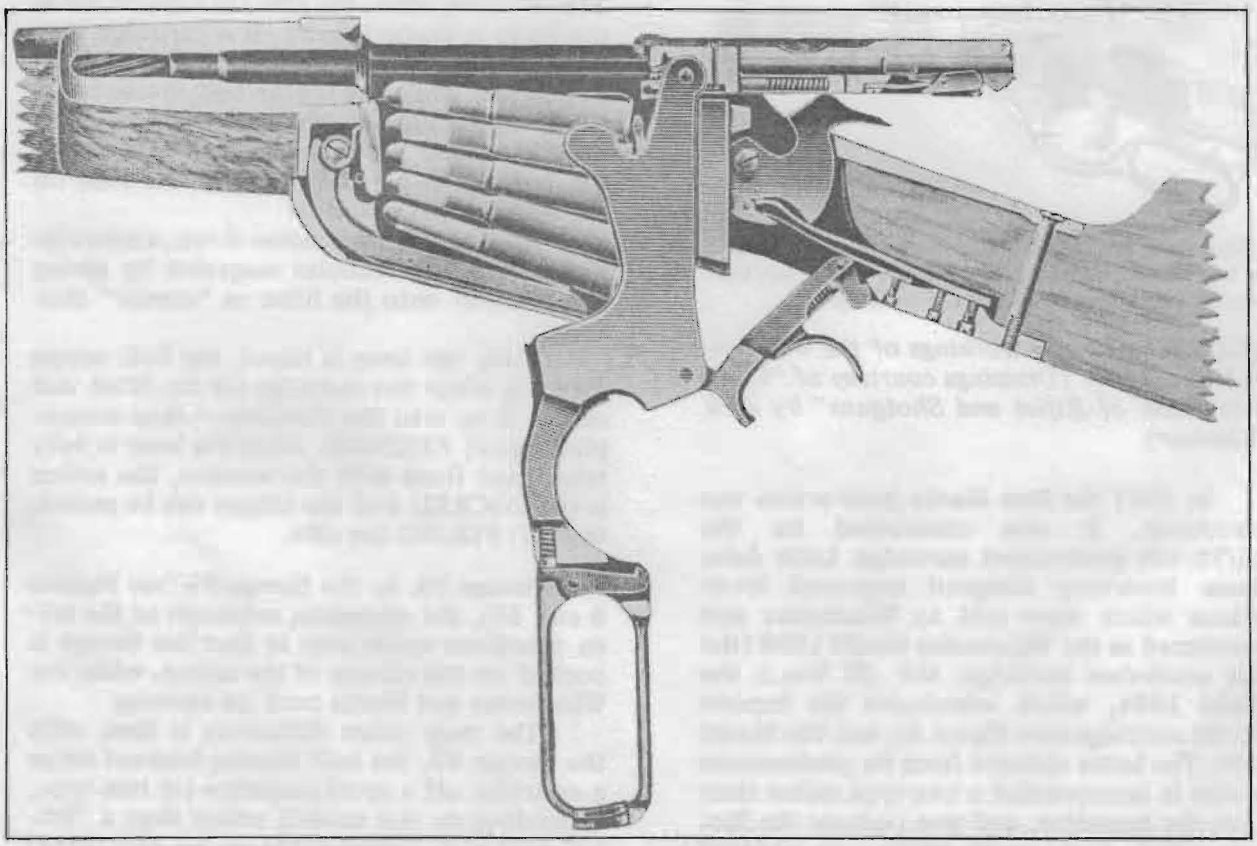
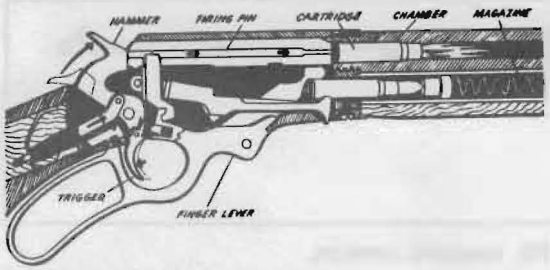
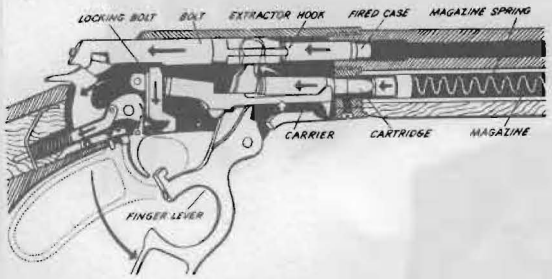


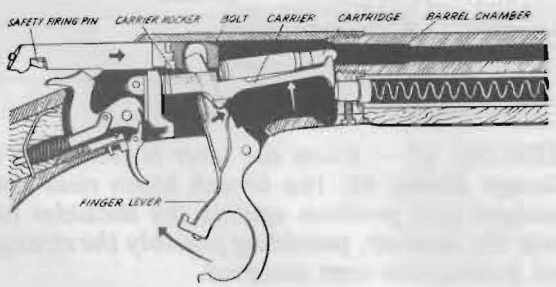
FIGURE 7 — The Winchester Model 1895, cutaway view.



1. With the rifle loaded and cocked, pulling the trigger releases the upper part of the trigger from the notch in the hammer. The hammer then moves forward and strikes the firing pin, detonating the cartridge.



2. When the lever is pushed forward, the locking bolt moves downward, disengaging from the bolt. The tip of the lever then engages a slot in the bolt and moves the bolt to the rear. As the bolt moves backward, an extractor hook pulls the fired case out from the chamber to a point where the spring-loaded ejector kicks out the case. At the same time, the magazine spring forces a cartridge onto the carrier. The lever completes its outward arc and the carrier and cartridge start moving up.



3. As the lever is returned to its original position, it first engages a pin on the carrier rocker which cams the carrier into loading position. As the lever continues moving toward "close," its tip pushes into the bolt slot, moving the bolt forward and chambering the cartridge. When the lever is fully returned, the locking bolt rises to match the notch in the bolt, thus aligning the safety firing pin (see first drawing). The rifle can now be fired.

FIGURE 8 — Inner workings of a modern lever-action, the Marlin Model 336. (Drawings courtesy of "Complete Book of Rifles and Shotguns" by Jack O'Connor)

How Lever Actions Lock Up

For lock-up, *Winchester* and *Marlin* types utilize a vertical rising block arrangement. As the breech closes, two locking lugs rise up and engage slots cut in both the block and receiver, thus locking the block at the rear. See Figure 11.

The Savage 99 (see Figure 12). The shoulder at the rear of the breech block of the Savage 99 wedges up against a corresponding shoulder at the top rear of the action when the lever is closed. The breech block also bears snugly against the sides of the receiver. When the fit is perfect, as is usually the case in newer 99's, an enormously strong action results.

The Winchester 88 (see Figure 13). This action is typically of the Mauser turn-bolt design, cocking on opening, except that it is lever rather than bolt-handle actuated. Three locking lugs provide 30% more bearing surface than most bolt-actions, and strong camming action permits extraction of even dirty ammo.

Still another type of center-fire lever-action is the Sako Finnwolf, made in Finland, which locks up with a unique rack and pinion system.

Most of the cheaper .22-caliber rim-fire lever-actions lock up by simple overbalanced camming. Closing of the lever exerts sufficient force against the cartridge head to achieve a satisfactory seal. Chamber pressures are so low that not much locking strength is needed.

Drawbacks of the Lever-Action

Inadequate lock-up surface and inadequate strength are characteristics of the older lever-action designs — and even of the newer configurations such as the current Winchester 94 and Marlin 336. Rifles in this class are invariably chambered for cartridges in the .30/30 class, generating from 38,000 to 40,000 pounds of breech pressure per square inch (psi).

Probably the most rugged lever-actions are the venerable Savage 99 and the comparatively new Winchester 88, both of which use high-intensity cartridges such as the .243 and .308 Winchester, well into the 50,000 psi category. The spool and box magazines of the Savage 99 and the box magazine of the Winchester 88 permit the use of pointed, spitzer-type bullets.

The older lever-actions with tubular magazines are limited to flat-nosed bullets because of the danger of recoil causing the point of one bullet to explode the primer of the next cartridge in line.

As all lever-actions (other than the Winchester 88) lock up at the rear, cases have a habit of stretching, making frequent trimming a must for the reloader.

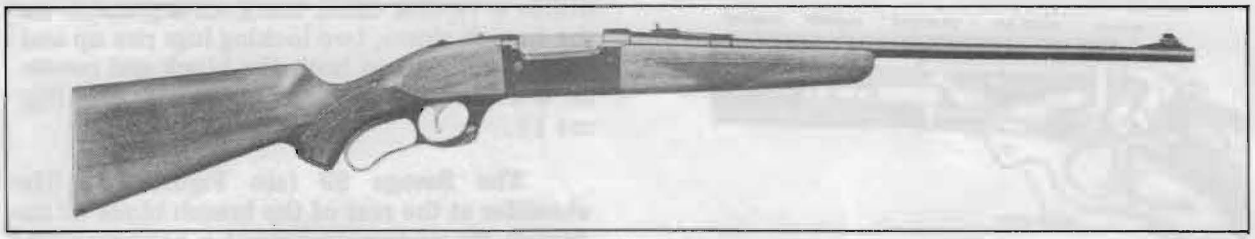


FIGURE 9 — The Savage Model 99, modern version.

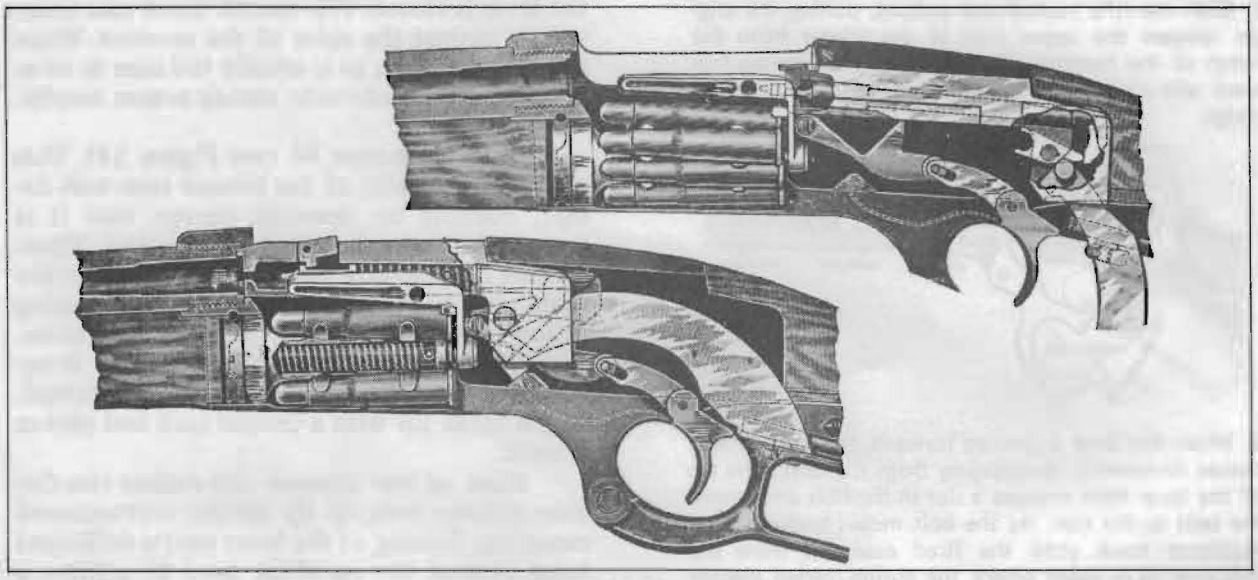


FIGURE 10 — Cutaway view, original Savage Model 1899. The top view shows the lever in the forward position, the bottom view with the lever closed. The design of contemporary Model 99's is essentially the same.

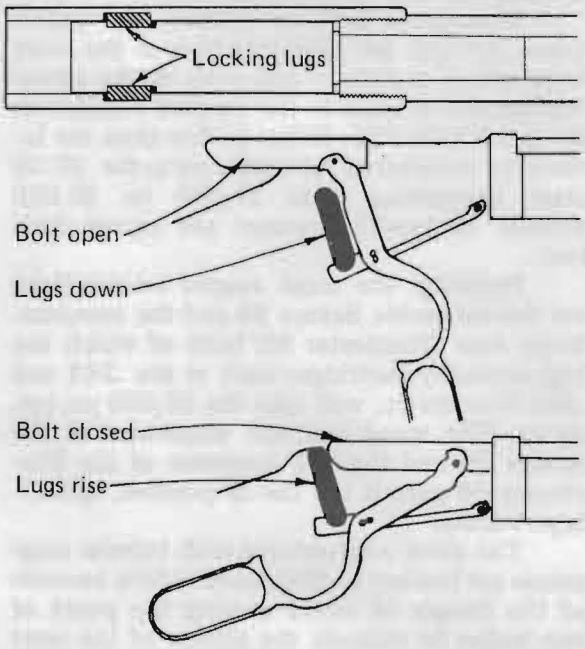


FIGURE 11 — In Winchester and Marlin lever-actions, two locking lugs at the sides of the receiver (see top drawing) rise when the lever is closed, locking the block at the rear as shown in the center and bottom drawings.

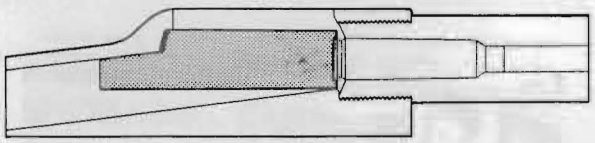


FIGURE 12 — When the lever is closed on a Savage Model 99, the breech block rises and wedges into position against the shoulder inside the receiver, providing possibly the strongest lever-action ever designed.

FIGURE 13 — Winchester Model 88. Although lever-operated, the design principle is essentially Mauser turn-bolt.

Before going on, please do Programmed Exercise 3-1. Make sure you write your answers on a separate sheet of paper before looking at the answers on the page specified.

PROGRAMMED EXERCISE

1

1. What is the chronological sequence of the lever-actions listed below? (Number from 1 to 5, beginning with the first one developed.)

   ___ Henry Repeater
   ___ Winchester 88
   ___ Volcanic rifle
   ___ John Moses Browning designs (manufactured by Winchester)
   ___ Savage 99

2. Match the lettered lock-up systems below with the lever-actions listed.

   ___ Sako Finnwolf
   ___ Savage 99
   ___ Winchester 88
   ___ Most other Winchesters and Marlins
   ___ Cheaper .22-caliber rim-fires

   A. Vertical rising block.

   B. Breech block wedge at the rear.

   C. Three locking lugs.

   D. Rack and pinion system.

   E. Overbalanced camming.

3. What are the four drawbacks to lever-actions?

4. Name the sequence of the seven basic functions in a lever-action.

Answers on Page 8

BOLT-ACTION RIFLES

Probably the first true turn-bolt rifle was the Needle Gun developed by Dreyse in the late 1830's (see Figure 14). It didn't shoot "needles," but was so named because of its long, needle-like firing pin which protruded from the rear of the bolt when cocked. The rifle was successful enough to be adopted by the Prussian army in 1842. However, because of its paper cartridges and "leaky" ignition system, shooters preferred to fire from the hip and thus escape the blowback and black face that could do as much damage as the business end of the arm.

The first really successful bolt-action design was the 11mm Mauser single-shot of 1871, which employed a true turning-bolt design (see Figure 15). In 1884 it was equipped with an under-barrel tubular magazine holding eight .43-caliber Mauser cartridges. Many of these rifles saw service in the Balkans as late as World War II (see Figure 16).

The next important step in the evolution of the bolt-action was the Spanish 1893 Mauser (see Figure 17) developed about the same time as the Krag Jorgenson rifle of Sweden, which was adopted by the U.S. military in 1892. The Mauser utilized a staggered column clip magazine as opposed to the Krag's ungainly box magazine which had to be loaded with single cartridges (see Figure 18). The Krag had only one locking lug while the Mauser had two, thus providing superior strength.

The Model 1893 Mauser was the forerunner of the greatest individual firearm design of all time — the Model 98 (see Figure 19). This model incorporated the two front locking lugs of the 93, but added an additional recoil lug toward the rear of the action for extra strength. Also, the cocking piece was shrouded to protect the shooter from escaping gas.

Another important difference was that the 98 cocked on bolt opening while the 93 cocked on closing. Originally, cocking on closing was believed more desirable. It enabled the soldier to open the bolt and extract the cartridge without any force "diluted" by the cocking operation. (In warfare, difficult extraction of dirty ammo could delay a needed second shot. Permanently. That was the theory anyway.) The strong camming and extraction of the Model 98 overcame most opposition of the cocking-on-close advocates.

The only other early turn-bolt rifle of any consequence was the Mannlicher, developed in Austria, which incorporated a spool-type magazine similar to that later used in the Savage 95 and Model 99 (see Figure 21). The bolt handle was positioned ahead of the receiver bridge, necessitating a split bridge which, when scopes were later developed, made mounting difficult. It was and still is a good action, but not as strong as the Mauser.

Paul Mauser's original design has been modified and improved upon by many manufacturers. His basic turn-bolt theories are reflected in almost every bolt-action rifle manufactured today, and in some lever-actions and auto-loaders. Many modern rifles also use the Mauser concept of a staggered column magazine.

How the Seven Basic Functions Apply in Modern Bolt-Action Rifles

For purposes of discussion, we'll consid-

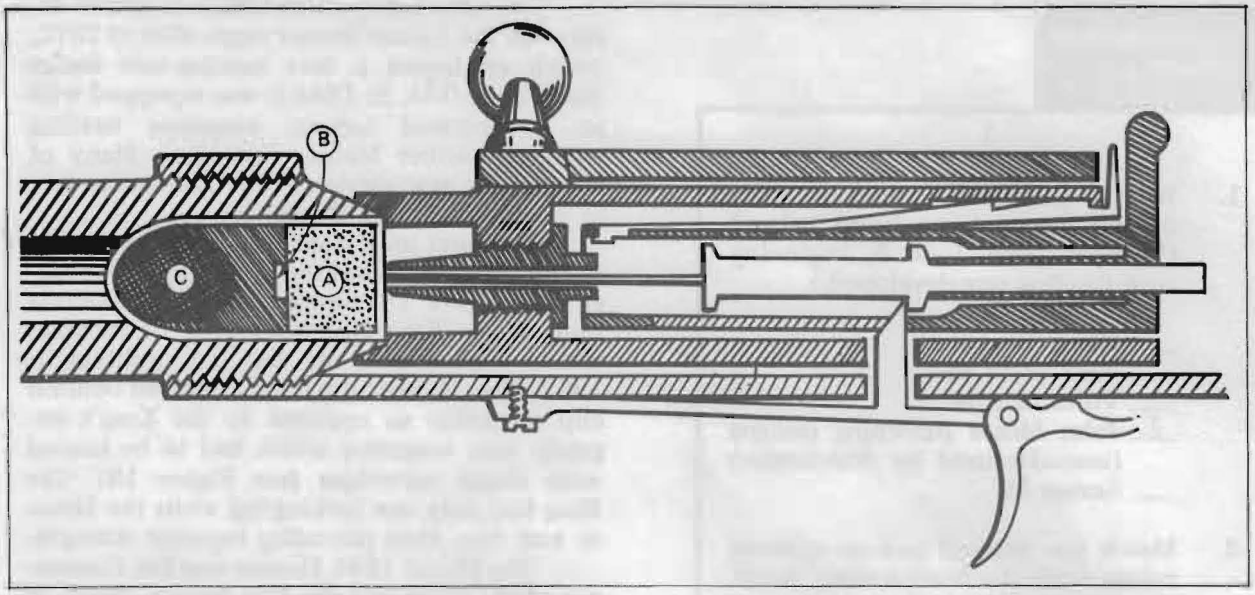


FIGURE 14 — The Dreyse Needle Gun. When the trigger is pulled, the long, needle-like firing pin punches through the powder (A) and strikes the priming compound (B) at the base of the bullet (C).

FIGURE 15 — The first Mauser 11mm single-shot, the Model 1871.

ANSWERS

1

1. Volcanic rifle
   Henry Repeater
   Browning designs
   Savage 99
   Winchester 88

2. D, B, C, A, E

3. Inadequate strength; inadequate lock-up surface; older actions limited to flat-nosed bullets because of danger of recoil; rear lock-up causes case stretching.

4. Unlock, extract, eject, cock, feed, lock, fire.

er the Model 725 Remington and assume that the rifle has just been fired. Refer to Figure 22.

1. As the bolt handle is raised, the bolt lugs rotate and (1) UNLOCKING takes place. A notch at the bottom of the bolt handle engages simultaneously and raises a spur on the firing pin head, thus pushing the firing pin to the rear and compressing the mainspring.

2. When the bolt assembly is drawn back, (2) EXTRACTION occurs as the case is drawn from the chamber. A circular spring in the end of the bolt (see insert drawing in Figure 22) tightens the claw, gripping the case head tightly. When the fired case clears the chamber, the spring-loaded ejector (3) EJECTS the spent cartridge. The magazine spring forces the next cartridge up into loading position.

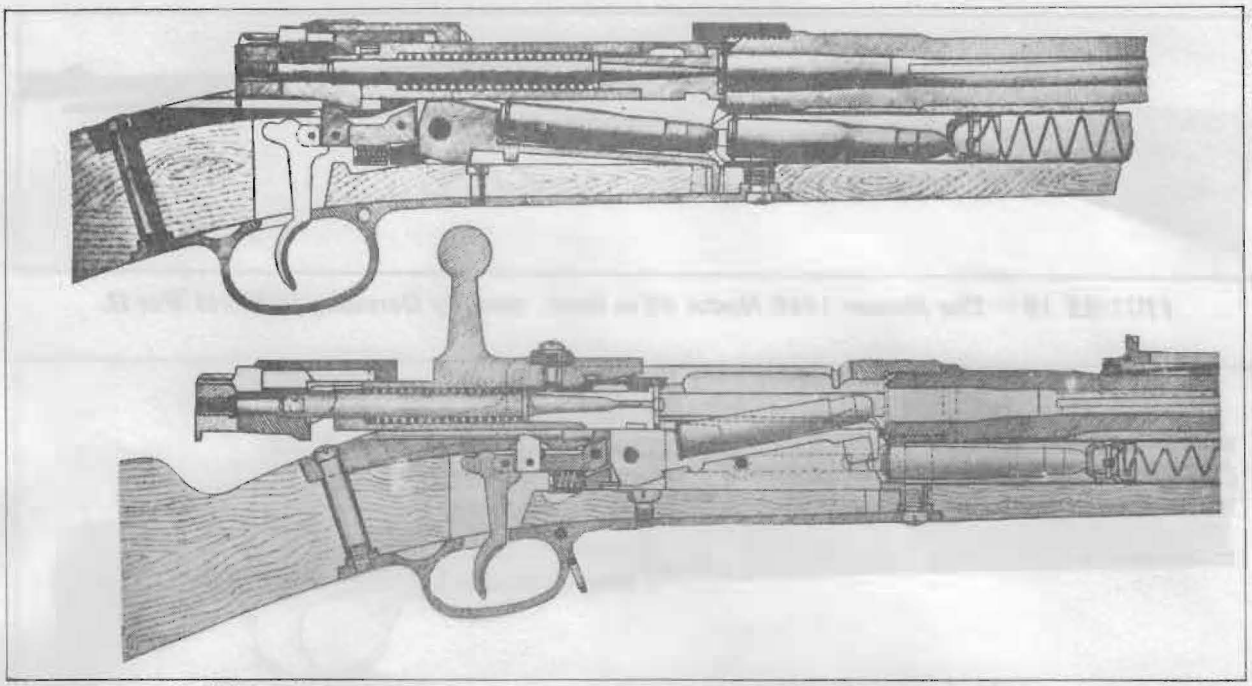


FIGURE 16 — Cutaway views, Mauser 11mm with the under-the-barrel tubular magazine added in 1884.

FIGURE 17 — The Mauser Model 1893, Spanish 7mm version.

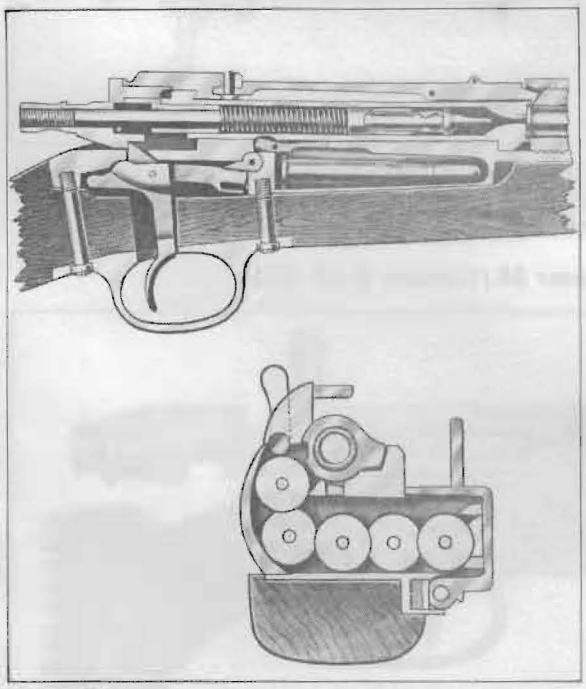


FIGURE 18 — U.S. Model 1898, Krag-Jorgenson. Receiver detail shows the rifle loaded, cocked, and ready for firing. Magazine detail shows the rear view of the magazine fully loaded and with the loading gate closed.

3. As the bolt is moved forward, it strips the cartridge from the magazine, (4) FEEDING it into the chamber. When the bolt is thrust fully forward and turned down, the lugs engage the chamber recesses, accomplishing (5) LOCKING. At the same time, the sear engages the firing pin head, (6) COCKING the rifle.

4. When the trigger is squeezed, it disengages the sear from the notch on the firing pin head. The mainspring thrusts the firing pin forward, (7) FIRING the cartridge.

All Mauser actions are good, but the Model 98 and its variations are best. Among the 98's are the Mexican, Peruvian, Costa Rican, Model 1909 Argentine, KAR 98, and GEW 98. Generally, the parts of these models are interchangeable.

The main difference between the KAR 98 and GEW 98 is that the KAR has the small, straight ring receiver while the GEW employs the standard large receiver and is essentially a heavier action. The KAR lends itself to "featherweight" sporter conversions.

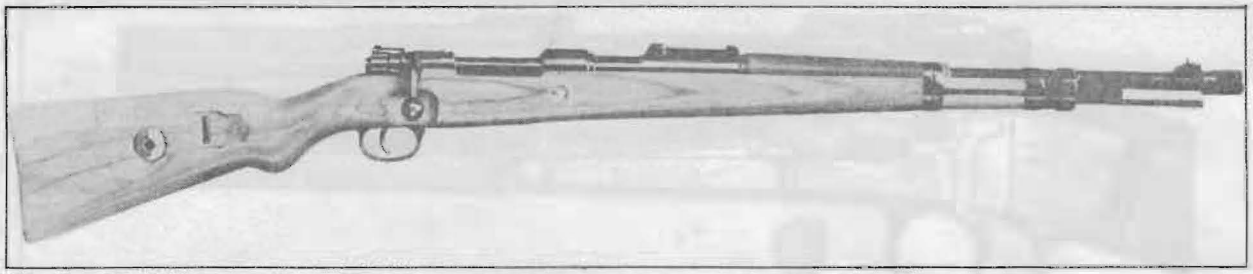
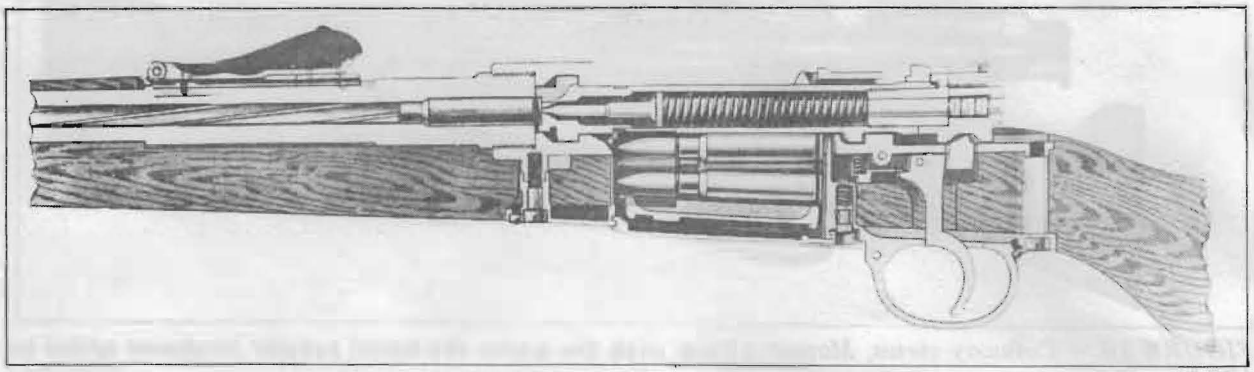
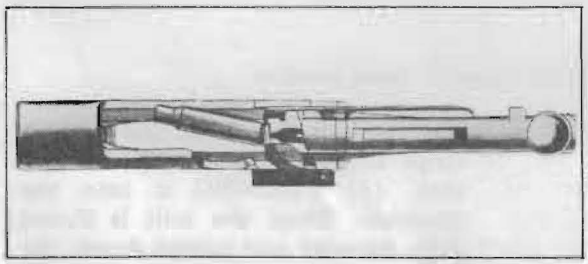


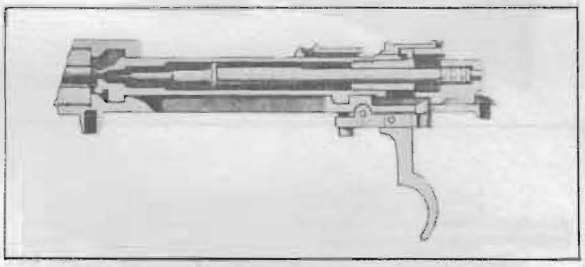
FIGURE 19 — The Mauser 1898 Model 40 in 8mm, used by Germany in World War II.



This illustration shows the left side of the rifle with the fired case in the chamber. Except for the compressed magazine spring, all parts are "at rest." Note the relative positions of the trigger spring, trigger sear, and cocking piece sear.



As the bolt is drawn to the rear, the ejector is swung out, thus pivoting the fired case outside of the rifle.



The action is cocked and ready to fire. Observe the engagement of the trigger sear with the cocking piece sear.

FIGURE 20 — Cutaway views, Mauser 98 (German KAR 98K).

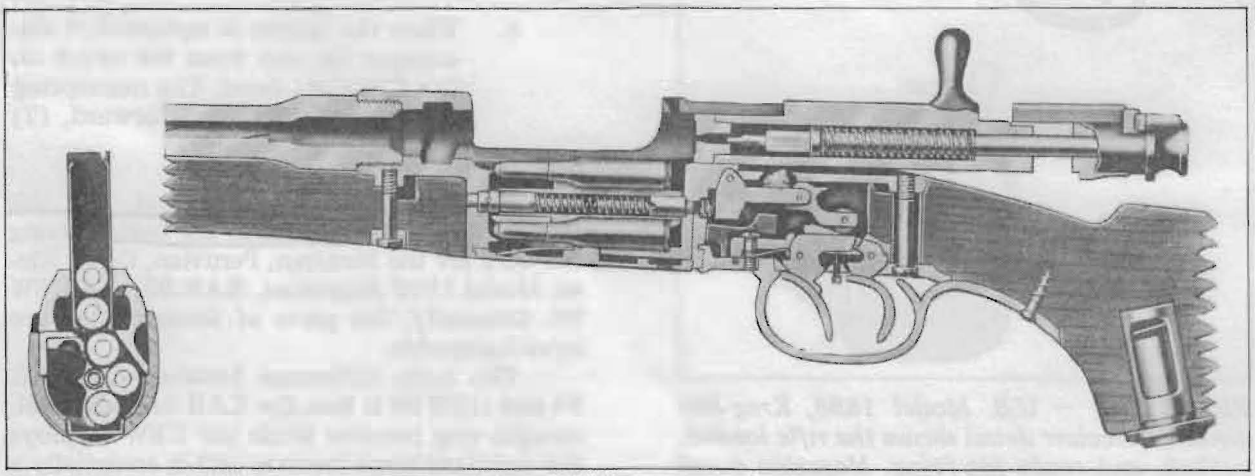


FIGURE 21 — Mannlicher-Schoenauer European sporting rifle with double-set triggers. Spool-type magazine served as "inspiration" for the first Savage lever-action, the Model 1895.

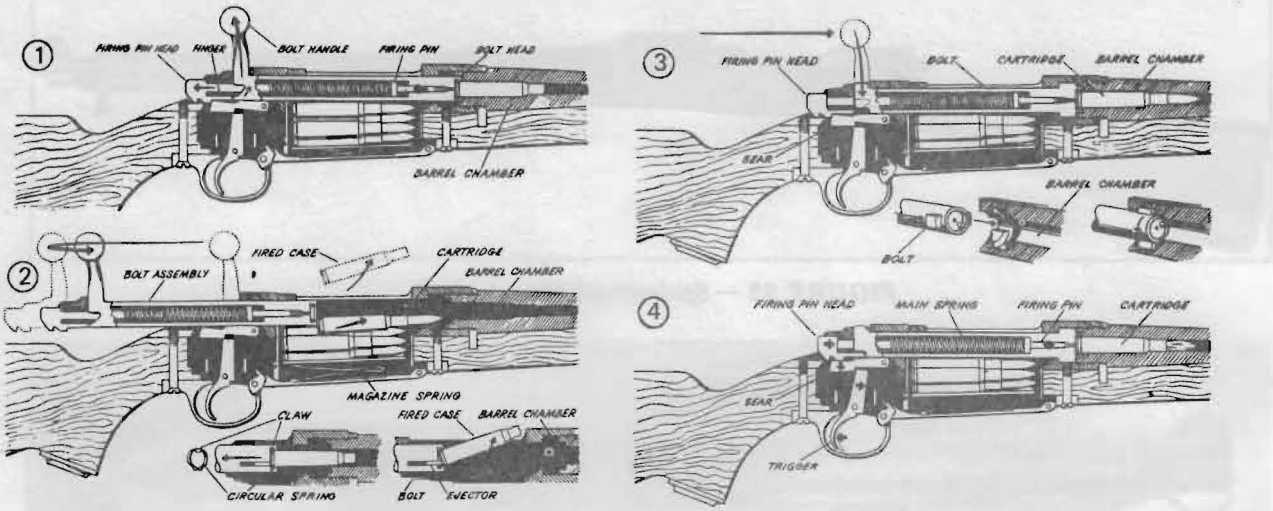


FIGURE 22 (drawings courtesy "Complete Book of Rifles and Shotguns" by Jack O'Connor)

A rather common action is the Model 1924 Yugoslavian, usually but not always bearing "1924" on the receiver ring. While virtually identical to the 98, it is a smaller, scaled-down version and its parts are not interchangeable with the standard 98.

Relative Strength, Mauser Actions

Those receivers manufactured during World War I are softer than those made after 1924, and if used for modern, high-intensity cartridges should be re-heat treated. This is especially true for KAR actions marked "Erfurt."

Model 98 actions manufactured between 1924 and 1942 are most desirable, as these (mostly peacetime) units were "proofed" to a a chamber pressure of about 100,000 psi — almost double the proof requirement for standard German or U.S. rifles.

Actions manufactured during the last two years of World War II, marked "1944" and often made by slave labor, are usually rough and should be suspect. On some versions the bolt guide rib was left off to reduce cost. However, high-pressure tests have proved that many of these World War II actions are as strong as their earlier counterparts. Leave them alone or test for hardness (as you'll later learn to do) before firing hot 8mm handloads or converting the action for modern, powerful cartridges such as the popular 8mm/06 Wildcat.

While 98 actions do lend themselves to fine sporter conversions, the shooter is usually money ahead by starting with a new commercial Mauser action. By the time the bolt is altered, the trigger modified, and a swing-away floor plate assembly and low-scope safety installed, there is little difference in cost. And these features are all usually incorporated in commercial Mauser designs.

Earlier Mauser Actions

The basic Model 93 Mauser, first made for the Spanish army, was soon adopted by many other countries "as is" or with only minor modifications and/or caliber changes. Those built on the basic 93 pattern were the Turkish M93; Swedish M94 and M96; Chilean M95; Uruguayan, Peruvian, Chinese, Transvaal, and Orange Free State Models 95; and the Serbian M99.

While most lack the third (recoil) lug of the 98, they are often used for "non-magnum" conversions to such calibers as .308 Winchester, .243 Winchester, .257 Roberts, etc. In blow-up tests these older actions have proved nearly as strong as the 98.

Other Mauser-Type Military Actions

Practically all turn-bolt military rifles are variations of the basic Mauser design. Changes, as in the case of the Springfield 1903, were largely detrimental and motivated more by the hope of escaping royalty payments (which didn't work — the U.S. paid about $1 million to Mauser up to World War I) than improving the design. Indeed, the original 1903 Springfield was "inspired" by some captured Spanish Mausers which U.S. Ordnance "studied" in 1900 to 1902. See Figure 23.

Springfield 1903. Changes from the original Mauser, and usually considered inferior, are the Springfield's two-piece firing pin (Mauser's is one piece); the high bridge caused by relocating the recoil lug; inadequate pro-

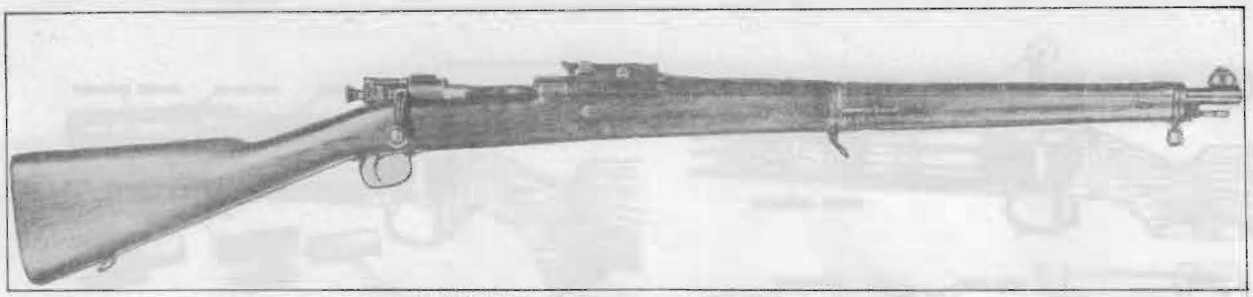


FIGURE 23 — Springfield Model 1903.

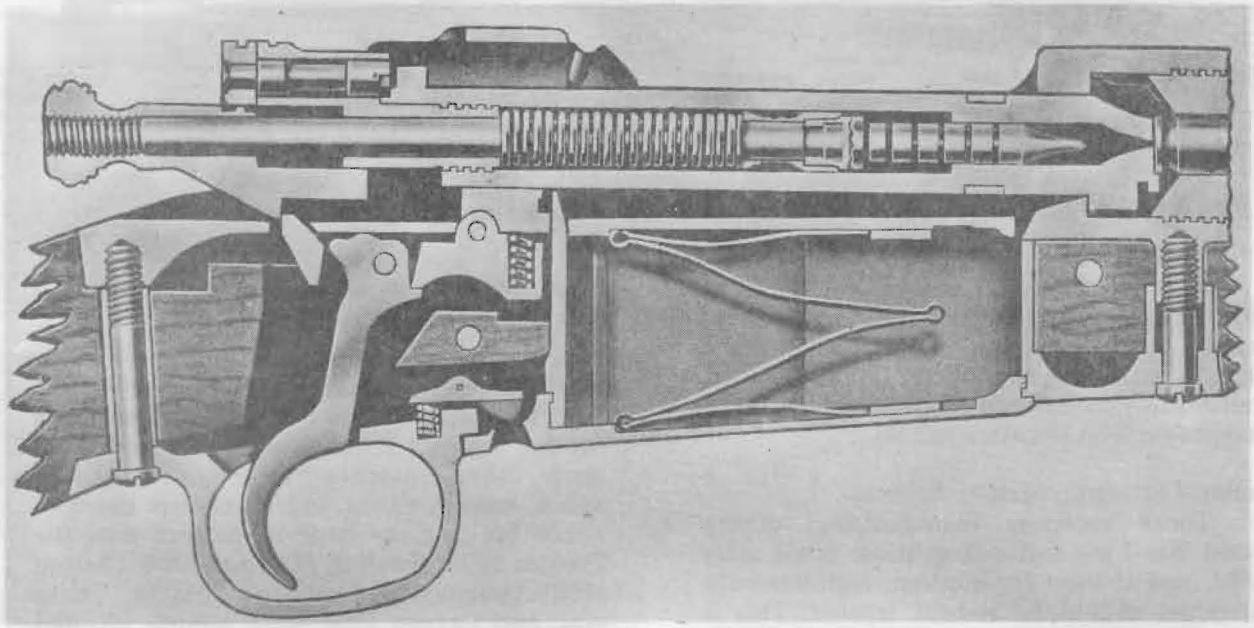


FIGURE 24 — Springfield Model 1903. Cutaway drawing shows the rifle loaded, cocked, and ready to fire with the magazine empty. Note the positioning of the trigger, sears, and spring components. The two-piece striker assembly, held together by the firing pin sleeve, is clearly indicated.

tection against escaping gases (not improved until 1934); elimination of the bolt stop and substitution of a weaker bolt cutoff. Even with these drawbacks, the Springfield still serves as a desirable basis for fine custom sporters.

Springfields bearing serial numbers under 800,000 are not recommended for high-intensity cartridges. They were manufactured at the Springfield Arsenal of carbon steel, case hardened. Such actions should be checked for hardness (Rockwell testing) and, if necessary, be re-heat treated. Actions numbered over 800,000 were made the same way, but were double heat treated for additional strength.

Those bearing numbers over 1,275,507 were made of nickel steel and are considered the best.

The 1903 actions manufactured at the Rock Island Arsenal changed from carbon steel to nickel steel with serial number 285,507 and are equally desirable.

P-14 and P-17 Enfield Actions. The P-14 and P-17 Enfield rifles are often considered heavier, modified versions of the Springfield, although they differ considerably. The action is most similar to the early cock-on-close Mausers. The Pattern 14 was designed for the .303 British rimmed cartridge and today lends itself to magnum modifications; because of the wider bolt face, it requires little alteration.

The P-17 Enfield (see Figure 25), chambered for the U.S. .30/06 cartridge and known as the British "Springfield," was manufactured by Remington and Winchester during World War I. Strong nickel alloy steel was used universally.

Enfield actions are large, rather clumsy, and well suited for modern, even magnum cartridge conversions. This action was used by Roy Weatherby for many of his first rifles, handling his then "wildcat" cartridge based on the long .300 H&H case.

The Enfield served as the direct ancestor of both Remington's and Winchester's first

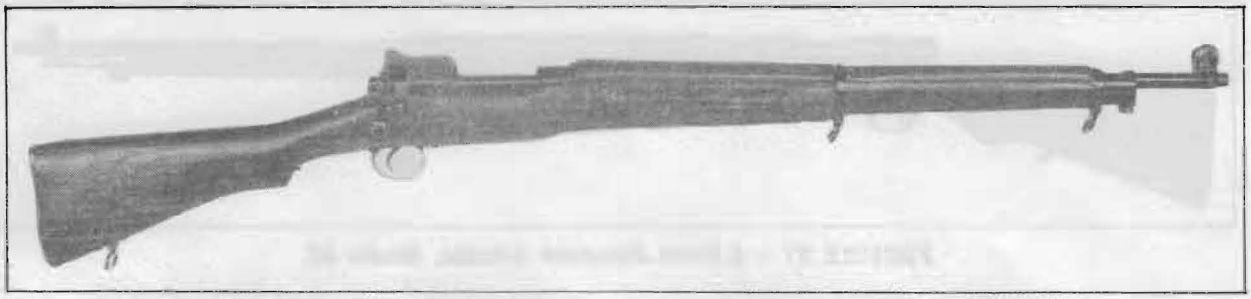


FIGURE 25 — The Enfield Pattern 17 (chambered for the .30/06 cartridge).

FIGURE 26 — U.S. Model 1917 Enfield (Pattern 17), one of the simplest and strongest bolt-action rifles ever made. Cutaway shows the bolt open, ready to move forward and strip the top cartridge from the magazine.

bolt-action sporting rifles: the Remington 305, manufactured prior to World War II, and the Winchester 54, which later evolved into the Model 70.

There are, of course, other good military actions such as the Japanese Arisaka (early 6.5 version) — see Figures 27 and 28 — which lend themselves satisfactorily to conversions. And some which do not, such as the Italian Carcano (see Figures 29 and 30).

Desirable Improvements, Mauser-Type Actions

Most genuine improvements on the basic Mauser-type action involve extraction and ejection. The most noteworthy are found in the Remington 721 and 722 series, which incorporated a round bolt with both ejector and extractor completely enclosed within the bolt. Other manufacturers have copied Remington in this respect. Ruger, however, utilizes an exterior extractor and interior ejector in the company's basically Mauser-design Model 77 rifle.

Lock-Up Systems, Bolt-Action Rifles

Bolt-actions lock up by means of lugs on the bolt face which, when rotated by the action of the bolt handle, engage recesses in the chamber. The Krag had one locking lug; the 93 and 98 Mausers have two locking lugs. The Krag was designed to contain pressures up to about 40,000 psi, the 98 for about the same pressure level. However, if the steel is of the proper hardness, good 98 actions can easily accommodate pressures up to 55,000 psi — the maximum safe limit for today's magnum cartridges.

Multiple Locking Systems. As cartridges became more powerful, the need for a stronger system became paramount. The solution was obviously a system that employed multiple locking lugs. This adds to the amount of bolt-to-chamber locking or shearing area and, theoretically at least, increases strength. We say "theoretically" because, if all lug surfaces

FIGURE 27 — 6.5mm Japanese Arisaka, Model 38.

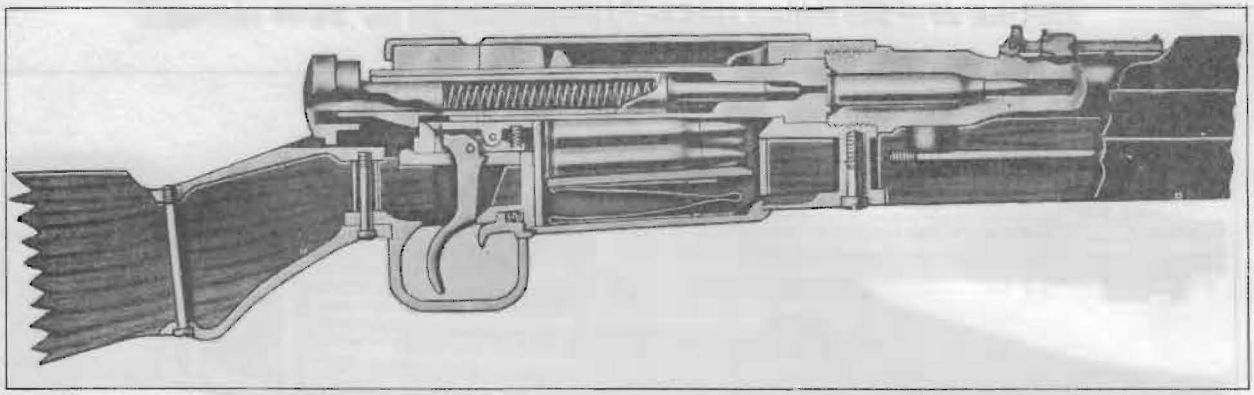


FIGURE 28 — Japanese service rifle (Arisaka). Shows details of mechanism with the rifle cocked and ready to fire. Note the position of the trigger sears and the unique mainspring — positioned inside the hollow firing pin section.

FIGURE 29 — The Italian Carcano 6.5mm carbine. Identical to rifle except that the barrel is 21" long, 10 inches shorter than on the rifle.

FIGURE 30 — Carcano cutaway view showing the action open and with loaded clip magazine. This firearm cocks on closing like the early Mausers.

don't bear fully and equally, the action is actually weakened and accuracy suffers. This can be checked by applying Prussian blue to the lug areas, then checking the receiver recesses for color.

At least two modern bolt-actions, both of super magnum persuasion, employ the front-locking multiple lug principle — the new Apollo Mach IV, with three massive lugs, and the Weatherby Mark V, with nine small lugs (see Figure 32). The Remington 788 and Schultz & Larsen Finnish rifle both use a *rear-locking* multiple lug set-up.

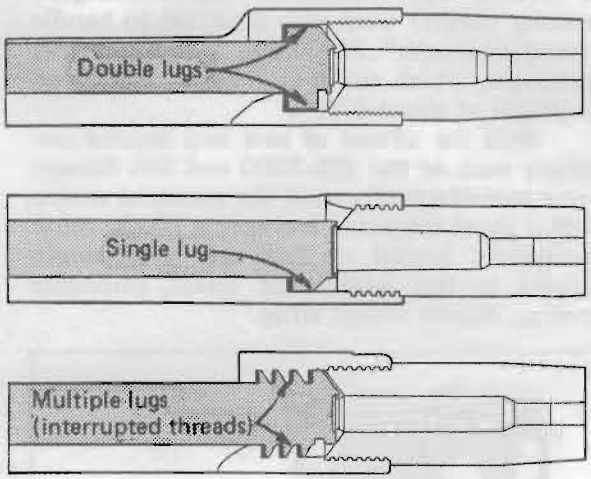


FIGURE 31 — Three types of bolt-action lock-up. The top drawing illustrates the conventional Mauser two-lug lock-up, with the lugs on the bolt engaging recesses in the receiver ring. The middle drawing shows the single-lug lock-up used on the Krag-Jorgenson, some early slide-actions, and other rifles. Support at one side only often changes bullet impact drastically when cartridges different from those used in zeroing are fired. The bottom drawing illustrates the multiple lugs which serve as "threads." When all lugs bear evenly, the action is stronger than the two-lug design.

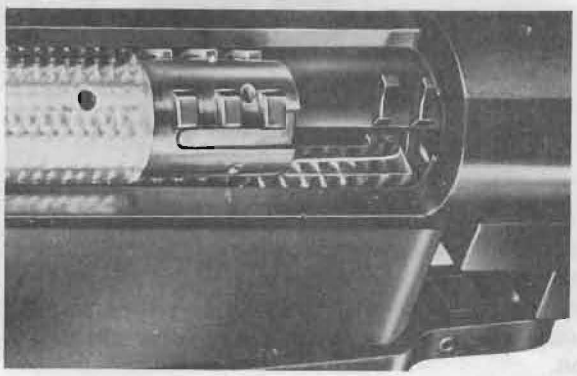


FIGURE 32 — Close-up of the Weatherby Mark V action showing multiple small lugs and recesses in the receiver.

In Apollos and Weatherbys, the lugs are of the same diameter as the bolt, and the bolt is the same size as the inside of the receiver. The cartridge head is fully enclosed, and the action is slick and smooth.

The multiple lug design (or interrupted thread design, as it is sometimes called), while primarily found on newer rifles, actually goes back to an earlier period. The system was probably first introduced by Charles Newton, a turn-of-the-century firearms and cartridge designer, in the rifles he made for his then and *still* impressive Newton cartridges. Not only was the multiple lug concept exceedingly expensive from a production standpoint, but in the Newton rifles his entire design was a disaster. The rifles could be fired without locking the bolt, and, following the maiming of a number of riflemen by bolts flying backward, the arm was discontinued.

Multiple lugs were used on other early rifles, notably the Remington pump and some auto-loaders. Today the system is also used on rifles of lever, pump, and auto-loading design.

A secondary advantage of the multiple lug design in bolt-actions is short bolt lift. The standard Mauser action requires a 90° lift to open the action. By adding additional lugs at the front or rear of the bolt, the bolt lift is shortened — to 45° to 60° — which provides faster repeat shots and ample clearance between the bolt handle and the scope bell.

Gas Venting, Bolt-Action Rifles

Since the invention of the self-contained cartridge, the need has existed to provide the shooter with protection against escaping gases — usually caused by excessive headspace, leaky primers, and/or high chamber pressure. Such escaping gas or blowback, if not diverted, could travel down the length of the firing pin and directly into the eye of the shooter.

Gas ports are therefore always engineered into the modern rifle.

The Mauser 98 left little room for improvement. Two gas ports, oblong shaped, appear on the left side of the bolt and extend into the firing pin hole. While most escaping gases exit through these apertures, any gases traveling along the outside of the bolt would be diverted to the side by the shield-like design of the forward bolt sleeve.

The Springfield 1903 originally had one, scarcely adequate gas port. In 1934 an additional port was added and gas venting was then very similar to the system used in the earlier P-17 Enfield. See Figure 33.

Such relatively high-pressure actions as the Apollo and Weatherby (see Figure 34) utilize a number of gas ports along the side of the bolt, as does the Schultz & Larsen rifle.

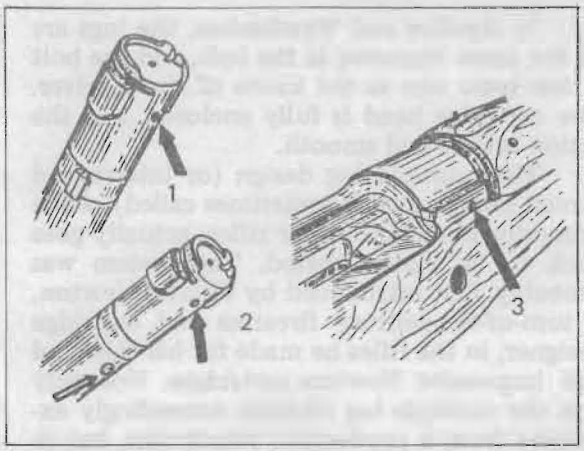


FIGURE 33 — Gas escape ports. Early Springfields (1) had only one gas port; later models incorporated a second port, similar to the Enfield (2). Excess gas is then exhausted through the receiver port as shown in (3).

FIGURE 34 — Weatherby Mark V, showing triple gas ports in the side of the bolt.

Safeties, Bolt-Action Rifles

There are generally three types of safeties employed: (1) those which disconnect the striker as in the Apollos and Weatherbys; (2) those which lock the striker as in the original and commercial Mausers; and (3) a type that should be banned altogether (usually found on cheap .22's), which merely locks the trigger and prevents its being pulled. The latter isn't really a safety at all, as a heavy jolt can jar the striker or the hammer off the sear, causing accidental discharge.

Manufacturing Bolt-Action Rifles

In older rifles, the receivers were usually forged from solid steel billets. Current production methods incorporate investment castings in which the metal is formed to tolerances that eliminate practically all machining and millwork. This process is not only cheaper, but the molecular structure of the steel is such that investment castings are much stronger than those forged from metal blocks. No internal stress is set up within the receiver, such as that caused by forging and metalworking.

Bolt-Actions Made in Several Lengths

Today there are basically three different lengths of bolt-action designs — short, medium, and "standard" — plus the comparatively new magnum-length action.

The original Model 93 and Model 98 Mausers and their progeny, the 1903 Springfield and Patterns 14 and 17 Enfield, were all designed for such "standard-length" cartridges as the 7mm and 8mm Mauser, .30/06, and .303 British.

Early sporter versions of the basic Mauser action by Winchester and Remington (among others) were also designed to handle "standard-length" .30/06 and .270 Winchester cartridges, which could be loaded to an overall length of about 3.25".

With the advent of new and shorter cartridges such as the 250-3000 and 300 Savage, some manufacturers used the standard action with a short magazine and spacer block; other gunmakers tooled up for new short-length actions in the interest of faster, smoother feeding, lighter weight rifles.

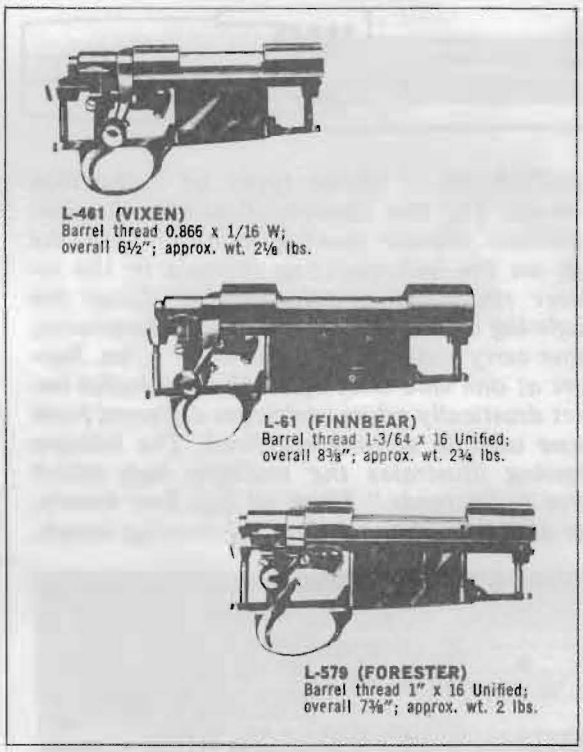


FIGURE 35 — Sako is but one of many manufacturers who make essentially the same action in different lengths for specific length cartridges. In addition to the three actions shown, Sako also makes a long magnum version.

Generally, major manufacturers of actions (such as Sako and BSA) now produce three different lengths of actions:

— a *short* version with a 2.3" or thereabouts magazine for the .222 Remington, .22 Hornet, etc.

— a *medium* version with a magazine of about 3.2" for .308 and .243 Winchester length cartridges.

— a *standard* or long-length action for the .30/06 and such short magnums as the 7mm Remington magnum and .264, .300, and .338 Winchester magnums, all of which are limited to 3.25" to 3.30" overall length.

Interestingly, when the age of magnums dawned and new, wider-diameter brass became the order of the day, the old standard-length action was used almost universally, requiring bullets to be deep-seated to fit the magazines (see Figure 36). By filling much of the "boiler room" with bullet rather than powder, the performance potential of the new cartridges suffered. However, the powers that be evidently decided that some velocity could be sacrificed in the interest of economy — the economy of not having to undergo expensive retooling for a long-magnum action.

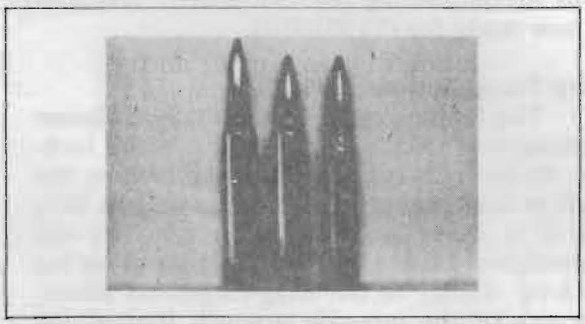


FIGURE 36 — "Standard-length" actions often require deep bullet seating. The .300 Apollo (left) and .300 Winchester magnum (center) utilize the same case and are shown with identical 180-grain bullets. The .300 Winchester magnum has the same overall length as the .30/06 cartridge (right) — 3.30". The Apollo measures 3.60" overall and holds more powder for greater velocity.

As such, all the new magnums — 7mm Remington, .264, .300, and .338 Winchester — all have cartridges measuring a maximum overall length of 3.25" to 3.30".

The Remington 721 rifle has a true long-magnum action, with the magazine capable of accepting long 3.60" overall cartridges. Nonetheless, the rifle is still throated for the short standard-length magnum cartridges. If bullets were seated to the maximum length permitted by the magazine (3.60") and throated proportionately, more powder could be added — providing a substantial velocity increase without increasing chamber pressure.

The new magnum long actions are best represented by the Apollo and Weatherby rifles, which permit optimum bullet seating (about 3.60" overall) for their long and powerful cartridges.

Of the military actions, only the Pattern 14 Enfield can be converted relatively easily to long-magnum length, requiring only minor bolt face alteration.

A few commercial long-magnum actions are also available, but the wait is usually long and the cost prohibitive. Previously a long Mauser action known as the Brevex, made in France, was manufactured — primarily for such heavy African cartridges as the .375 H&H magnum, the .416 Rigby, and the .505 Gibbs. The cost was high, from $750 to $1,000.

Before going on, please do Programmed Exercise 3-2. Make sure you write your answers on a separate sheet of paper before looking at the answers on the page specified.

PUMP-ACTION RIFLES

The familiar pump "trombone" or slide-operated rifle has been popular ever since Colt introduced the "Lightning," well before the turn of the century (see Figure 37). It was, however, made for low-power cartridges, the rimmed blackpowder .25-20 and .32-20, and it never gained wide acceptance.

The first really successful pump rifle was the Remington Model 14 of 1912 (see Figure 38), which was chambered for smokeless cartridges of higher intensity — rimless versions of the .25-35, .30-30, .32 Special, and .35 Remington. (All but the .35 are now obsolete.) Later the Model 14 was equipped with a different stock and tagged the Model 141, which was in continuous production until World War II.

The popularity of the pump rifle followed the tremendous acceptance of the pump shotgun, notably the Winchester 97. Hunters accustomed to their fast-firing fowling pieces found the transition to a rifle with the same action easy and pleasant. And the pump action *is* fast — providing quicker follow-up shots (except in the prone position) than any action but the auto-loading.

The Model 14 (and 141) overcame the principal objection to most pump rifles: a tubular magazine that required blunt bullets to avoid recoil-caused detonation in the magazine. Remington's fluted or spiral tube effectively offset cartridges so that the tip of one didn't rest on the primer of the next in line. For the first time, pointed Spitzer-type bullets could be used in tubular magazines.

PROGRAMMED EXERCISE

2

1. The popular Model 1893 Mauser became the remarkable "Mauser 98" with what three improvements?

2. From smallest to largest length, what are the four bolt-action sizes currently in use?

3. The multiple lug locking system adds bolt chamber locking area and shortens bolt lift. What are the advantages resulting from each of these modifications?

4. List the sequence of the seven basic functions of a bolt-action.

5. Designate whether each of the following firearms operate with lever-action or bolt-action by placing a B or L in the space provided.

   ____ Dreyse Needle Gun
   ____ Volcanic rifle
   ____ Krag Jorgenson rifle of Sweden
   ____ Henry Repeater
   ____ Winchester Model 1895
   ____ Model 98 Mausers
   ____ Springfield 1903
   ____ John Moses Browning designs
   ____ Sako Finnwolf
   ____ Savage 99
   ____ Winchester 88
   ____ Marlin 336

6. Place a check in the blank in front of each bolt-action firearm that would be suitable for magnum conversion.

   ____ Enfields
   ____ Arisaka (Japanese)
   ____ Springfields bearing a serial number under 800,000
   ____ Mauser models

Answers on Page 21

Following World War II, Remington discontinued the Model 141 and brought out the present Model 760, the first and only slide-action rifle designed for such high-intensity cartridges as the .30/06, .270, and .280 Remington. The old tubular magazine was replaced by a more efficient detachable box type.

Today pump rifles are manufactured for all but magnum cartridges. There are a number of .22-caliber rim-fire versions, including the Remington 572 and Winchester 270. The Savage Model 170 accommodates the venerable and still popular .30-30.

Sequence of the Seven Functions in Slide-Action Rifles

In slide-action rifles, the bolt or breech block is moved forward or back by manipulating the forearm, which is attached to the bolt assembly by one or two action bars, depending on the firearm. The sequence in the Remington Model 760 and most pumps is as follows (see Figure 40):

As the forearm is pulled to the rear (after firing or manual release of the action lock), it (1) UNLOCKS the action, then (2) EXTRACTS, and at the end of the movement (3) EJECTS the cartridge. As rearward bolt travel stops, the hammer is (4) COCKED. When the forearm is moved forward, the bolt strips the cartridge from the magazine, (5) FEEDING it into the chamber. In the final forward motion, the bolt rotates and the lugs are engaged, thus accomplishing (6) LOCKING. The rifle is now ready for (7) FIRING.

How Pump-Actions Lock Up

The Remington 760, essentially a Mauser turning-bolt design, has a multiple lug lock-up. As the bolt is seated it turns, locking the lugs in the receiver. Other pump-actions lock up in a variety of different ways. The old Remington 14 and 141 employed a single lug lock-up similar to the Krag-Jorgenson which, because of the one-side support, limited the action to pressures of not higher than 42,000 psi (.30-30 class).

.22-Caliber Pump-Action Rifles

Pumps in .22-caliber rim-fire, because of low chamber pressure, do not need locking systems or lugs requiring great strength. In some instances the rear of the bolt or breech block is angled to fit into an angled recess at the top rear of the receiver as in the Savage 99 discussed previously; or the front of the bolt is raised to fit into a matching recess in the top front of the receiver; or the breech block is made in such a way that it moves up or down with "ears" matching mortises (grooves) in the receiver, such as in the old Winchester Model 62 (see Figure 41) and in the Winchester and Marlin lever-actions illustrated earlier.

Disadvantages of Pump Rifles

Some detractors claim that the pump,

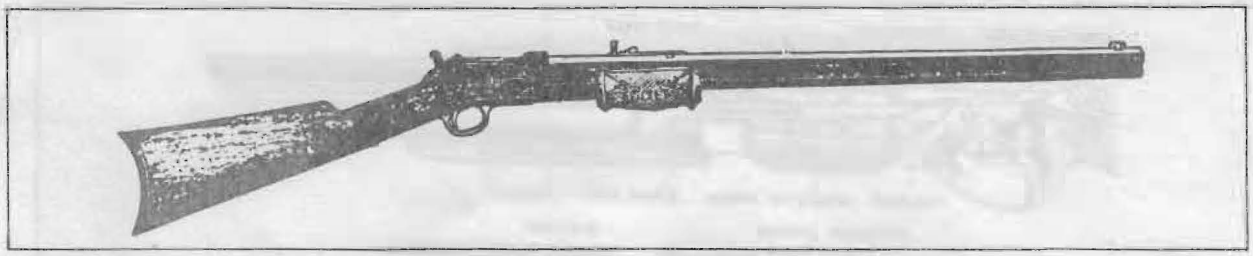


FIGURE 37 — The famous Colt "Lightning," considered the first pump rifle. Manufactured from 1895 to 1900.

FIGURE 38 — Remington Model 14.

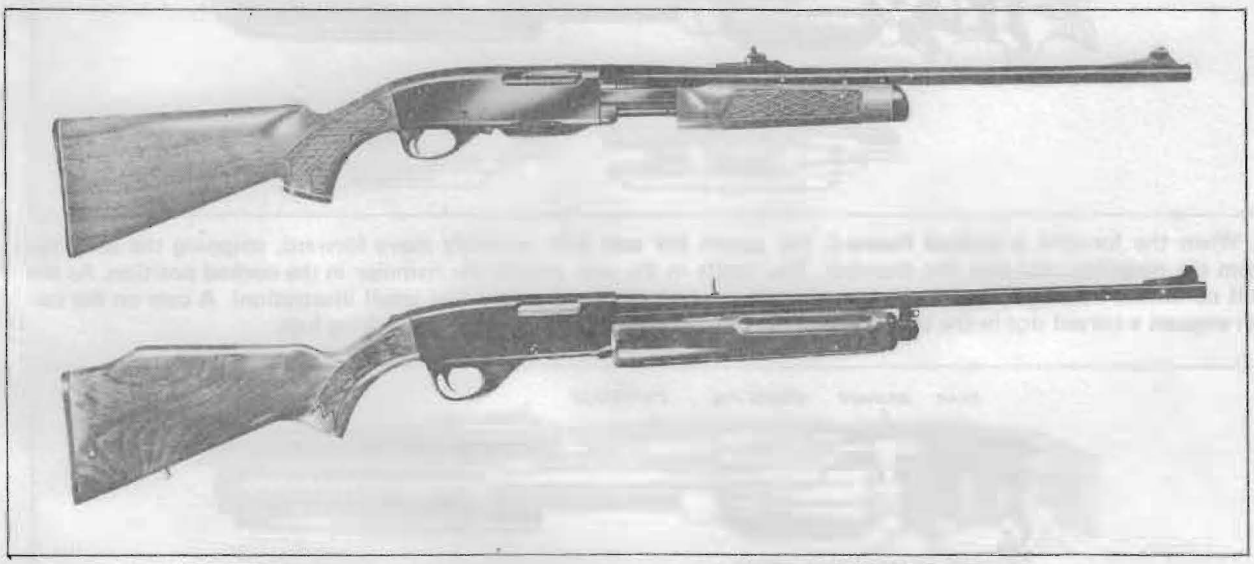
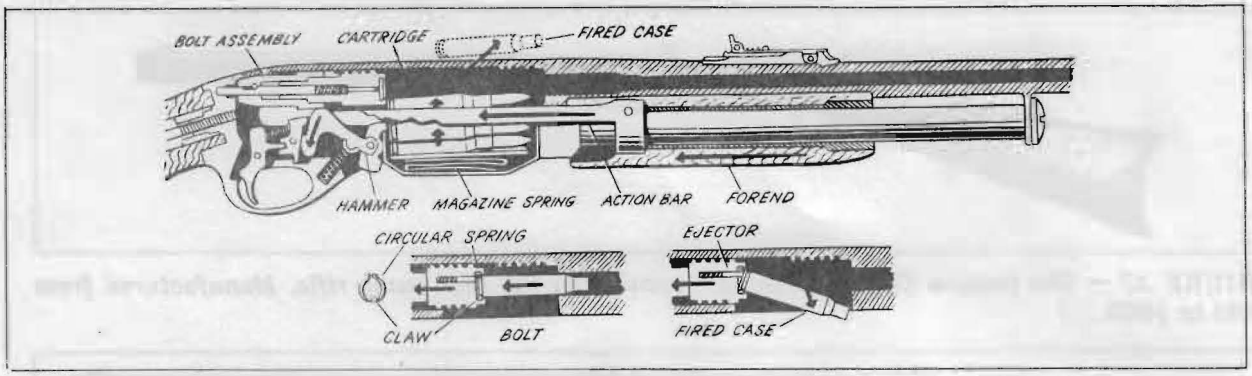


FIGURE 39 — Modern pump-action rifles. The Remington 750 "Gamemaster" (top) is the only slide-action rifle to handle such high-intensity cartridges as the .30/06, .270, .308, etc. The Savage 170 (bottom) accommodates the low-pressure, but still popular .30/30.

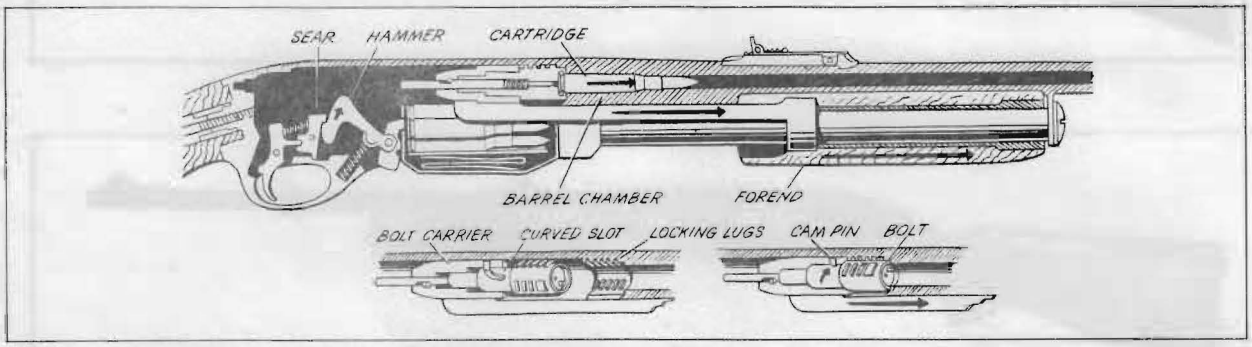
due to its two-piece construction, is not as accurate as the bolt-action rifle with its one-piece stock. This is largely true. However, most pump rifles are sufficiently accurate for the purpose intended. A big game rifle should keep its shots in a three-inch circle at 100 yards, six inches at 200 yards, etc. Most center-fire pumps will do that well, and usually better. Such guns in the .22 rim-fire class are sufficiently accurate for small game or plinking, which are really their only functions.

A particular disadvantage is that most pumps are of the hammerless design, thus depending upon a safety which locks only the trigger and *not* the hammer. This type of "safety" can allow the gun to fire inadvertently if dropped on a hard surface. Another undesirable feature of all .22-caliber rim-fire rifles with tubular magazines becomes apparent when bullet lubricants pick up dirt and grit. Dirt eventually causes the magazine to operate in a sluggish or sticky manner, leading to failure to feed.

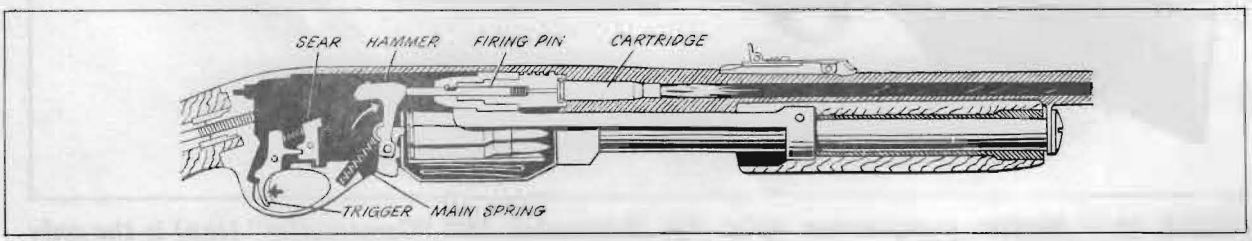
Not long ago, for example, a hammerless .22 pump rifle was seized in the commission of a crime and was ordered forfeited to the state. This particular gun, after unloading, had been "dry-fired" at least 200 times by various officials. One day it was taken from the rack in the police armory and leveled out the win-



1. As the forearm is moved to the rear, the action bar and bolt assembly are pushed backward, simultaneously pressing the hammer downward and ejecting the fired case. A "loop" spring with a claw in the face of the bolt (see small lefthand drawing) hooks under the rim of the cartridge and extracts it from the chamber. When the case clears the chamber, the case is flipped clear by the ejector spring in the bolt. The magazine spring then pushes a new cartridge upward.



2. When the forearm is pushed forward, the action bar and bolt assembly move forward, stripping the cartridge from the magazine and into the chamber. The notch in the sear retains the hammer in the cocked position. As the bolt continues moving forward, the bolt threads contact the locking lugs (see small illustration). A cam on the carrier engages a curved slot in the bolt, causing the bolt to turn and thread into the locking lugs.



3. Pulling the trigger causes the trigger sear to disengage from the notch on the hammer, permitting the mainspring to drive the firing pin against the cartridge primer. (In the interest of clarity, the safety lock and disconnector are not shown in this illustration.)

FIGURE 40 — Inner workings of a modern pump-action rifle, the Remington Model 760. (Drawings courtesy "Complete Book of Rifles and Shotguns" by Jack O'Connor)

FIGURE 41 — The Winchester Model 62, one of the first pump .22's, a collector's item today.

dow. The "shooter" pumped the action, then pulled the trigger, remarking, "I had one just like this when I was a kid." At this point the rifle fired, sending a bullet into crowded downtown Los Angeles. Fortunately, no one was hit. The cartridge had remained in the clogged magazine for at least four months, despite frequent pumping of the action. Which proves one thing — it never pays to take anything about guns for granted.

It behooves anyone dealing with firearms, either owning them or repairing them, to be sure that all tubular magazines are cleaned periodically and that the springs are in good condition and will not jam up or fail to push cartridges onto the carrier.

Advantages of Pump Rifles

Most pump guns manufactured today are of the so-called hammerless variety with the hammer shrouded within the receiver. The clean lines of these rifles, most with ejection ports on the sides, lend themselves admirably to mounting of scope sights directly over the bore. Rim-fire versions usually have a dovetail milled into the receiver top, permitting the use of a low-powered, inexpensive scope without the cost or bother of purchasing a scope mount base.

A major factor in the pump gun's favor is that a shooter, particularly the lefthanded variety, can own both high and low-powered rifles and shotguns, with the same familiar and fast action. And the pump-action is *fast* — exceeded only by the semi-automatic.

ANSWERS

2

1. A recoil lug was added for strength; the cocking piece was shrouded to protect the shooter from escaping gases; cocked on opening.
2. Short, medium, standard, magnum.
3. Increased strength — from increased bolt chamber area; faster repeat shots and scope bell clearance — from shorter bolt lift.
4. Unlock, extract, eject, feed, lock, cock, fire.
5. B, L, B, L, L, B, B, L, L, L, L, L.
6. Enfields and Arisaka.

Owning a bolt-action deer rifle, a lever-action .22, and perhaps a pump shotgun is asking for confusion and trouble. More than one deer hunter, accustomed to his "trombone" shotgun, has vainly "pumped" his new bolt-action while a trophy buck streaked for cover.

SEMI-AUTOMATIC RIFLES

World War II did for the semi-automatic rifle what World War I accomplished for the bolt-action repeater. Large numbers of men, accustomed to bolt and lever-actions, gained respect for the semi-automatic rifle through use of the M1 Garand and M1 carbine. Today the "old" Garand is all but obsolete, yet it paved the way for several center-fire (including magnum variety) semi-automatic rifles plus a myriad of .22 rim-fire designs.

Probably the first "example" of a true auto-loading design was the brainchild of John Moses Browning. He mounted a paddle to the front of a Winchester Model 73 rifle and linked it to the lever mechanism (see Figure 42). The force of gases exiting from the muzzle pushed the paddle, thereby operating the 73's lever "automatically." From this basic start, Browning eventually invented several different types of semi-automatic mechanisms which were incorporated in his shotgun and machine gun designs.

The basic difference between an auto-loading firearm and other designs is that of the seven functions, only one of which is performed manually — firing. The other six are done automatically, permitting the shooter to concern himself only with aiming and squeezing the trigger. For this reason, semi-automatic sporting firearms, usually referred to by the misnomer "automatics," are quite popular. A succession of shots is seldom necessary in the game field, but the relative ease of operation and knowing those follow-up shots are there has "sold" the self-loader to many hunters.

There are three basic groups of semi-automatic designs:

1. Gas-operated.
2. Recoil-operated.
3. Blowback.

Gas-Operated Design

The most familiar type of self-loading or semi-automatic action is the gas-operated; there are two subdivisions of this type: (1) the long-stroke system, and (2) the short-stroke system. The M1 Garand (see Figure 43) and the M1 carbine (see Figure 44) of World War II, both gas-operated, are examples of

FIGURE 42 — Browning's first semi-automatic experimental rifle (top) was gas-actuated by the muzzle blast. His second experimental rifle channeled the gases to a piston (rather than a paddle) which activated the mechanism.

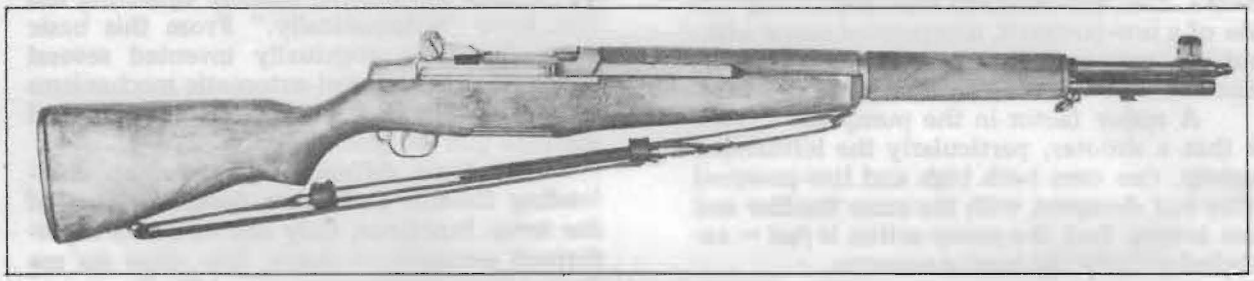


FIGURE 43 — U.S. Rifle Cal. .30 M1 (Garand).

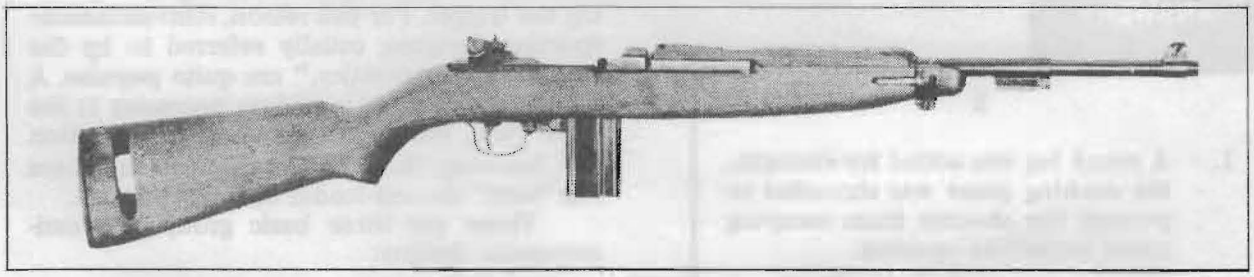


FIGURE 44 — U.S. Carbine Cal. .30 M1.

each type. The Garand uses a long-stroke system in that gas vented off near the muzzle activates a piston with a *long* operating rod which in turn activates the action.

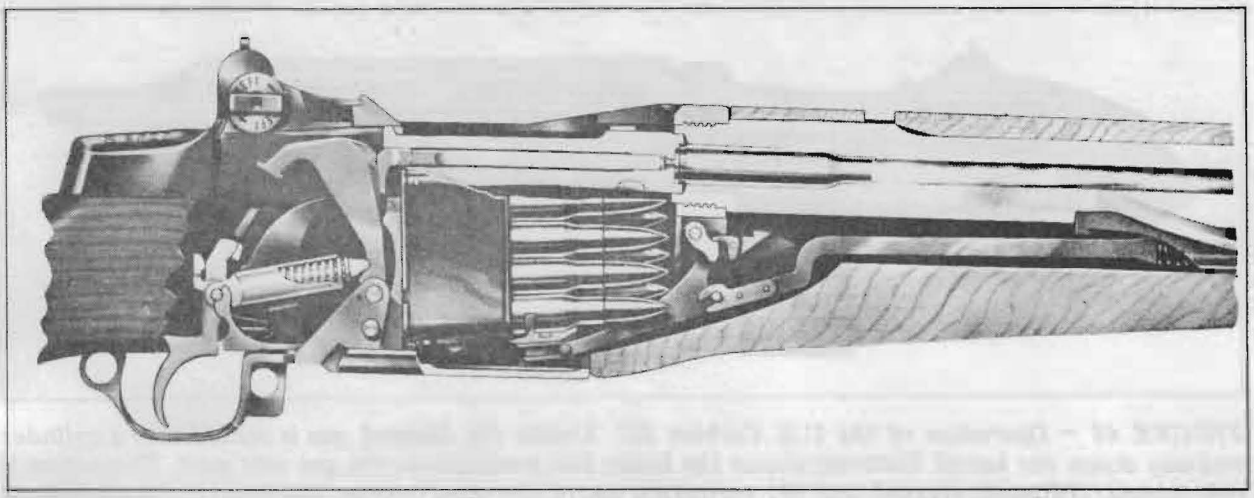
In the short-stroke gas system, such as is used in the M1 carbine and many modern auto-loaders, the gas is vented through a port midway down the barrel and into a gas cylinder where it activates a short-stroke piston moving only about a quarter of an inch. The short movement of this piston is transmitted to an operating rod or arm which then opens and operates the bolt.

In all gas-operated semi-automatic arms, the action is opened by the force of the explosion (gases), and is closed by strong springs which were compressed by the gas.

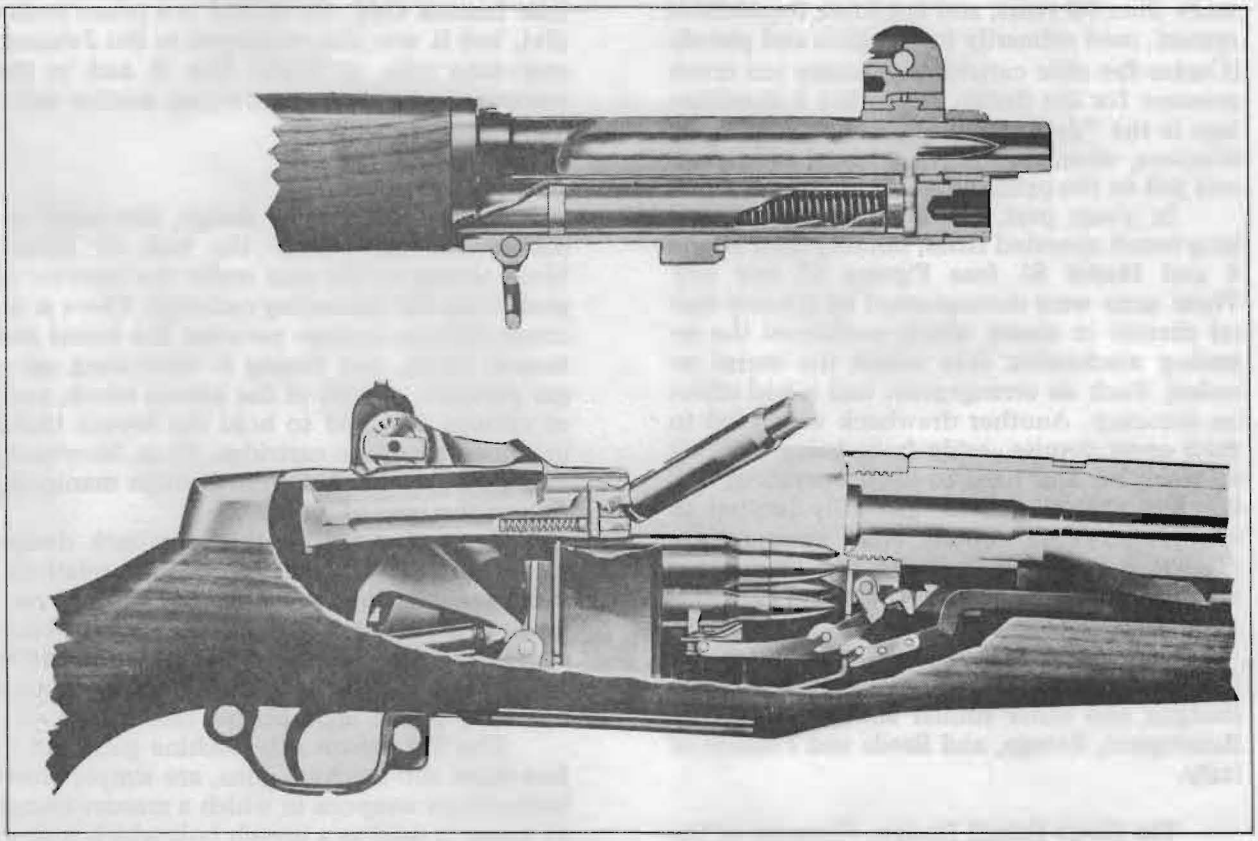
Recoil-Operated Design

The second type of semi-automatic operation is by recoil, and there are two types — long recoil and short recoil.

The Long-Recoil Design. Long recoil is so called because the barrel and bolt (breech block), securely locked together, recoil farther



1. Exploded view at moment of firing. The hammer has been driven forward by the spring within the plunger tube, thus driving the firing pin into the primer. The action is still locked. The bullet is still in the barrel (see inset below) and gas behind the bullet is entering the gas vent port where it will activate the piston.



2. The bolt has been unlocked and driven back by the operating rod. The spring-loaded ejector pivots the fired case out of the rifle. The hammer has been forced back and cocked and a new cartridge rises into position for chambering. The bolt assembly, rebounding forward against spring tension, will strip off and chamber the next cartridge.

FIGURE 45 — Operation of the Garand.

than the length of the cartridge — usually three to four inches. The bolt is temporarily locked at the rear of the action while the barrel, under the impetus of compressed springs, moves forward. The fired case, secured to the breech bolt by the extractor, is ejected when the barrel starts its forward motion. Upon return to battery (firing position), the barrel trips a lever which unlocks the breech bolt. The bolt then moves forward, picking up a new cartridge and chambering it as the bolt slams home.

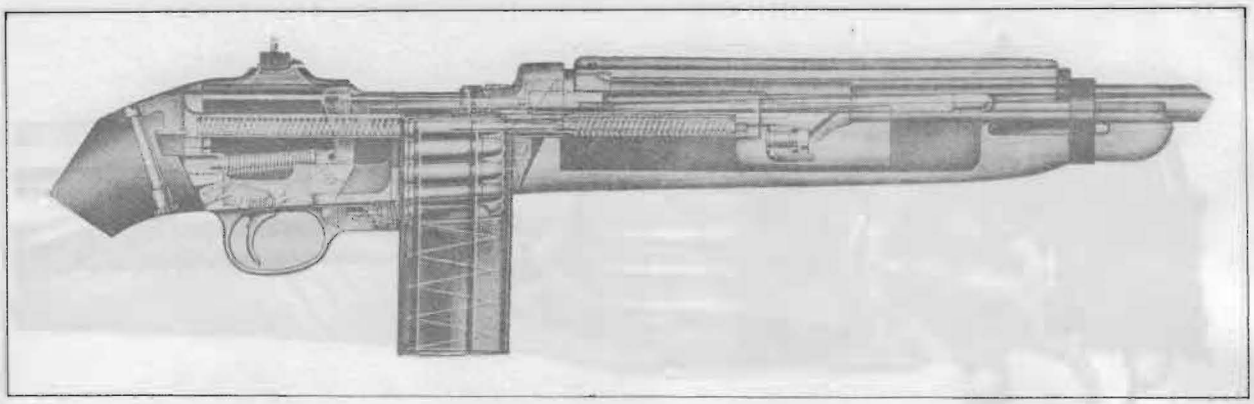


FIGURE 46 — Operation of the U.S. Carbine M1. Unlike the Garand, gas is vented into a cylinder midway down the barrel. Cutaway shows the bullet just passing over the gas vent port. The action is still locked. Although Garand and M1 cartridges are of the same caliber, the cases and ballistics are vastly different.

The long-recoil design has been in use for more than 50 years, and is a solid, dependable system, used primarily in shotguns and pistols. (Center-fire rifle cartridges generate too much pressure for the design principle.) A disadvantage is the "double slam," annoying to many shooters, when the recoiling barrel adds a second jolt to the primary recoil.

In years past, Remington made several long-recoil operated rifles, notably their Model 8 and Model 81 (see Figures 47 and 48). These arms were distinguished by a heavy barrel shroud or sleeve which contained the arresting mechanism into which the barrel recoiled. Such an arrangement had a bad effect on accuracy. Another drawback which led to their early demise, aside from being difficult to work on and hard to keep operating, was the fact that they were generally limited to medium-powered .30-30 class ammunition. (The Model 81, however, was also chambered for the .300 Savage, a more powerful cartridge approximating early .30/06 performance.)

Arms of the long-recoil design are the familiar "Hump Back" Browning auto-loading shotgun and other similar shotguns made by Remington, Savage, and Breda and Franchi of Italy.

The Short-Recoil Design. Firearms of the short-recoil design also incorporate the breech bolt locked-to-barrel system of the long-recoil design in which the bolt and barrel recoil together when the gun is fired, thus compressing a recoil spring. However, the barrel stops moving after only a short distance (1/4" to 3/8") and unlocks from the breech block. Gas pressure and inertia then carry the breech block fully to the rear until stopped by a buffer spring. The breech block rebounds forward, picks up and chambers the next cartridge, and is ready for firing.

This system is usually used in handguns (the famous Colt .45 M1911 is a prime example), but it was also employed in the Johnson semi-auto rifle of World War II and in the comparatively recent Browning double automatic shotgun.

Blowback Design

In the "blowback" design, the barrel remains stationary while the bolt or breech block moves to the rear under the impetus of push from the exploding cartridge. There is no connection or linkage between the barrel and breech block, and timing is dependent upon gas pressure, weight of the breech block, and/or springs designed to hold the breech block in place against the cartridge. Thus, blowback-operated systems function through manipulation of the laws of inertia.

Arms that utilize the blowback design are usually low-powered, requiring a relatively short breech block movement. The only center-fire rifles that come to mind of blowback operation are Winchester's semi-automatic .351 and .401-caliber models which were used by many police departments (see Figure 49).

The Thompson sub-machine gun, and in fact most sub-machine guns, are simple blowback-design weapons in which a massive chunk of metal is used as a breech bolt which is driven rearward by the force of the burning gases. Since the breech bolt is quite large, substantial inertia (the tendency of a body at rest to remain at rest) must be overcome. By the time the bolt starts to move to the rear and allow gas to escape, the bullet is already out of the barrel. Moving forward, the bolt cocks the action, then picks up and chambers a fresh cartridge.

Some blowback semi-autos, when incorrectly assembled or with badly worn parts, can fire fully automatic — constituting dan-

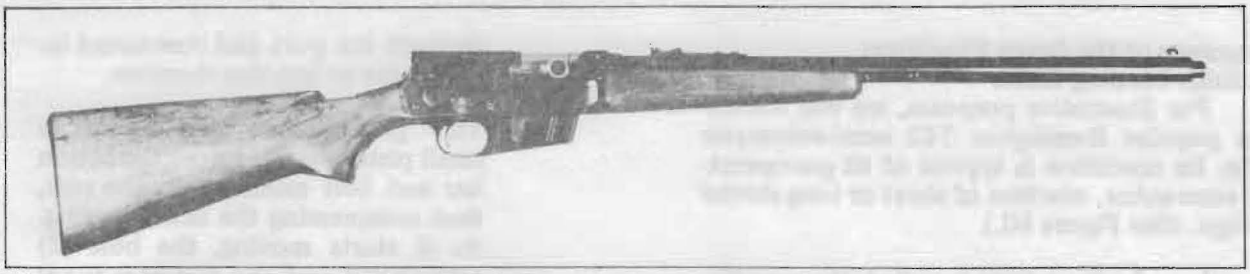


FIGURE 47 — The Remington Model 81A.

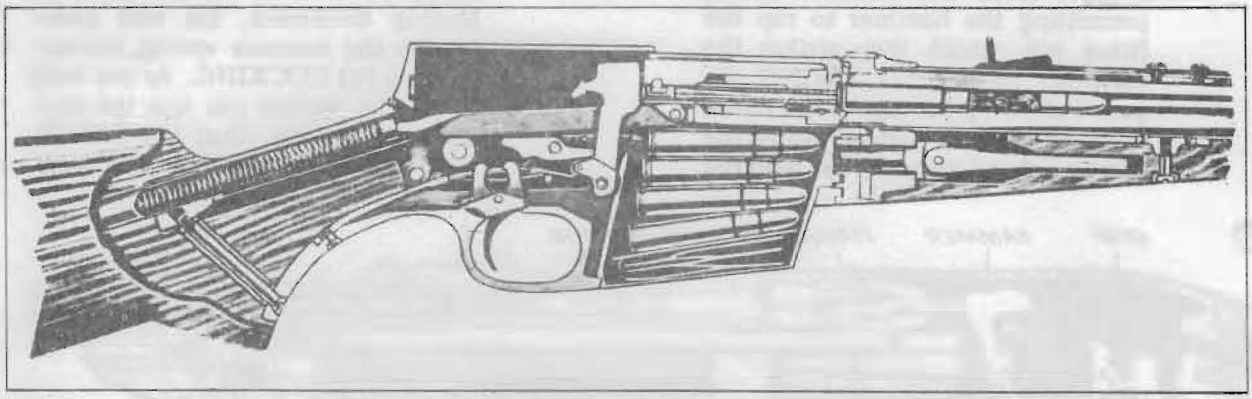


FIGURE 48 — Cutaway view of the Remington Model 8 at the moment of firing. This rifle was also designed by John Moses Browning.

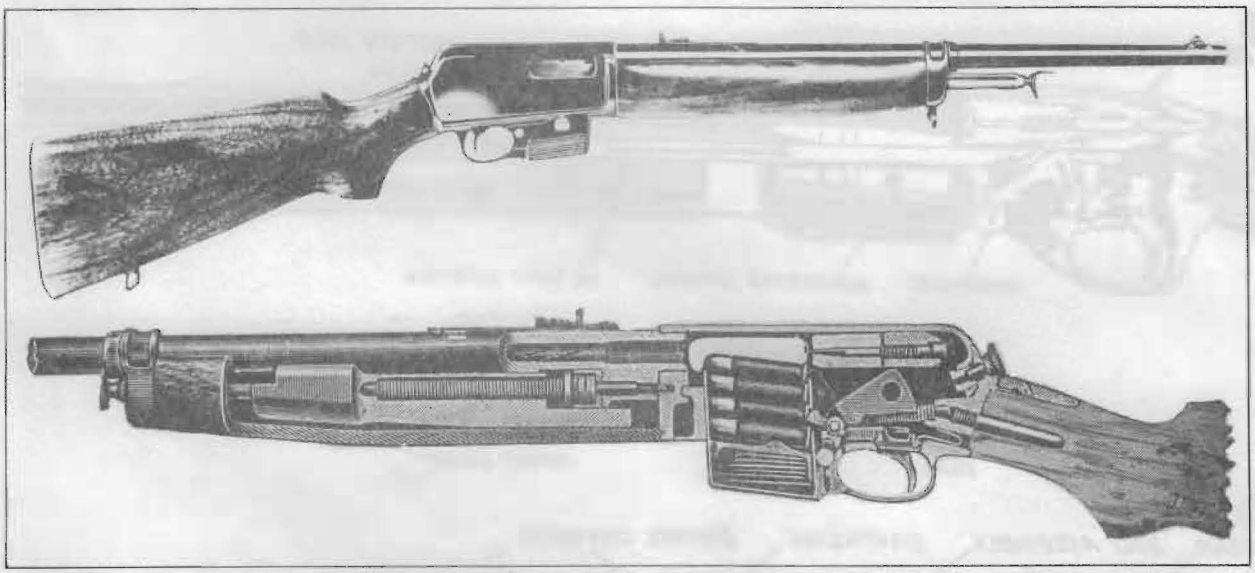


FIGURE 49 — Winchester semi-auto rifle of blowback design in .401 caliber. Designed by T. C. Johnson.

gerous and highly illegal firearms. Most, however, incorporate a "disconnector" which holds the hammer back and prevents it from following the barrel to firing position, thus making a separate trigger pull necessary for each shot.

The seven firearm functions operate the same with blowback-operated firearms as they do when the gun is gas-operated. Most .22 rifles in semi-automatic design are blowback-operated, as are most low to medium-powered handguns. This system has not been found practical for high-powered rifles since the comparatively large breech bolt required would result in an unbelievably cumbersome, unwieldy, and heavy rifle. It has been calculated that a .30/06 of blowback design would require a breech block weighing about 27 pounds!

Sequence of the Seven Functions in Auto-Loading Rifles

For illustrative purposes, we will discuss the popular Remington 742 semi-automatic rifle. Its operation is typical of all gas-operated semi-autos, whether of short or long-stroke design. (See Figure 50.)

1. As the trigger is pulled, the sear disengages from the hammer notch, permitting the hammer to rap the firing pin, which then strikes the cartridge primer, (1) FIRING the gun. Following passage of the bullet over the gas port midway down the barrel, expanding gases are metered through the port and downward into the gas or impulse chamber.

2. This gas pressure acts against a small piston which forces the action bar and bolt assembly to the rear, thus compressing the action spring. As it starts moving, the bolt (2) UNLOCKS and the cartridge is (3) EXTRACTED from the chamber. Moving backward, the bolt compresses the hammer spring, accomplishing (4) COCKING. As the bolt stops, the ejector pin tips the case from the action, thus (5) EJECTING the fired cartridge. The path

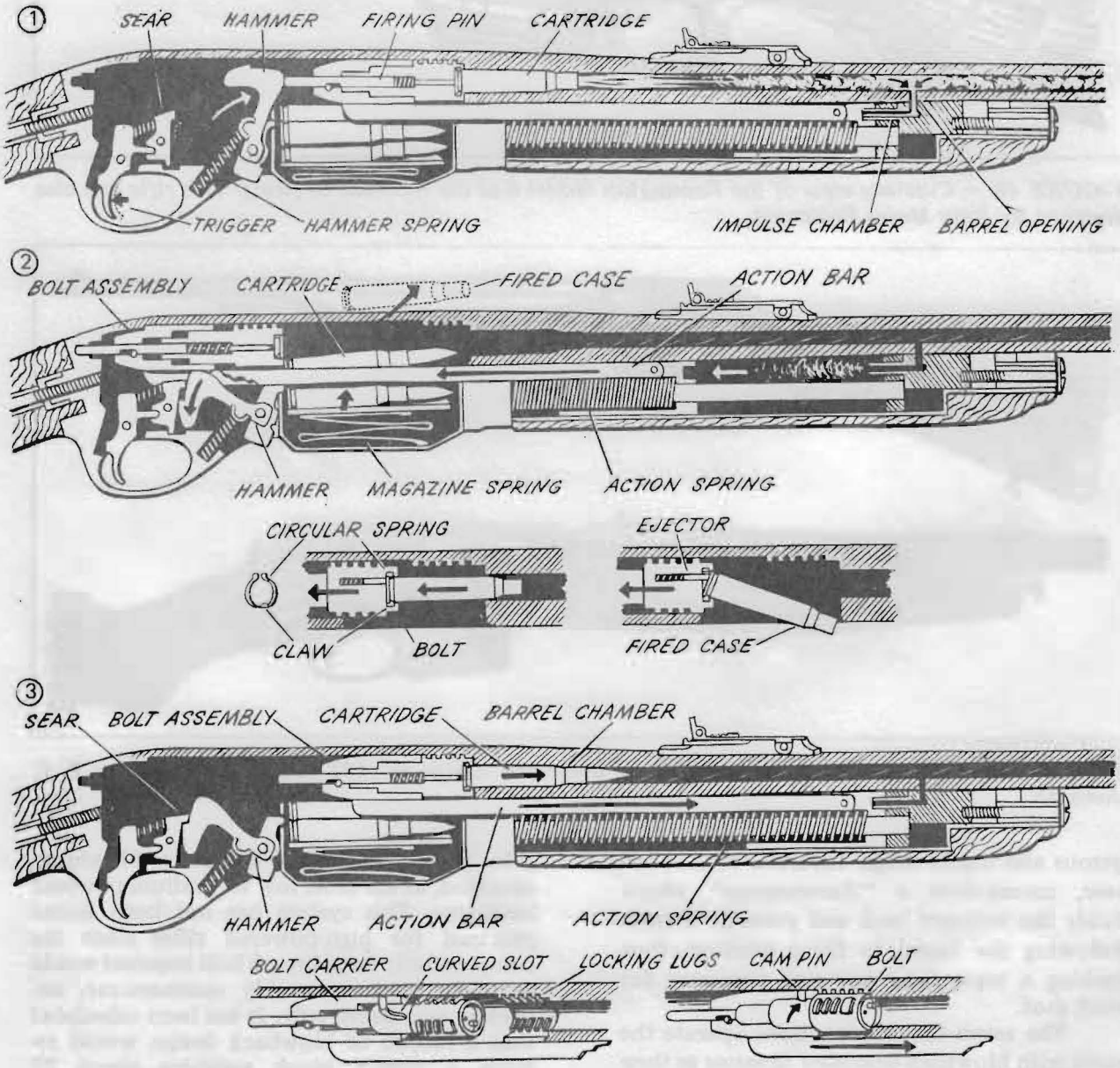


FIGURE 50 (drawings courtesy "Complete Book of Rifles and Shotguns" by Jack O'Connor)

has been cleared for the next cartridge which, under pressure of the magazine spring, has risen into feeding position.

3. The compressed recoil spring now forces the bolt forward. It strips the in-position cartridge from the magazine and forces it into the chamber, thus (6) FEEDING. As the bolt closes firmly, the lugs rotate, (7) LOCKING.

The sequence is repeated automatically following each manual trigger let-off.

Winchester's semi-automatic sporter, the Model 100, has a unique self-metering gas system (within the cylinder) which incorporates a cup-shaped piston facing the muzzle of the rifle. This cup has a small hole that matches up with the vent hole in the barrel. After sufficient expanding gases have entered the two matching holes to operate the action, the piston cup moves to the rear and cuts off the gas "supply." This self-metering device eliminates "pounding" and makes for a smoother operating action.

The new Browning semi-automatic sporting rifle, first marketed in 1967, has an operating mechanism very similar to that of the M1 carbine in which a short-stroke piston operates the action system (see Figure 51).

By way of contrast, the M1 Garand takes its gas from a port very close to the muzzle. It was originally thought that the lessened gas pressure at that point would exert a longer, slower push against the piston and minimize "slamming." A long operating rod was, of course, required — which caused other problems and has been done away with in more recent designs.

Before going on, please do Programmed Exercise 3-3. Make sure you write your answers on a separate sheet of paper before looking at the answers on the page specified.

PROGRAMMED EXERCISE

3

1. Place a checkmark in the blank before each firearm advantage which applies to the pump-action rifle:

   ___ Allows fast follow-up shots.
   ___ Accommodates magnum cartridges.
   ___ Is an easy transition from the popular pump shotgun.
   ___ Shoots more accurately than a bolt-action.
   ___ Accommodates a superior style of safety.
   ___ Easy, safe feeding is assured by the tubular magazine.
   ___ Most designs allow excellent mounting of various scope sights.

2. Name the sequence of the seven basic functions in a pump-action.

3. Which recoil system is most commonly found in handguns? In submachine guns? In shotguns?

4. Some blowback semi-automatics can be extremely dangerous. Why?

5. Name the sequence of the seven basic functions in a semi-automatic operation.

Answers on Page 28

SINGLE-SHOT ACTIONS

Few rifle enthusiasts today give more than a passing thought to how greatly the "lowly" single-shot breech-loading rifle influenced and changed the course of history.

In the 1850's through the 1870's, the "new" breech-loaders, with their comparatively rapid reloading capability, provided military supremacy for many armies which faced (and defeated) other armies equipped with slow-firing muzzle-loaders.

The prairies of North America were swept clean of buffalo with powerful, long-range,

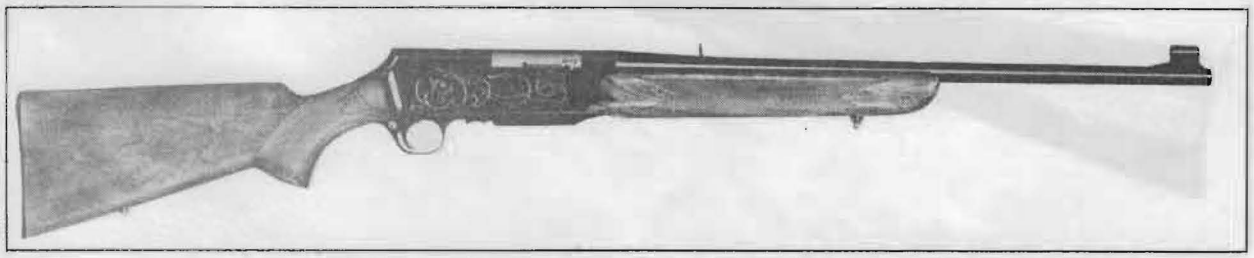


FIGURE 51 — Browning semi-automatic rifle, Grade II.

single-shot Sharps and Remington rolling-block rifles — some equipped with primitive, yet effective telescopic sights.

The Dropping (or Falling) Block Design

The direct ancestor of most modern single-shots was the Sharps rifle developed by Christian Sharps during the 1840's, when percussion ignition largely replaced flintlocks. The Sharps rifle was to single-shots what the Mauser was to bolt-actions. Sharps' dropping-block design, in which the breech block rose and dropped vertically in mortises milled in the receiver walls, was exceptionally strong and provided a perfect gas seal. Thousands of Sharps rifles, originally designed for breech-loading of paper bags containing powder and projectile which were sheared at the tail by the rising block (thus exposing powder), were successfully converted to metallic rim-fire and center-fire cartridges.

The Sharps rifle was also exceptionally accurate, giving rise to the term "sharpshooter" in describing the marksmanship of Union forces equipped with such rifles during the Civil War.

The original Sharps exposed-hammer design was followed by a number of hammerless (concealed in frame) variations, including the Sharps-Borchardt of 1870, the match-winning American Ballards, the British Farquharson, and the famous Stevens "Ideals."

Probably the best known of the Sharps progeny was the Winchester single-shot of 1879, one of John Browning's first designs sold to Winchester (see Figure 54). It was made in many different forms and for different cartridges, with the various designs known as high-wall, low-wall, thick-wall, and thin-wall (referring to receiver dimensions, of course).

Basically Lever-Action Single-Shots

All Sharps-inspired or derived designs were essentially single-shot lever-action rifles in that the action was operated by a pivoting trigger guard or lever behind the guard. When the breech block dropped by moving the lever forward, the chamber was exposed for loading the cartridge. After firing, extraction (and sometimes ejection) was also accomplished by opening and/or "snapping" the lever.

Today, perhaps because of the nostalgia craze, single-shots are again in big demand — from hunters and shooters wanting to "relive" the past and/or give game a better break.

Modern center-fire one-at-a-timers include the Ruger No. 1, similar in appearance to the handsome and venerable British Farquharson but greatly improved mechanically; the Browning single-shot, basically a modified Winchester Hi-Wall; and the New Riedl single-shot, which incorporates a unique rack and pinion activating system. Interestingly, while outwardly resembling a classic oldtimer, the Riedl incorporates an incredibly strong action and lock-up and is available in chamberings

ANSWERS

3

1. Choices 1, 3, and 7.
2. Unlock, extract, eject, cock, feed, lock, and fire.
3. Short recoil; blowback; long recoil.
4. Worn parts or arms incorrectly assembled can fire fully automatically.
5. Fire, unlock, extract, cock, eject, feed, and lock.

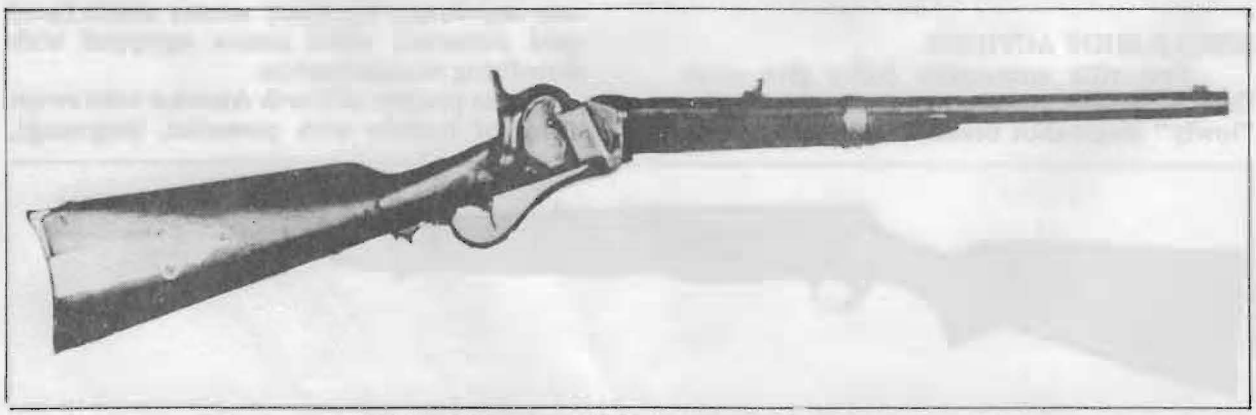
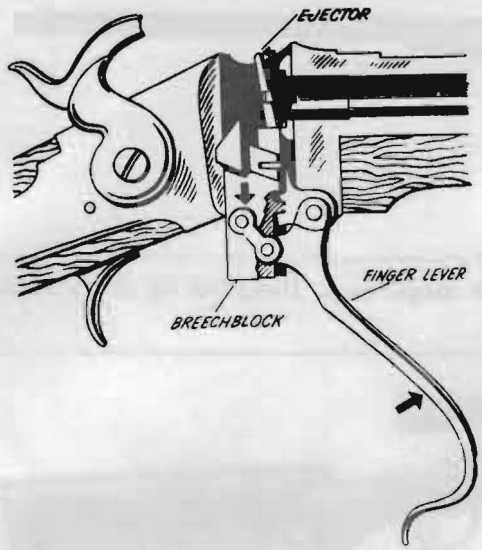
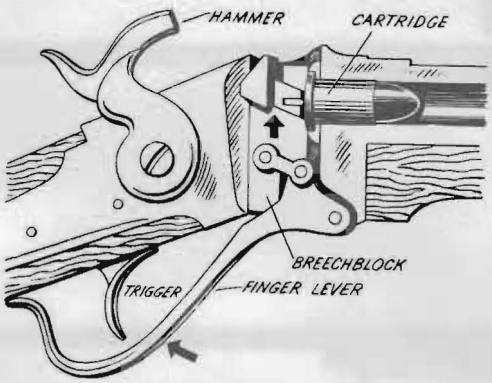


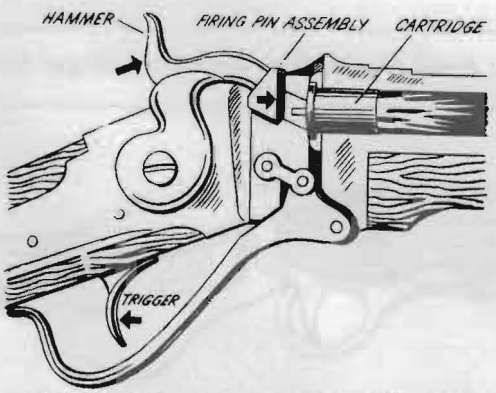
FIGURE 52 — U.S. Carbine, 1848, Sharps patent.



1. The finger lever is pushed forward, which drops the breech block, at the same time moving the ejector back – thus ejecting the spent case.



2. The rifle is then loaded manually. When the lever is raised flush with the stock, the breech block rises, locking the cartridge into the chamber. The trigger is cocked by thumbing back the hammer.



3. Pulling the trigger releases the hammer, which then strikes the firing pin assembly and detonates the cartridge.

FIGURE 53 — Inner workings of the Sharps action. (Drawings courtesy of "Complete Book of Rifles and Shotguns" by Jack O'Connor)

for the hottest performing magnum cartridges today.

The Tipping-Block System

Another great single-shot breech-locking principle was developed by Henry O. Peabody in 1862. Unlike the falling-block design in which the breech block moved up or down in mortises, the Peabody design employed a block hinged at the rear which, when activated by a lever, lowered the front edge, thus exposing the chamber (see Figure 56).

Because of the short lever throw, reloading was fast. Also, the Peabody was remarkably accurate. These features made the rifle desirable from a military standpoint, and thousands were purchased by the governments of Canada, Rumania, France, Denmark, Mexico, and many other countries.

Calibers Included .41, .43, .45, and .50 Rim-Fire

The Swiss, a nation of riflemen, were impressed with the Peabody's basic design and performance, but obviously didn't care for the large, exposed, manually-operated hammer. They hired a master mechanic, Frederich von Martini, and told him to "improve it." Martini did, and so brilliantly that the name and fame of Peabody were all but buried.

Martini dispensed with the exposed hammer. He added a lever arrangement that automatically cocked a concealed hammer when the action was opened; and a handsome lever to the rear of the trigger guard that replaced the original and ungainly full-pivot trigger guard (see Figure 57).

Martini sent his modified action to England for testing and consideration, where it was fitted with the then new Henry barrel system using a polygonal bore. The resulting rifle was known as the Martini-Henry and in .45-caliber was adopted as the British service rifle in 1871.

Old Martini actions are frequently used as the basis for fine single-shot sporters, usually chambered for such short cartridges as the .22 Hornet or .357 magnum. Mounting of a scope on such an action creates a problem because of the limited room for cartridge loading and extraction. The smaller one's fingers, the better.

The basic Martini action is also used today in some .22 rim-fire match rifles made by several European manufacturers.

Rolling-Block Design

Like the Peabody action which is best known as the Martini, the Rider rolling-block system was invented by one man, a Leonard Gieger, but became famous through the modi-

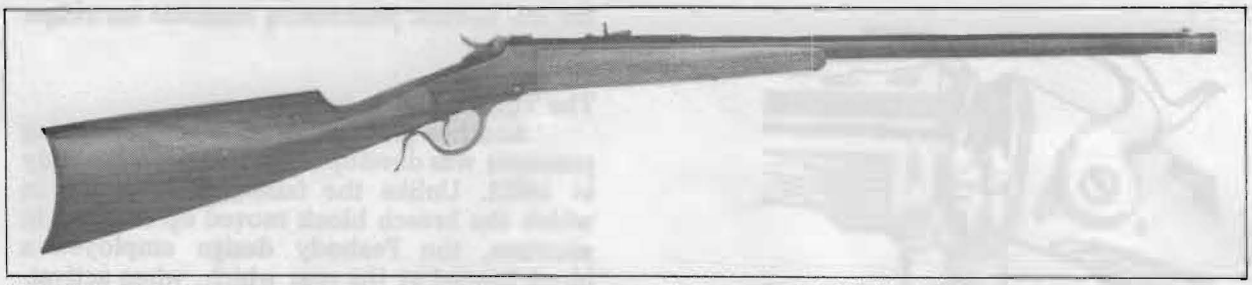


FIGURE 54 — Winchester's world-famous dropping-block single-shot. Designed by John Moses Browning.

FIGURE 55 — Three modern single-shot rifles. From top: Riedl classic, New Browning, Ruger No. 1.

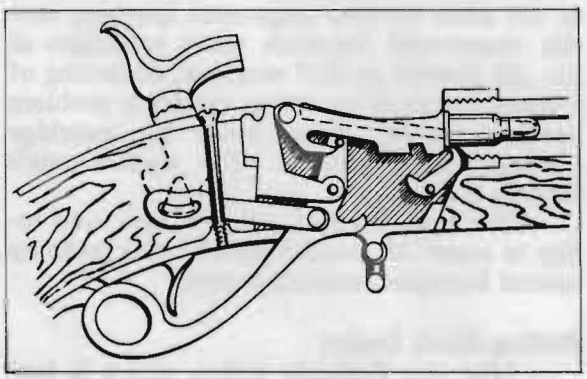


FIGURE 56 — The Peabody tipping-block mechanism. Original drawing shows principle of operation.

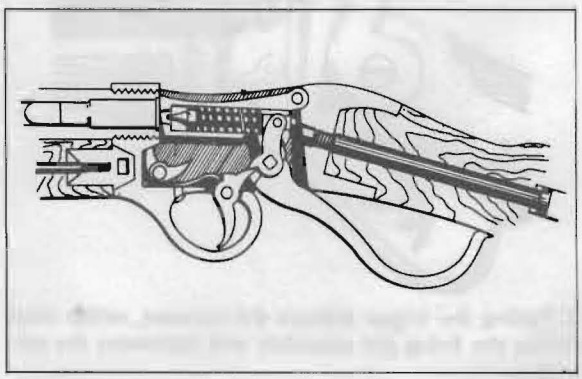


FIGURE 57 — The Martini-Henry mechanism. Original drawing illustrates the variation and improvement of the basic Peabody design.

fications of another, Joseph Ryder (or Rider). Both men had patents on a similar rolling-block design, but Gieger's was the true basis of the Remington rolling block (see Figure 58). Ryder, employed by Remington, slightly changed Gieger's design for production (Remington had purchased both patents).

The rolling-block design is the simplest of all single-shots (see Figure 59). Enormously strong, the design consists basically of two pivoting breech-locking mechanisms, one mounted behind the other, which are attached to the frame by large axis pins.

The primary mechanism is the breech block, pierced and containing the firing pin which, when the hammer is cocked back, can be rolled up (and down) from the chamber by means of a thumb spur or extension. When flush against the chamber, the breech block is spring supported, but not locked into place.

The second mechanism is the hammer, mounted behind the breech block, also by an axis pin. When the hammer is cocked back and the breech block is rolled up against the chamber (two separate operations), the rifle is ready to fire. Release of the trigger lets the hammer fall. However, before the hammer can strike the firing pin, a projection under the surface of the hammer assembly slides smoothly into place behind and under the breech block. This locks the breech bolt firmly against the chamber, a split second *before* the hammer hits the firing pin.

The Remington rolling block, not perfected until just after the Civil War, was never adopted by the U.S. Army. However, the U.S. Navy ordered 12,000 rifles in 1867. Moreover, more than one million RB military rifles and carbines in 7mm (7 x 57), .45/70, and a host of other calibers were sold to Denmark, Sweden, Norway, Spain, Egypt, Argentina, China, and other countries, primarily between 1867 and 1879. Its popularity was short-lived, however, as the first bolt-action Mauser was just over the horizon, appearing in 1881.

In the 1950's, "surplus" Remington rolling-blocks were imported into the U.S. by the tens of thousands, with prime specimens selling for as little as $9.95. One intrepid West Coast importer advertised them "complete with plans for making a rolling block rifle floor lamp," for $7.95. Today *replicas* made by Navy Arms are selling very well at $150!

While seldom used for sporter conversions, authentic rolling-blocks are fast becoming collector's items.

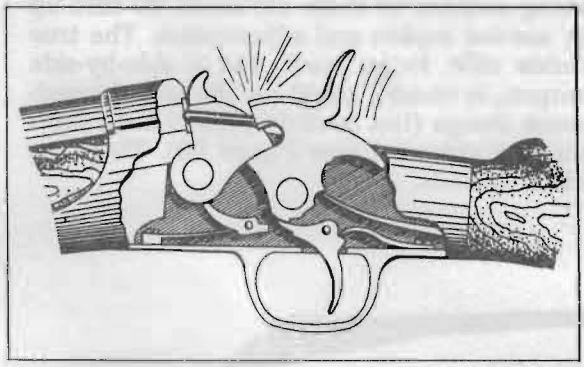


FIGURE 59 — Cutaway view of the Remington rolling-block system. Shows breech-locking mechanism at moment of firing. Original drawing.

Sequence of the Seven Functions in Single-Shot Rifles

If you were to pick up an empty Ruger No. 1 single-shot rifle and, holding it by the left forehand, push down on the lever release which is spring-loaded and located immediately behind the trigger guard, and then push the lever down and forward, you would accomplish the following . . .

The gun is (1) COCKED as the striker mechanism is pushed back against the spring tension of the mainspring until the striker is caught and held by the sear. While being cocked, the action is also being (2) UNLOCKED as the breech block drops, exposing the chamber for feeding and loading. Here, (3) FEEDING is by hand and the cartridge is inserted manually. As the lever is brought back up, the block rises behind the cartridge, thus (4) LOCKING the action. The rifle is now ready to fire. After (5) FIRING, the lever is moved down and forward, dropping the breech block in its mortise and, depending upon how the user has set the ejector/extractor mechanism, the cartridge is (6) EXTRACTED and (7) EJECTED from the gun. Actually, after the

FIGURE 58 — Replica rolling-block Baby Carbine by Navy Arms.

shell is extracted about 1/4", it is kicked from the gun by the ejector.

DOUBLE RIFLES

You won't see *too* many double rifles. Although not common in this country, a surprising number of these oldtimers do turn up for needed repairs and adjustments. The true double rifle looks much like a side-by-side shotgun, is usually based on the same hinged-breech design (but beefed up), and has a shotgun-type extractor (see Figure 60). There the similarity ends.

FIGURE 60 — Fine double rifles are usually lavishly checkered and engraved, sometimes costing as much as $5,000.

A double rifle is actually two rifles in one, with separate triggers and locks. If one malfunctions, the other works. Double rifles are not to be confused with the European Drilling, essentially a side-by-side double shotgun with a single slender rifle barrel mounted under the tubes.

The double rifle is essentially a British specialty and has never been popular in the U.S. Only a small number were ever built in this country. Aside from the fact that double rifles were never really needed here, the big drawback was high production costs. The twin rifle bores had to be adjusted until shots from both barrels converged at the same point — usually 50 to 100 yards. Adjusting the barrels took many painstaking hours and frequently days, by a master armorer — soldering, firing, resoldering — ad infinitum. When that rifle would be required to stop a charging elephant or rhino (and most were designed for such purposes), accuracy *had* to be good — superior to the "accuracy" provided by double-barrel shotguns with slugs printing perhaps a foot apart at 50 yards.

At the wage levels being paid in this country, it would be impossible to manufacture double rifles today at a price that would bring enough sales to warrant production. Double-barreled rifles were, however, fairly common in the blackpowder era for a brief time. None of the manufacturers stayed in business more than a few years.

The L. C. Smith Company, makers of a fine double shotgun, also manufactured double-barrel rifles for a short time and in limited quantity. Winchester made at least one Model 21 in a double rifle configuration, but such a firearm has never really caught on in the United States.

Most double rifles have traditionally been made in England, Belgium, Germany, and Austria, where a few are still being manufactured — primarily for sportsmen hunting large, heavy, dangerous game in Africa or India. The prices asked are astronomical — from $2,500 to $5,000 per rifle, yet the waiting lists are long, with delivery scheduled from six months to as long as two years.

Double rifles have always received the utmost attention, respect, and care in countries such as Africa where they were used for many years in hunting elephant, rhino, Cape buffalo, and lion. Around the turn of the century, exceedingly long, powerful "African" cartridges could not be used in the bolt-action repeaters of the time. Therefore, double rifles, in heavy .40 to .60-caliber, were introduced (see Figure 61). No repeating rifles could (and can) deliver a second shot faster and with less possibility of malfunction. These double rifles were chambered for many different types of cartridges, including the long-defunct blackpowder types. Many were made with Damascus barrels, suitable for blackpowder loads only. Any such firearm coming into your gun shop for repair should be treated with great respect. Almost without exception, double rifles are valuable — as a functioning firearm or as a collector's piece (which, indeed, most are).

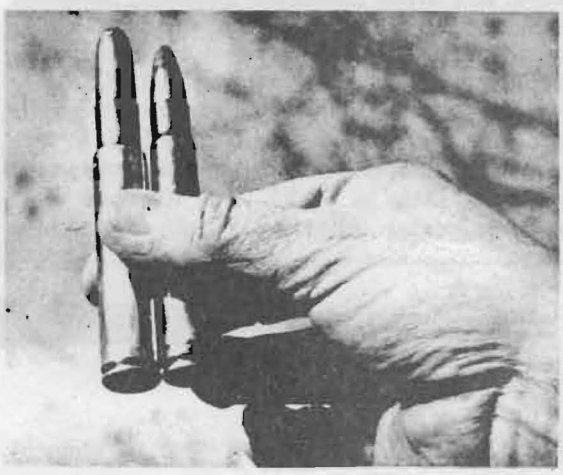


FIGURE 61 — Such double rifle cartridges as the .416 Rigby (left) dwarf even the powerful .375 H&H magnum.

We have covered a lot of ground in this unit. Let it rest — get into your Unit 3 Gun Shop. Then come back and hit it again. You should then be ready to take (and pass) Examination 3 and send it to School Headquarters for grading.

Before going on, please do Programmed Exercise 3-4. Make sure you write your answers on a separate sheet of paper before looking at the answers on the page specified.

PROGRAMMED EXERCISE

4

1. The single-shot rifle can be divided into what four basic designs?

2. Name the sequence of the seven basic functions of a single-shot rifle.

3. Match the following popular guns with their actions.

___ Winchester Model 100
___ Remington Models 141 and 760
___ Winchester 88 and Savage 99
___ "Hump Back" Browning shotgun
___ Thompson automatic
___ Mannlichers to Mausers
___ Martini-Henry
___ Sharp rifle

A. Lever.

B. Blowback.

C. Single-shot (lever).

D. Pump.

E. Gas-operated semi-automatic.

F. Long recoil.

G. Bolt-action.

H. Tipping block single-shot.

Answers on Page 34

ACKNOWLEDGMENT

We are indebted and deeply grateful to Stackpole Books, publishers of *Small Arms of the World* and other fine firearms publications, for the many technical drawings and rare photographs appearing in this study unit.

ANSWERS

4

1. Dropping (or falling) block; lever; tipping block; rolling block.

2. Cock, unlock, feed, lock, fire, extract, eject.

3. E, D, A, F, B, G, H, C.

NOTES

NOTES