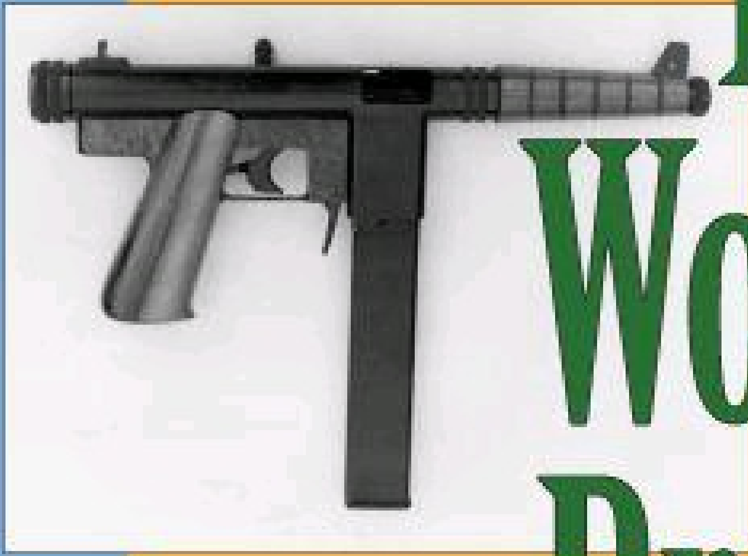
Home Workshop Prototype Firearms



How to Design, Build, and Sell Your Own Small Arms

Bill Holmes

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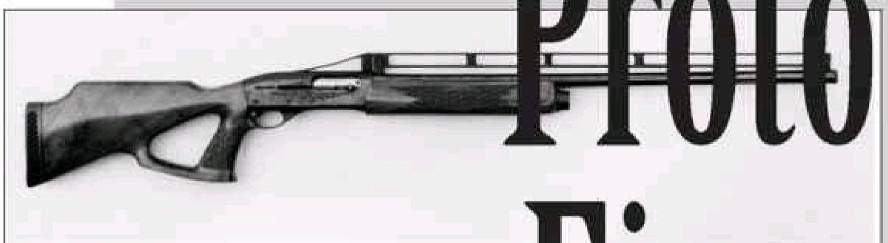

How to Design, Build, and Sell Your Own Small Arms

Bill Holmes

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Warning

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The .50-Caliber Rifle Construction Manual
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The Home Workshop .50-Caliber Sniper Rifle (video)

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by Bill Holmes

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Introduction

If the mail I get pertaining to the subject is any indication, there is widespread interest in designing and building firearms in one's own home or workshop. Unfortunately, far too many of these would-be gun builders lack a little something when it comes to designing a workable firearm, and even more when it comes to building it.

A prime example of this comes from a letter I received from a would-be gun builder who resides in a northwestern state, describing an automatic rifle which he said he intended to build. According to his letter, it would be a full-automatic rifle, chambered for the .50-caliber machine gun cartridge, made entirely from "C.R.S." (which I assume meant cold-rolled steel), and "straight blowback." He went on to say that the rifle would have a fiberglass stock and 20-round magazine and weigh 15 pounds, complete with telescopic sight.

Now this all sounds pretty good to the average person. However if put into practice, his plan would contain a number of design flaws. In the first place, "cold-rolled steel" is a common nickname for a low-carbon steel known as 1018. If this is the material my correspondent had in mind, it would be about as poor a choice there is to fabricate a firearm from. The reason for this is that 1018 simply will not heat-treat to the hardness required to prevent battering or upsetting and would wear rapidly. Also, this material does not have sufficient tensile strength or the ductility required to withstand the shocks and stresses imparted by heavy caliber firearms, or light calibers either for that matter. We will discuss this further in the chapter on materials.

Also, it should be noted that "straight blowback" is practical only in firearms chambered for low- or medium-pressure cartridges, mostly pistol cartridges of low to medium power. The reason for this is that the breech of such a gun is not locked at the moment of firing. Only the weight of the breechblock, or bolt, usually combined with forward pressure from one or more recoil springs, keeps the action closed at the instant of firing. Also, since the pressure generated by the burning powder is exerted in all directions, it pushes the cartridge case walls outward against the chamber as well as pushes the head, or base portion of the case, to the rear against the breechblock and out of the chamber with the same amount of force applied to the base of the bullet to push it up the bore. Therefore, the bolt or breechblock must be of sufficient weight to remain closed until the bullet is well up or out of the bore and the pressure has diminished significantly. If it opens too soon, it will either pull the head off the cartridge case since the case walls grip the chamber wall, or it will blow the case apart. Either condition is extremely dangerous since it allows the hot gasses to escape from the breech end, sometimes accompanied by bits of metal from the blown-apart cartridge case. This not only may cause bodily harm to the user and anyone else close by, but it may blow the gun apart. In the case of the .50 caliber, this breechblock would have to weigh so much and would be so cumbersome that it would render such a firearm impractical.

Another widespread idea that doesn't quite work out the way people think it will is this business of "filing down the sear to make it a full automatic." Seldom does a week go by without my receiving a letter from some well-meaning soul with more mouth than brains describing in detail just how easy it is to do a full-automatic weapon conversion using this method. Here again, it doesn't work out in practice quite the way it does in theory.

What will happen here, in the event that a file will actually cut the hardened sear, is that when you do get it filed or ground or whatever, it doesn't hold the hammer or striker in the cocked position anymore. You are now required, after inserting a loaded magazine, to pull the slide or bolt to the rear and allow it to slam forward. At this time, if the firing pin is long enough to fire the chambered round (an inertia-type short firing pin probably won't do anything), the weapon will fire and keep on firing until it is empty or jams. There is no way to stop it. The trigger doesn't do anything anymore. Fortunately, most guns jam on about the second or third shot after being subjected to this modification., so not as many people get hurt as would be likely if this "conversion" worked the way it was supposed to.

Another expert told me last week how you could pull a toy balloon over the muzzle of a .22 barrel and shoot with absolute silence.

This book, then, is intended primarily to describe what actually will and what won't work in designing and building a prototype firearm and address the problems inherent in amateur firearms design. Most of what is contained in this book I know will work because I have tried it. Most of what won't work I also know about because I have tried that too.

Some of the material in this book is similar to parts included in some of my other books. I regret this in a way, but on the other hand, I cannot assume that everyone has all my other works, and I want this book to be as complete as possible. So bear with me if you find that you are reading something here that you have seen before. Someone else may be reading it for the first time.

A tremendous amount of work is required to design and build a firearm from raw material. Most of the time it is accompanied by quite a lot of frustration. Once it has been accomplished, however, and the finished working firearm is in hand, there is a feeling of pride and accomplishment that must surely be somewhat similar to what a mother feels when she looks on her newborn child for the first time. And since beauty is in the eye of the beholder, you and I could never build an ugly gun, no matter how it looks to others.

Chapter 1

Gaining Experience

How does one learn to build guns? This is the question most frequently asked.

Well there are gunsmithing schools, which may or may not teach you what you need to know. They probably will show you how to put together custom rifles and accurize pistols. But when it comes to actually designing and building a firearm from raw material, from what I have seen they are somewhat lacking.

Today there are people scattered throughout the country calling themselves “gunmakers,” and probably not over a dozen have actually made a gun. One of these people recently moved into a nearby town. I met him at a gun show, where he had a couple of tables on which were displayed several rifles built on military Mauser actions with commercial barrels installed and a popular brand of “almost finished” stocks on them that he had fit and finished. He was passing out cards with his name and address on them along with the title “Gunmaker.”

“Do you have any guns here that you actually made?” I asked.

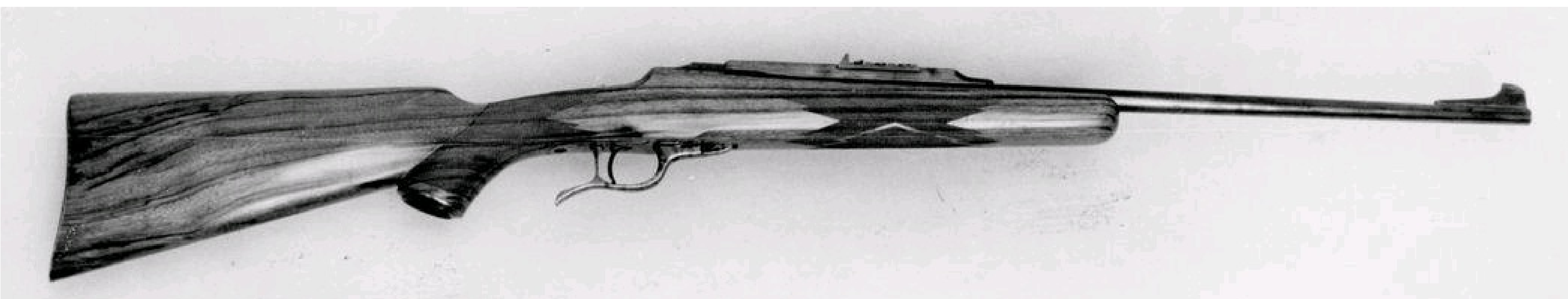
“All of these,” he said, sweeping his hand across the tables.

“No, no,” I replied. “Not guns you simply assembled; guns that you actually made.”

At this point, he admitted that this was what he called making a gun. He had never actually made a gun. He was just a mechanic.

My own experience started back around 1940. I was 12 years old at the time, but I was already into refinishing old guns and trying to make stocks. Back then, at least in our area, most centerfire rifles were lever actions. The .22s, were Remington and Winchester pumps, and the shotguns consisted mostly of double-barrels. Many of these had broken stocks, which I attempted to replace. I had a rasp, three or four chisels, a drawknife, and a hand drill. My dad had a workbench with a good heavy vise mounted on it, and a local blacksmith had a band saw. He sawed my stocks to shape form—or he did until one day he sawed two of his fingers off. After that, I sawed them myself.

Holmes falling-block single-shot rifle.



Holmes 9mm autoloading pistol.

Holmes 9mm auto with 6- and 16-inch barrels and detachable buttstock. A pistol with a 6-inch barrel and a detachable stock requires a tax stamp and BATF registration (it's considered a "short-barreled rifle").

As I gained experience, the quality of my work improved, and it fell my lot to restock most of the guns with broken stocks in our community. By the time I was 14, I had already made over a hundred stocks, mostly for side-lock, double-barrel shotguns, and all from the block. There were no semifinished stocks for these guns.

Shortly after World War II started, we moved to California, where my parents both worked for Lockheed. This was the best thing that ever happened to me education wise. The high school I attended had a well-equipped metal shop as well as a wood shop—and, most important, an instructor who actually took a keen interest in anyone who really wanted to learn.

I became acquainted with most of the good gunsmiths in the area. Arthur Shivell, Powell and Miller of Pasadena (designers of the Powell Miller Venturied Freebore, or PMVF, cartridges, which were copied by Weatherby), and, most important of all, Joe Pfeifer. Joe had a clubfoot and wore a heavily built-up shoe to compensate for it. This kept him out of the military, and he had a shop in his garage in Roscoe, (later called Sun Valley) California. For some reason these people took an interest in me and showed me how to do most phases of gun work.

I bought a low-number Springfield action from Shivell that was supposedly reheat-treated by Sedgley and hit Joe Pfeifer up for a barrel blank. He said he didn't have any material to make one from, but if I could come up with a suitable piece of material, he would make me one. At the time, all suitable steel for such jobs went to the war effort.

About this time, we made a trip back to Arkansas, where I managed to come up with a Model T Ford truck drive shaft. I took this back to Joe, who seemed overjoyed to get it. It contained enough material for three barrels. He drilled and rifled one for me in exchange for the other two pieces.

With some help from the metal shop instructor, I turned it to what was considered a "sporter" contour and threaded it. I got a discarded military barrel from somewhere and copied the approach cone and extractor slot. Then I took it back to Joe, who chambered it for me. No chamber reamers were available at the time.

I tried to order a semi-inletted stock from both Stoeger and Bishop (they cost five dollars at that time), only to have my money returned. None were available for the duration of the war. Fortunately, one of my father's buddies came to my rescue. He had several walnut planks of sufficient thickness, which, he said, were in the attic of his house when he moved there several years before. He said he had no use for them, so he gave them to me. I made my own stock.

Holmes .22 autoloading pistol.

My first 12-gauge autoloading shotgun.

This was an experimental gun, built to see if it would silence a shotgun effectively. It still sounded as loud as a .38 Special, though it reduced recoil to almost nothing.

My second 12-gauge autoloader.

Holmes 12-gauge autoloading shotgun.

Holmes self-opening trap gun.

One of the gunsmiths I knew, I don't remember which one, gave me a Lyman 48 receiver sight and a ramp front sight, which I installed on the rifle. I really wanted a Weaver 330 or a Lyman Alaskan telescope sight, but none were available at a price I could afford.

We mixed a bluing solution in the school chemistry lab from a formula I got from one of the old gunsmithing books, and I polished the gun entirely by hand, using files, emery cloth, and sandpaper.

I now had what I thought was a pretty nice rifle, and I should have left it alone. But Clyde Baker's book talked about making checkering tools from umbrella ribs, and I had to try this. Needless to say, the addition of this checkering job did not improve the appearance of my rifle.

A little later on, Monte Kennedy and a couple of other people started a gun operation near where we lived. Naturally, I started going over there to try to learn something new. In the course of our conversations, I let slip that I also made gunstocks. They immediately wanted to see one. I guess they thought it inconceivable that a 16-year-old kid could make a gunstock. I didn't much want to show them any since their guns were obviously superior to mine, but I took my rifle and a double-barrel shotgun over and showed them both guns.

To my surprise, they didn't laugh. "Hell, kid," Kennedy said, "these would be pretty good stocks if you hadn't fucked the checkering up." He proceeded to show me how to lay checkering out and gave me some good checkering tools. My checkering improved quite a bit after that.

Another man who helped me a lot was a vagrant blacksmith named Pete. I never heard his last name or knew where he came from. One day there was a Model T Ford truck parked on a vacant lot just down the street from where we lived with a large tent erected beside it. These belonged to Pete. It turned out that the owner of the lot let Pete camp there in exchange for Pete's shoeing his horses. He not only took care of all the horses in the neighborhood but did whatever welding anyone needed. He sharpened tools, repaired automobiles, fixed home appliances, repaired watches and clocks, and, most important of all, worked on guns.

AR-15/M16 conversion with folding stock.

Latest version of my 12-gauge slide action shotgun. This one had a "camo" paint job, which didn't add anything to its appearance.

An experimental 9mm closed-bolt pistol.

A 9mm conversion unit on an AR-15/M16 lower receiver shown with a detachable butt stock; 16-, 10- (mounted), and 6-inch barrels; and 15- and 30-round magazines. Using an original M16 receiver to make a 6-inch-barrel pistol is making a “shortbarreled rifle” according to the BATF.

Left side of a 12-gauge slide-action shotgun.

Pete didn't have much use for most of the kids in the neighborhood. They teased him and wouldn't leave his property alone. But he liked me, mostly, I suppose, because I treated him with respect and didn't touch anything that belonged to him without permission. I think this was probably the reason most of the area gunsmiths tolerated me. I know at least one of them kept all the others run off. But he was nice to me.

Pete showed me how to put case-hardening colors that looked better than the real thing on gun frames without a lot of heat. He showed me how to make parts from raw material with only a file, a hacksaw, and a hand drill. Even more important, he taught me how to heat-treat the finished part. He stayed camped there for several months, and finally one day he was gone. I was sorry to see him go.

After the war we moved to Cimarron, New Mexico, where my father owned and operated a sawmill. P.O. Ackley and George Turner started a gun making operation there called Ackley and Turner, which went bankrupt in short order. Ackley went on up to Trinidad, Colorado, and talked his way into a teaching position in a gunsmith school. Turner started a company to manufacture cattle squeeze chutes. He was the real brains behind their gun making business. He was taper boring shotgun barrels and cutting long forcing cones 50 years ago, long before these latter-day gunsmiths invented such things. I learned a lot from him too.

After a stint in the army, the last year of which was mostly spent sporterizing 03A4 rifles for the big brass, I went to Georgia. Here, among other things, I designed and built several specialty weapons for a government agency. I was also involved in refurbishing and modifying a number of weapons that went to Fidel Castro back before he ran Fulgencio Batista out and took over Cuba.

During this period, one of the leading gunsmiths in the area decided to start a gunsmith school. He seemed to think I should enroll in his school. I told him I didn't have time, but he stayed after me to try it for a few days just to see if I didn't need to attend. By the end of the second day, I realized that I already knew more than he did. I didn't go back.

In 1964, I had a series of disagreements with some of the people I was doing work for, so my family and I moved back to Arkansas. Here I intended to do gun repair and custom rifle and shotgun work. But it wasn't long before I was contacted by some of the people I had dealt with before wanting various special purpose guns, so I was right back into design and fabrication again.

I built an all-plastic .22 pistol that would pass through any metal detector in the world. It wasn't really all plastic; it was mostly nylon and had a ceramic firing pin. Ammunition for this weapon was concealed in a special belt buckle. Several were smuggled aboard aircraft completely undetected.

I built several intermediate-range sniper rifles. These were bolt actions, chambered for the .45 ACP cartridge, and used M1911 .45 pistol magazines. They were silencer equipped and capable of hitting quart oil cans consistently at 200 yards when properly sighted in.

I built several longer-range sniper rifles in both .308 and .300 Winchester Magnum. These were all-metal rifles with quick takedowns that could be contained in a 26-inch case. Calibers were interchangeable by switching barrels and boltheads. These rifles would hit quart oil cans consistently at 500 yards.

I also built .22 open-bolt machine guns that everyone said wouldn't work. They said the cartridge case would hang under the firing pin and jam the gun. I put the firing pin at the bottom and let the cartridge head slide across it, something no one had ever thought of before. Open-bolt guns, closed-bolt guns, locked-breech guns—I made them all at one time or another. I also built semiautomatic versions of these for the civilian market.

I built several versions of an autoloading box-magazine shotgun before I finally got one that suited me. I also built a slide-action version of this gun. Several companies contracted to produce them, but all they actually produced was wind.

I built trap guns with very little recoil and several versions of a single-shot falling-block rifle.

So, you see, I've acquired the experience, mostly the hard way. It took several years, but I learned.

I am sure you could learn a lot in a gunsmith school if you really wanted to, but it would mostly cover custom rifle work and the like. If you expect to actually design and manufacture firearms, your time will be better spent in a good vo-tech school learning to set up and operate precision machine tools. Then, with a few years of experience, you should be able to make anything you dream up. All by yourself. In your own shop.

Chapter 2

Tools and Equipment

While it is possible (although time consuming) to build a firearm in its entirety with a few files, a hand hacksaw, and a hand drill, decent power tools will not only cut down the construction time but probably also improve the quality of the finished work considerably. Let's take a look at some of the equipment that would be required for an operation of this kind.

Probably the most important item is an engine lathe. With suitable accessories and tooling, such a machine can perform all sorts of operations, including turning, threading, boring, and knurling. With a milling attachment, it can in many instances substitute for a milling machine, take the place of a drill press, and when properly equipped, even put rifling in barrels.

When contemplating the purchase of a lathe for the first time, far too many people actually go out of their way to seek out the smallest machine they can find, not only to save money but with the mistaken idea that the smaller machines are actually more precise when making small parts. In fact, I read an article sometime back by a self-proclaimed lathe expert in which he stated that a small 6- to 9-inch lathe was best for making most gun parts. He claimed that a larger lathe of 14 to 16 inches would be clumsy to operate, and that the operator would probably break such small parts as firing pins when attempting to turn them on the larger machine.

As far as this writer is concerned, the truth of the matter is that a modern geared head lathe with a 14- or 15-inch swing and 40 inches or more between centers is the only way to go. Such a machine usually weighs a ton or more and, when properly set up on a rigid surface and leveled, will provide a solid, vibration-free platform for turning operations. The geared head machine, in addition to its ease in changing speeds compared to a belt-driven headstock, will also allow heavier cuts to be taken with less tendency to chatter than the belt-drive machine is capable of.

The machine should be level, both lengthwise and crosswise, and preferably bolted to the floor.

A 17-inch lathe, as shown here, is sturdy, accurate, and vibration-free. A 13-inch lathe is adequate and less expensive.

This welding machine will do MIG, TIG, and stick welding.

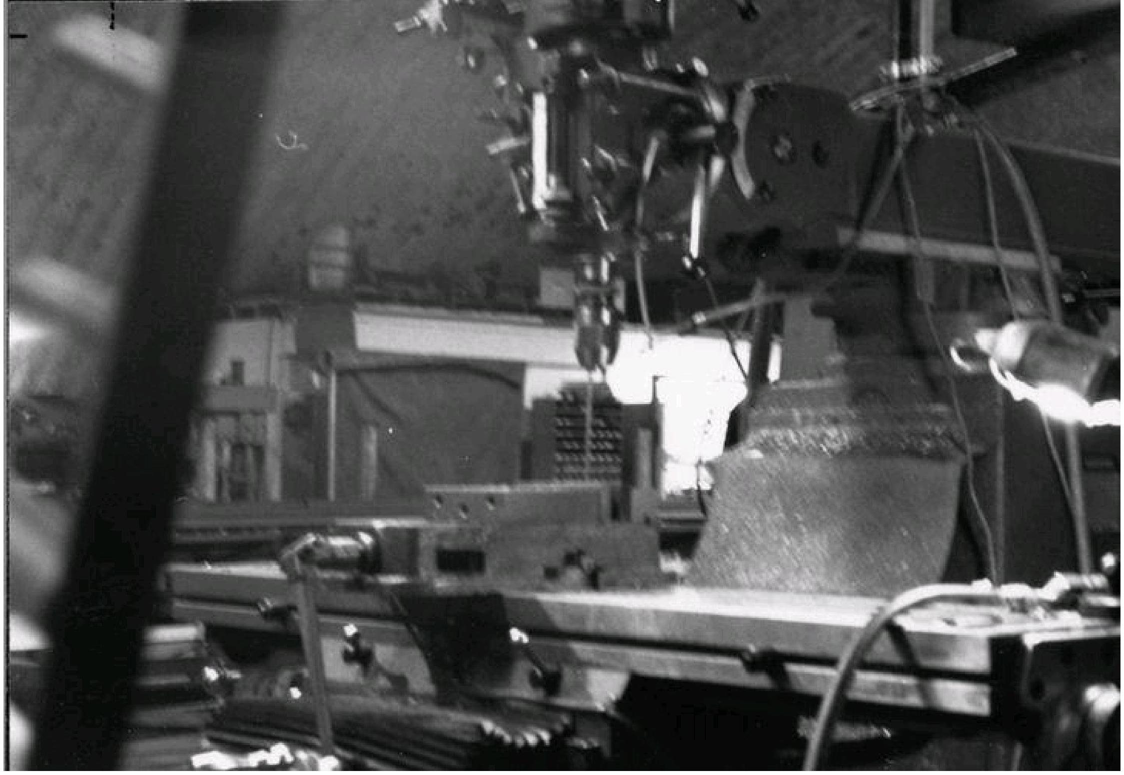
Many novices neglect to do this, and not only does accuracy suffer, but the machine may wear rapidly due to misalignment.

Most machines of this size will come equipped with three-phase motors. Unless three-phase power is available at your installation, you will require some sort of converter to allow running the motors on single-phase current. These are available through machine tool supply houses, ranging from small boxes for use with one motor to the large Rotophase types, which, when properly wired into the circuit, will start and run a whole shop full of motors. These are also expensive.

Both a three-jaw and a four-jaw chuck should be acquired with the lathe if possible. If only one chuck can be afforded, it should be the four jaw since irregular shapes as well as round can be centered precisely through individual movement of the four jaws, whereas the three jaws open and close simultaneously and will only accommodate round stock.

A milling machine is almost mandatory if much work is anticipated.

Precise drilling operations can be simplified by using the mill as a drill press.



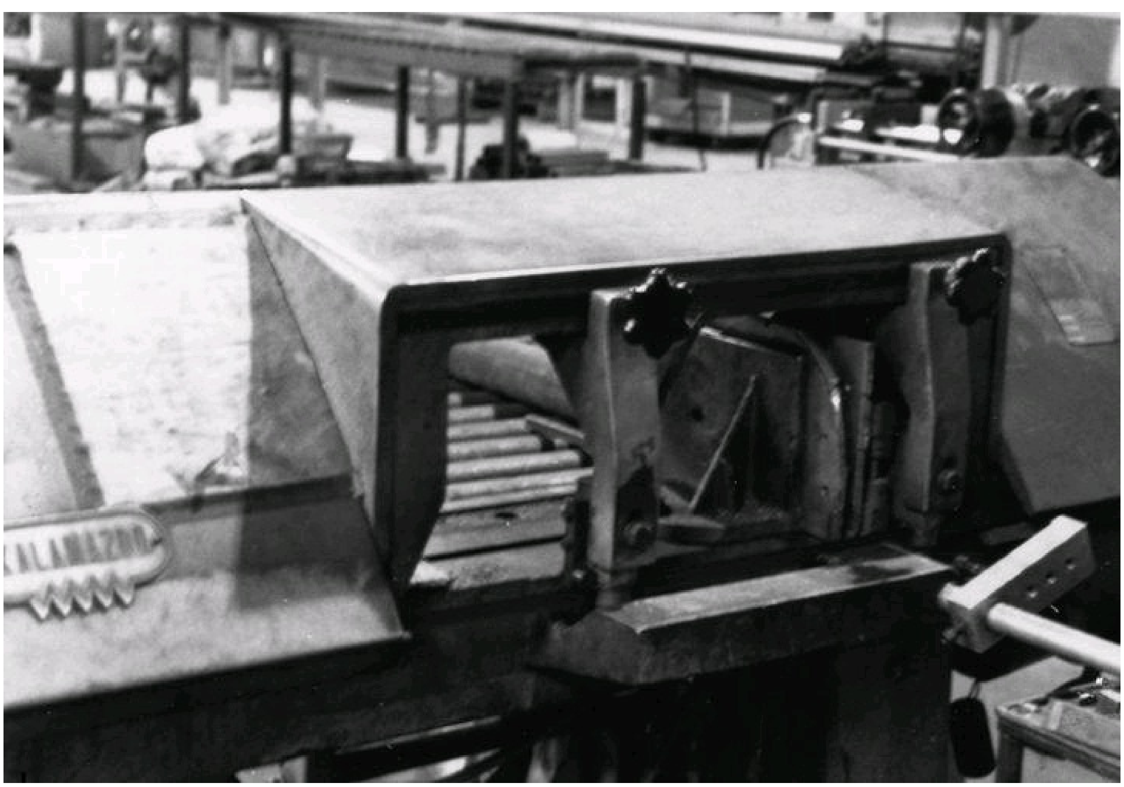
A set of collets and a collet closer would be nice to have, as well as a quick-change tool post, a live center for the tailstock, a drill chuck, a steady rest, a follower rest, and also, if possible, an adjustable automatic carriage stop.

To better understand why I suggest such extras as an automatic carriage stop, perhaps it would be worthwhile to describe my own shop and its operation.

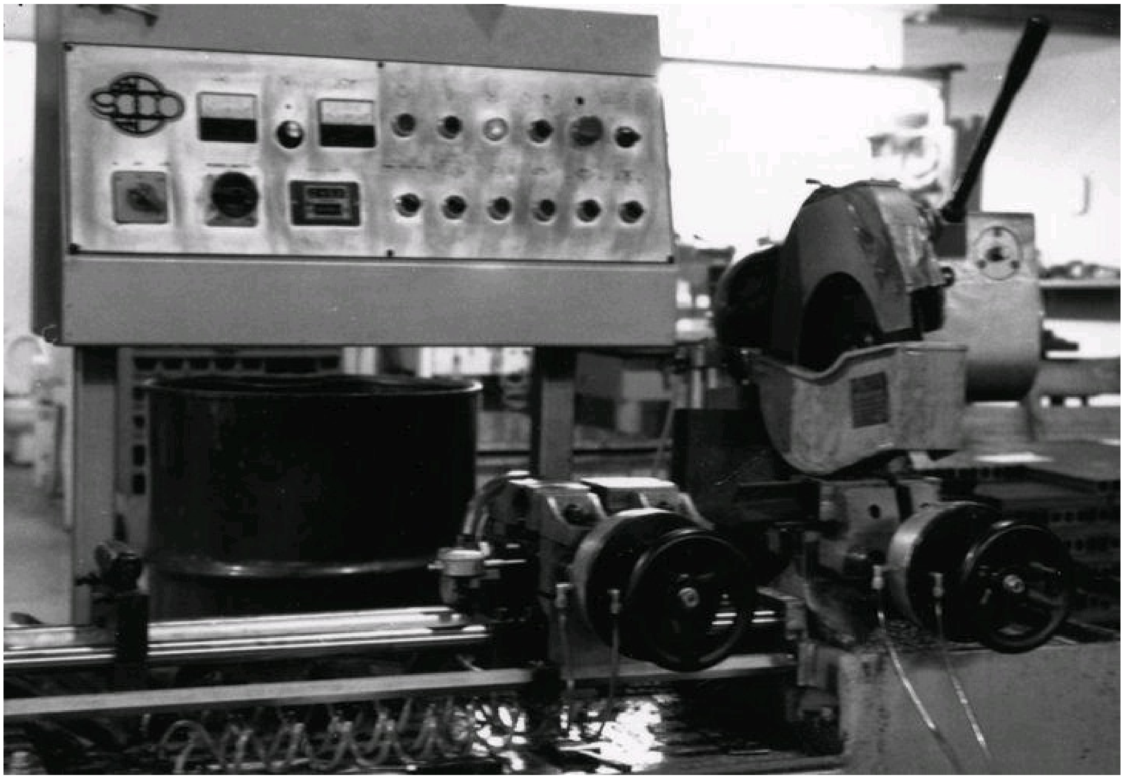
My shop is a one-man shop. At present I am engaged in building a trap gun of my own design. By working long hours and running several machines at the same time, I can usually build three of these guns per month. I know, I could hire some help and probably up production. But I have tried it several times in the past, and after a while the employees decided that they knew more than I did and didn't need to do what I told them. I don't like to argue, so I work by myself. If it isn't right, there is only me to blame.

I have two engine lathes: a 15-inch Colchester and, parallel to it but facing the opposite direction with a 4-foot walkway in between, a 14-inch Taiwan-made lathe. At one end of the walkway stands an Induma vertical milling machine, while at the other end is a Bridgeport vertical mill. Each has a power feed on the table. Arranged in close proximity as they are, it is possible to run at least two and much of the time all four of these machines at the same time simply by setting up a cut and engaging the power feed of each. Since the automatic carriage stop will disengage the power feed when it reaches the end of the cut, I can simply go from one machine to the next, setting up a new cut and restarting the power feed.

A metal-cutting saw is useful.



A “cold saw” is faster than a continuous-blade type.



Located just a short distance away from these four machines, I have a small turret lathe, a combination MIG, TIG, and stick-welding machine, as well as an oxy/acetylene welding and cutting outfit. I have a horizontal metal-cutting band saw with an automatic shut off (which means I don’t have to stand over it to shut it off when it finishes a cut), a wood-cutting band saw, and a large vertical metal-cutting band saw. This last machine is even more versatile because it has a built-in blade welder and grinder. This enables me to buy blade material in 100-foot rolls and make up blades for all three saws at a fraction of the cost of ready-made blades.

If no milling machine is available, slots and openings can be cut with a hand grinder using cut-off wheels.

I also have a surface grinder, a small electric heat-treat furnace, a pedestal grinder, and a couple of bench grinders. Some polishing equipment coupled with a bluing setup and the usual files and hand tools pretty well round out the shop, giving me the capacity to make up about anything I might want in the firearms line. Now if I only had the skills and ability to go with the tools and machines . . .

You probably noticed that I did not mention owning a drill press. This is because I do not have a drill press as such. By mounting a drill chuck in the milling machine, I not only have a solid, sturdy drill press, but I can locate holes exactly where I want them without any guesswork.

The most versatile milling machine for our purpose is a full-size Bridgeport-type machine with at least a 42-inch table. If you anticipate installing ribs on shotgun barrels or machining rifle barrels to a cross section other than round, then a 48- or 49-inch table machine should be procured. Although most gun setups require only a mill vise and no more than four collets—specifically 1/4, 3/8, 1/2, and 3/4 inches—to take care of 90 percent of any work you may contemplate, it is desirable to have a full set of collets from 1/8 to 3/4 inch by sixteenths. A drill chuck is a required item. Also useful at times are a rotary table, a dividing head, and a boring head. As previously mentioned, a power feed on the machine will allow it to run while you perform other work and is almost like having an extra man in the shop, except you won’t have to argue with him.

As with the lathe, the milling machine should be level both lengthwise and crosswise and bolted to the floor. Close attention should be paid to making sure the vise jaws are parallel to the table. Otherwise the machine will not make parallel cuts. I could have bought a little Clausing milling machine at just about my own price not long ago from a fellow who thought it was worn out. I aligned the vise with the table (it was cocked about 2 degrees), leveled the machine, and bolted it down for him. After we ran it for a little while, he took it off the market. He said it was like having a new machine and was no longer for sale.

Many experienced machinists neglect bolting the machines down. Some even snicker when it is suggested. While it is true that the weight of the machine usually will make it fairly solid, bolting it down will dampen and absorb vibration. This, to me at least, makes it worthwhile.

The welding equipment that you should own depends on what types of welding you are proficient at or willing to become proficient at. I say willing to become proficient because to become good at it you must practice, practice, and practice some more. This is the only way to become a first-class welder. You can learn how from books or schools, but experience is the only way to develop proficiency. If you are capable of using them, there are combination machines available that will do TIG (this stands for Tungsten Inert Gas) welding, which is often referred to as heli arc welding, MIG welding (this is a wire-feed process), as well as stick welding, which will take care of about any welding jobs you need to do.

Lacking the skill to use the welding equipment, the best alternative is to find a full-time welder who understands guns and will realize that beads must be built up above the surface to permit machining flush, and what effect polishing and bluing will have on it. The average heavy equipment welder who spends his time welding on bulldozers, dump trucks, and the like will usually ruin the kind of work you need him to do and should generally be avoided.

In any event, the shop should have an oxy/acetylene outfit to be used for silver soldering, brazing, welding, and cutting, and to apply heat for certain bending and forging operations. It can also be used to harden and temper certain types of steel when no furnace is available.

You will also need a grinder of some sort. A good vise is essential, as is a metal-cutting band saw. Such saws are available for both horizontal and vertical use. Use it horizontally to cut material to length. Vertically it can be used to saw parts such as hammers, triggers, and sears almost to shape, after which they can be finished by milling, grinding, or filing.

Several files of assorted shapes and sizes should be on hand, together with a few metal-cutting chisels, some punches, a scriber or two, and a square and level. Other items can be acquired as needed.

Chapter 3

Materials

Quality firearms should be made of wood and steel. At times it is acceptable to use aluminum as a weight-saving measure. Shotgun muzzle brake bodies are an example of this. But, what I refer to as “pot metal” such as zinc, zamak, pewter, and the like should be avoided.

Quality sporting firearms will have stocks made from high-quality hardwood such as walnut, maple, or myrtle. Beech, gum, sycamore, and the like are used on cheaper guns and are, at most, second best.

There has been a trend over the past several years to try and brainwash the shooting public as to the superiority of synthetic stocks for use on hunting rifles and shotguns. This is mostly a pipe dream that the manufacturers have conned the gun writers into believing and passing on.

While it may be true that in some instances these are more stable and less apt to warp than their wood counterparts (try leaving one out in the hot sun all day), and they are supposedly less prone to cracking and breaking (try dropping one on a hard surface in cold weather), the real advantage is the cost saving due to cheaper materials and less labor.

I have used synthetic stocks and forends myself in the fabrication of military-type weapons and, at one time, in an economy-grade trap gun that I intended to market. This was done, in the case of the military weapons, primarily to save weight, but also because I could obtain surplus M16 stocks at extremely low prices (from $2 to $8 dollars each) and easily adapt them to fit my guns. In the case of the trap gun, I molded the grip, used modified M16 buttstocks, and turned the forend from black nylon. The time saved in finishing and elimination of checkering, plus cheaper materials (I used wood costing $200 in the deluxe-grade gun, as opposed to $15 worth of materials in the economy grade), was passed on to the customer in the lower-priced gun.

There are all sorts of cheaper grades of steel that could be used to fabricate the metal parts, that is, if we only intended to fire a few rounds through the gun. But what we are seeking here are materials to make our parts that will last for several thousand rounds and more. Therefore, we must seek out and set in place the best materials available for this purpose. While there are people who would question my choices, as far as I am concerned, chrome molybdenum steels such as 4130, 4140, and 4150 are suitable to build the entire gun. Known as Chrome moly, Brake die, Maxell and other nicknames, these steels are easily heat treated, machine cleanly, and possess high tensile strength and elasticity. Furthermore they can be welded without ruining them, as sometimes occurs with other steels.

Nickel steels of the 2330-2340 variety are also entirely usable, as are the nickel chromium steels designated 3130, 3135, or 3140.

The numbers associated with these steels, in case anyone is wondering, are partial descriptions of their compositions. The first figure describes the class to which the steel belongs. The second figure indicates the percentage of the main alloying element. The last two figures indicate the carbon content in hundredths of one percent or “points.” Therefore, 3140, as an example, describes a nickel steel with approximately 1 percent nickel content and a carbon content of forty hundredths of one percent, sometimes referred to as 40 points of carbon.

4130 seamless tubing is ideal for shotgun barrels, tubular receivers, and the like. It is usually available from metal supply houses in so many inside diameters and wall thicknesses that at least one will be close enough to adapt to your use.

Round stock is available in the desired compositions and in almost any diameter needed from these same metal supply houses. Flat stock for hammers, sears, triggers, etc., is also available from the same sources in almost any fractional thickness desired.

In many cases, these materials must be purchased in rather large quantities. If the vendor can be persuaded to cut off the small quantity desired, they will charge you an exorbitant price for it. Many metal supply companies will try to charge $15 to $25 just to saw a piece of metal in two.

Therefore, when only one gun is to be built, look for some other source of materials. Automobile and truck axles contain material suitable for bolts, barrel extensions, gas cylinders, and whatever other round parts are needed. Actually, if sawed into strips, flat parts can also be made. Axles can usually be obtained from salvage yards for $2 to $5 dollars each. Leaf springs, as used on the rear axles of older cars and pickup trucks as well as on larger trucks, are a source of flat stock. Hydraulic cylinders and discarded shock absorbers contain smaller-diameter shafts useful as round stock and tubing. This tubing will seldom, if ever, be adaptable to shotgun barrel use, but in certain instances it can be used for receivers. Motorcycle front forks will yield just about the same sizes and types of tubing and round stock as the hydraulic cylinders, as will large-diameter aluminum tubing, which can sometimes be used to make shotgun muzzle brake bodies.

Some of the material suggested, especially the axles and leaf springs, will be too hard to machine easily. They will require softening, or annealing. This is accomplished by heating the metal slightly above its critical point and allowing it to cool slowly. Since the average heat-treat furnace is too small to fit the axles or spring leaves, another method must be found.

Fire departments usually take a dim view of uncontained open fires within city limits, so you will likely have to go to the country to do this. Accumulate and pile up enough wood to make a fire that will completely surround the metal objects and burn for three or four hours. Place the metal objects on top of your wood pile and start it on fire. If you have enough wood, it will heat the metal to the required temperature. As the fire burns down, the metal parts will sink into the ashes, where they cool very slowly. They are usually left overnight; when removed the next morning, they will probably still be warm. They will also be softened to a point where they will machine easily.

The axles described are usually made from material with a high enough carbon content to permit heat treatment to any hardness desired. Many of these are made from the same 4140 recommended in the first place. They are also found made from 4150, 4340, 2340, 3140, and other alloys.

Leaf springs are mostly made from material with a high carbon content. Compositions commonly found in these are 1085, 1095, 4063, and 4067.

It should also be mentioned that the stems of automobile engine valves are suitable for firing pins. They, too, must be annealed before they will machine freely.

After the component parts are cut to shape, fitted, and finished, they should be heat treated as detailed in Chapter 20. Properly done, parts made and heat treated as described will last a lifetime.

For those who think a gun should be made from stainless steel (I am not one of these), it should be noted here that seamless tubing of the same dimensions deemed proper for the shotgun barrels described is available with a cold-drawn finish in 416 stainless according to the company I buy from. Round and flat stock is available from the same source. If you must have stainless, an alloy called 416F, which is a nickel-bearing chromium steel with enough sulphur added to make it machine freely, is probably the best choice available.

There are any number of companies and individuals advertising gunstock wood in several of the gun magazines. If you will be satisfied with black walnut, a local lumber yard usually will have at least a small supply on hand. This is true in the eastern and midwestern states. In California and other far western states, one can also find a goodly supply of so called “English” and “Claro” walnut. It is advantageous to be able to examine wood before you buy it.

Most large cities have at least one plastic supply house that carries, or can get, black nylon or other synthetic material to use in forends. Fiberglass and epoxy can be found at auto parts houses. They sell it to body shops for use in auto body repair. Boat builders and repair shops also keep a supply on hand. If M16 buttstocks are required, several surplus gun parts suppliers advertise them for sale.

Chapter 4

What to Design

With an equipped shop in place, the next item on the agenda is to decide what to design and build.

Probably just as important is the question of what *not* to design. Of course, the opinions expressed here are my own, but with almost 50 years of experience and observation to draw on, I must be partly right.

There is no point in developing a firearm that even comes close to duplicating or replicating an existing design. Even if successful, it would only get a share of the market while competing with its predecessors. Unless obviously superior in one or more aspects, it probably will get less than a full share.

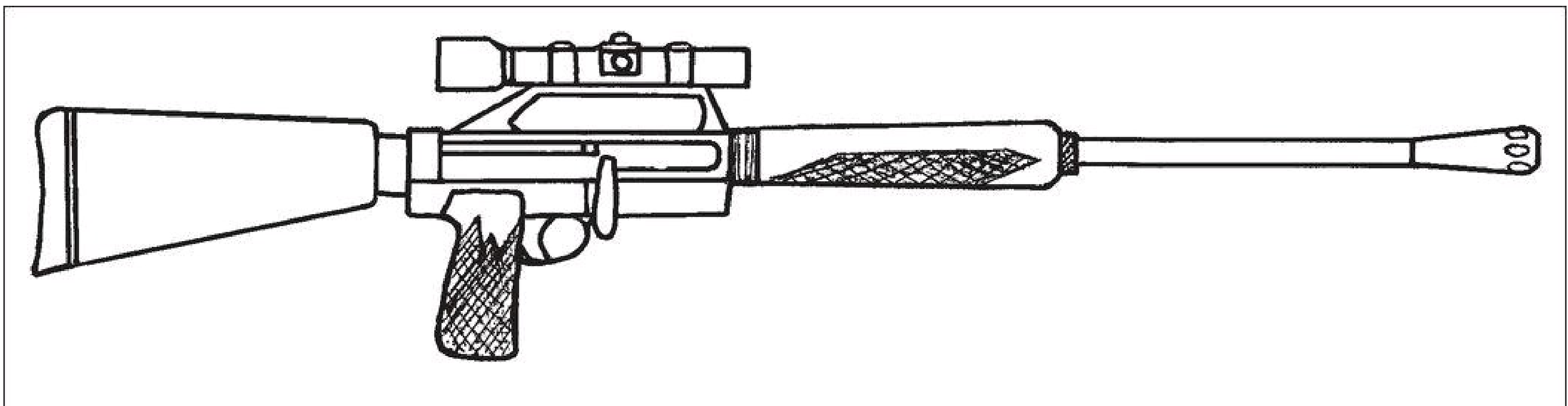
The Colt M1911 pistol is a good example of this. For several decades, the Colt and various foreign licensees stood alone (or almost alone) in their field without serious competition. Suddenly, after the patents expired, everybody and his brother tried to build a similar gun. In time, each got a little share of a market that had previously been dominated by the one maker. Most of these companies have fallen by the wayside, leaving only two or three who, as of this writing, are also in financial trouble.

Today, the high-capacity semiautomatic pistol is the only kind most shooters want to talk about. But there are already so many of these on the market that, unless one could come up with a design obviously superior to the rest, there is no point in trying to design another.

If one were to attempt another of these, probably the most noteworthy deviation from existing designs would be one with a fixed barrel and a separate bolt locking into the frame. This could very well result in a gun with superior accuracy, since the position of the barrel in relation to the sights would remain constant, or nearly so. There is also room for improvement in the triggers of these guns, especially in the double-action mode.

Actually, any design effort put forth probably should be devoted to developing some sort of manually operated action. Whether we like it or not, sooner or later the wrong person is going to get shot with a semiautomatic firearm. This will result in the law severely restricting or forbidding any more weapons of this type from being manufactured. Never mind the fact that these won't kill anyone any deader than any other gun. The so called "media," most of whom don't even know which end of a gun to load, are determined to bad mouth these guns. Sad to say, more and more people are succumbing to the influence of these antigun people. Even though the Second Amendment of the Constitution of the United States guarantees my and your right to bear arms uninfringed, there is a very good chance it will happen. So, anyone devoting enough effort to design and build a gun from now on with the intention of being able to market it should probably avoid automatic weapons of any sort.

A rifle with a design such as this would have far less recoil than conventional designs.



This prototype 9mm autoloading pistol is being built as an improvement (?) over my original MP83. It also has a folded sheet metal lower receiver and sights made in the same manner. This gun has a longer receiver, allowing a longer, heavier bolt to be used, which slows down the cyclic rate. Both open- and closed-bolt models can be built by changing bolt and trigger assemblies. This one is also easier to build than my original gun. Both are made from wood and steel, not cheap plastic and pot metal.

This is an unfinished prototype autoloading .22 pistol designed to ease manufacture and correct shortcomings inherent in my original MP22. This gun has but one threaded union, which is at the muzzle end of the barrel, compared to three in the original. The lower receiver is folded from sheet metal instead of machined from aluminum, as was the other. The sights are also folded from sheet metal. Both open- and closed-bolt configurations are possible simply by changing bolts. When finished, this gun will have the forward portion of the upper receiver, which surrounds the barrel, ventilated with four rows of holes. Quite a bit of fabrication time can be saved building this gun as compared to the original.

In time, slide actions, or "pumps," will probably achieve popularity. These fire almost as fast as autoloaders and are far more likely to remain legal. There are people who will tell you that a slide action is more reliable than an autoloader due to the fact that "if it jams you can simply work the slide, thereby clearing the jam." This is not necessarily true. Most jams of this type that I've ever experienced required digging or prying the jammed round out of the gun the same way you would with the autoloader.

Shooters are becoming increasingly recoil conscious. Designs that lessen felt recoil significantly will gain popularity in the future. Shotgun recoil can be reduced greatly through use of the muzzle brake design shown in Chapter 11. Combined with an overbored or "backbored" barrel while incorporating a spring-loaded telescoping buttstock in a design that features a straight-line recoil and high sight line will result in a gun with almost no recoil. Note that I said almost. The only way I have found to make a gun "absolutely recoilless" as some have advertised is to leave the firing pin out. If it won't shoot, it can't kick.

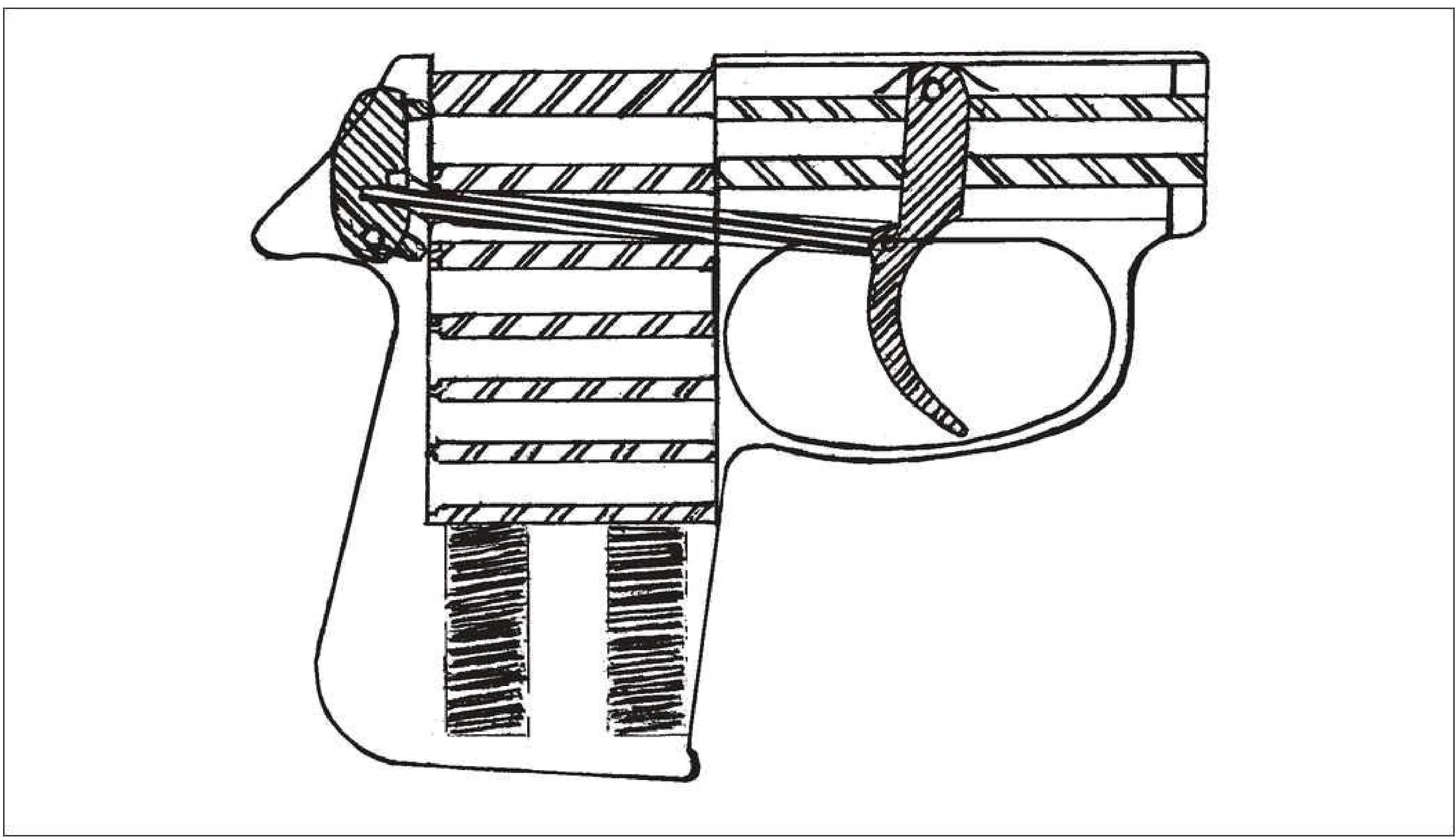
Rifles can be designed in the same manner, except the oversize bore cannot be incorporated.

Bolt-action rifles have long been considered the ultimate accuracy wise. I have no quarrel with this. However, one designed and built incorporating the features described above, while not as attractive as the "classic" style rifle so popular with custom gun makers, will have much less felt recoil, especially in heavy calibers.

Single-shot falling-block actions have limited popularity, especially in rifles. There has been little significant change in the design of these in over a hundred years except to substitute coil springs for the leaf springs used in the originals. I built a few with two-piece receivers that were inletted into one-piece stocks in the same manner as a bolt-action rifle. This allowed a stock shape similar to the classic bolt-action design, and a number of people considered them quite attractive. There did not seem to be enough demand to justify the tooling costs required to mass produce them, and the shop-made guns cost too much to build, so they more or less fell by the wayside.

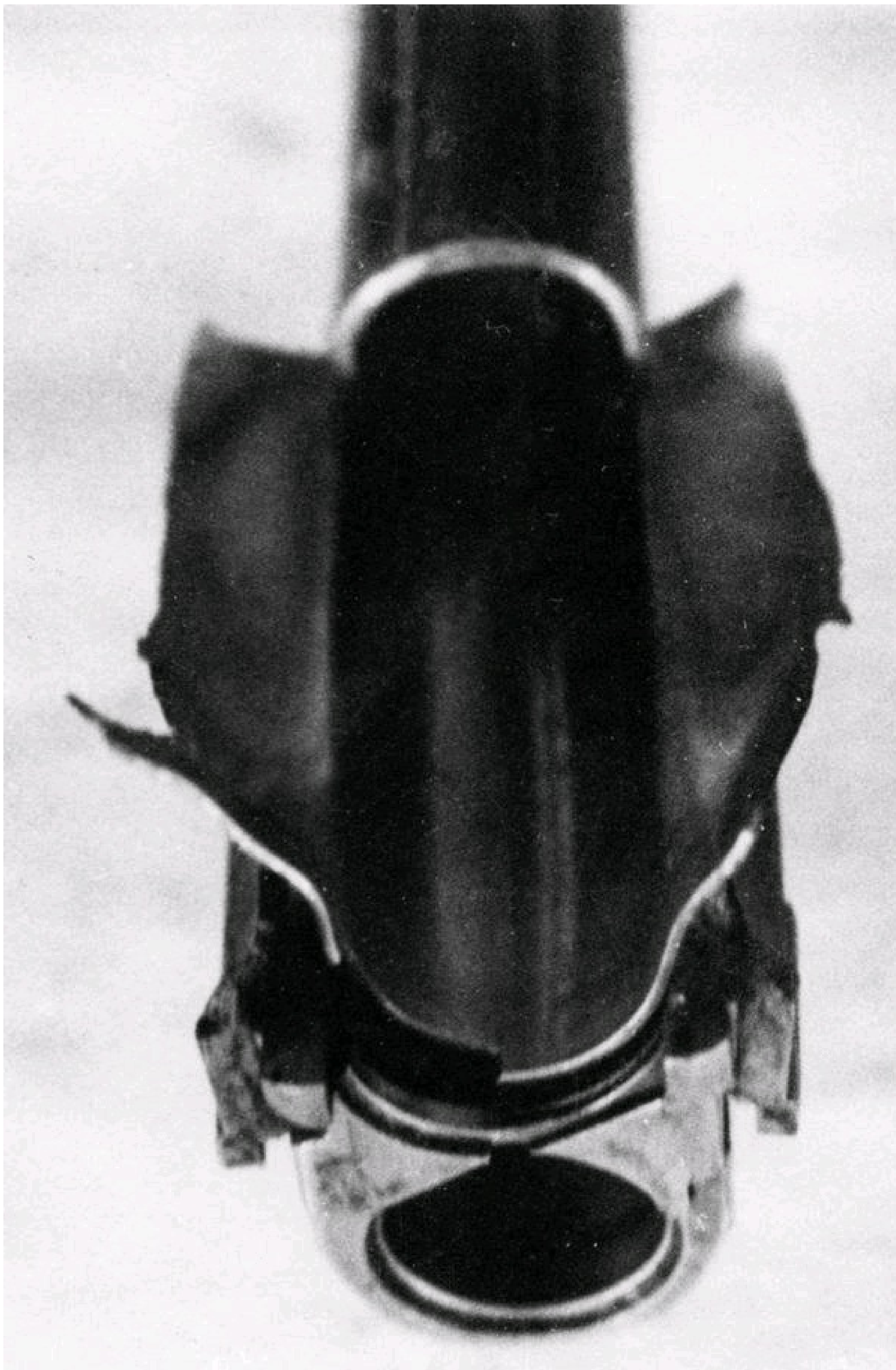
Interchangable barrels and detachable buttstocks, making a rifle and pistol combination, can be desirable features. However, if the short barrel is in place when the buttstock is added, an illegal weapon will result.

Rising-chamber compact pistol. A compact .22WRM is considered by many to be desirable for a “backup” or “hideaway” gun. One fault with this design would be the chamber block interfering with the sight line. However, since such a gun would be used at very short range, its compact size would outweigh this drawback. The trigger would be double-action only. By increasing the size slightly, larger calibers could be used.



Easy access to working parts is a desirable feature.

The result of inexperience, ignorance, and reloaded shells.



I have long thought that a high-grade top-break revolver built on the same principle as some of the older Smith and Wessons or maybe the British Webleys and Enfields would find a ready market. The speed and ease of ejecting empty cartridges combined with unimpeded access to the cylinder for reloading would offset any disadvantages inherent in the design. If properly designed, this should find a good market among combat revolver shooters.

The designer should always try to utilize preformed materials in a design as much as possible. In many cases, it is possible to use seamless tubing for receiver material that is already of a usable inside and outside diameter and already has a smooth finish, both inside and out. Shotgun barrels can be made from 4130 seamless tubing requiring very little finish work on the bore. It is also possible to obtain square or rectangular tubing that can be adapted to use as trigger housings, lower receivers, magazine housings, etc.

All dimensions should be kept to a standard size (fractional if possible). This will allow using standard-size round, square, and flat stock in many instances with very little machine work required to cut them to size. Saving manufacturing time and materials which will be reflected in lower production costs.

As far as I am concerned, firearms should be made from wood and steel where practical. Pot metal and plastic should be confined to BB guns and cap pistols; real guns should be built from quality materials. There are, of course, exceptions to this. Many military-type firearms require fiberglass or plastic stocks. In certain instances, aluminum can be substituted for steel to save weight (the shotgun muzzle brake described in this book is a good example of this). But for guns intended for civilian or sporting use, where quality should be your first consideration, such practices should be avoided when possible.

Chapter 5

Design Theory

As stated in an earlier chapter, firearms with high-capacity detachable box magazines, whether they be shotgun, rifle, or pistol, are becoming more desirable. These and specialty single shots such as trap guns and falling-block rifles seem like the logical types of firearms to develop.

Apart from the low-powered autoloading blowback actions, all firearms must be built around a locking system of sufficient strength to contain whatever pressure is generated during firing. These locking systems can consist of a rising or tipping block that locks the bolt body into the roof of the action, usually mating with a barrel extension; a rotating bolt, or bolthead in which lugs on the bolt rotate into recesses in the receiver, thereby locking the action; roller and inertia-locked actions and falling-block single shots, in which the breech block slides vertically, exposing and closing the chamber; as well as break actions.

It is my own opinion that autoloading firearm designs should be avoided. Sooner or later, even more laws restricting their ownership and use will come into being, which will limit the market severely. If you should decide to pursue an autoloading or automatic design, every precaution should be taken to make it as difficult as possible to convert it to full automatic. Eventually, some bright lad will manage to turn one into a machine gun, assuming your gun is put into production, and then guess who will be in trouble.

I built and marketed such a gun at one time. Due to the design, it was necessary to put a projecting pin in one side of the sear, which acted as a disconnector. The trigger assembly could not be assembled with this pin in place. I reamed a tapered hole in the sear and, after final assembly, drove the pin in and bradded it on the back side. It never occurred to me that anyone would drive it out again. Removing this pin turned the gun into a full automatic. As long as the trigger was held back, the gun would continue to fire until empty. Of course it wouldn't fire single rounds anymore, which rendered it worthless as far as I am concerned. I like to hit targets with one shot instead of simply spraying bullets in the general direction of the target. But for some reason there are any number of people who get enjoyment out of spraying lead. The feds caught some people with converted guns, declared them all machine guns, and put an end to my pistol business.

The sad part is that with just a little more thought, the gun could have been made slightly different so that it would not have fired unless the pin was in place. It simply never entered my mind.

You should first define the intended use of the finished gun. This will, in many cases, determine barrel length, magazine capacity, caliber, and overall configuration. The action type can then be chosen.

For a number of years I have been fascinated by shotguns, both single-shot trap guns and high-capacity box magazine guns. So if I seem prejudiced toward these guns, bear with me. The same designs can be scaled up or down to fire rifle or pistol cartridges.

A magazine must be designed and built that will feed the specific cartridge or shell used. This should be done first and the gun designed around it, since a close-fitting magazine housing is desirable for foolproof feeding.

I learned the hard way that high-capacity shotgun magazines must have a curve to present the top shell in the same plane, regardless of how many shells the magazine has in it. Due to the rim, the shotgun shell is bigger at the back than at the front. A straight-bodied magazine will feed five, sometimes six shells fairly satisfactorily. But if more are added, the nose of the top shell dips to a point where it will no longer feed.

To determine the correct curve to cause each shell to feed on the proper plane, arrange a full load of shells atop each other, with each top rim just ahead of the one under it, on a piece of paper and draw a line along both the back and front. No computer is required to determine this, just common sense.

Magazines for rifle and pistol cartridges can usually be made in a straight-bodied double-row configuration. These cartridges are far easier to make feed from a magazine than are shotgun shells. In an ideal situation, the magazine lips will release the rear end of the shell or cartridge just as the nose of the round enters the chamber. This requires careful layout of the position of the magazine well in relation to the breech end of the barrel. Ejection should occur as soon as the empty case completely exits the chamber. This can be adjusted to compensate for any error in design calculation by making the ejector longer than required. and cutting it back to the proper length after the gun is finished.

Ejection ports must be of ample size to allow the empty case (or loaded round) to exit freely without interference. Especially in the case of the shotgun, the empty case must be ejected before the top round in the magazine pops up into feeding position. This requires the magazine to be positioned somewhat further to the rear, whereby the empty case is ejected while the bolt is still on top of the next round, keeping it out of contact with the empty case. The bolt must then travel further to the rear, allowing the next round to pop up into feeding position in front of the bolt face, which pushes it forward out of the magazine as the bolt closes.

Dependable feeding of rifle and pistol cartridges can usually be established by using an approach cone of some 40 to 45 degrees at the breech end of the barrel. Such a feeding system was incorporated into the design of the M1903 Springfield rifle as well as the M54 and pre-1964 M70 Winchester rifles, among others. This breeching system was frowned on and considered unsafe by writers and armchair experts for several years. Now it has been "rediscovered" by several producers of higher-grade guns.

The shotgun will require a feed ramp just in front of the magazine to guide the blunt-ended case upward into the chamber. The barrel extension will have an approach cone similar to that described for the rifle and pistol, except it will require a shallower angle.

A locking system must now be decided on. Probably the easiest system to make up in a small shop is one with a rotating bolthead (or a rotating bolt if bolt action is used) locking into a barrel extension. The barrel is threaded into the barrel extension, forming a solid unit whereby the bolt and barrel assembly are locked together. This can save a considerable amount of machining time and effort over cutting bolt locking recesses directly into the receiver, and it relieves the receiver of most stress and stretching action that would take place with the bolt locking directly into the receiver body.

The means of opening and closing the action must be chosen. If the bolt action is used, it will be little different to other bolt actions in principle. The number of locking lugs will determine the amount of bolt lift required. In a slide-action or autoloading design, the operating mechanism can encircle the barrel instead of hanging down under it as in existing designs. This will usually mean that only one action bar, which connects the operating mechanism to the bolt, can be used. However the action bars can be wider than normal and have curved cross sections, making them stiffer than the thin, flat action bars used in other designs. The autoloader would have the gas piston encircling the barrel, with the gas port(s) at a point close enough to the chamber to cause unlocking while there is still enough pressure in the barrel to give the bolt sufficient impetus to assure that it opens completely. This is especially important with the shotgun.

With the box-magazine gun, upward pressure from the magazine spring pushes the shells up against the lower side of the bolt, creating friction that is not present in a tubular-magazine gun. If any of the recoil-reduction devices, which includes the overbored barrel, are included in the design, the bolt will need all the help it can get to open completely. Even the tube-magazine guns already in existence sometimes fail to eject and feed when fired from the hip with the butt unsupported. This is another argument for the slide action.

The receiver must be long enough to contain the barrel extension at the forward end, plus the full length of the bolt, and be of sufficient length to allow the bolt to open completely. It must also be of sufficient diameter or width to allow the full width of the magazine to fit into the lower side, plus accommodate a full-sized ejection port just above it.

The bolt must be long enough so that in the closed and locked position, it extends far enough past the rear of the magazine opening for the firing mechanism—whether it be hammer fired, striker fired, or whatever—to mate with the parts in the lower receiver. If it is to be a hammer-fired gun, the only accommodation for the firing mechanism will be a lengthwise hole for the firing pin. If striker fired, not only a firing pin hole but a slot for the sear and a bored-out recess for a retainer bushing will be needed. If it's a turn bolt, a cocking cam must also be cut. With a shotgun and most .22 rimfires, two extractors are required. Actually the outside one on the same side as the ejection port is the extractor. The inside one, just across from it, simply serves to hold the shell head in place against the bolt face during extraction. In rimless rifle and pistol cartridges, a counterbore in the bolt face serves to hold it in place.

Some sort of trigger housing or lower receiver must be used to house the firing mechanism. This will include a trigger guard, safety, and a means to mount the grip. The ejector is also fastened to this in some way, as is, in most cases, the magazine latch. While it is possible, and involves less work, to drill through both sides of the lower receiver for the hammer, sear, and trigger pivot pins, it is worthwhile to make up a separate housing to contain these parts and mount it inside the frame. This not only eliminates exposed pin or screw heads, which don't improve the appearance of the gun, but also prevents pins from working out, which can render the weapon inoperative.

Provision should be made for the buttstock to be attached to this assembly. This is usually accomplished through means of a drawbolt that extends through the buttstock and is threaded into the receiver.

Though a safety can be placed in several locations, one of the handiest is on the bottom side of the receiver directly forward of the trigger. Not only is it equally accessible to either hand, but it can be pushed forward into the firing position with the trigger finger. This was once the position favored by the military, but they got involved with incorporation of a selective-fire switch with the safety and moved it to the side of the gun, where it is easily accessible only to the right-handed shooter.

I made some shotguns once using an M16 hammer and trigger with the safety in the same position as the M16 selector switch/safety. About half the people interested in these guns were left-handed, so I wound up putting a safety lever on both sides so that it could be operated with either hand. This was similar to the ambidextrous safeties used on combat-type autoloading pistols. This safety worked fine, but it was complicated and difficult to make. The simple sliding safety just in front of the trigger corrected that.

A safety should be just that—a safety, rendering the gun incapable of discharging when it is engaged. This means it should lock the sear directly into the hammer notch, making accidental discharge impossible. Simply wedging the trigger in its forward position is not good enough. It is possible for the hammer to jar off the sear if dropped, especially if the hammer notch or sear nose angle is steeper than it should be. The safety shown in the shotgun drawings will pass any military drop test ever devised.

It is likewise imperative that a disconnector be devised to cam the trigger out of engagement so that the gun cannot fire until the action is locked. Properly fitted, when the bolt body is moved to the rear one eighth inch or more, the trigger is disconnected and the gun will not fire. Do not neglect this. I built a trap gun once with a straight pull bolt. It would have required a complicated arrangement to incorporate such a disconnector, so I left it out. I took this gun to a trap shoot and let several shooters try it. It didn't kick much and shot slightly high, so everybody liked it.

Everything went fine until I went into the club house to have a drink with the club manager. While we were in there, I heard a loud report. Sure enough, one of the "expert reloaders" had put a shell in the gun that wasn't resized properly, and it wouldn't let the bolt close enough to lock. It fired without being locked and blew the bolt to the rear. No trace of the empty case was found; it was simply blown to bits. No one was hurt, and neither was my gun. But if someone had been standing close to the ejection port, they could have been. I have never built another such gun without a proper disconnector.

A turnbolt action, in which the firing pin is cammed to the rear as the bolt is opened, will not need such a disconnector. While the firing pin will move forward if the trigger is pulled with the bolt partly open, the sear will contact the cocking cam, which will not allow the firing pin to travel forward far enough to contact the primer unless the bolt is almost completely closed.

If the slide-action gun is built, some means should be provided to keep the slide locked forward until either the trigger is pulled, causing it to be released, or a manual slide-release button is depressed. This will prevent the slide from jarring or vibrating partway open, which might cause the trigger to disconnect and not fire when it is needed.

Regardless of the design or configuration, the sight line will be between 2 and 2 1/2 inches above the comb for comfortable shooting. This will fit the average shooter fairly well. Fat boys with thick cheeks will require slightly more. A length of pull (the distance from the buttplate to the trigger) of 13 1/2 to 14 inches will fit the average person. In a trap gun, where the weapon is shouldered and in the firing position when the target is called for, it can be somewhat longer. If the pistol grip design is used, the stock length is of less importance than with the standard stock. The forend should be long enough to prevent the shooter's hand from coming in contact with the hot barrel.

If the shotgun muzzle brake is used, the front sight should be mounted on top of it. It should have vertical adjustment incorporated into it so the shooter can move the point of impact in relation to the sight picture. Windage, or lateral pattern movement, is accomplished by rotating the muzzle brake slightly and locking it in place with the lock nut. In the trap gun especially, the rear aiming point should also have vertical adjustment, which will allow the shooter to move it up or down until it fits him exactly. This will eliminate one of his excuses for missing targets.

Most of the previous observations are also valid when applied to other designs. The single-shot falling-block action, while difficult to build, makes up into a most attractive firearm. If the receiver is built in two parts and inletted into a one-piece stock, it not only should be as accurate as a comparable bolt action, it also permits cleaner stock lines as found in the so called "classic" style custom rifles.

One of the most difficult tasks in building a falling-block gun is properly locating the spot for the firing pin hole. This can be made easier by turning a sharp point on a rod that will slip fit into the bore. The rod is inserted in the barrel with the pointed end toward the breech. With the breechblock closed and in firing position, the end of the rod extending from the muzzle is tapped with a hammer. The sharp point will mark the firing pin location.

If you are using a rimfire caliber, it is a simple matter to measure from the center mark the correct distance for the firing pin location. We read about people trying to locate rimfire firing pin locations by painting the head of a fired case with some sort of marking compound and closing the bolt on it. They say the firing pin depression won't leave any mark, and this locates where the firing pin is supposed to go. In practice, if the breechblock fits up snug against the breech end of the barrel as it should, whatever marking compound was painted on the head of the case will be smeared across the face of the breech block as it is closed and will therefore indicate nothing. Provision must also be made for the firing pin tip to retract before, or just as, the breechblock begins to open. Otherwise the firing pin will likely hang up in the fired primer or rim indentation and either break the firing pin or cause the action to be extremely hard to open.

When you have your design firmly fixed in your mind as to how you want it to look and work, it should be drawn, full size, on paper.

It is sometimes helpful to make cardboard cutouts of the working parts and pin them in place on the drawing. Many times little things like moving a pivot pin slightly or determining the correct location for a hammer notch can be accomplished through use of this method.

With the design finalized, it may be helpful to make up a full-scale model from wood, or plastic, or both. When the model is built, all sorts of little things that don't show up on drawings which can cause problems often become apparent. While this may seem like a lot of extra work, it is far better to discover miscalculations and design flaws and correct them on such a mockup than to discover them after the final project is mostly finished and maybe having to scrap part or all of it.

Chapter 6

Helpful Hints

The purpose of this chapter is to pass on any bit of information that I can think of which might be helpful to you. Some of it might have been included in other chapters. Other parts of it probably have no relevance whatsoever. But again, some of it might come in handy.

When drilling holes, if they are expected to be round and straight, sharp drills must be used. The material to be drilled should be clamped or held in a vise and secured to the mill or drill table. If you try to hold it in one hand and feed the drill into it with the other, as many people try to do, torque caused by resistance to the drill tries to turn the material in the opposite direction, causing the drill to crawl off center. This is the cause of most crooked or oversize holes.

Holes should be started, especially on rounded surfaces, with a center drill, drilled to depth with an undersize drill, and finished with a drill of the proper size. When holes are to be tapped partway through, the hole is first drilled with the tap drill, the full-size portion drilled for clearance, and the hole tapped, in that order. When drilling for pivot pins, such as for a trigger or hammer, the frame or housing that the pivoting part fits into should be drilled from the side that the pin is installed from with a drill of the same size as the pin. The opposite side is drilled with a slightly smaller drill to grip the pin and hold it in place, and the hole through the pivoting part slightly larger so that it will pivot without binding.

Contrary to popular opinion, a .125-inch pin will not rotate freely in a .125-inch hole. Assuming that we are using a 1/8-inch pivot pin, we drill the hole completely through all surfaces with a No. 31 drill, which measures .120 inch, or .005 undersize. The one side is drilled to 1/8 inch, or .125 inch. The hole through the pivoting part is drilled with a 3.20 millimeter drill, which has a diameter of .126 inch. This will allow the part to pivot on the pin without resistance and still not wobble. Holes for other sized pins are done in the same manner.

Straight holes can be drilled fairly close to their required location with a hand drill, provided that the work is clamped or otherwise secured to prevent its movement. Both hands should be used to hold the drill in an absolutely vertical position, or at 90 degrees to the work. Holes should be started with a center drill and drilled to depth with an undersize drill, followed by the drill of the correct size.

If absolute precision of hole location is essential, the milling machine should be used in the same manner as a drill press, with the work fastened securely to the table and moved into exact location with the table feeds. Even now, the center drill should be used first, followed by drills as described above.

Bolt lugs, raceways, holes spaced around the diameter, etc. are located and spaced through use of a rotary table, dividing head, or spacer. In the event none of these are available when needed, fair success can be had in locating equally spaced positions around the outside diameter by wrapping a strip of masking tape around the work and marking the exact length of one turn. The tape is removed, laid out flat, and measured. This measurenent is divided by the number of positions required and each of these marked on the tape. The tape is then wrapped around the circumference of the work once more. Each of these marks now represents a center line for the rows of holes used in the shotgun muzzle brakes, or center lines for bolt lugs, or whatever. Inside divisions can be made by wrapping the tape around a shaft that fits the inside diameter closely and dividing as above. It is then inserted into the work and location marks transferred from the tape to the end of the work. This method is not intended to replace precision equipment, but if only a few such operations are to be undertaken and the equipment is not available, this method will pinpoint locations to within a very few thousandths, if care is taken.

Grinding wheels are usually too slow to shape metal parts. The sanding discs used primarily in automobile body shops are available from hardware and auto parts stores. These are fairly stiff, fiber-backed discs usually of 7- or 9-inch diameter. They are available in grits ranging from 24 to 120. A backplate just slightly smaller than the discs is made from plastic, masonite, etc. and mounted behind the disc on an arbor. Parts can be shaped to almost exact contours using this method. These are also useful when shaping wood.

Inside polishing, such as inside trigger guards and the like, is made easier by sawing a lengthwise slot in a wood dowel. Strips of abrasive cloth or paper are mounted by placing one end in the slot and winding several turns around it in the opposite direction of its rotation. A 1/2-inch drill chuck that can be mounted on a motor arbor and the dowel chucked in it is ideal for this. Use a fairly high-speed motor of 3750 RPM or similar for this.

Recoil pads mounted on the straight-line recoil type buttstocks have upper mounting screws that come out right in the place where the stock bolt hole is located. Sometimes another screw can be located higher and miss the bolt hole. It is easier to silver-solder a screw head to the end of the stock bolt that will accept an Allen wrench. The recoil pad's upper screw hole is enlarged to permit insertion of the Allen wrench and a corresponding slot cut in the face of the pad. The pad is then mounted in place using epoxy cement and the lower screw. The stock bolt is turned by inserting a long, round-bodied Allen wrench through the face of the recoil pad. If a coating of oil or grease is used to lubricate the Allen wrench, the face of the recoil pad will show little or no evidence of the wrench insertion after it is withdrawn.

Marks and scribed lines on metal are often hard to see during the sawing or milling process. A thin coal of layout fluid such as Dykem brushed on and allowed to dry for a few minutes will make subsequent lines more visible. This product is available from both machine tool and gunsmith supply houses in red, blue, or other colors. Obtain a can of remover and thinner at the same time. An even better method consists of polishing the surface of the metal bright and swabbing on a solution of copper sulfate. This will leave a thin layer of copper deposited on the surface that causes any markings to stand out vividly. Copper sulfate is a blue crystalline powder available from drug stores. It is also known at Bluestone and Blue Vitroil. The solution is made by adding all the copper sulfate that four ounces of distilled water will dissolve. Add 12 to 15 drops of sulphuric acid to this.

Years ago, a cold bluing solution that came in two bottles was marketed. The contents of the first bottle (copper sulfate) was swabbed on the clean bright steel, which imparted a thin copper layer. The contents of the second bottle, which consisted mostly of arsenic trioxide, was applied next, which turned the copper black. As I remember, it resulted in a better black color than the modern cold blues. But, like most of the others, it started to rub off in a short time. It was also one of the foulest smelling concoctions I ever came in contact with.

In many instances, silver solder will be used to mount sight bases, trigger guards, barrel bands, and various other parts. There are people who will tell you that the correct way to join parts using this material is to cut strips of the flat “ribbon” material and sandwich it between the parts to be joined, whereupon heat is applied, the solder melts, and, when cool, the joint is made. This may work for some people. Everytime I tried it, however, the results were somewhat different. When the work is clamped together and the sandwiched silver solder melted, the parts tend to shift or slip in their relationship to each other. Besides that, I was never sure that all the solder melted and flowed.

A far better method, at least for me, is to apply flux to the surfaces to be joined and clamp them together. The adjacent surfaces are rubbed down with soapstone or a soldering “talc” crayon, which will prevent the solder from adhering to the exposed surfaces. Using a wire-type silver solder of 45- to 55-percent silver content, the joint and surrounding metal is heated until it just begins to turn red and the end of the solder touched to the joint. The application of heat is continued until the molten solder is visible all around the edges, at which time the heat is withdrawn and the work allowed to cool. Care must be taken not to overheat it since silver solder has a tendency to simply evaporate when overheated, and the fumes are toxic. The joint is then cleaned of the flux and soapstone residue, and any excess material is removed using files or scrapers.

Whether we like it or not, sooner or later we will be required to turn the outside of a barrel to a specific size and contour. The easiest way, as concerns the small shop, is to mount the barrel between centers in the lathe and set the tail stock over enough to cut the appropriate taper. Since the breech end usually has a threaded shank followed by a straight tapered forward section followed by an abrupt taper or tapered curve, there is usually a length of 18 to 20 inches that consists of a straight, gradual taper usually of .150 to .200 inch over the entire length. This taper can be set up to give an almost exact measurement by mounting a dial indicator on the cross slide of the lathe and measuring the amount that the tail stock is set over. After a few passes are made with the lathe tool, and while the barrel is still oversize, the muzzle end and the point where the taper ends are measured. The amount of tailstock set-over is changed to correct whatever error is present.

A steady rest can be used to support the barrel and dampen it to prevent chatter by offsetting the steady rest jaws to coincide with the tail stock offset, but it will require moving a couple of times. Usually there will be a slight step or ridge where the previous cut is stopped and a new one started. Therefore it is probably easier to turn the full length without using the steady rest, instead using a wood block held against the barrel to dampen the vibration and draw filing the entire length to remove tool and chatter marks, finishing with varying grits of bench strip.

When using high sights, it is extremely important that the sights stand exactly vertical, or straight up and down. This can present a problem, since these are not easy to hold in place with clamps or to determine when they are straight up. One way to do this is to clamp the receiver or barrel in the milling machine vise, making sure it is square and level. A rod with a sharp conical point is mounted in the mill collet. The sight assembly is located in place and held by pressure between the quill and mill table. A weighted string, or plumb line, is suspended from the ceiling directly in front of the work. Then, by sighting along the surface, the sight assembly can be aligned vertically with the string by moving the cross feed of the mill table until it is straight up and down, whereupon the sight assembly is silver-soldered in place.

Turning long firing pins can present a problem. The lathe tool must be sharp and set up to contact the material to be turned exactly on center. The material is mounted in the lathe with one end extending from the chuck for a short distance and the free end supported by a center. This section is turned to size, taking light shallow cuts. It is then extended further and again turned to size. This is repeated until the entire length is formed. It is then mounted in the lathe chuck with just enough extending to turn the nose to its specified diameter, and the counter-stink end for the lathe center is removed. The hemispherical tip can be formed with a file and polished with abrasive cloth.

Coil springs must be supported for most of their length, either by an inside guide pin or a spring pocket enclosing most of the spring’s length. Otherwise they may buckle and deform, rendering them inoperative. As used with triggers, sears, extractors, etc., spring pockets are drilled in the part to contain most of the length of the spring, thus supporting it around the outer surface. When coil springs are used as long, traveling hammer springs and the like, they must be supported by an internal guide rod. Many times, the compressed length should be taken into consideration when determining spring pocket depth and length of travel of moving parts. This is easily determined by multiplying the number of coils in the spring by the diameter of the wire that the spring is wound from.

There are times when it is important to determine thread depth, and no chart or table is on hand to refer to. The root diameter (the size of the screw shank remaining inside the threads) can be determined to within a couple of thousandths by dividing the pitch, or number of threads per inch, into 1.299. Since a 100-percent thread will not screw into a 100-percent hole, some clearance must be allowed. A 75-percent thread is an accepted standard. Therefore we would take the result of the division above and use 75 percent of it, which gives a satisfactory tap drill size or hole size in which threads will be machined.

When glass bedding or epoxy-based compounds are used to reinforce or fill gaps between wood and metal joints, it is absolutely necessary that any holes, depressions, cracks, seams, or anything else that this material may be forced into when drawn together be plugged or sealed to prevent such from occurring. Holes can be plugged with paraffin wax, cracks and seams taped over, and slots and depressions filled with wax. All surfaces except the ones the substance is to adhere to must be coated with some sort of release agent to prevent them from becoming bonded together permanently. If no commercial release agent is available, automotive paste wax can be used. Give the exposed surfaces a thin coat and let it dry, then give them another coat. All screw threads must also be coated. Antifreeze that contains glycerine can also be used for this.

Shotgun bores and chambers, as well as rifle and pistol chambers, can be polished by slotting the end of a wood dowel, inserting one end of a strip of abrasive cloth or paper in the slot, and winding it around the dowel in the direction the work rotates. With the barrel held in the lathe chuck, the cutting end of the dowel is inserted in the bore, the lathe turned on, and the hand-held dowel moved slowly back and forth through the bore. The abrasive material should be a snug fit in the bore and will require frequent replacement. A final polish should be applied using 400 grit (wet or dry) paper followed by crocus cloth. Lubricant is used throughout the process. Chambers can be polished in the same manner by using correspondingly sized dowels. This is, more or less, a makeshift operation to be used in the absence of commercial hones and polishing heads. However if sufficient time and effort is invested, it will give good results.

When barrels are installed, either in receivers or mated to barrel extensions, they must be drawn up tight. When mated to a receiver, this is easily accomplished using a barrel vise and an action wrench. The barrel extension sometimes presents problems since it is difficult to fasten onto with a means to turn it. One way to tighten or remove it is to bore a pair of hardwood blocks to the same diameter as the extension. A clamp is made with a bolt on each side to fit over and contain the blocks. One leg of this clamp is either long enough to serve as a handle or turned to fit inside a length of pipe, which serves as a handle. This is used in the same manner as an action wrench.

Flat parts can be polished while retaining flat sides and sharp edges by placing abrasive cloth or paper on a sheet of plate glass and rubbing the part to be polished back and forth across it. As usual, progressively finer abrasive grits are used, as well as cutting oil.

Holes can be drilled or bored in the lathe and shoulders and threads can be cut to exact depth by mounting a dial indicator on the lathe bed in a location where the stylus will contact the lathe carriage as it reaches the bottom of the cut. The indicator should be set up to stop on a number after the indicating hand has traversed the dial a couple of times, not just as contact is made. This will give ample warning before the stopping point is reached.

There are times when slots must be cut that cannot be reached with ordinary milling cutters. It is also difficult to cut such slots with a hacksaw, since succeeding saw cuts tend to slip over into the adjacent cut. If the mounting pins in the hacksaw are replaced with longer pins, more than one blade can be mounted simultaneously in the saw frame. This will allow wider slots to be cut at one time, with the slot width regulated by the number of blades used.

Most feeding problems in box-magazine guns can be alleviated by reshaping the magazine lips and/or follower. If the nose of the cartridge or shell tries to contact the top of the chamber before entering, the magazine lips should be bent inward slightly. Reshaping the follower so that the forward end rides lower in the magazine may also correct this. If the shell hits at the bottom, the magazine lips are spread slightly or the follower is bent to ride lower at the rear. Sometimes the cartridge nose will hang on the left or right sides. This can usually be corrected by bending the lip slightly upward on the side the bullet should be steered toward, or by bending the opposite side downward.

When small boring bars are needed for use in the lathe and none are available, end mills can be mounted in the tool post (especially a four-way tool post) and one flute used as a cutting edge. The body should be angled just enough to provide clearance. You can’t bore deep cavities with these, but they work in a pinch.

To obtain a good finish when turning plastic, as with forends, a sharp, round-nosed tool should be used. It should have twice as much clearance as used for cutting steel and no rake. The material is turned at a fairly high speed and fed slowly. This material must not be allowed to overheat since the surface tends to melt, spoiling the finished surface. Therefore, friction, the primary cause of heating, must be kept to a minimum.

Chapter 7

Actions

Rifles and shotguns can have autoloading or automatic actions, slide actions, lever actions, bolt actions, single-shot actions, and multiple-barrel actions, or be muzzle loaders. These same action types, with the addition of revolvers, have been used in pistol actions. Of late, a few shotguns and rifles have again surfaced with revolving cylinders, but most didn't last long. There were also revolving rifles and shotguns built back in the 1800s, but they went the same way as their modern counterparts. Gas leakage between the barrel and cylinder gap was one reason for their demise. Weak frames was another.

There are several different types of autoloading actions. In the locked-breech category, there are short recoil, long recoil, gas operated, inertia locked, and hesitation locked. The unlocked, or blowback as they are usually called, actions have no mechanical lock. The weight of the bolt, or breechblock, in combination with spring pressure holds the bolt closed at the instant of firing, hopefully until the bullet is well up the bore and pressure has diminished.

These fall into two categories: closed bolt and open bolt. Closed-bolt guns are striker fired or fired by a separate hammer. The bolt remains closed until fired, at which time it travels to the rear, extracting and ejecting the empty case, until it is arrested by the return, or recoil, spring. It is then pushed forward by the compressed spring, picking up and chambering a fresh cartridge. The bolt then remains closed until fired again.

The open-bolt gun usually has a fixed firing pin machined into the bolt face. The bolt is held in its open position until the moment of firing, at which time pulling the trigger allows it to slam forward, picking up and chambering a cartridge as it moves forward, until the cartridge seats in the chamber and the firing pin slams into the primer, firing the round. The bolt then travels to the rear, extracting and ejecting the empty case, where the sear engages and holds the bolt open until the gun is again fired. This type of gun is usually inaccurate, partially due to the hard, lengthy trigger pull found on most of these guns but mainly due to the disturbing motion of the heavy bolt slamming forward between the time the trigger is pulled and the instant of firing.

Centerfire blowback action.

Inertia-locked autoloading blowback action.

Blowback pistol trigger assembly.

These blowback type actions are only suitable for low-powered cartridges and should not be considered for any other use.

Likewise, most short-recoil actions are only suitable for low-powered cartridges and should not be considered for any other use. Short-recoil actions are so named because the breech is locked at the instant of firing, and the bolt and barrel then travel together for a short distance to the rear until the bolt is unlocked, usually by some sort of cam or toggle action. This allows it to continue its travel to the rear while the barrel is stopped and moves forward again when the bolt returns forward, thereby locking the breech once more. The Browning-type autoloading pistols as made by Colt, Smith and Wesson, Ruger, and others are examples of this type of action.

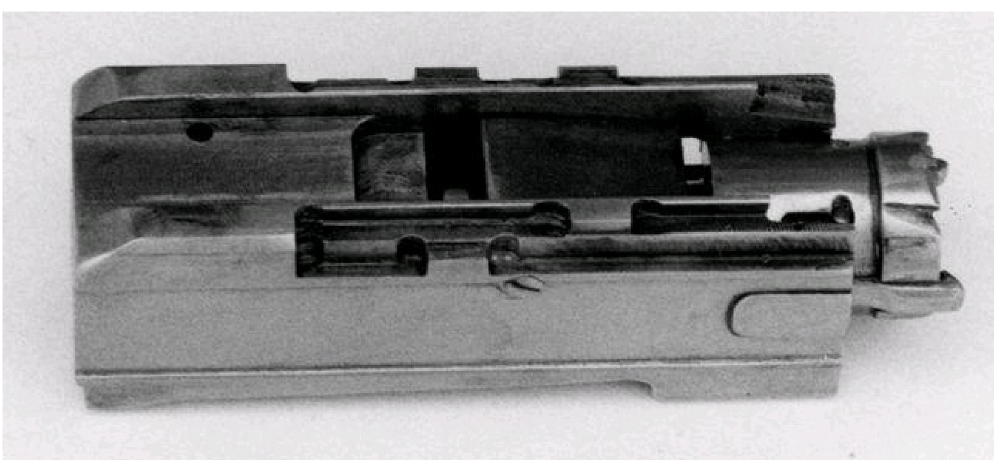
Long-recoil actions work in much the same way, except that the barrel and bolt travel as a locked assembly most of the way to the rear, where unlocking takes place. The barrel then moves forward while the bolt is held to the rear for a short interval, then allowed to move forward. Browning A5 shotguns, among others, are an example of this.

The gas-operated action is considered superior to either of these, mostly because the barrel is fixed in the frame and does not move. This type action normally has one or more gas ports positioned somewhere near midway between the chamber and muzzle of the barrel. Gas passing through the port(s) pushes against a piston, which is connected in some way to the bolt. This opens the bolt far enough to unlock it, after which recoil and residual gas pressure cause it to continue its rearward travel until stopped by the compressed recoil spring, which then pushes it forward to the locked position once more. These gas-operated actions usually will do more toward recoil reduction than the other types. Many modern autoloading centerfire rifles and shotguns use this system.

The inertia-locked action also features a non-moving fixed barrel. As used, the heavy bolt surrounds a bolthead with a heavy spring between them. When the gun is fired, either the bolt stands still and the rest of the gun recoils to the rear, compressing the spring, or the bolt jumps, forward compressing the spring. I have never been entirely sure just which action takes place, but anyway, the spring ends up compressed. Then the compressed spring kicks the bolt to the rear, causing it to unlock, and inertia, recoil, and residual gas pressure cause it to continue to the rear until the compressed recoil spring stops it and pushes it back forward to the locked position. While this is a simple action that requires less parts to make it work, it depends on recoil to make it function. I built several autoloading shotguns and some self-opening trap guns using this type action, and they worked perfectly. But when I attempted to cut down on the excessive amount of recoil generated by adding muzzle brakes, spring-loaded stocks, overboring, etc., the action would no longer open completely.

Shotgun bolt with rotating bolthead.

Rising-block shotgun bolt.



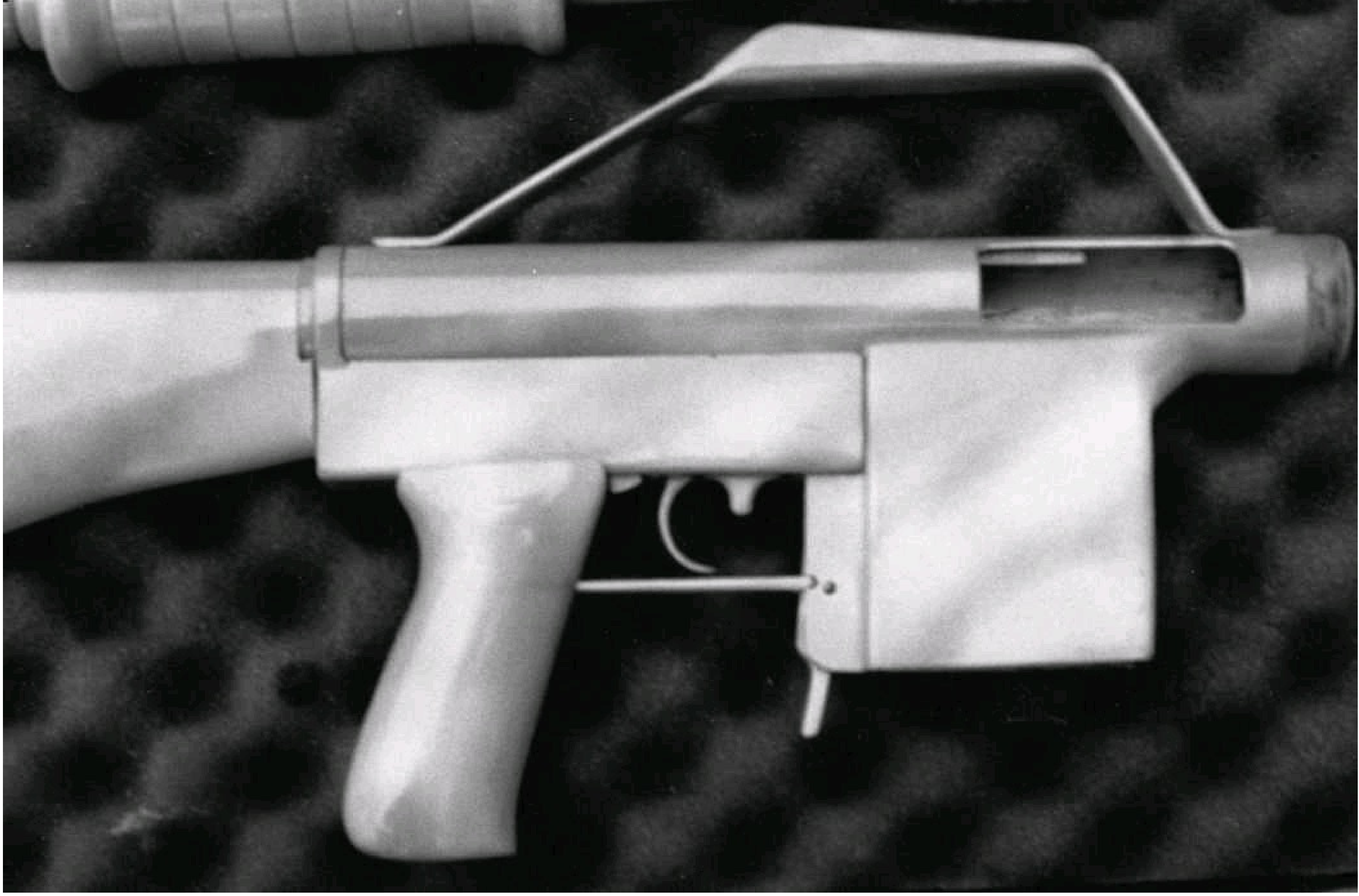
Benelli shotguns use an action of this type. But they use a tight bore some .005 to .006 inch smaller than the standard .729-inch 12 gauge bore to generate enough recoil to make them work dependably. This results is an accelerated recoil level, making the Benelli guns some of the hardest kicking guns on the market.

Then there is a locking system usually referred to as a hesitation lock. Here again, there is a heavy bolt surrounding a separate bolthead. Between the two are a pair of rollers that are pushed outward into engagement with corresponding depressions in either the receiver walls or a barrel extension when the bolt body is all the way forward, more or less locking the action. Upon firing, the rollers remain cammed in the locked position until recoil moves the bolt slightly to the rear. At this point the rollers collapse inward, allowing the bolt to proceed to the rear unimpeded except for the compression of the recoil spring.

The drawback to this system is that in some cases it doesn't remain locked long enough. Most of the firearms using this locking system attempt to control premature opening of the bolt by cutting shallow grooves, or flutes, lengthwise in the chamber walls. Some will tell you that the added friction caused by pressure forcing the case walls into these grooves hold the case in place longer. Others say that the grooves allow gas to flow between the case and chamber walls, "floating" the case and permitting easy extraction even though chamber pressure is still high. Most Heckler & Koch firearms use this locking system.

.22 blowback action.

Slide-action 12-gauge.



Self-opening trap gun action.

Slide, or pump, actions work in much the same way as the autoloaders except that the bolt is moved back and forth manually through use of a reciprocating slide handle, or forend. These usually lock either by means of a rotating bolthead or a rising block. Either of these mates with corresponding recesses in a barrel extension. There have also been designs in which the rear end of the bolt tips up or down into a recess in the receiver to lock.

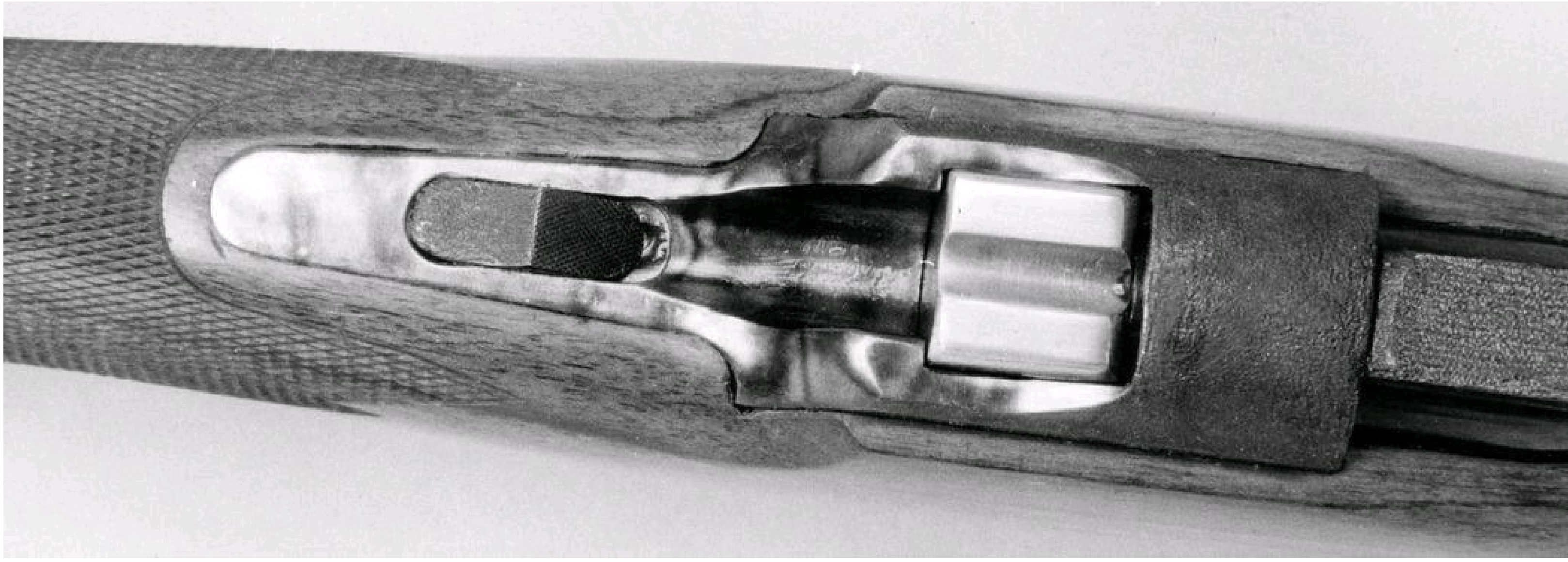
In many cases, the same bolt and receiver used in the autoloader can also be used in the slide action. This is especially true with the gas-operated autoloader, in that the gas ports, piston, recoil spring, etc. are eliminated from the design. The slide handle connected to the operating bar(s) is in its place.

The bolt action has long been considered the strongest and most accurate of the lot. But if locking lugs of equal size and quality of material are used, there is no reason why the slide action or autoloader with a rotating bolthead should not be equally strong and capable of containing an equal amount of pressure. The main reason for the bolt action's superior accuracy lies in its one-piece stock. This allows bedding the action solidly in the stock while permitting varying amounts of pressure or support to be exerted against the barrel by the forend, or, in some cases, letting the barrel float free with no interference from the forend whatsoever.

Most bolt actions are of the turn-bolt variety. These will have one or more locking lugs spaced around the circumference of the bolt body. While usually found at the front, several designs have these lugs at the rear end of the bolt. Some even use the root of the bolt handle as the locking lug. For years, the standard for military and sporting actions was two locking lugs spaced 180 degrees apart and located just behind the bolt face. Several also had an auxiliary, or safety, lug located close to the rear of the bolt in case the other two failed. The lugs extended outward and were considerably larger in diameter than the bolt body, requiring raceways cut most of the length of the receiver to allow the lugs to move back and forth.

Bottom side of falling block.

Falling block action with square breechblock.



Falling-block action with round breechblock.

Slide-action 12-gauge shotgun with square receiver.

In recent years, a number of designs have appeared with three or more lugs spaced equidistantly around the bolt body with the lugs of the same diameter. This eliminates the need for bolt raceways cut in the receiver. The more lugs that are used, the less bolt lift is required (two lugs require a 90-degree bolt lift, three require 60, and four require 45), but the shorter bolt lift requires a steeper angle in the cocking cam. This can result in considerably more effort required to lift the bolt in a three- or four-lug action than needed with the two-lug job.

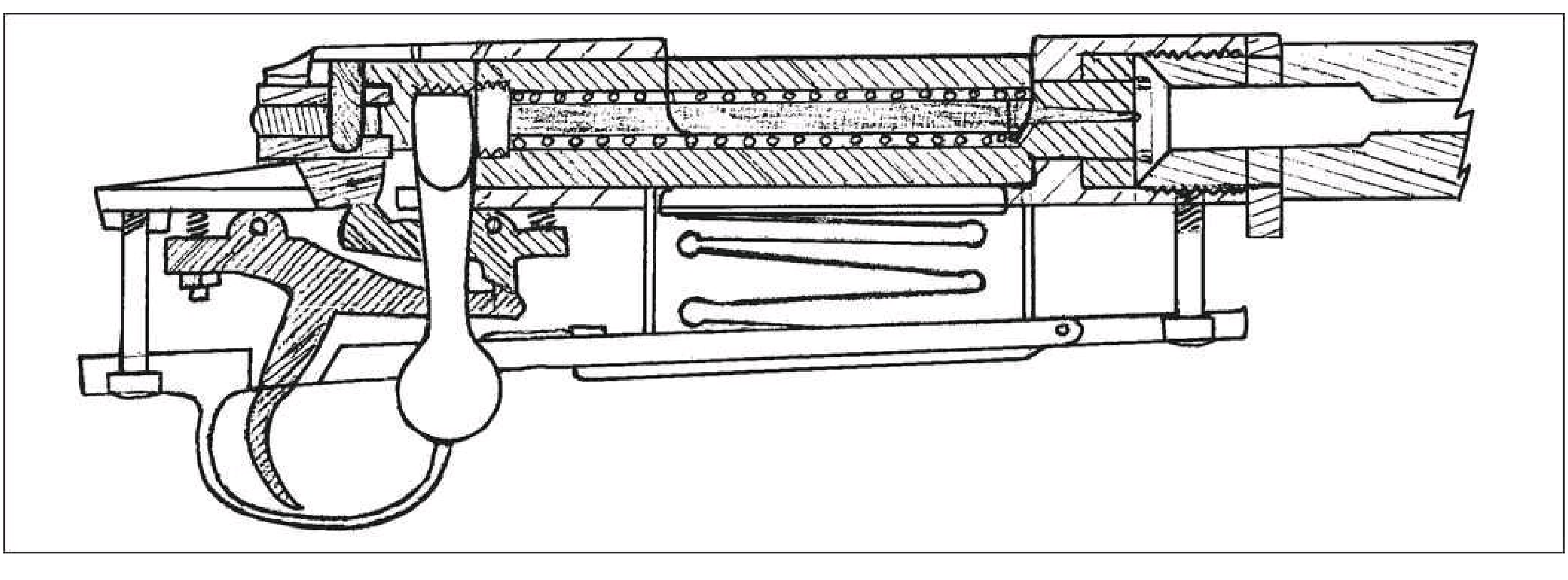
There are also straight pull designs, which may have a rotating bolthead operated by cam action or a cross bolt that locks through both sides of the receiver. I made several trap guns based on the straight pull cross-bolt action. Browning also built a gun they called a "T bolt" that had a similar action. They offered no advantage over the turn bolt.

Lever actions are only used on rifles at present. Winchester made shotguns years ago, and Marlin also made a few, as well as at least one other firm. They couldn't compete with the slide action, however, and gradually faded away. The more modern lever actions have either rotating boltheads that lock at the front just behind the barrel or locking bolts located at the rear of the action which ride in slots in the frame and engage into slots in the bolt, locking both together. Several reproduction rifles are available, duplicating Henry and early Winchesters, that use the original-style toggle link lock. These are not suitable for high-pressure cartridges.

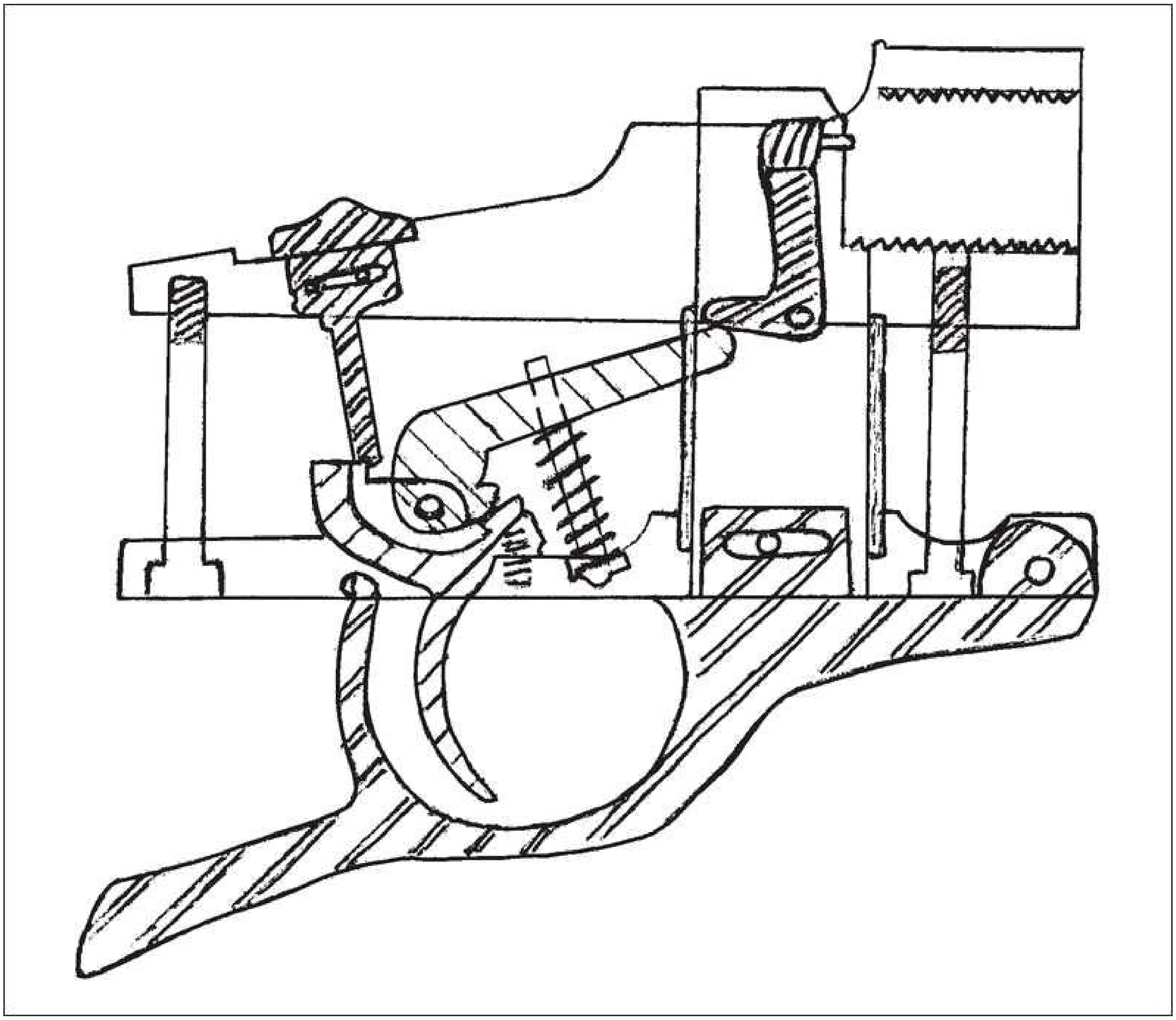
Single-shot actions, that concern us here, can be classified as falling-block actions and break-open actions. The break-open actions usually hinge in the middle just ahead of the trigger guard. Several different types of locking bolts are used to lock the barrel assembly in place against the frame. This bolt is normally withdrawn by pressing a top lever crosswise. This type of action, properly made, is suitable for use with any cartridge made for a shoulder-fired firearm.

The falling-block action uses a lever-actuated breechblock that slides up and down in the receiver, closing and opening the breech end of the barrel. Both these and the break-open action usually incorporate an automatic ejector that throws the empty case out of the chamber when the gun is opened after firing. Both types are usually hammer fired and contain very few moving parts. The falling-block action, properly designed and built, is suitable for use with high-pressure cartridges.

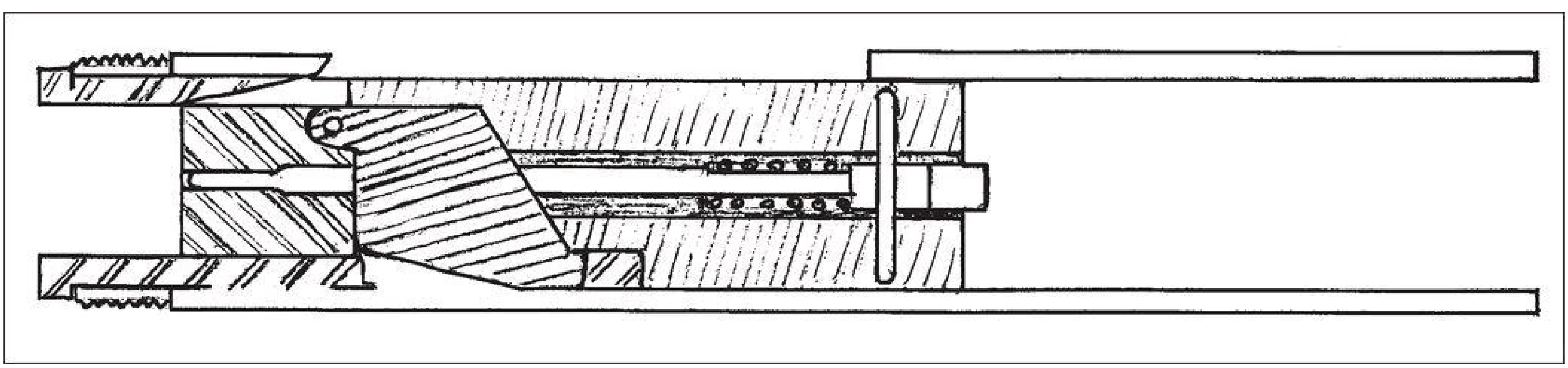
Turn-bolt, magazine-fed action.



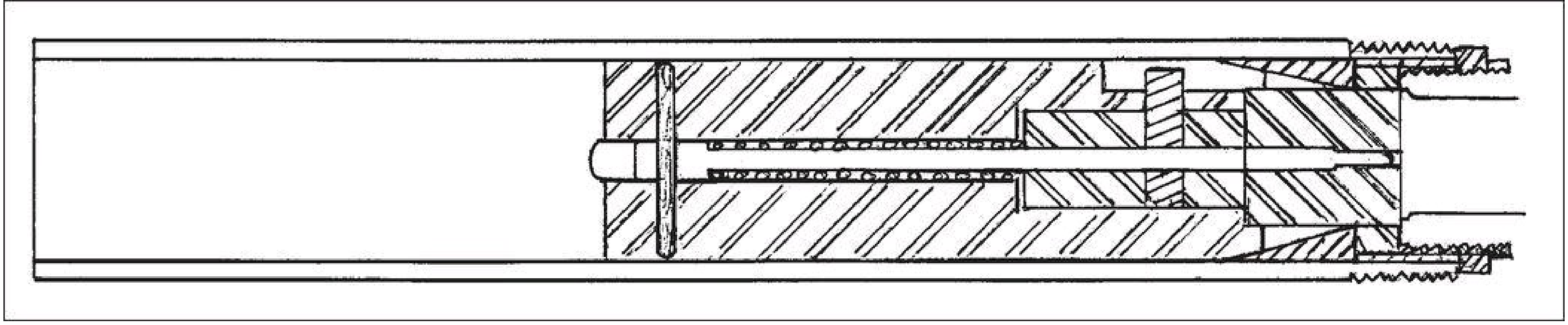
Single-shot, falling-block action.



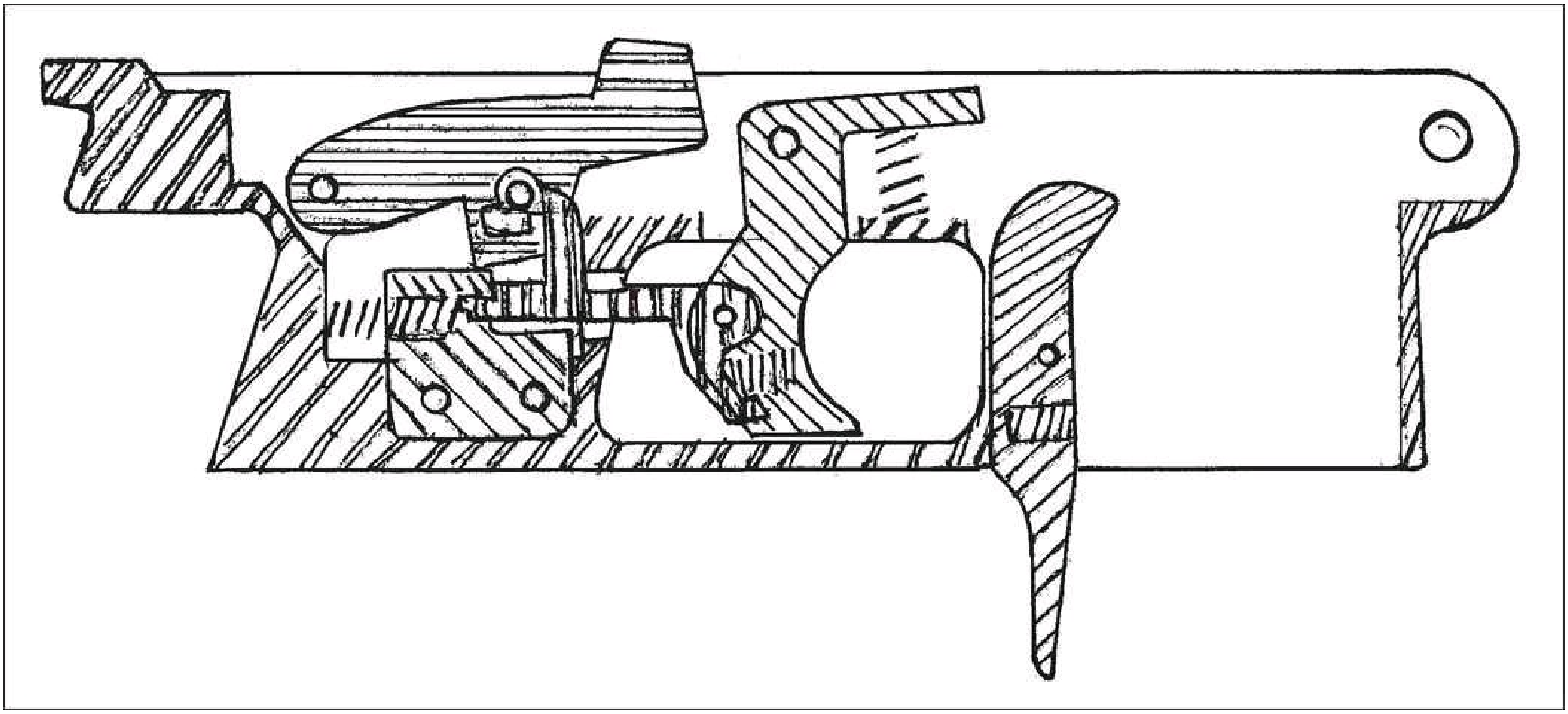
Rising-block action shown in 12-gauge dimensions. It can be used in automatic, slide action, or straight pull.



Rotating bolthead action as used in 12-gauge shotgun. It can be automatic, slide action, or straight pull and is adaptable to other calibers and gauges.



Open-bolt, blowback, .22 pistol trigger assembly.

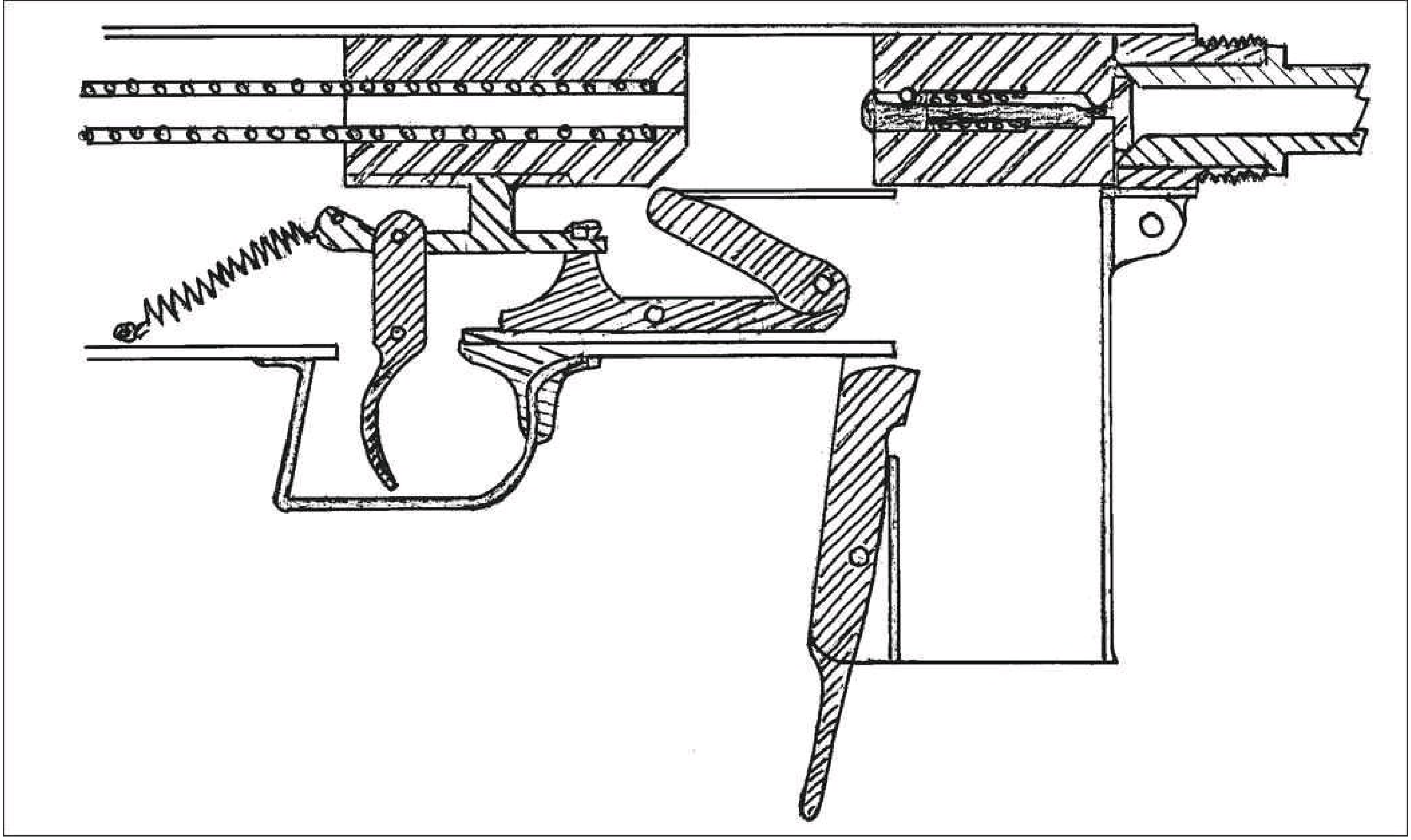


Multiple barrel firearms are almost always built on break-open actions. Barrel arrangement will be either side by side or over and under. These actions hinge and lock in the same way the single-shot break actions do. Used primarily in shotguns, these actions are also used in double rifles that can be in any caliber used in shoulder-fired firearms.

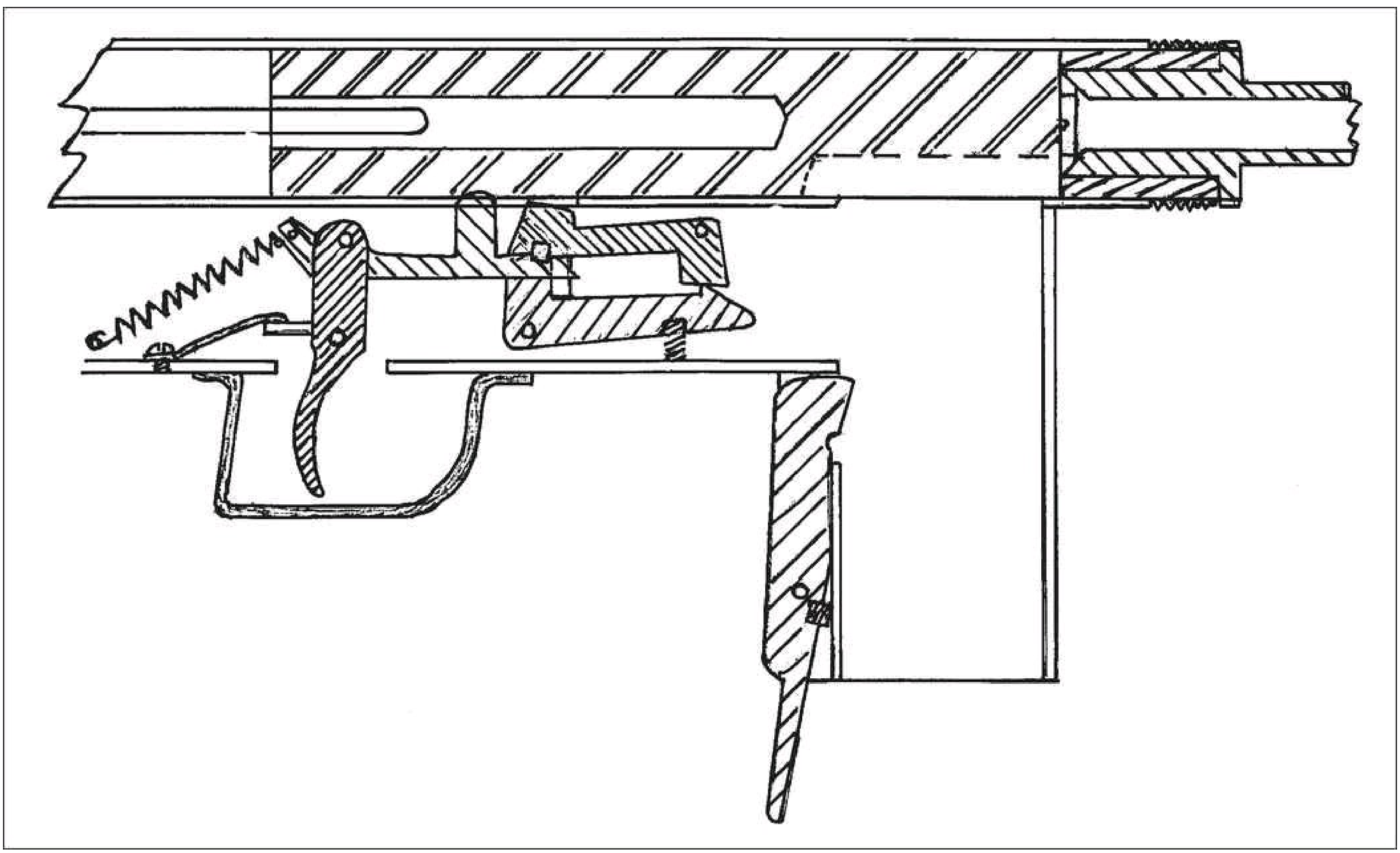
There is too much handwork and fitting involved in making a gun like this for it to be profitable in a small shop. I designed and built a double rifle once. It was almost 20 years ago. It took me over six months to build it. I never got a dime for it. After shooting it a few times, I let a friend (?) of mine take it to the west coast to display it at a gun show. He was going to promote it and form a company to produce it in quantity. I never saw him, or the gun, again.

Multiple-barrel guns also exist in three- or four-barrel configurations. This includes four shotgun barrels with two directly above the other two, or one barrel directly under and between the upper side-by-side barrels. These can and have been made with shotgun barrels in combination with rifle barrels too, such as rifle barrels along side and between over-and-under shotgun barrels. These are only a some of the combinations that have been dreamed up. Like the double rifles, these are too time consuming to make a profit on. But I have made all sorts of guns before that I didn't get anything for, so I may try one of these sometime, just to show people that I can.

Closed-bolt blowback action for low-pressure cartridges only.



Open-bolt blowback action for low-pressure cartridges only.



Single-shot bolt action.

Upper receiver separated from lower.

Bolt

End view of the bolt. The locking lugs and ejector are visible

Of the action types described in this chapter, the autoloader, slide action, and bolt action are the easiest to manufacture in the small shop. Receivers can be fabricated from round seamless aircraft grade tubing known as 4130. It is also referred to as chrome moly by aircraft mechanics and fabricators. This material can be obtained in almost any size and wall thickness desired at least close enough to adapt to your usage.

When using such tubing for receivers, round solid stock such as 4140-4150 or similar compositions can be obtained in sizes that will require only a light lathe cut, at most, to slide back and forth inside the tubing. The firing pin hole, bolt face cuts, and any relief cuts are far more easily located and centered using round stock than when square or rectangular bolts are used. This should be kept in mind when designing the firearm, since quite a bit of fabrication time can be saved.

Lower receivers, trigger housings, magazine housings, etc., can be bent to shape from sheet metal. Triggers, hammers, and the like can be sawn to shape as closely as possible from flat stock and finished by milling, filing, and grinding.

Lever actions, single shots, and multibarrel receivers require machining from rectangular material. While some of the excess material can be removed from the exterior by sawing, extensive mill work is required to form the inside surfaces. This can be expensive, both material and time wise. It is recommended that the round receiver and bolt-type designs be used if possible.

We will look at actual designs using these principles later in the book.

Chapter 8

Action Fabrication

Much time and machine work can be saved by selecting an action design that incorporates a receiver made from tubing. Several of these have been described in other parts of this book. Actions of this type can be adapted to rifle, shotgun, or pistol applications by changing the dimensions slightly.

The tubing diameter and wall thickness can be as small as 7/8 inch outside diameter with .059 inch wall thickness for .22 rimfire applications; 1 1/4 inch outside diameter with .065 inch wall thickness for centerfire pistol cartridges; and 1 1/2 inch outside diameter with .120 inch wall thickness for 12-gauge shotguns and centerfire rifle cartridges.

Magazine housings, if for a multishot firearm, can be formed separately and pinned or bolted to the receiver. They can also be folded from sheet metal and welded in place. While either method is acceptable, a stiffer assembly will result if the welded-on housing is used.

With the thinner tubing, barrel bushings should be turned to a push fit inside the receiver and welded in place. Neater welds will result if 1/4-inch holes are drilled equidistantly around the circumference of the receiver, just behind the front edge, and the bushing welded in place through these holes. Each weld is then dressed flush with the surface, leaving no evidence of such a weld ever having been made. The barrel bushing will require threading to accept a barrel retaining nut, or sleeve. Thicker-walled receivers are threaded directly for the nut.

Overall length is dictated by the length of the bolt and the cartridge used. It must be long enough to allow the front face of the bolt to move to the rear far enough to pick up cartridges from the magazine. This can range from as little as an 1 1/2 inch for pistol cartridges to 3 1/2 inches for certain rifle and shotgun cartridges.

An opening for the magazine must be cut in the appropriate location on the lower side and an ejection port just above it. Also, slots are needed to clear the hammer, ejector, and disconnector, if one is used. In certain applications, the back end of the receiver is threaded and an end cap threaded to match. Most designs will also require a block welded to the bottom side at the rear, which is drilled and tapped for a grip and lower receiver mounting bolt. Some of these require a similar block at the front for a crosspin or screw. A sight base is mounted on the top rear when used as a pistol. Rifles and riot-type shotguns will have a combination sight base and carrying handle mounted. A single-shot trap gun will use an adjustable sighting rib. These are either welded or silver-soldered in place.

Bolts are made using appropriate round stock turned to a size that will slide freely through the receiver tube. If used in an autoloading blowback type, no locking lugs will be necessary since the bolt weight and pressure from the recoil spring(s) are depended on to keep the bolt closed until pressure has diminished.

Any manually operated action, even a .22 rimfire, will require some means to lock it shut. Probably the easiest way to accomplish this, at least the most uncomplicated way, is through use of a rotating bolt, or in some cases, bolthead. This is accomplished by machining a predetermined number of locking lugs around the circumference of the bolt, which mate with matching surfaces in the receiver or barrel extension. The number of locking lugs used is a matter of choice. With low-powered cartridges only one small lug may be required. For over a century, two fairly large lugs have been used in conventional bolt-action rifles. However, as has been mentioned elsewhere, less bolt lift will be required if more lugs are used.

If a turn-bolt action is used in the designs presented here, the locking lugs will be machined to match cuts in a barrel extension. The cocking cam must be aligned with the slot in the receiver wall that the bolt handle reciprocates in. The extended guide portion of the cocking piece also rides in this slot. Due to the large diameter of the bolt body, the cocking cam slot can still be quite shallow, even with multiple lugs, which lessens the effort needed to open the bolt with the firing pin in its forward position. It is recommended that four lugs be used, as it will require only half as much bolt rotation to unlock the action as would a two-lug bolt.

A bolt handle can be joined to the bolt body by drilling a crosswise hole through the bolt body at the point where the bolt handle is to be located. A stub is turned on a bolt handle blank, leaving it .006 to .008 inch larger than the diameter of the hole through the bolt. This blank is placed in a freezer overnight, which will cause it to shrink slightly. Just before installation, the bolt body is heated, which, in turn, will expand it slightly. It isn't necessary to heat it to a point where it changes color; it will expand at a fairly low temperature. Then, before it has a chance to cool, the stub of the handle is started in the hole and, using a heavy hammer, driven entirely through the bolt body. When the assembly thus made cools and warms to room temperature, the heated part will shrink and the cold part will expand slightly, resulting in a joint almost as solid as if welded. The bolt handle is then machined and bent to the desired shape. A close-fitting crosspin can be installed to hold it in place if desired, but it is not necessary.

As used in an autoloading or slide-action design, a separate bolthead is used that incorporates the locking lugs. The lugs are rotated by an angled cam cut in the bolt body, which bears against a pin projecting from the bolt head, and cams it into rotation through forward and rearward movement of the bolt body. This in turn is connected to a forend (if a slide action) or a gas piston sleeve (if an autoloader) by a wide action bar.

When used in low-powered single-locking-lug guns, the entire bolt can be made in one piece, wherein the entire unit will rotate to accomplish locking and unlocking.

It is also possible to use square tubing in the fabrication of receivers. My own shotguns were originally built in such a manner. This was done because I couldn't figure out a way to connect the bolt to the action bar in a round-receiver gun. These are harder to machine than the ones with round receivers. A plug must be made from square stock to be welded inside the front end of the receiver. This requires a hole bored through the exact center and threaded, plus the feeding or approach cone and locking recesses machined in one end.

The bolt was also made from square stock. A hole was bored through it for the firing pin and rotating bolthead. In several blowback versions it was required that a small firing pin hole be drilled in one end, then the material reversed and a larger hole for the firing pin body and spring drilled from the other end. These holes, to be satisfactory, had to be concentric and meet exactly. In a small shop, one is required to use a lathe equipped with a four-jaw chuck for this, mounting the work and centering it through use of a dial indicator. This isn't actually too difficult, but it takes time.

There are armchair machinists who will tell you that if you only loosen two adjacent jaws of the four-jaw chuck to reverse or replace the material, it will go back exactly centered simply by tightening these same two jaws. I must have read a different book, because I could never do this. Even when I used a torque wrench and tightened them exactly the same each time, the work was always off some and required centering again. Not long ago, by chance, one of these experts came into my shop and started telling me how easy it was to center square stock and repeat it as above. I tried to get him to show me, but when it didn't work for him either, he went off mumbling that there was something wrong with my lathe chuck.

One day it occurred to me that by using a takedown barrel that was held in place by a screw-on collar and removing the entire assembly—barrel, action bar, bolt, and all—from the front of the receiver, I could use a round receiver after all. This didn't actually reduce the amount of machine work by much, but it virtually eliminated the time required in centering it, as was required with the square stock. Since that time, my own receivers have been made from round stock.

The lower receiver can be folded from sheet metal or machined from solid stock. If formed from sheet metal, both ends will require a filler block welded in place. The one at the back end can be thin since it simply closes the opening, but the one at the front must be long enough to contain a recess for the receiver mounting block to fit into.

When formed to a size and shape that suits you, the upper edges must be machined flat and square and the inside cut to the same radius as the receiver. This is best done by using a ball cutter of the same diameter as the upper receiver. A cap to fit against the rear of the receiver is turned to size, with a hole drilled and tapped for the stock bolt, and welded in place at the rear of the lower receiver. This can be located exactly by placing the cap between the upper and lower receivers. With both of these and the end cap located where you want them, clamp them together, holding the cap in place. It is now welded along both sides and across the back.

If a bolt slot is cut from the ejection port entirely through the rear end as will be required to allow installation and removal of the bolt in the bolt-action gun, the end cap should be left solid across the top to keep the bolt slot from spreading. When used with the others, where the rear end of the tubing remains solid, the upper half of the thin portion of the cap can be cut away. This will permit the rear end of the receiver to lift straight up, pivoting around the front mounting screw.

At least one of the trigger mechanisms described in the trigger chapter can be adapted for use in the actions described here. In certain cases, a trigger guard is cut to shape and welded or silver soldered to the lower side of the receiver.

Double extractors should be installed in shotguns and guns firing other rimmed case calibers. Actually the term “double” or “dual” extractors is slightly misleading. The outside extractor does all the work; the inside one holds the shell head in place against the bolt face and prevents it from slipping out from under the extractor proper.

An ejector must be located where it will contact the casehead, throwing the empty case out of the gun just as soon as the action is open far enough for the case to miss the breech end of the barrel. Ideally it will be located just below the inboard extractor and project through the bolt face just inside the outer diameter.

Those little spring-loaded ejectors that are pinned into the face of the bolt should be avoided if possible. These project from the bolt face until forced back, compressing the spring when the bolt is closed with a shell in the chamber. Therefore the casehead cannot slide up under the extractors as it is being fed from the magazine. Instead it must be pushed into the chamber ahead of the extractors because the protruding ejector won’t let it move up across the bolt face. Thus these extractors are required to jump over the case rim. They are also apt to malfunction when dirty.

I have seen these ejectors get foreign material under them, or rust, which prevents the bolt from closing on the cartridge. Once a friend of mine went all the way to Alaska and couldn’t use his gun because of this very thing. He brought it to me, telling me the “headspace grew.” When I showed him what the trouble was, he traded the gun for a rifle with a Mauser action and swore that he would never own another like it.

Several of the trigger assemblies described will allow placement of a sliding safety just forward of the trigger. As far as I am concerned (and many others confirm this), this is the ideal location for the safety since it is equally accessible to the trigger finger of either hand.

When the rotating bolthead is used, a guide rail must be riveted or welded inside the receiver at the top to hold the bolthead in the open position as the bolt moves back and forth. Without this, resistance to the bolt feeding a shell from the magazine will try to force the bolthead into the locked position. The bolthead must be held in the open position until the lugs actually start into the lug raceways.

The single-shot falling-block action has appeal to a number of people, especially to admirers of the “classic” style custom rifles. The biggest drawback to building these in a small shop is the amount of machine work involved. If produced in sufficient quantities, investment castings could be produced which would reduce machining time considerably. If cast slightly oversize and finish ground, the appearance would not suffer.

The first step, after acquiring a suitable length of rectangular material, is to mount it in the four-jaw chuck and, when centered, bore a hold for the barrel tenon. This should be bored with an undersize drill, which will also form the cartridge feed trough directly behind the breechblock opening. The hole is then enlarged to the root diameter of the thread to a depth slightly deeper than the length of the barrel tenon and threaded using a small inside threading tool. The threading should be finished and the face cut square before the material is removed from the lathe.

The receiver blank is removed from the chuck and remounted with the surface that will ultimately be the bottom side facing outward. An opening for the breechblock is located and centered. It is then drilled completely through and bored to size. If a round breechblock (which is suitable for low- to medium-pressure cartridges only) is to be used, a counterbore to accept a tubular breechblock guide is bored 1/8 inch deep.

If a square breechblock, which will withstand high pressures, is used, the opening is bored as above. It can be machined square, except for the rounded corners, with an end mill. The corners can be cut square by filing or broaching. By making a filler block to just fit the opening and leaving a flange at the upper side to keep it in place, and slots cut along the corners for a broach to slide through, the inside corners can be cut square by pushing or pulling the broach through the opening.

All excess material is then removed by sawing and/or milling, and the receiver formed to shape. A slot is cut through the upper tang for the safety lever and a wider recess for the safety slide.

The lower receiver is cut from a separate piece of flat stock and the breechblock opening made. If the round breechblock is used, the opening is counterbored on the upper side for the tubular breechblock guide. With the guide in place and used as a spacer and locating point, holes for the action screws can be drilled and tapped. For appearance sake, the rear action screw hole should not be drilled cmpletely through the upper tang.

The breechblock is machined to a slip fit inside the receiver opening. Slots are cut for the lever and hammer clearance and the front side machined to mate against the breech end of the barrel. The barrel can be fitted and chambered at this time.

Small parts, including the lever, hammer, trigger, safety, and ejector, are laid out and cut from flat stock. They are then finished and fitted in place. A lengthwise slot must be cut in the bottom left side of the receiver to accept the ejector, which is pinned in place. A relief cut must also be made in the end of the barrel to accept the ejector blade.

This action will require quite a bit of hand fitting to work properly. When fitted and assembled, the breechblock should open easily until the chamber is exposed. A harder pull downward on the lever releases the ejector, which throws the empty cartridge case out of the gun. The lever is then pulled upward slightly, which cams the ejector back into the breech face and latches it. Lowering the lever until it meets resistance from the cocked hammer should align the groove in the top of the breechblock with the chamber opening, whereby dropping a cartridge in the feed groove and tilting the muzzle downward causes the cartridge to slide forward into the chamber. The lever is then pulled upward until it latches and the gun is ready to fire.

The barrelled action must be completely inletted into the stock before the firing pin hole is drilled. This is because the breechblock may not fit in exactly the same relationship as it does when out of the stock. The hole location is marked as described ealier in the book.

A single-shot bolt-action trap gun is made by threading a 9 1/2 inch length of 1 1/2 inch outside diameter tubing, having a wall thickness of .120 inch, at the forward end to accept a barrel retaining nut. The bolt is made from 4140 or similar round stock. Four locking lugs are machined at the forward end, which mate with recesses in a barrel extension. The bolt handle is attached as described earlier. A block is welded or silver soldered to the bottom of the receiver to house either the number five trigger or, in case a release trigger is desired, the number nine trigger described in Chapter 12. A block is welded in place at the lower front to receive the lower receiver mounting cross bolt.

A lower receiver is machined from a solid block—the end cap welded in place at the top rear and a trigger guard on the bottom.

Two extractors are located 180 degrees apart at the bolt face, and an ejector is located so that it just pushes the front end of the case out of the ejection port when the bolt is retracted.

The adjustable rear sight platform is silver soldered in place atop the receiver. There are those who would have you believe that no rear sight or, as used here, reference point is desirable or necessary. This may be true for certain experts. But this requires the shooter’s eye to serve as the rear sight. Unless his (or her) face is positioned exactly the same in relation to the stock for each shot, the gun will throw the pattern in a slightly different place. Therefore I suggest that the rear sight be used on the gun. It can always be removed or depressed into its lowest position for the shooter who doesn't want it.

Chapter 9

Barrels

As long as they remain available, rifle and pistol barrels should be purchased as either preturned or cylindrical blanks from one of the several manufacturers offering these products. A considerable amount of specialized equipment and tooling is required to bore, ream, and rifle a bore. This can cost an enormous amount of money that can be better spent elsewhere. It also requires extensive experience to produce consistently accurate barrels. And since the prototype rifle or pistol will have to be as accurate, or more so, than its contemporaries if we intend to market it, we should go with the best available. If one of the preturned contours can be adapted to the design used, quite a bit of machining time can be saved. If not, either a contoured blank of sufficient diameter to turn to the required contour and size or a cylindrical blank must be used. It should be noted that several of the larger manufacturers also buy their barrels from these companies.

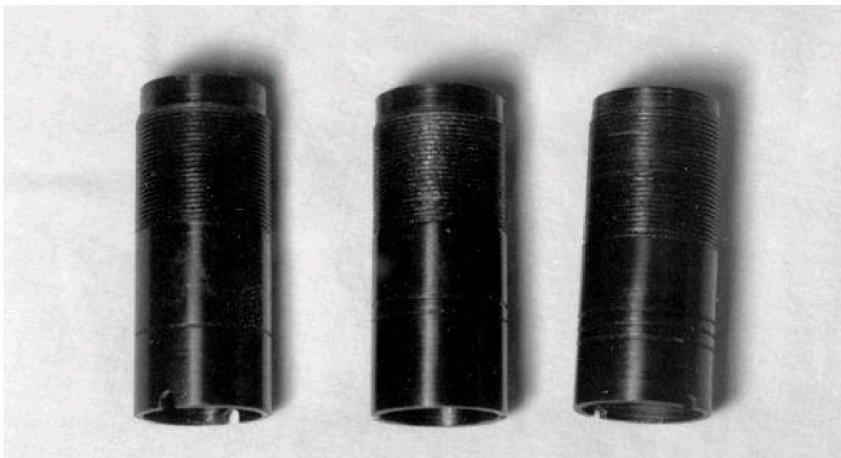
Shotgun barrels are a different story. Very few barrel makers offer shotgun blanks. Several years ago I obtained a number of these from a maker who swore that they were equal to or better than commercial quality. They did have a fairly good interior finish, which I enhanced by lapping. The outsides were also reasonably well done, although not even close to the dimensions specified. When I cut some of them off to reduce the length, I discovered that they were not concentric; one side would be thicker than the other. This was not necessarily unusual. Many commercial shotguns have this same problem, which is usually only discovered if the barrel is cut off to shorten it. But these barrels were also very soft. I was told they were made of “1037 carbon steel.” I installed screw-in chokes and after a few hundred shots, bulges developed just behind the choke tubes. I complained about this to the barrel maker, but they said I had installed the choke tubes improperly and it was my own problem.

I started making my own barrels from 4130 seamless tubing and my “problem” disappeared. I never had another bulged barrel. I have never bought anything else from that barrel supplier either.

Choke tubes add versatility. They can range from cylinder bore to full choke.

Slots in end are for tightening too.

These tubes are full, modified, and improved cylinder.



A quarter can be used to tighten or loosen choke tubes.

It was learned several years ago, through my own experiments and those of others, that a larger-than-standard shotgun bore not only has less recoil, but more velocity and tighter patterns than the barrels with the standard .729-.730 inch bore diameter in a 12-gauage gun. This is essentially the result of reduced friction and less shot deformation. Barrels that have larger diameters than standard barrels are commonly referred to as “overbored” or “backbored,” depending on who does the referring.

A standard-size tubing (4130) is available from steel companies nationwide in 1 1/8-inch outside diameter, has a .188-inch wall thickness, and a bore diameter of .749 inch. This is ideal for the 12-gauge barrels described here. This same tubing is available in a 1.0-inch diameter, a wall thickness of .188 inch, and a bore diameter of .624 inch, which will work in a 20-gauage barrel.

As used on the military and police or “assault” guns, a cylinder bore (no choke constriction) is desirable. So we have no problem with choke. If used in trap, skeet, or sporting shotgun barrels, however, varying degrees of choke are not only desirable but, in the case of the trap gun, mandatory. While it is possible to roll or swage choke into the end of the barrel, the simplest and most desirable solution is to install screw-in chokes. While most shotgun makers charge extra for guns so equipped, in our case it is the easiest way.

Since we are using an oversize bore, we will be required to make our own choke tubes. The standard-size choke tubes used by most manufacturers measure 13/16 inch (.8125 inch) in outside diameter in 12-gauge and are threaded 32 threads per inch. The 20-gauge tubes are 11/16 inch (.6875 inch) in diameter, with 32 threads per inch.

I used these tubes for years in my own overbored barrels without mishap. Then one day I picked up a catalog from a well-known gunsmith supply house and found that these self-proclaimed experts had ordained that you cannot install screw-in chokes in a 12-gauge barrel with a bore diameter over .735 inch or .624 inch in the 20 gauge. It goes on to say that exceeding these dimensions WILL CAUSE DAMAGED CHOKE TUBES and LIKELY CAUSE A BARREL BLOWOUT. It was probably because I hadn't read this before, but I had never had a problem with this. But then, I used a gun with damascus barrels for years before I read that they would blow up in your hands if fired. So apparently ignorance is bliss.

I find the above hard to believe, especially if the tubes are installed concentric to and in line with the bore. The standard choke tube of .8125-inch diameter is .0625 inch larger than our .750-inch bore. It has a wall thickness of .03125 inch. These same people sell what they call "thin wall" choke tubes measuring .775 inch in diameter and threaded 44 threads per inch to be installed in barrels with bore diameters of .729- .730 inch. Since these tubes only have a thickness of .023 inch, why aren't they also dangerous? And who appointed these people to make the rules?

I have gone along with this, though, simply because anyone who has read their minimum requirements and damages a choke tube or barrel for whatever reason is going to swear that it was my doing because I violated the "rules." The tubes I use now are 53/64 inch (.8285 inch) in diameter and threaded 32 threads per inch. These are not available commercially, so I am required to make them myself. It is extra trouble, but I've decided not to take any chances. Now that an "expert" has informed me that the old way was unsafe, they would probably start blowing up on me. I still shoot a damascus barrel on occasion, though.

Before we leave the subject of overbored barrels and choke tubes, it should be mentioned that 12-gauge barrels have been made with bores of .800 inch or more. A conversion that has been popular for some time now features a bore diameter of .780 inch. In effect, what this amounts to is a 10-gauge barrel shooting 12-gauge shells. These, apparently, don't have much recoil and pattern well, but several people who have owned them tell me that they have had trouble with wads not sealing, especially in cold weather. Another shooter who has one of these guns recently told me that his gun shot low, and when he tried to bend the barrel (as shooters are prone to do) to make it shoot higher, it collapsed because the barrel walls were so thin. So it may very well be that some of these overbored barrels have been overbored a little too much.

If the muzzle brake described herein is used in conjunction with one of the .750-inch bored barrels, tighter patterns than normal will be realized. The first time I patterned one of these muzzle-braked guns, I had a choke tube with .030-inch constriction in the gun. In a standard gun barrel, I would have expected this combination to put 70 to 75 percent of the shot in a 30-inch circle at 40 yards. To my surprise, it put 100 percent of the shot in a 24-inch circle. I made up some more choke tubes and discovered that .015-inch constriction gave about the 70 percent that I expected in the first place.

Further experimentation with this and subsequent guns led us to the conclusion that the gas bleed-off before the shot charge entered the choke caused the tighter patterns. This conclusion was reinforced by several paragraphs in Tom Swearengen's book, *The World's Fighting Shotguns*. On page 456, Swearengen states that a Winchester engineer decided that poor buckshot patterns were caused by dense propelling gas turbulence acting to unbalance shot wads as they emerged from the gun muzzle. This guy cut six equally spaced slots 4 inches long and .025 inch wide behind the muzzle. His patterns also tightened significantly, just as mine did.

To make a shotgun barrel from the raw tubing, a section is cut to length and the ends squared and counterbored slightly. It is then chucked in the lathe at about the midway point and the tailstock center placed in the protruding end. The shank is turned to size and threaded to screw into the extension, or the receiver as the case may be. A straight cylinder some 2 inches long and turned just enough to assure concentricity is left just ahead of the threaded section. If a threaded forend retaining nut is to be used as on the trap barrel shown, a raised band is left at a point 10 1/2 inches forward from the breech end. This band is 1.065 inch in diameter and .625 inch long and threaded 24 threads per inch. The portion between the cylindrical breech section and this threaded band should be turned to a diameter of .950 inch, with the diameter just ahead of the breech section gradually tapered for a distance of some 2 inches and blended into the .950-inch diameter.

The blank is then removed from the lathe, turned end for end, and again chucked with the unturned portion extending from the chuck and the tail stock center supporting the end. If the muzzle brake is to be installed, two bands are left as shown in the drawing and the remainder turned to .900 inch both between the threaded bands and extending back to the forend retainer nut band.

If the assault-type barrel is used, it is made in the same way, except that no threaded bands are required. You should also make sure that the barrel exceeds the legal minimum length of 18 inches enough so that no one will question its legality. There are people who don't know where to begin when it comes to measuring shotgun barrels. Once, several years ago, a bumbling Oklahoma town marshall tried to confiscate one of my box-magazine autoloading guns because, he said, the barrel was too short. He was trying to measure it from the receiver forward. While I was trying to tell him that the barrel extended another five eighths of an inch into the receiver, he insisted that it started at the front edge of the receiver and was illegal. This happened at a small town gun show. Luckily, a state trooper who knew something about guns came along and set him straight. But it could happen again. And to you.

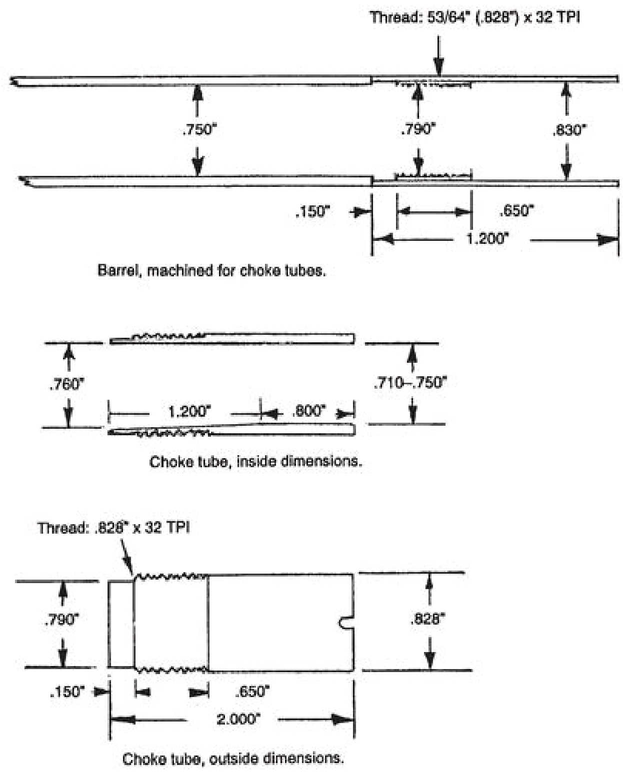
A standard finish reamer can be used to cut the chamber if a pilot bushing that will just enter the bore is fitted to it. If a reamer with a removable pilot bushing is used, you simply make up a larger bushing. If you have a reamer with a solid pilot, you must turn the pilot down enough to make and fit a bushing to it. A carbide lathe tool is used to turn it to .625 inch, and the bushing is bored to just fit over it and turned on the outside to just slip into the bore.

The muzzle end of the barrel is secured in the lathe chuck and the tail stock center inserted in the breech end. The steady rest is mounted on the lathe bed and set up just behind the threaded breech end. If no steady rest is available, the cylindrical breech portion can be caught in the chuck with the muzzle end extending through the headstock. While not actually as important as with a rifle barrel, it is imperative that the bore is centered with as little run out as possible.

Now, with the lathe set up to turn at its lowest speed, the chamber reamer pilot is started in the bore. A tap wrench is secured on the drive end of the reamer with the tailstock center contacting the center hole in the drive end. The pilot and flutes are given a good shot of cutting oil, the lathe turned on, and the reamer fed into the bore by pressure from the tailstock. The tailstock is fed with one hand while the other holds the tap wrench handle to prevent it from turning. Since only a small amount of metal is removed in cutting the chamber, the finish reamer can be used for the entire operation. However, it should be withdrawn frequently and the accumulated chips removed and given a liberal coat of cutting oil.

The rim cut depth, which actually determines headspace, is arrived at by inserting the bolt in its locked position in the barrel extension (or receiver body as the case may be) and measuring from the outside edge of the barrel extension to the bolt face. This measurement will be the same as the distance between the barrel shoulder (which mates against the barrel extension) and the head of a chambered shell or headspace gauge. You should probably subtract .005 to .010 inch from this measurement simply to make sure that a thick-rimmed shell will chamber. A slight amount of excessive headspace is not as critical in a shotgun as many people think. It is far more important that the bolt close and lock on any and all types and makes of factory-loaded shells. Note that I said factory shells. Fully half of these self-styled ballistic geniuses who try to reload ammunition have no idea what they are doing and don't completely resize shells to factory specifications. Therefore, their shells won't chamber in any other gun except the one they were fired in, if that. Chambers must be cut to accommodate factory ammunition only and the reload sized to fit.

With the chamber cut to finished dimensions, the barrel is removed from the lathe and reversed, whereby the muzzle end is centered in the steady rest or chuck. It is most important here that the bore is centered without runout.



Here again, since we have an oversize bore, no standard tooling is available unless you want to go ahead and install standard-size choke tubes. Even then you will have to make up at least one pilot bushing that just fits the bore and use it on both the reamer and tap.

If several barrels are to be machined to accept the choke tubes, it would be a good idea to either make or have made a suitable reamer and tap with pilots at least 2 inches long to do this work. There are custom tap and reamer makers who will do this work, but they will charge an arm and a leg for it.

If only a few barrels are to be made, and provided the bore runs concentric in the lathe, the machining can be done in the lathe using a boring bar and a small inside threading tool to accommodate the choke tubes shown in the drawing. The inside of the barrel is bored to a diameter of .795 inch and a depth of 2.0 inches at the muzzle end. The first 1.200 inch is then enlarged to .830 inch. These cuts can be made to the exact depth by mounting a dial indicator on the lathe bed and setting it to where the carriage contacts it at a predetermined number, which is the finished depth. The boring tool should be ground at an angle that will form a raised lip at the bottom of the cut. The skirt of the choke tube, when bottomed, then fits inside this lip, and there is no gap between the two to leak gas or for the shot charge to jump.

The smaller diametered portion (the .795 inch part) is threaded 32 threads per inch to a depth of 2.000 inch from the muzzle. Again, this depth can be cut exactly through use of the dial indicator.

Since no standard choke tubes will fit, we will have to make the choke tubes too. While this entails a little bit of extra work, it is worthwhile since we wind up with choke tubes that fit exactly with any choke diameter desired. This is not always possible with commercial chokes.

Seamless tubing is usually available only in 20-foot lengths. If you expect to make up enough choke tubes to make it economical to purchase a full section of this, it comes in a standard size of 7/8 inch (.875 inch) outside diameter, with a wall thickness of .083 inch, leaving an inside bore diameter of .709 inch. This is ideal for our purpose since it only requires turning the outside down .047 inch to a diameter of .828 inch. If you only intend to make a few, it is more economical to obtain a short length of 4130 or 4140 round stock and drill a pilot hole that is enlarged with the boring tool. The only advantage offered by using stainless is that it won’t rust in place quite as fast.

A section of the tubing 12 1/4-inch long (this will make six choke tubes) is chucked in the lathe, with enough material extending from the chuck to allow one choke tube to be machined full length. The outside diameter is turned to .828 inch. Use a slightly round nose tool for this and a slow feed to get the finest finish possible. The outside end is turned to .790 inch for a short distance of .150 inch. The next .800 inch is threaded with 32 threads per inch pitch. As the finish thread depth is almost reached, the barrel should be tried on it. Support the chamber end of the barrel with the tail stock center to keep it in line and try to screw the barrel on the choke tube. Keep taking shallow cuts on the choke tube thread until it will just screw on by hand and stop. Of course it would have been easier to try the finished choke tube to the barrel thread while we were cutting it, but we didn’t have a choke tube to try.

The inside diameter is bored to size using a boring tool with a long, straight cutting edge. If fed very slowly and using cutting oil, a smooth surface is obtained that, with a bit of polishing, will be at least the equal of commercial chokes. The rear end, or what might be properly called the “approach cone” portion of the choke tube, can be cut either by setting the compound at one degree and feeding the boring tool with it, or through use of a standard long forcing cone reamer normally used to lengthen the tapered area just ahead of the chamber. If one of the little high-speed hand grinders such as a Dremel tool is available together with the adapter to mount it on the lathe tool post, an extremely smooth finish to the inside of the choke tube can be obtained by using 3/8- or 1/2-inch felt bobs coated with 400 grit buffing compound as a finishing operation.

The finished choke tube is cut to length at the muzzle end, and two or four slots are cut equidistantly around the circumference to enable tightening or removal of the choke tube. A 3/32-inch end mill can be used for this.

The riot gun barrel is made in the same manner except for being shorter. Usually these are used without choke tubes or any choke constriction, resulting simply in a cylinder bore. The muzzle brake can be used or not, as desired. These same methods can be used to make up any other shotgun barrels desired by varying the outside dimensions to suit and changing the barrel thread to mate with whatever action it is used with.

Rifle barrels are turned and fitted using much the same methods. As previously mentioned, you should obtain a barrel blank with all the excess metal possible already removed. If you are required to turn a full-length taper, the easiest way is to set the tail stock over enough to cut the desired taper. It must be turned between centers. The steady rest is adjusted to support the barrel and positioned about halfway between each end. Then, with a slightly round nosed cutting tool fed with a fairly fast feed, the portion between the tail stock and the steady rest is turned to size. The steady rest is loosened and moved toward the chuck and remounted and the exposed portion turned to size. The steady rest is then removed and remounted between the lathe carriage and the tail stock. This allows access for the cutting tool to turn the remainder to size. Barrels turned in this fashion will probably require draw filing after turning to remove tool marks, high and low places along the barrel that show-up as “ripples,” or wavy surfaces when sighting along the length of the barrel after polishing and bluing.

Chambering and threading is accomplished in the same manner used for the shotgun barrel except that it is imperative that the bore runs absolutely concentric and true. The steady rest should be used to support the breech end and a short section at the muzzle caught in the chuck.

The chamber should be cut by first using a roughing reamer, which removes the bulk of the excess metal, followed by the finish reamer, which removes only a small amount. Many gunsmiths, in an attempt to save money, buy only a finish reamer and use it to cut the entire chamber. This is poor economy since a reamer used in this fashion will wear and become dull rapidly. If only the finish reamer is available, at least part of the excess metal should be removed with drills that are slightly smaller than the finished chamber diameter, followed by the finish reamer as described. Chambers can be polished using 400 to 600 grit wet or dry sandpaper, followed by crocus cloth wrapped around a small dowel and held against the chamber wall as the barrel revolves.

Chapter 10

Recoil

Recoil can be described as an opposing reaction caused by the pressurerequired to push a bullet or shot charge up the bore.

When a cartridge or shell is fired, expanding gasses from the ignited powder charge push the projectile up the bore with sometimes as much as 60,000 pounds per square inch of pressure behind it. This pressure expands in all directions, but since it is contained by the chamber walls, it pushes forward against the base of the projectile. At the same time, it is trying to push the gun to the rear with the same amount of pressure, plus an additional amount caused by friction and resistance between the projectile and the bore.

Since the projectile usually weighs less that 2 ounces in the case of the shotgun and usually less than 500 grains in rifles and pistols, and the gun weighs several pounds, the gun moves to the rear far more slowly than the projectile moves up the bore. Therefore, a heavy gun will have less apparent recoil than a lighter one of similar design and caliber.

That at least one of the factors governing perceived recoil rests in the human mind can be illustrated by a couple of incidents that happened several years ago.

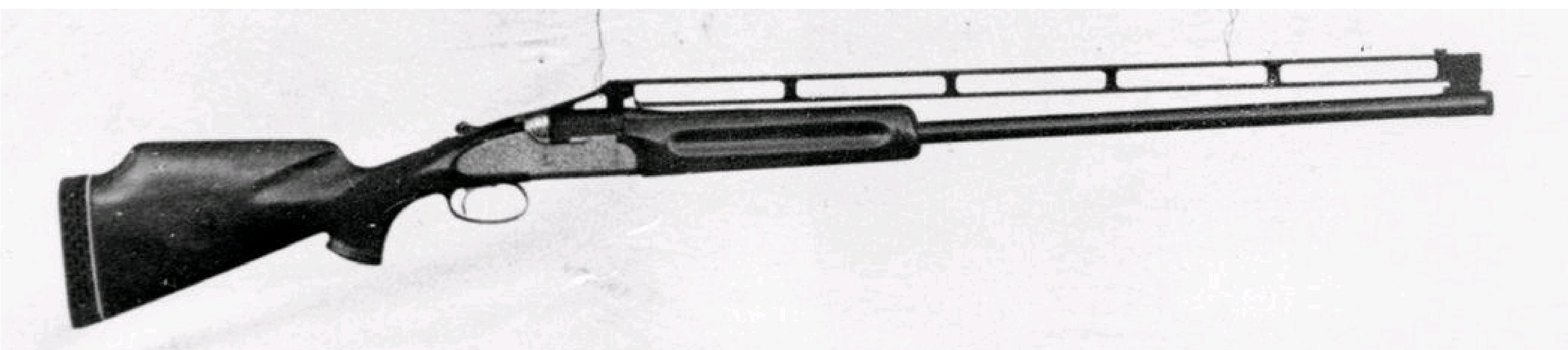
A few years back, I had a trap range in conjunction with my gun shop. We usually held a registered shoot about once a month and shot practice rounds and for fun on other weekends.

On one particular weekend, a lady who shot with us regularly came to me and told me she thought the recoil reducer in the buttstock of her Ljutic Mono gun had shifted or turned since the gun seemed to be kicking her more than usual. She asked if I would look and see if that was what was wrong.

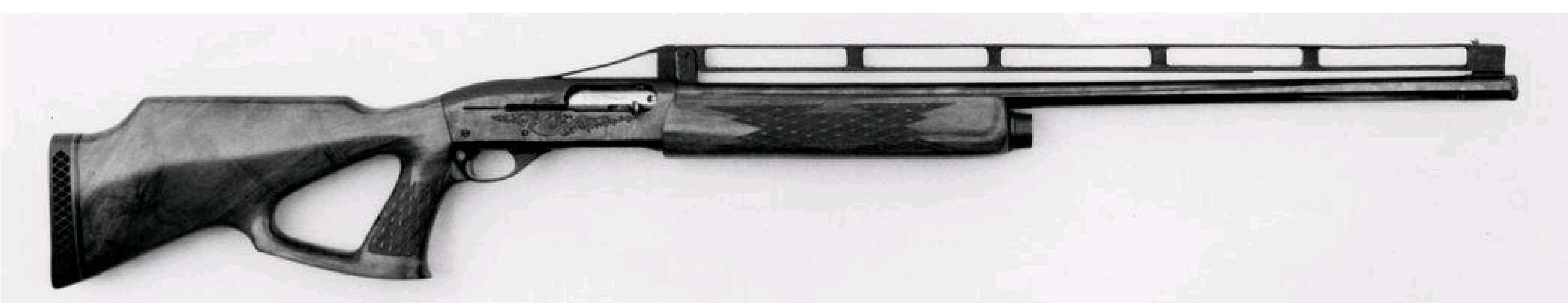
I took it into the shop and removed the recoil pad. There was no recoil reducer in the stock. Not even a hole for one.

As an experiment, I put the recoil pad back on her gun and took it back to her. I told her that it was, indeed, turned wrong. She proceeded to shoot the gun the rest of the afternoon and insisted that it didn't kick nearly as much as it did before. When she had finished shooting for the day, I took her and the gun into my shop and again removed the recoil pad. When I showed her that the gun had never even been bored to accommodate a recoil reducer, she became quite angry, insisting that she had paid the people who sold her the gun an exorbitant price to install one. I installed one for her. And while I personally couldn't tell any difference either before or after the installation, she insisted that it cut the recoil of the gun in half.

This high-rib Weatherby conversion cut recoil by at least 20 percent.



This high sight line Remington 1100 has less recoil than before.

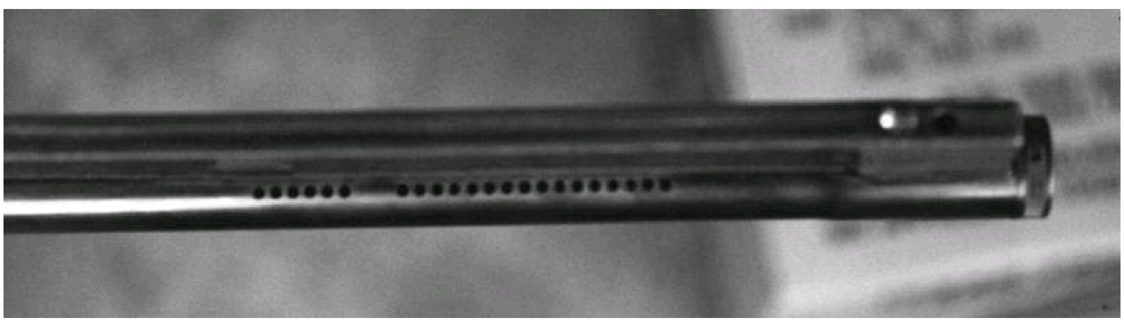


A straight-line recoil with a high sight line lessens felt recoil, especially to the facial area.

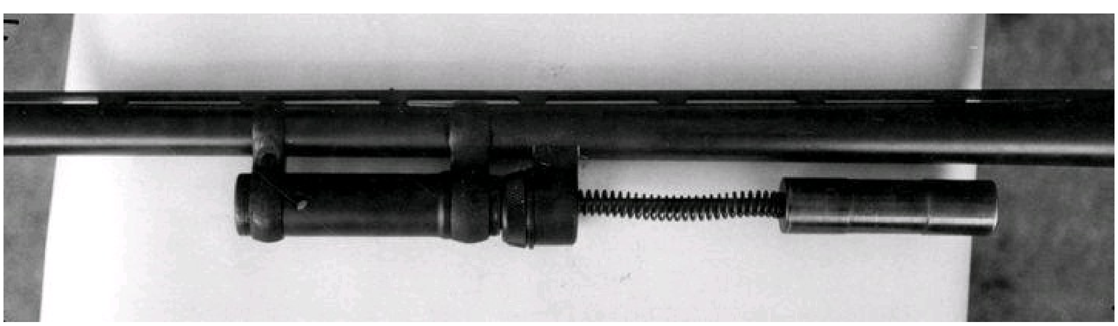
During this same time period I had a M870 Remington slide-action trap gun for which I had installed a gas-operated recoil reducer of my own design in the magazine tube. I asked a squad of shooters to shoot their five rounds each on one station with this gun. All five agreed that the gun had considerably less recoil than a similar gun without the device.

I took the gun back into the shop, and a short time later, brought it back out to the same five shooters. I told them that this gun had a heavier weight in the recoil device and a larger gas port and asked them to shoot this one and give me their thoughts on which one kicked the most.

"Porting" may lessen muzzle jump but does little to lessen recoil.



The piston assembly used in that shotgun.



This gas-operated recoil reducer made in the early 1980s was an attempt to lessen recoil.

To my surprise, three of the shooters said this one kicked less, one said more, and the other one just grinned. I never did tell them it was the same gun.

So as you can see, it is possible to convince many shooters that a gun has less recoil than it actually has without really doing anything to reduce it. There are, however, several ways to actually reduce recoil considerably.

Probably the easiest way is to simply install one or two of the so called “recoil reducers” in the buttstock. The main reason that these may seem to reduce recoil is due to the added weight, which a handful of rocks would do just as well. However, as illustrated previously, the knowledge that they are there will convince many shooters that the gun actually kicks less.

A straight line stock with a high sighting plane on the order of the M16 military rifle will reduce perceived recoil somewhat. Actually the gun will still generate approximately the same amount of recoil as a conventional firearm of the same weight and caliber. The high sight line allows the shooter to shoot with his/her head erect, and the straight line design causes recoil to be directed straight back into the shoulder instead of upward into the cheek. There is also little or no muzzle jump or rise with a design of this type. This will also tend to convince the shooter that the gun has less recoil than the conventional design.

Various spring-loaded or hydraulically dampened telescoping buttstocks have been tried. Probably the best of these was one called a Hydracoil stock. It had a hydraulic cylinder to absorb recoil and was quite effective. Winchester sold Model 12s so equipped. For some reason, probably because most were made of plastic, they didn’t sell well and more or less faded away. Just in the last few years these stocks have been “rediscovered,” and while most are effective, they are also ugly. Most have a strut or cylinder or two protruding from the butt end of the stock with a recoil pad mounted on the end, leaving a gap at least an inch wide between the end of the stock and the recoil pad. This may be effective, but it looks terrible, which is probably the reason most shooters don’t use them.

Some time ago I designed one to use on my trap gun. This one has the spring-loaded cylinder fastened to the receiver of the gun with the buttstock surrounding it. It still isn’t pretty, but it has fairly clean lines without any open gaps. This one absorbs more recoil than any of the others that I have tried. A description of how to make these is included in Chapter 14.

A 12-gauge, bolt-action, single-shot trap gun with muzzle brake and spring-loaded, telescoping buttstock. It has very little perceived recoil.

A 12-gauge, slide-action, box-magazine shotgun with muzzle brake.

It is possible, in the case of the shotgun, to increase the bore diameter from .005 inch to .050 inch over the accepted standard size. This results in less friction, with a corresponding decrease in recoil. This can be overdone to a point where wads no longer seal,. especially in cold weather. From my own experience, I believe some .020 inch over standard is probably best. It has been said that lengthening the forcing cone to 1 3/8 or 1 1/2 inch reduces recoil substantially. It doesn't really do all that much, but if the shooter thinks it does, why not?

Another school of thought has produced the idea that porting the shotgun barrel by drilling one or more rows of small holes on each side of the rib and just behind the choke reduces recoil. This is seen mostly on single-barrel trap guns and is touted as reducing muzzle jump. It doesn't reduce recoil much, if any. And with a singles gun where a rapid second shot is uncalled for, who gives a damn if the muzzle jumps. With a straight line design, it won't jump anyway.

The most effective recoil-reduction device that can be fitted to rifles, shotguns, and some pistols is the muzzle brake. One of these, properly designed, can reduce recoil more than any other known device.

The muzzle brake designs shown in Chapter 11 are effective and do not increase the noise level significantly. Keep in mind that the larger the diameter of the expansion chamber, the more effective the brake will be.

If we design a rifle or shotgun using the high sight line and straight line design with a telescoping buttstock and an efficient muzzle brake combined with the bore modifications previously mentioned (in the case of the shotgun), the end result probably won't be as graceful as some, but it will most assuredly result in a firearm with less recoil than ever before experienced. This is especially desirable in a trap gun, where the shooter may shoot some 200 to 300 rounds in a single day. It also makes heavy caliber rifles pleasant to shoot.

Chapter 11

Muzzle Brakes

The most effective means of recoil reduction is the muzzle brake. Properly designed and installed, these can actually eliminate as much as 80 percent of felt recoil. The drawbacks inherent with the use of these are, in most cases, an increase in the noise level. A really effective brake will increase the noise level somewhat, regardless of what some people may tell you about “quiet” muzzle brakes. They also add some to the girth and sometimes length at the muzzle.

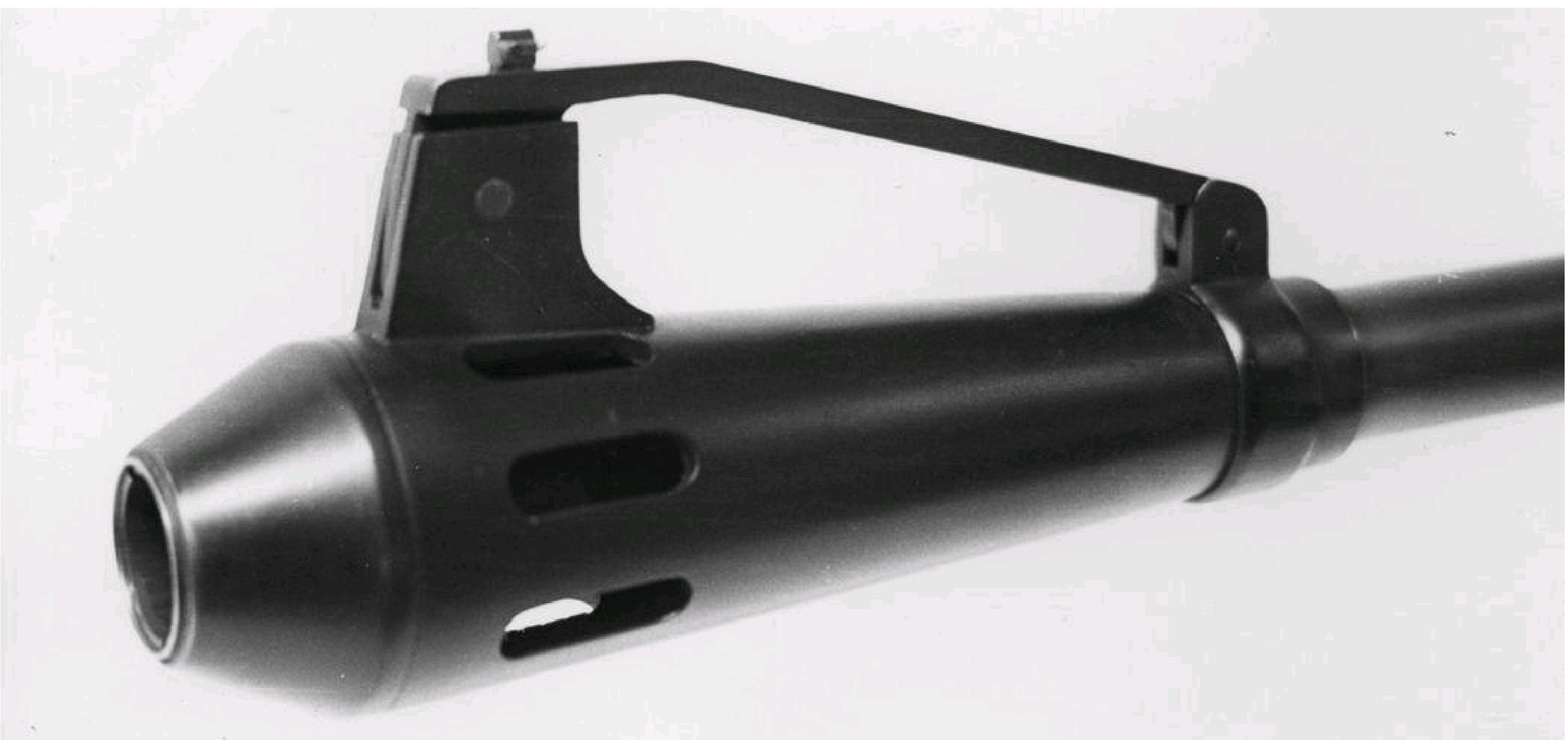
A really effective brake will be some 2 inches long when installed on a rifle barrel, around 6 inches long on a shotgun, and anywhere from 1 to 2 inches on a pistol. The diameter should be the largest possible without interfering with the sight picture. For maximum effectiveness, the shotgun brake should be at least 1 1/2 inch in diameter. This makes a high sight line almost mandatory. Diameter of the rifle brake can be from .600 inch for calibers .30 or smaller if installed on conventional stocked rifles to as much as an inch if used on a high sight line gun. Here again, efficiency will improve as the diameter is increased. Pistol brakes can, in many instances, be machined directly into the barrel without any increase in length or diameter.

The inside diameter is bored and threaded at the rear end to screw onto the correspondingly threaded muzzle end of the barrel. The remaining body is bored leaving a wall thickness of .050 to .060 inch, the wall at the forward end some .100 to .125 inch thick, and an exit hole .004 to .008 inch larger than the bullet diameter.

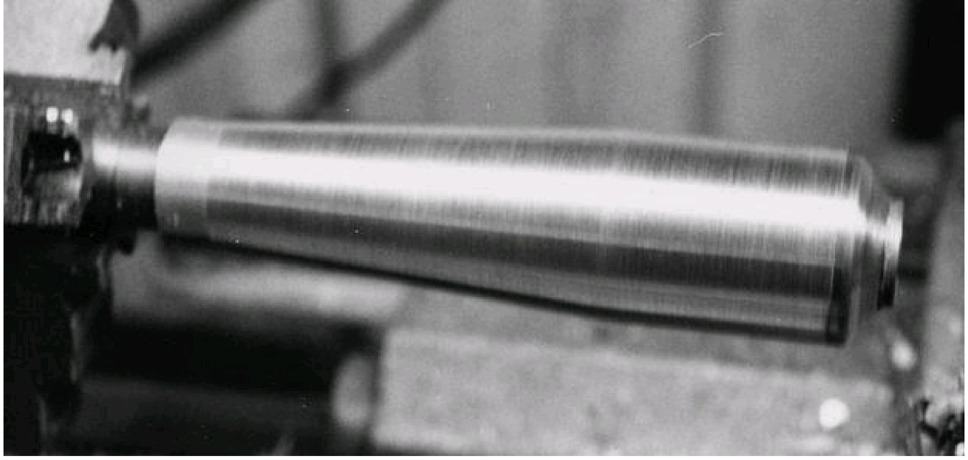
Gas exit holes are indexed and drilled perpendicular to the bore and should conform to a regular pattern, mostly for the sake of appearance. These can be round holes of .187 inch diameter, spaced .300 inch apart, and laid out in six or eight rows of four holes each spaced equidistantly around the diameter.

The shotgun brake will require six or eight rows of .125 inch holes spaced .200 inch apart in rows approximately 4 inches long. The inside of the barrel must be polished after drilling to remove any burrs or cratering incurred during drilling. Needless to say, these holes are located behind the choke.

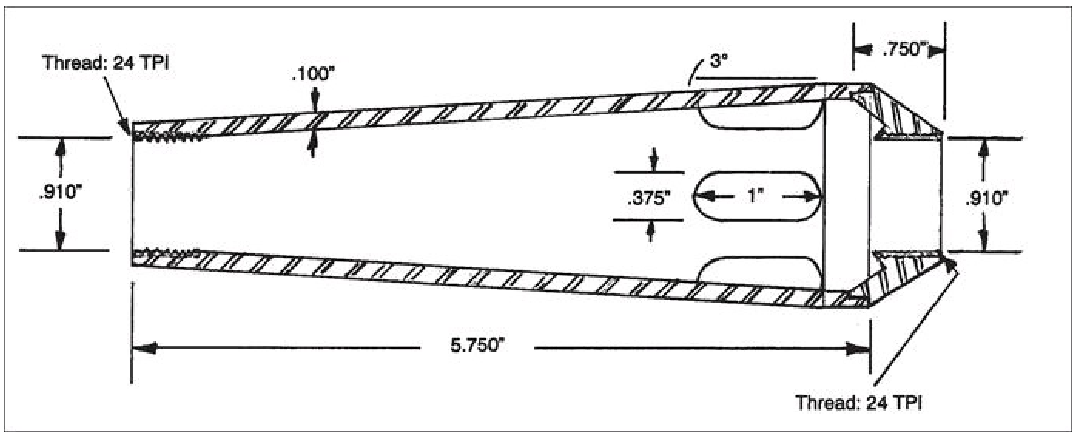
A tapered muzzle brake mounted on a trap gun. The front sight is adjustable for both windage and elevation.



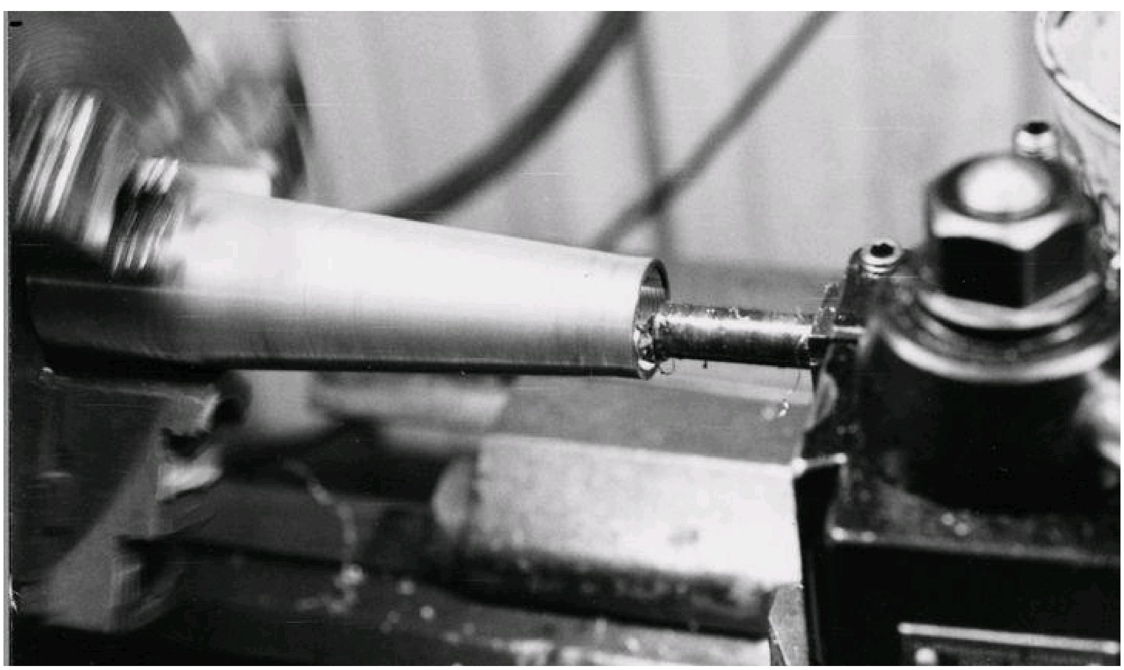
The completed shotgun muzzle brake.



Shotgun muzzle brake with tapered body.

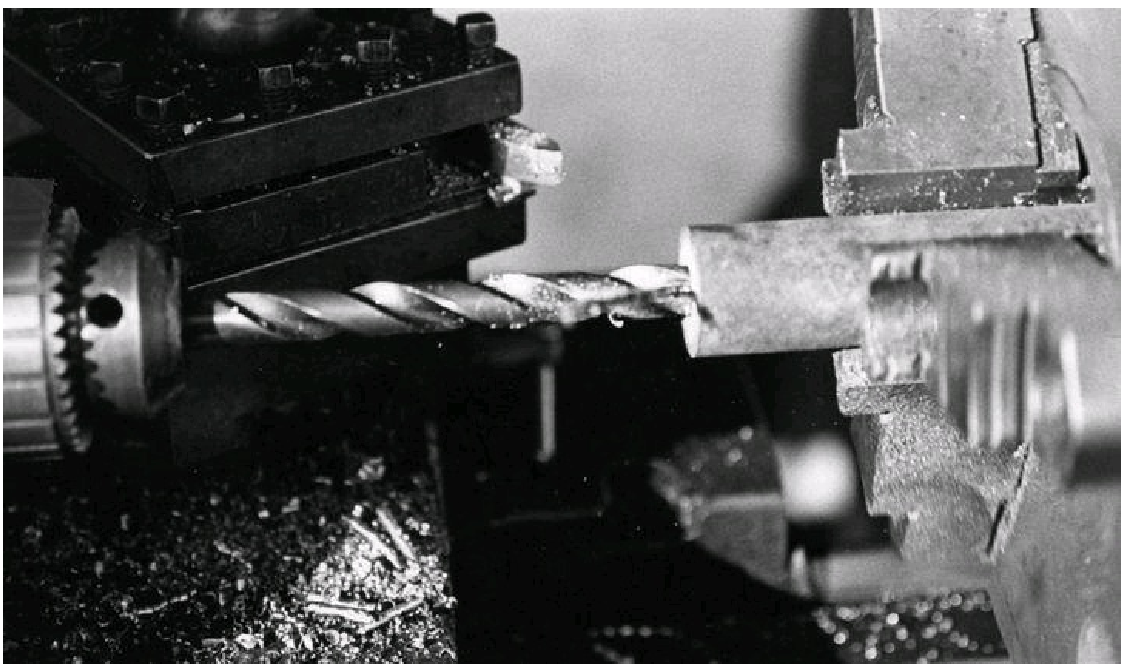


Threading the muzzle brake.

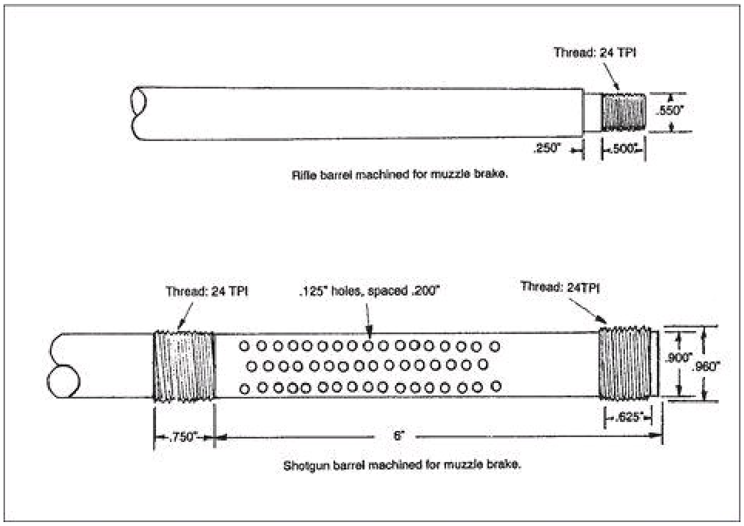


Ports are drilled in the barrel using the milling machine.

The pilot hole is drilled through the brake body.



Outside diameter is turned to size.



The muzzle end of the barrel must be threaded, 24 threads per inch, and a raised collar must be located 6 inches to the rear of the muzzle. If the barrel is turned from an oversize blank, a length five eighths of an inch long and enough oversize to thread should be left just behind the muzzle and another of similar dimensions 6 inches behind the muzzle. If using a barrel that is already too small for this, it will be necessary to make collars, bored to a slip fit over the barrel, and silver solder them in place.

The muzzle brake body is made of aluminum, in this installation, to save weight. If possible, it should be 1 3/4 inch in diameter at the muzzle end and bored to a .100-inch wall thickness.

If the tapered version is used, which looks better than the straight cylinder, the rear end should be bored to size and threaded first. It is then screwed onto a short dummy barrel section that has been correspondingly threaded. The dummy barrel, or arbor, can then be chucked in the lathe and the taper cut using the compound slide set at the proper angle. If using a small lathe with less than sufficient travel on the com-pound, you will have to cut the taper in two setups, cutting to the limit of the compound travel, then moving the carriage enough to cut the rest.

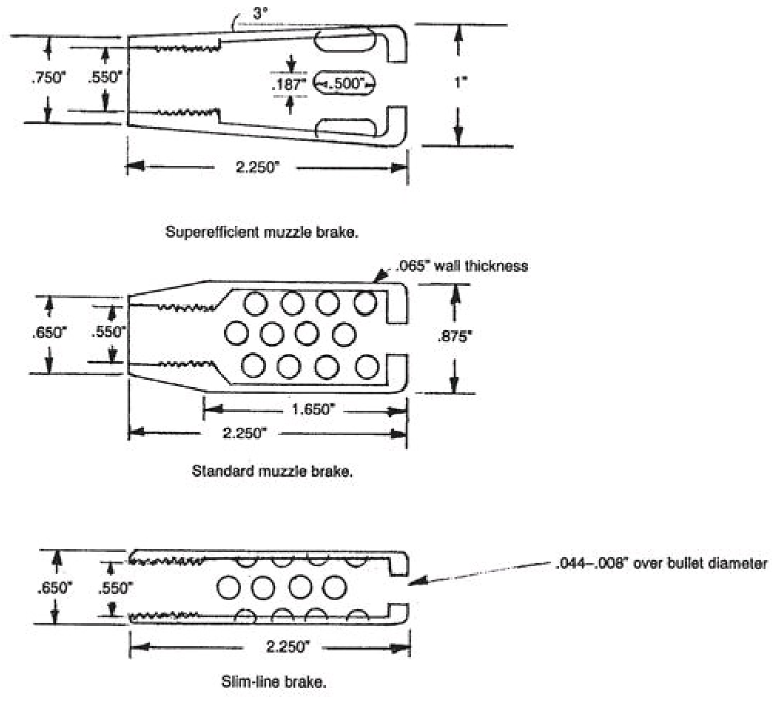
Muzzle brake mounted on 12-gauge, slide-action gun

A plug, or cap, is turned to fit into the front end and threaded to screw onto the barrel.

Gas ports should be a series of 3/8-inch slots, 1 inch long, spaced equidistantly around the diameter and just to the rear of the muzzle cap.

A straight cylinder brake is made in the same manner, except that no taper is cut, either inside or out, and an end plug similar to the muzzle cap must be used at the back end also.

A sleeve, or jam nut, is bored and threaded to screw onto the collar at the rear end of the brake. A couple of .187-inch holes are drilled through the sides to allow tightening with a spanner wrench. In use, this collar is threaded on to the barrel first, followed by the brake body, then the end cap. With the front sight, or rib post, in its desired position, the collar is drawn up against the rear end of the brake, locking it in place. It is possible to make lateral adjustments for windage by rotating the brake body before tightening.



Rifle muzzle brake configurations.

The front sight or rib post should be fabricated and fastened in place on the brake body. While it is possible to weld it in place, I recommend that it be held in place using screws unless you are a bona fide expert at welding aluminum. Welding thin aluminum parts is a tricky business, and you can easily wind up with ruined parts if this is attempted.

Another drawback to using aluminum is the fact that it can't be blued by conventional methods. It will require anodizing, which is an expensive process to set up for. Unless you can find a commercial metal finisher offering this process, the only other choice is to paint it.

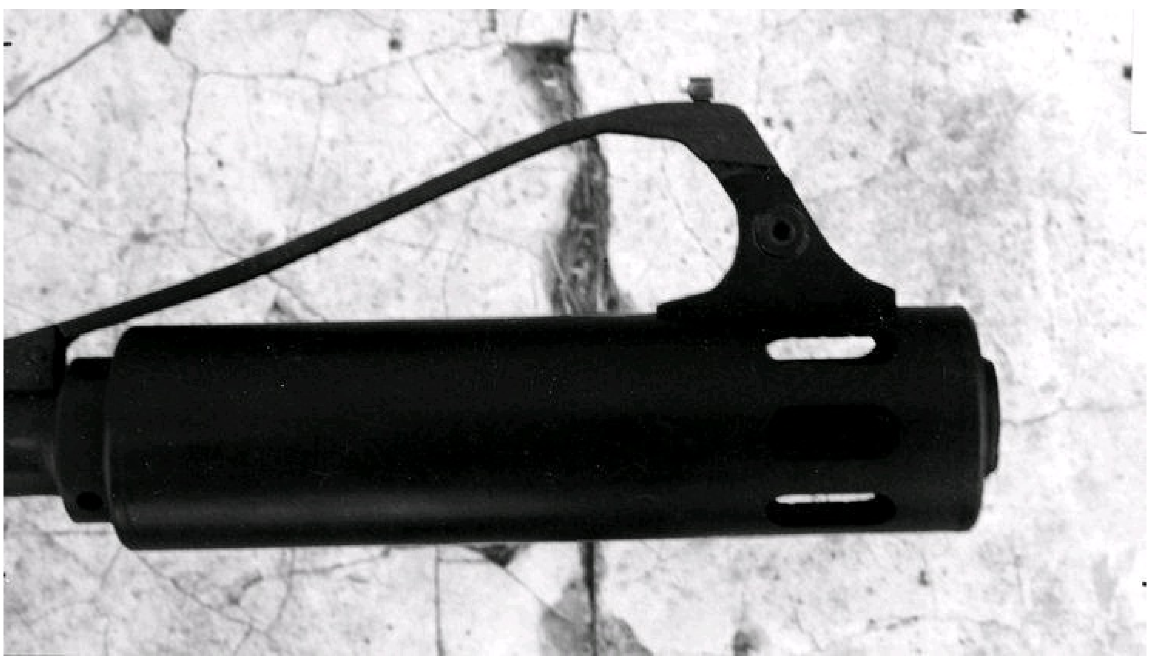
In the event you are compelled to do this, the metal surfaces should be bead blasted or sand blasted first to give a slightly rough finish for the paint to adhere to. A thin coat of flat black enamel is sprayed on and allowed to dry, followed by a second coat. When thoroughly dry, it is then placed in an oven and baked at 350 to 400 degrees for a couple of hours. This results in a fairly durable finish and, if properly done, will look almost as good as a commercial finish.

The larger-than-bore-diameter expansion chamber, with a wall at the front end for the gasses to push against, is the key element to an efficient muzzle brake. When a comparison is made, the ones having a hole through the body just slightly larger than bore diameter and forward-sloping gas ports are sadly lacking.

When installing the rifle brake, the barrel should be threaded between centers and the threads cut with as little slack as possible. It is essential that the bullet exit hole be concentric with the bore. Otherwise accuracy will suffer.

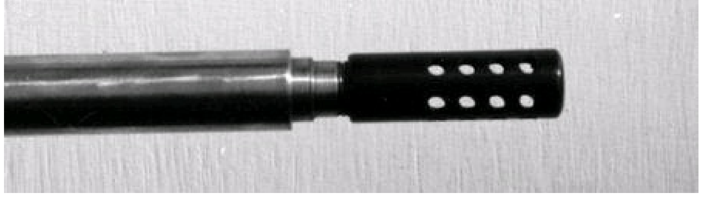
Porting a shotgun barrel does little to reduce recoil, though it may reduce muzzle jump. Gun design will achieve the same result.

Cylindrical muzzle brake on a 12-gauge trap gun.



Threaded arbor is mounted in lathe chuck. The brake is screwed onto it for outside finish cuts.

Standard muzzle brake mounted on arbor.



Tapered muzzle brake mounted on arbor.

Be warned that inexperienced federal agents may very well try to seize shotguns equipped with the muzzle brakes described here. On more than one occasion in the past, they have mistaken them for silencers. There is no reason to believe that they are any smarter now than they were then.

Chapter 12

Trigger Assemblies

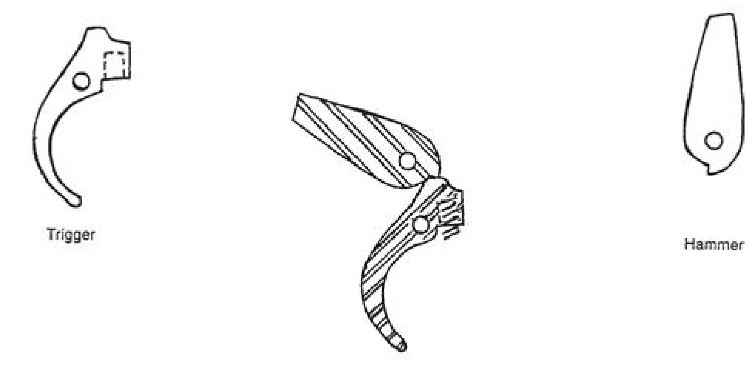
Trigger assemblies, as described here, will include the trigger, hammer, sear, disconnector, trigger bar, and whatever springs are required. It is recommended that these parts be housed in a separate housing contained inside the frame, or receiver, that can be removed and installed as a unit. This not only eliminates unsightly exposed pins, it also blocks each end of the pins and holds them in place.

I have included sketches of 12 different trigger assemblies. One of these should fit any design requirements called for. There are at least 20 more that could be included, but it would require a separate book to describe them all.

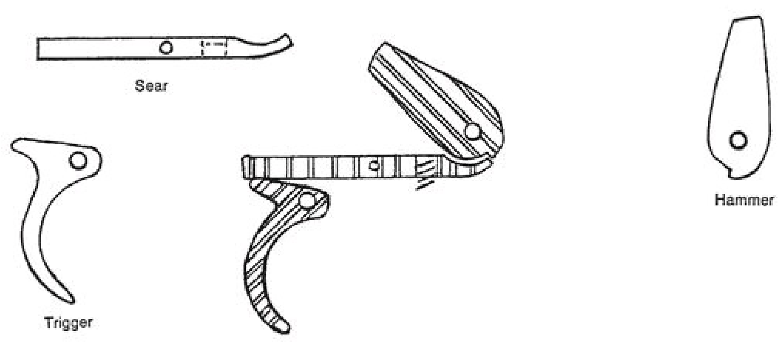
As you design your mechanism, keep in mind that spring and pin locations can have an effect on the finished product. If the trigger spring is placed 1/2 inch from the pivot pin, for example, it will have slightly less pressure but will be far easier to compress than if the spring is only 1/4 inch from the pin. If the portion of the trigger that actuates, or bears against, the sear or hammer is 1/2 inch above the pivot pin, it will take twice as much effort to pull than if it is 1/4 inch away. However, the trigger will require twice as much movement to fire the gun. When a trigger bar is used to push or pull the sear out of engagement, the pivot pin that locates the trigger bar should have as much distance between it and the trigger pivot pin as possible. This reduces trigger travel in direct proportion to the distance between the two pins.

In designs incorporating a safety, if it really is a safety, it will lock the sear securely into the hammer notch. Do not try to get by with a safety that only blocks the trigger. These give a false sense of security since the sear can be jarred or vibrated out of contact with the hammer, especially if dropped. Don't take chances with this.

Sketch number one shows what is likely the simplest trigger mechanism known since the matchlock. There are only two moving parts. The trigger nose engages in a notch in the hammer, holding it in the cocked position until the trigger is pulled. Since there is no disconnector, the hammer is free to move forward any time the trigger is depressed. This assembly is useful primarily in single shots and single-action revolvers.



Trigger number one.



Trigger number two.

Number two is similar to number one except that a sear bar is added. While this is done primarily so that the trigger can be positioned further to the rear in relation to the hammer, it is also possible to obtain an easier trigger pull since the camming lever portion of the trigger will have more leverage. If the hammer notch and the sear nose are smooth and square, a fairly good trigger pull can be obtained. Since no disconnector is provided here either, this one is also better suited to single shots.

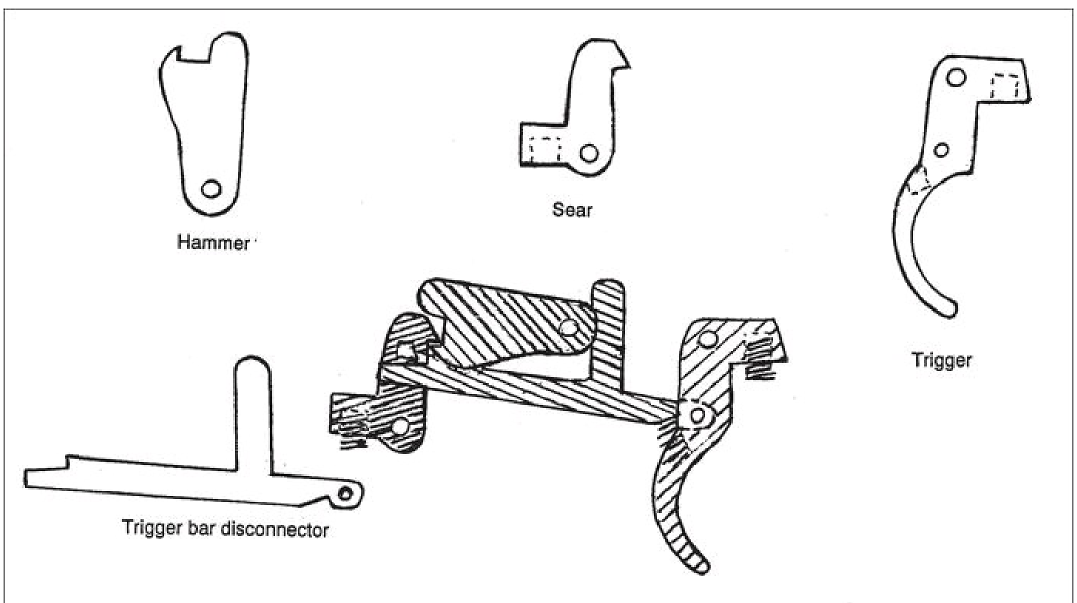
Number three is useful when the trigger must be positioned a distance in front of the hammer. A trigger bar and disconnector are added here, making this assembly adaptable for use in reciprocating bolt actions. The sear engages a slot in the top of the hammer, holding it in the cocked position. Rearward movement of the trigger bar pushes the sear out of engagement. Movement to the rear of the bolt rides the disconnector downward, camming the trigger bar out of engagement with the sear. The disconnector should be close to the rear edge of the bolt, preventing discharge until the bolt is fully locked.

Number four is similar to number three, except the trigger is located behind the hammer. It can be located whatever distance behind that is required simply by extending the length of the trigger bar and disconnector. A separate disconnector is used. If made on the trigger bar, as in number three, the forward movement required to push the sear out of engagement would also move the disconnector into the rear edge of the bolt, camming the trigger bar out of engagement. Since a considerable distance exists between the trigger bar pin and the trigger pivot pin, very little trigger movement is required to fire the gun. A sliding safety is used here which, when pushed to the rear, locks the sear into the face of the hammer. The only way anyone could make this one fire with the safety engaged would be to exert enough pressure on it to break it. The safety is disengaged by pushing it forward with the trigger finger.

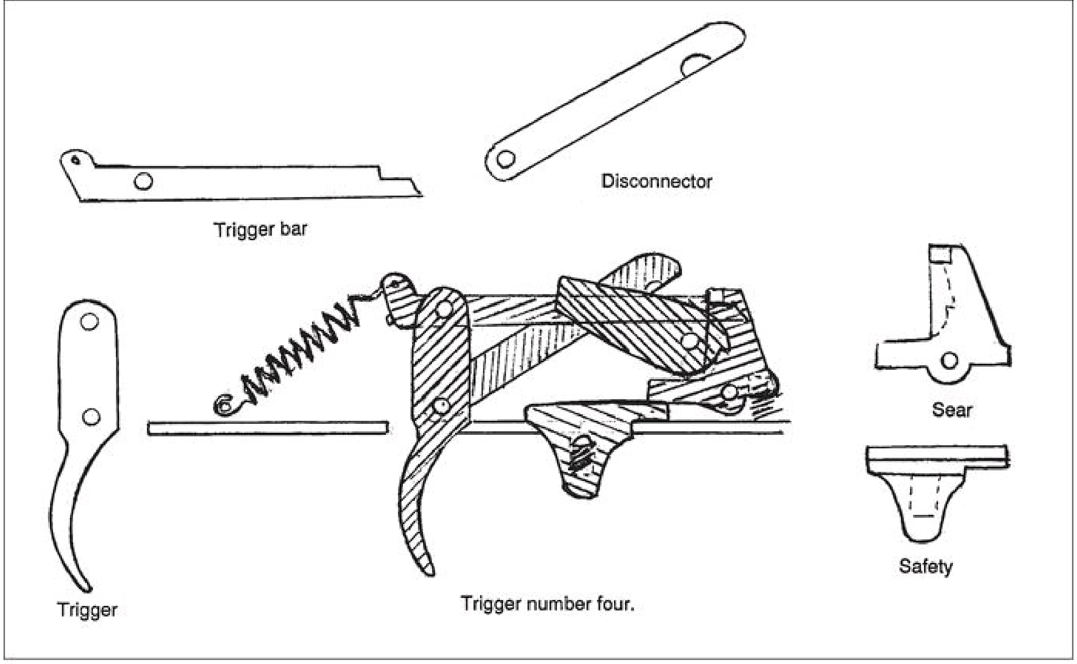
Removable trigger assembly for pistol.

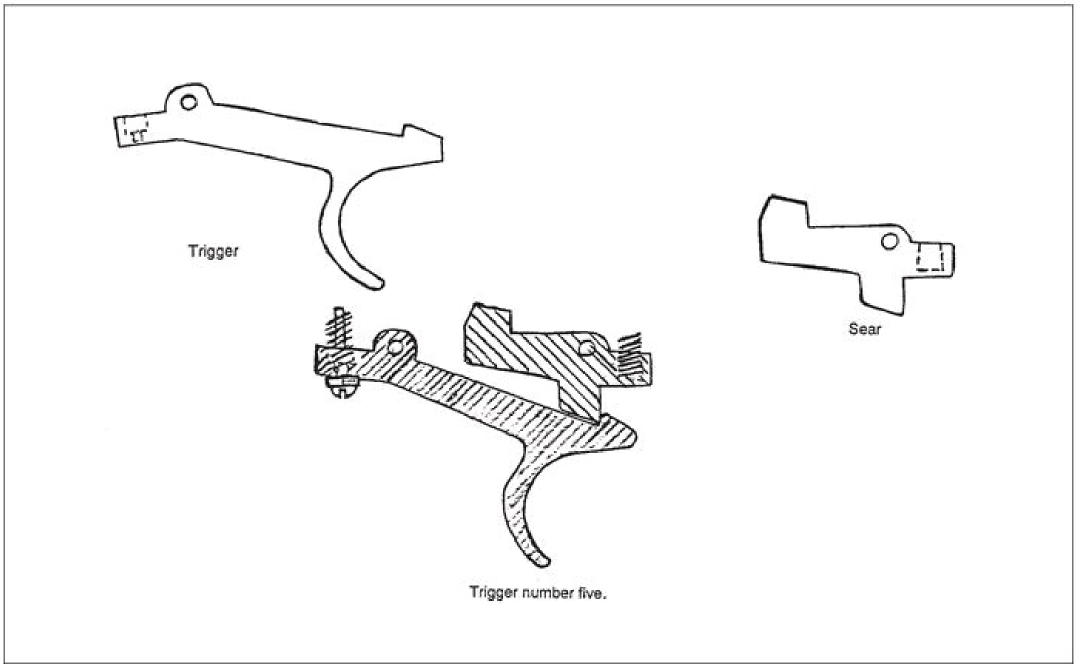
Shotgun trigger assembly.

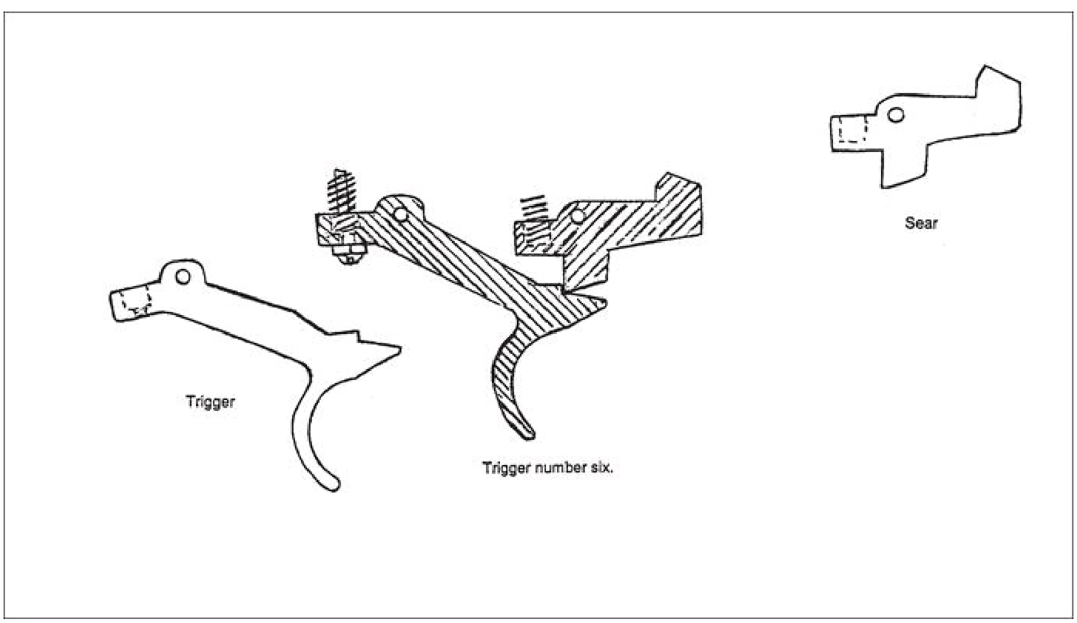
Number five is used in striker-fired guns such as bolt actions. It works in much the same way as a M70 Winchester trigger except the sear is reversed since it is necessary to move the trigger forward in relation to the rear end of the bolt. I have used this trigger design in my bolt-action trap guns. With the sear stoned smooth and square and the trigger notch to match, a safe 2-pound trigger with very little movement can be obtained. There are people who think such a trigger is not necessary on a shotgun, but anyone who ever tried one liked it. The screw behind the trigger pivot pin serves as a guide for the trigger spring and eliminates overtravel. This is an excellent bolt-action trigger.



Trigger number three.



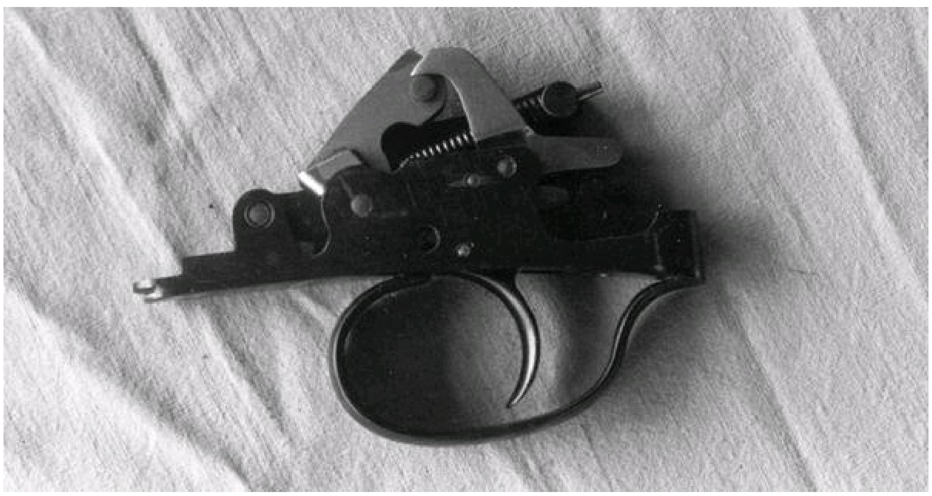




This trigger assembly for a single-shot shotgun is similar to the Winchester M70 trigger. It provides a safe, light pull with very little trigger movement.

This is desirable in a shotgun.

Perazzi release trigger conversion made by the author.



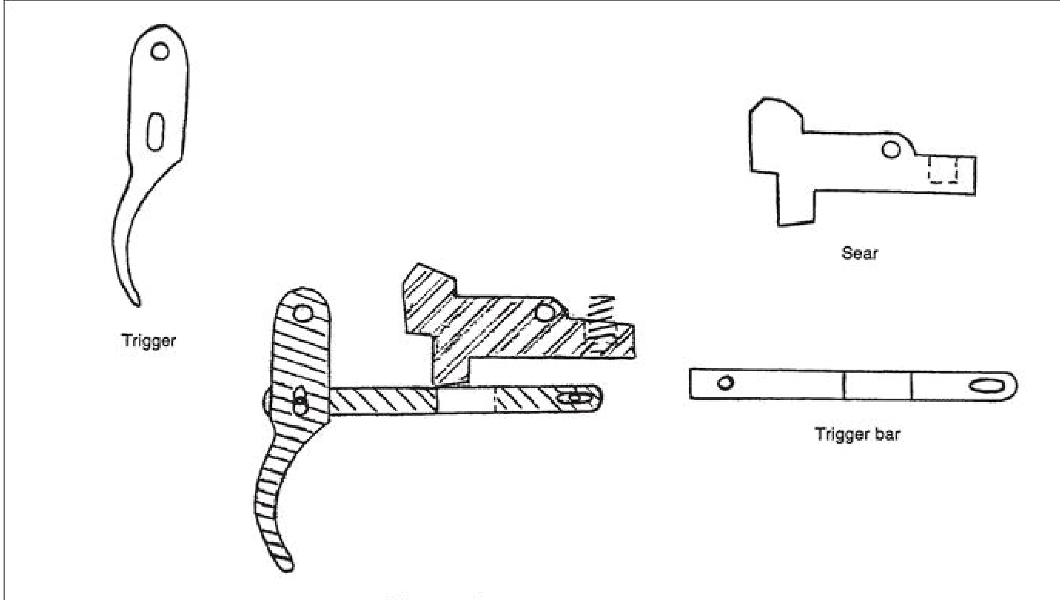
Number six works in the same way, except that the sear is turned around, resembling the M70 trigger closely. This design permits the trigger to be moved further to the rear than number five. If these are used in a trap gun or single-shot target rifle, a safety is of little concern. If used in a magazine gun or a hunting type, a safety should be incorporated. It can be installed directly in front of the trigger, whereby pushing it to the rear locks the trigger to the sear. It is pushed forward to disengage. The same safety design will work on number five equally well.

Number seven is another for use in striker-fired guns. In this case the sear drops straight down when the trigger pulls the drawbar-type sear from under it. This trigger is especially useful when you need a trigger positioned still further to the rear. It is slightly harder to manufacture than numbers five and six but it is very positive and can be set up to give a very light pull with little trigger movement. This one will require a lever or crossbolt safety just behind the trigger, which will prevent any rearward movement when engaged.

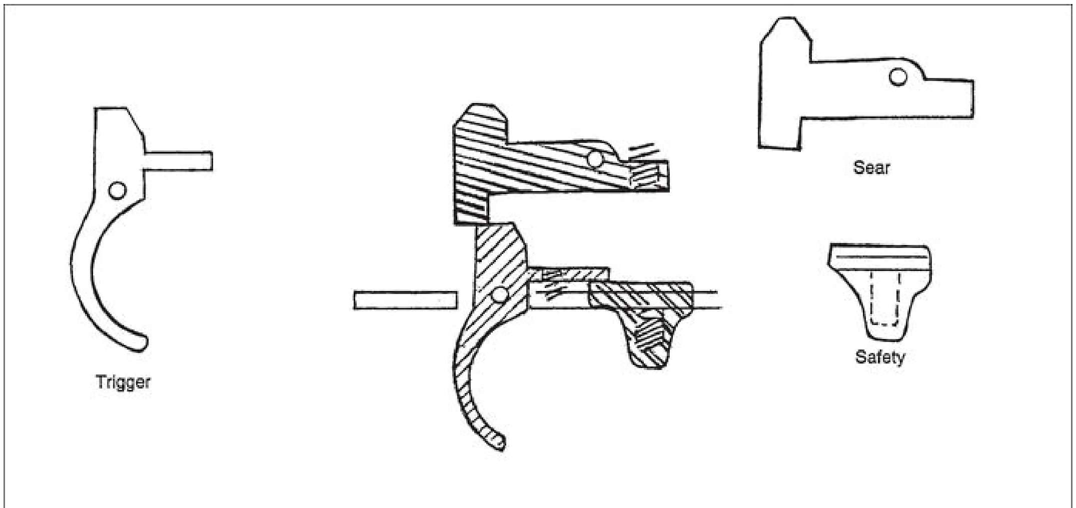
Number eight is a very simple trigger for use in striker-fired guns. It can be set up with a light pull and probably the least amount of movement as any described. This one, too, can have the sliding safety just ahead of the trigger.

Number nine is a release trigger for a striker-fired gun. There are any number of trap shooters who believe they simply must have a release trigger. To those not familiar with the term, a release trigger is exactly as it is named—the shooter pulls the trigger to the rear and holds it until the instant of firing, at which time he simply relaxes the rearward pressure, *releasing* it, and the gun fires. Many shooters use these believing that they prevent flinching. Others think they are faster than a pull trigger. This may or may not be true. But if the shooter thinks it is, and it helps him, why not?

Such a trigger has little value for use in hunting weapons and could be dangerous. But in the trap gun, where the shooter has all the time he needs to position the gun and set his trigger, it can be quite useful. It also has merit when used in certain target or sniper rifles. Again, the shooter must have ample time to set the trigger before firing. Frankly, I have never known of anyone else making a release trigger for a striker-fired gun, but this is only because striker-fired trap guns are virtually nonexistent.



Trigger number seven.



Trigger number eight.

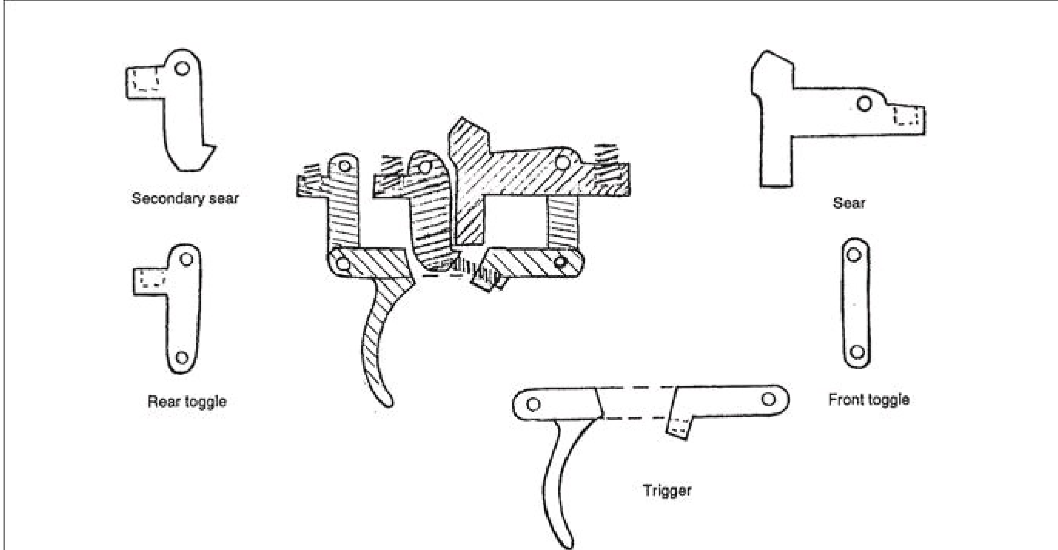
Shotgun trigger parts.

A release trigger conversion.

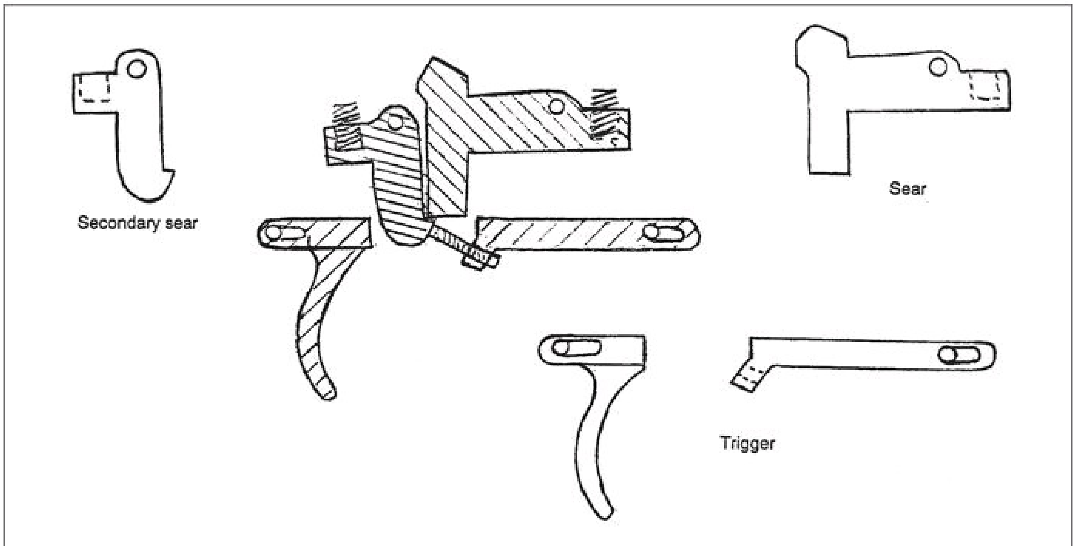
A few years ago I made up several sniper rifles, both in medium and longer range. These were bolt-action guns, and I had used the number six trigger in the design. I had been planning to build a bolt-action trap gun so I designed a release trigger for it and went ahead and put one in one of the rifles. I asked the people who were getting the guns to try it and tell me how they liked it. I didn't hear anything for several weeks. But then, one day they brought back all the guns that I had delivered and wanted a similar trigger installed in each one.

These triggers set with somewhere around a 5-pound pull and require very little pressure to hold. Simply relaxing the trigger finger causes the gun to fire, and the shooter already has any flinching that he might be guilty of over when he pulls the trigger. I would imagine these would be popular on target rifles if publicized.

Number ten is also a release trigger for the striker-fired gun. This one has a sliding drawbar to serve as a secondary sear and activate the primary sear. It should be used when it is necessary to move the trigger further forward or to the rear, since the trigger proper can be moved along the lower face of the drawbar. Either of these triggers can be converted to pull triggers by turning in the screw located on the bottom of the sear bar. This will cause the sear to be pushed out of engagement before the secondary sear engages, causing the firing pin to go forward when the trigger is pulled. Backing off this screw a couple of turns will allow the sear bar to be pulled under the sear block before the primary sear releases. This blocks the sear block and keeps it from falling when the trigger is pulled further to the rear, releasing the primary sear. When the trigger is allowed to move forward, the sear bar also moves forward and out from under the sear block, allowing it to fall and the firing pin to move forward, firing the gun.

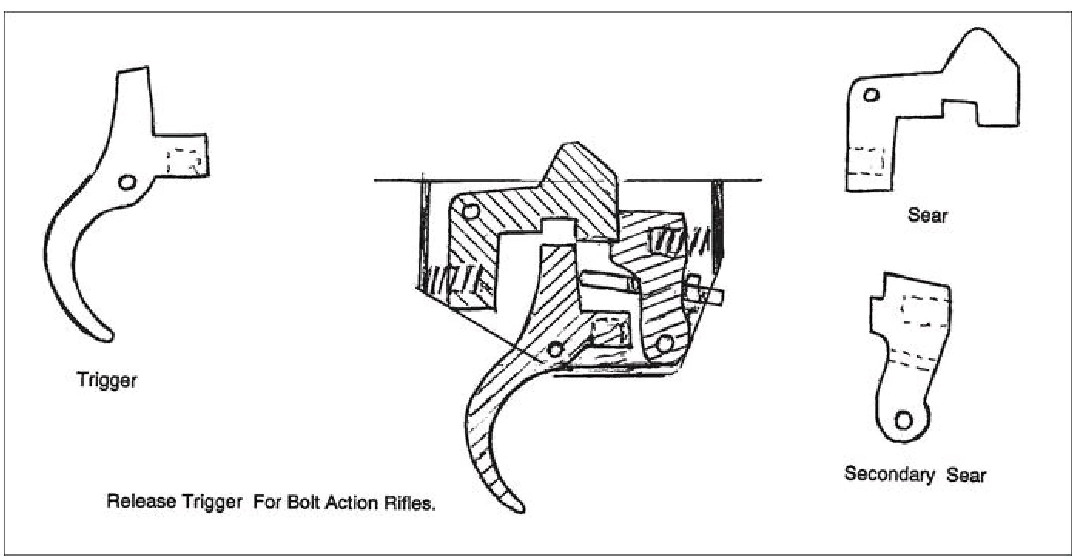


Trigger number nine.



Trigger number ten.

This release trigger is adaptable to striker-fired, bolt-action firearms. It is most desirable in target, sniper, or varmint rifles where deliberate shots are the rule. In use, when the trigger is pulled or moved to the rear, the upper front edge of the trigger moves forward, blocking the sear. At the same time, it moves the secondary sear forward out of engagement with the sear. This allows the sear to move slightly downward, preventing reengagement of the secondary sear. Thus, when pressure on the trigger is relaxed, the sear moves out of engagement with the firing pin, allowing it to move forward and fire the cartridge. This permits an especially “fast” trigger, with most opportunity to flinch removed.

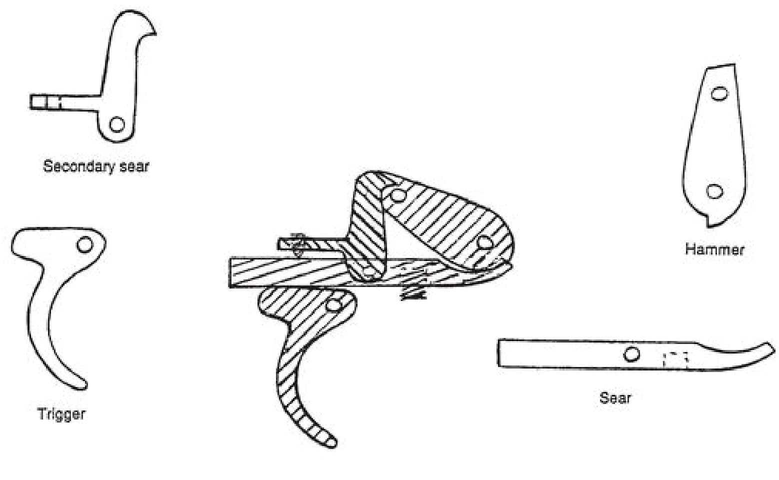


Release Trigger For Bolt Action Rifles.

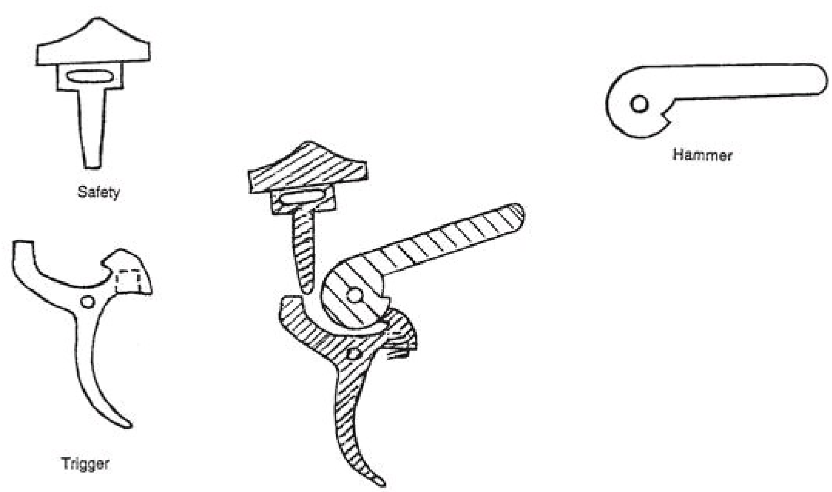
Number eleven is a release trigger for hammer-fired guns. These are the type usually found in break-open single and over/under trap guns. I have also used them in my own hammer-fired guns. These are easier to make than numbers nine and ten. This is primarily a trigger of the number two design with a pin placed through the side of the hammer, with one end protruding from the right side. A secondary sear is made from 1/8-inch flat stock with a tab folded over at the tail end to contact the upper side of the trigger at the rear end. An adjustment screw is installed in the cam portion of the trigger to bear against this tab. In use, the adjustment screw is turned in to a point that it cams the hook end of the primary sear over the hammer pin just before the primary sear releases the hammer. As the hammer is released, it moves forward slightly until arrested by the hook over the pin. When pressure on the trigger is relaxed, the hook no longer bears on the pin, thereby permitting the hammer to move forward. Backing the screw out a couple of turns will disengage the secondary sear, allowing the assembly to operate as a standard pull trigger.

When the trigger begins to "pull through" or fire when the trigger is pulled, the adjustment screw is turned in slightly, which moves the secondary sear forward, restoring its release trigger function.

In use, the release trigger must be dependable. It must not fire prematurely or when the trigger is pulled. A good test for proper adjustment can be made by placing one thumb against the back of the trigger and exerting forward pressure while pulling the trigger slowly to the rear with the other hand. If it is ever going to pull through, it will do it under these conditions. If it should pull through, turn the adjustment screw in slightly and try it again. Repeat until the condition is corrected.



Trigger number eleven.



Trigger number twelve.

Trigger number twelve is for use in a single-shot falling-block action. I have used this trigger in several guns of my own design. It is very simple, consisting of only two moving parts: the hammer and the trigger. The main drawback to this design is the use of a transfer bar to transmit the impact of the hammer blow to the firing pin. This is not unique to this design, however, since most such actions use a similar system of some sort. This one uses less parts.

When the operating lever is depressed, it draws the breechblock down with it. The rear edge of the breechblock contacts the front face of the hammer, forcing it downward against the spring until the hammer notch rotates far enough downward to permit the trigger to engage the hammer notch and hold it in the cocked position. As the action is closed, the breechblock moves upward. When the trigger is pulled, the hammer moves to the top, striking the lower rear leg of the transfer bar, which drives the vertical leg into the firing pin, moving it forward into the primer. The hammer is stopped by the rear end of the breechblock, while the inertia firing pin continues to travel another .040 inch forward and rebounds the same distance. This is to prevent the firing pin from hanging up in the primer or cartridge rim, which could break it or at least prevent the action from opening freely.

A sliding safety is located on the upper tang, with a leg that contacts the rear of the trigger, preventing movement.

The hammers, triggers, sears, etc., can be made from 1/4-, 5/16-, and 3/8-inch flat stock. This must be quality material that will stand a lot of shock and contain enough carbon to heat treat. The annealed flat spring stock is also suitable for this.

If possible, the thin sheet metal parts such as the trigger bars, disconnectors, and secondary sears should be made from this same material. There is a good chance that you won't be able to find any. You can either cut the thicker material down to the appropriate thickness with the milling machine, or you can make them from 12-gauge sheet metal and case harden them.

The trigger housings, when used, can be bent to shape from 16-gauge sheet metal. In several of these designs, mousetrap-type springs such as M16 hammer springs are used for the same purpose. This eliminates the need for a coil-type hammer spring, which also requires a strut, or guide, and sometimes a mounting bracket. It also saves space.

Parts made from 4140 should be heated to 1500 to 1600 degrees Fahrenheit, quenched in oil, and drawn at 800 degrees. Flat spring stock parts are quenched at 1450 to 1550 degrees and drawn at 600 degrees.

Chapter 13

Magazines

The primary key to flawless operation of a multishot firearm lies in the use of a sturdy, properly designed magazine. A magazine should retain its shape, have lips that won't spring or bend, and feed the top cartridge in the same plane regardless of whether the magazine is fully loaded, half full, or down to the last round.

Since a close fit between the magazine and magazine housing (or well, or whatever it is called on your particular gun) is an absolute requirement to assure flawless feeding, the magazine should be built or otherwise acquired first and the gun designed around it. If possible, I suggest that you buy magazines that are already in existence, provided that high-quality magazines can be