HOME WORKSHOP GUNS
FOR DEFENSE AND RESISTANCE

Volume One:
The Submachine Gun

By Bill Holmes

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PALADIN PRESS
BOULDER, COLORADO

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ISBN 0-87364-085-3
Printed in the United States of America

Published by Paladin Press, a division of
Paladin Enterprises, Inc.
Gunbarrel Tech Center
7077 Winchester Circle
Boulder, Colorado 80301 USA
+1.303.443.7250

Direct inquiries and/or orders to the above address.

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WARNING

It is against the law to manufacture a firearm without an appropriate license from the Federal Government.

It is also illegal to own or possess a full automatic weapon except those that are registered with the Alcohol, Tobacco, and Firearms Division of the United States Treasury Department and until a tax is paid on the weapon.

There are also state and local laws limiting or prohibiting the possession of these weapons in many areas.

Severe penalties are prescribed for violations of these laws.

Be warned!

Bill Holmes gathered the practical know-how contained within this book over a period of twenty years as owner, operator or gunsmith in several gun shops in several states.

Bill Holmes' home workshop submachine gun is short, comparatively light, and easy to handle.

FOREWORD

While it is illegal at the present time to possess or manufacture the firearms described in this book, there may very well come a time when the guns described herein could mean the difference between life and death, freedom or captivity, or starvation and existence.

The danger may come in the form of an invasion by a foreign power, or by revolution from within, or hopefully not at all; but if the time does come, access to a firearm might very well mean survival or more.

With this in mind then, let us look at some firearm designs that can be made in the home workshop with a minimum of equipment and material.

In this first volume, I will show how to build a submachine gun. In later volumes, we will take up a semi-automatic pistol, then both falling-block and bolt action rifles.

There are those perhaps, who will question whether or not the methods and designs will work. The easiest way for the doubter to find out, one way or another, is to try them. I personally know they will work. The reason I know is because I have, in time past, built and tried the weapons described. Of course, I don't do it anymore. It's against the law. If and when the time comes that I need a gun and cannot buy one, I guarantee you that I personally can make one or more that will work and be dependable.

While we are on the subject of legality, let me say just a couple more words. A submachine gun is a very unsatisfactory type of weapon to have in most cases. It is usually heavy, awkward, and an inaccurate weapon, suited mainly to the task of killing people. However, I have never been able to see that it is any more dangerous or lethal than any other gun; so why it is illegal,

Above: In this right side view of the gun, the stock is closed and the magazine latch has been removed. The dummy barrel is fitted with a dummy breech block, without the extractor, firing pin, or ejector.

Right: This picture shows the left side of the gun with the stock extended. The gun holds thirty-two rounds, weighs approximately eight pounds, and has an overall length of approximately twenty-two inches when the stock is in the closed position.

while a pistol, rifle, and shotgun are not, is hard to understand. But that's the way it is.

I am going to assume that the builder has a bare minimum of tools and equipment, or can get them. Also, since materials may be scarce at the time one is attempting to build one or all of these guns, I will discuss alternate sources of materials from time to time.

To a great many people who might read this book, some of the detailed instructions on the use of tools and the repetition of directions throughout the book may sound a bit foolish. Remember though, there are also those readers who might not have the slightest knowledge of how to use even a file. Therefore, if part or all of the descriptions of methods seem redundant, please bear with me, for the next reader may not have the experience or knowledge that you have.

Let me repeat once more—"To manufacture and/or possess these guns is illegal." I do not advocate or recommend that you undertake any of these projects at the present time. Rather, practice the methods outlined, gather materials and equipment, and then, if the time arises when you must have a gun, to survive or defend yourself, you will be ready.

Chapter One

Tools and Equipment

"If only I had the tools." How many times I have heard this statement over the years, usually followed with a glowing account of what the person could or would build if he only had the proper tools. Of course, if he did have the tools to work with, his project still wouldn't get done. But it does sound good when told this way.

It would indeed be nice if everyone had a fully-equipped machine shop, and I personally have such a shop at the present time. There was a time when I didn't though. It has not been too many years since I had only a few files, a hacksaw, and an egg-beater type hand drill to work with. Lacking a vise, I would manage to secure material I was working on by sitting on it, clamping it to a board with a "C" clamp, or by holding it in one hand while working on it with the other. If quality suffered, I never noticed.

True, it took a little longer, but I managed to make almost any part I needed with these simple tools. You can too, if you are willing to spend the time to try.

For example, the ejection port, magazine opening, and cocking lever slot in the receiver could all be formed in short order with a vertical milling machine. Since we don't have such a machine, we will scribe the outline of these openings in their proper locations. Carefully drill a series of one-eighth inch holes about three-sixteenths inch inside the outline and spaced one-fourth inch apart. Then, by enlarging these one-eighth inch holes to one-fourth inch, with a suitable drill, the unwanted inner portion will fall out. If the holes were not spaced exactly and a thin web remains between the holes, poke them through with a chisel. The opening may then be finished to the proper size and shape with files.

Irregularly shaped parts such as triggers, hammers, sears, etc., may also be readily made by scribing the outline of the part on a piece of material that is as close to the proper thickness as possible, and then by drilling a series of inner-connecting holes around the outline. This should then be finished with files.

Learn to use files. Almost anything that can be done with a milling machine can also be done with the correct file. In fact, the file is sometimes referred to as "The poor man's milling machine."

Several files should be acquired and kept on hand. In addition to several eight and ten inch flat files, commonly known as mill bastards, you should have several sizes of round files (chain saw files will serve nicely and are available in a variety of sizes), various sizes of three-cornered files, and whatever small square files you can find.

If a grinder is available, almost any size and shape of opening or part can be formed. This is done by grinding a smooth side on a section of the file and by grinding portions of some of the files to certain widths.

A hand hacksaw will prove to be very useful, together with several of the best blades you can buy. The higher priced blades will usually turn out to be the cheapest in the long run. If possible to obtain, a small electric sabre saw with the proper metal cutting blades is a handy thing to have. Many a file stroke can be saved at times by using either of these saws.

At least one, good, cold chisel should be obtained, and if possible, purchase three of these, ranging in size from one-eighth inch to one-half inch in width. One or more center punches should be on hand and a sharp scriber of prick punch.

A drill press would also come in handy. If one is not accessible, we can make do with a one-fourth inch or three-eighths inch hand drill. Or lacking even this, then one of the hand-cranked "egg-beater" style drills may be used. If hole locations are properly punched, and if care is taken to hold the drill at a right angle to, or square with the work, then an acceptable job will result with any of the above mentioned hand drills. We can get by with one-eighth inch, three-sixteenths inch,

A "Poor Man's Lathe" is jackleg gunsmithing at its best. This method is generally not recommended for accuracy, but will suffice when a lathe is not available. Many lathe operations may be performed satisfactorily in this manner.

Above: Sanding discs, common in automobile body shops, may be mounted on arbor and used for grinding and sanding operations. A stiff back plate of masonite or similar material is attached behind the sanding discs.

Right: If the pins in a hacksaw frame are replaced with longer ones, several blades may be used simultaneously. Wide slots may be cut in this manner.

and three-eighths inch drill bits, plus appropriate drill sizes for the tapped holes we will make. It will be helpful to have at least two of each size.

We will also need the use of a lathe, some type of welding equipment, and a grinder to sharpen the chisels, punches, and drills. Some type of measuring equipment is also a necessity—preferably micrometers up to two inches or a vernier caliper, together with a small protractor and a scale or ruler at least twelve inches long.

These items, with a few taps and corresponding drills, should give us enough equipment to complete the project. A list of the bare minimum of necessary tools would include:

A 1/4 inch or 3/8 inch drill motor (or hand type drill)
Drill bits; sizes 1/8, 3/16, 1/4 and 3/8 inch
A hacksaw with several blades
Ten inch flat mill bastard file
Three-cornered triangular files (small)
Round files: 1/8, 3/16, or 1/4 inch (Preferably all)
Small square files
Cold chisels: 1/8, 1/4, and 1/2 inch in width
Center punch
Scriber
Twelve inch ruler
Protractor
Appropriate taps with corresponding drills
Tap wrench
Plus the use of a lathe, welding equipment, and grinder.

Right: With the hand tools shown here, together with the use of a lathe and welding equipment, you will be able to build the gun described in this book.

Chapter Two

Materials

Certainly the easiest, most fool-proof way to obtain the needed materials would be to make up a list and go to an appropriate supplier. Naturally, this is what we will do if possible. However, when the time comes to acquire our materials, there may not be any supplier. If this becomes the case, other sources must be located.

The body, or receiver, of the submachine gun is made from one and one-half (1.500) inch inside diameter tubing with a wall thickness of one-eighth inch. The finished length will be ten and one-half inches. Assuming that tubing is not commercially available, another source must be found. Boiler tubing or high pressure pipe is suitable for this. Drive shafts from some of the little foreign cars are also close to the proper size. Occasionally one will find an old steel bedstead (commonly referred to as an old iron) made from seemless tubing. If it were absolutely necessary and nothing else was available, I personally would not hesitate to use gas or water pipe, but only as a last resort.

An eight inch section of nine millimeter (0.357 inches) barrel with an outside diameter of at least five-eighths inch will be needed. This we will obtain by buying a barrel blank from any of several suppliers. (One twenty-four inch barrel blank will make three barrels.)

If this is not possible, then the easiest way to make a suitable barrel is to obtain a discarded military rifle barrel of seven millimeters, .30, or eight millimeters, and ream the bore to size. Then you may cut new rifling as described in the chapter on barrel manufacture. Failing this, we will have to drill, ream, and rifle a section from quality steel rod. This must be good steel. An old iron bolt or rod will not last long enough to make the project worthwhile. Automobile axles and sometimes steering shafts (the shaft that the steering wheel is

fastened to) are a good source of supply for this. Car and truck transmissions also contain shafts made from quality steel.

A section of quality steel, one and one-half (1.500) inches in diameter and three and one-half (3.500) inches long is required to make a bolt or breech block. Here again, various truck or tractor axles are a source of supply, as are shafts from many farm implements.

In a great many cases, these substitute materials will be too hard to machine or work. This is no problem though, if firewood is available. Simply build up a good sized wood fire and place the material to be annealed (softened) in the middle. When the fire burns down, the material will be surrounded by hot coals and ashes and should be left to cool, preferably over night. It will then be soft enough to file, saw, or drill.

Another three inches of one and three-fourths (1.750) inch round stock will be needed for a breech plug and barrel bushing. This should also be of the highest quality steel available.

Two pieces of approximately one-eighth inch sheet steel, two inches wide and six inches long, will be necessary to fabricate a magazine well and trigger housing. This should be easy enough to come by. Angle iron or bed frame material is sometimes suitable for this. And while it is slightly thicker than necessary, enough material can be cut from an old automobile frame to satisfy our needs.

In addition to the materials mentioned, bits of steel in three-eighths inch and one-half inch thickness will be needed for the trigger and sear, the magazine latch, and the stock release. Round stock can be used for the various pins, and if suitable coil springs can not be found, music wire can be wound to form the various springs.

Valves from gasoline and diesel engines are a source of quality round stock. Old farm tools and sometimes truck springs, or frame material, yield flat stock of sufficient thickness for triggers, sears, and some other parts. In most cases, these will require annealing (remember our wood fire?) before they can be worked.

There are many sources for the coil springs of the type we need. Many electric switches, carburetors, and fuel pumps contain such springs, as do locks, clocks, radios, old television sets, and many kitchen appliances.

If you look long enough, something will turn up that can be adapted or rebuilt into the part you need. As a matter of fact, a visit to the local automobile salvage yard should turn up sufficient materials for your needs

since a junked car will contain all, or nearly all, of the required materials.

I suggest you carefully study the chapter on heat treatment, (Chapter Eleven) before you begin to gather your "junk."

The left side of a completed gun. The magazine is surplus Sten clip, the receiver is made from seamless tubing, the trigger and magazine well from old car frames, the barrel blank was purchased commercially, the stock formed from a screw jack handle, the rear sight from O3A3, the front sight from 98 Mauser, and the breech block, breech plug, and barrel bushing from tractor axels.

Chapter Three

Receiver

Since the receiver, or body of the gun, is the main section that all other parts and components are fastened to, it is only logical to begin by building it first.

Hold the ten and one-half (10.500) inch section of one and one-half (1.500) inch I.D. tubing and square the ends. This will be easier, and result in better quality, if it is done in the lathe. A bevel of thirty to forty-five degrees should be turned on the end that the barrel bushing will be welded into. The butt end, or the end farthest from the barrel, should be threaded in the lathe with a one and five-eighths (1.625) inch diameter by twenty-four threads per inch, to a depth of three-fourths inch.

A barrel bushing should now be made from round stock, one and three-fourths (1.750) inches in diameter by one inch long. Turn three-fourths inch of the length to a slip fit inside the receiver tubing, leaving a one-fourth inch wide shoulder. This shoulder should also be beveled thirty to forty-five degrees on the inner face. The bushing may be threaded and drilled either now or after it is welded in place. This can best be done by drilling a hole through the exact center of the bushing while it is chucked in the lathe. A 37/64 inch drill is the proper size for this, followed by a five-eighths inch by eighteen tap. Better results are usually obtained by drilling first with a small drill, followed by the full sized drill.

Then push this plug into the receiver and weld it in place. This should fill the mated, beveled surfaces and build the weld up slightly above the surface, after which it may be turned smooth and flush with the surface in the lathe. This can best be accomplished with an electric welder or an arc welder. The heli-arc process is preferable if it is available.

The next step is that of indicating three lines on the

receiver. A center line should be located along the top of the receiver, followed by a line 180 degrees on the exact bottom side, and still another line on the right side, ninety degrees from both top and bottom lines. This third line will be in a nine o'clock position when viewed from the front (barrel) end. These three lines may be located and marked easily by clamping a cutting tool with a sharp conical point ground on it into the lathe tool post, exactly on center. The point should then be lightly fed against the work and drawn lengthwise along it, with the lathe carriage being cranked by hand. After that is completed, rotate the work ninety degrees clockwise and repeat the procedure. This will result in very straight and extremely accurate lines, especially if the head stock can be locked or held firmly in place while the carriage is moved along the work.

One inch rearward from the front face of the receiver (since the barrel bushing is now welded securely in place, its front face will be considered the front face of the receiver) will be the extreme front of both the

The receiver body consists of tubing with a barrel bushing welded in the forward end.

RECEIVER OR BODY OF GUN.

Layout lines may be marked by rotating the tubing by hand against the sharp pointed lathe tool.

Longitudinal lines may be made by drawing a sharp pointed tool along the length of the stationary piece.

ejection port and the magazine opening. On the right side center line, measure from this one inch point, another five and one-half inches to the rear. This will be the bottom outline of both the ejection port and the cocking lever slot.

Then, beginning one inch to the rear of the front receiver face and one-half inch to the right of the top center line, scribe a line one and one-half (1.500) inches long. This is the upper outline of the ejection port. Lines should be scribed at both the front and rear ends of this line, connecting it to the bottom line, thus forming a complete outline of the ejection port. Another line should be scribed three-eighths inch above and parallel to the first line drawn (the bottom ejection port line extension to the rear) with a three-sixteenths radius at the rear.

An indentation made at the top (as shown in the drawing), forming a pocket for the cocking lever to latch into, will provide a simple and effective safety. This safety will be virtually fool-proof. To implement, you simply pull the cocking lever all the way to the rear and

A drill press and vise such as those pictured are handy for drilling holes. However, the same can be accomplished with a hand drill if you are careful in holding the drill at a right angle to the work.

THREADED I.625"X 24 T.P.I.

BREECH PLUG

DRILL WITH 37/64" DRILL
THREAD 5/8"X 18 T.P.I.

BARREL BUSHING

The only way the gun could fire with the cocking lever in the safety notch, as it is pictured, would be if the lever broke off. The cocking lever is sturdy though, so it isn't likely that that would ever happen. Also note the ejection port and the slot for the cocking lever. They might not be dirt-proof, but they are simple and fool-proof.

upward. Then, when the rearward pressure is relaxed, the mainspring (bolt spring) locks the lever by wedging it firmly in position. There is no way this safety will fail unless enough pressure is brought to bear to break off the cocking lever. The rest of the corners of this opening should have a one-eighth inch radius.

Another opening should be laid out beginning one inch rearward of the receiver face and centered over the bottom center line. If a Sten gun clip is used, this opening should be one and one-half inches long by seven-eighths inches wide (seven-sixteenths inches on each side of the center line). Other magazines may require slightly different dimensions. The corners of this opening should be cut square, without radius.

Another series of lines should now be scribed one-eighth inch inside the border lines already made. Make center punch marks at one-fourth inch intervals along these lines and drill a one-eighth inch hole through each punch mark. Substitute a one-fourth inch center drill for the one-eighth inch drill, and redrill all the holes to one-fourth inch. The unwanted inner portion of the openings should fall free, leaving only a little file work to finish.

The slot for the cocking lever is made in the same way, except that one-eighth inch holes are drilled one-fourth inch apart on the center line and redrilled with a three-eighths inch center drill forming a slot three-eighths inch wide and four inches long.

The reason center drills are used to redrill the holes is because they will not crawl or spread to the next hole as a regular twist drill might.

Center a sear opening over the bottom center line with the front of its three inches to the rear of the magazine opening. This opening should be three-eighths inch wide by three-fourths inch long and made in the same manner as the others.

A breech plug should be turned from one and three-fourths inch in diameter by one inch round stock. Reduce the diameter to one and five-eighths (1.625) inches on three-fourths inch of the length, leaving the remaining one-fourth inch the full diameter which should be knurled. The turned down portion is threaded twenty-four threads per inch (1.625 inches by 24) to screw into the rear of the receiver. This plug should be bored out inside, leaving approximately a three-sixteenths inch wall thickness, both to form a well for the recoil spring and to reduce weight.

A magazine well is formed either by bending one-eighth inch flat stock around a form of the same dimensions as the magazine or by welding strips together to form the front and both sides. The front must be radiused to fit the curve of the receiver, after which it should be positioned over the magazine opening and welded in place. Care must be observed to insure that the box remains in line with the opening.

The rear wall of the boxes is now made to the dimensions shown in the drawing and welded in place. The inside of this magazine box should now be smoothed with files and emery cloth or stones until the clip may be inserted and removed with very little effort.

This magazine box is left longer than necessary until the entire weapon is finished. At that time it will be trimmed by filing off the bottom until the clip seats itself far enough for cartridges to feed properly.

This photograph shows the top of the receiver, the trigger housing, and the removed clip. Note the position of the ejection port. The cocking lever is long and curved forward, to prevent accidental slippage. The grip is checkered walnut.

TEMPLATES FOR MAGAZINE HOUSING

ALL PARTS FROM 1/8" SHEET STEEL

MAGAZINE BOX CONSTRUCTION AND ASSEMBLY

Side view of receiver. Note the heavy bead on the spot where the magazine well is welded to the receiver. This particular receiver was made from one-fourth inch thick tubing. A band, one-fourth inch thick, was left on each end and the remainder was turned to one-eighth inch wall thickness. The thinner, straight wall tubing described in the text will work as well as the tubing pictured.

Bottom view of the receiver showing from left: magazine well, sear slot, and threaded opening for the stock bolt.

Side view of the breech plug. The plug screws into the rear of the receiver. It is knurled for a no-slip grip.

Inside view of the breech plug. The bored out portion serves both to lighten the weight and to house the rear end of the main spring.

Chapter Four

Breech Block

The breech block, or bolt as some insist on calling it, is made from one and one-half inch round stock that is three and one-half inches long. It should be made from material that can be hardened to prevent battering or undue wear. If commercial steel is available, then buy a type that you (or someone with the facilities) can harden to between thirty-five and forty on a Rockwell "C" Scale. If none is available, then you will have to take your chances on something like a truck axle. Tractor transmissions sometimes contain shafts suitable for this also.

At any rate, a suitable piece of material is chucked in the lathe, with the end squared and true. A counterbore of sufficient diameter to accept the cartridge head should be machined in the face of the breech block. For the nine millimeter Parabellum cartridge, this counterbore should be two-fifths inch in diameter by one-tenth inch deep.

A firing pin of .055 inch to .065 inch diameter, with a protrusion of not less than .050 inch or more than .060 inch, must be located in the exact center of this counterbore. This firing pin may be made in several different ways. It may be machined directly on the bolt face as the counterbore is formed, made separately and held in place by a threaded bushing, or made separately and threaded in place.

The latter method is the type I prefer since it isn't too hard to make and is easily replaceable if it wears down or breaks. Therefore this is the type shown in the drawing. Drill a hole to receive the firing pin with a Number 26 drill, making it one-half inch deep with a flat bottom. A flat pointed (square ended) drill may be ground and used after the hole is drilled to depth to form the flat bottom.

Now bore this hole to one-fourth inch diameter for the first one-tenth inch depth to receive the enlarged

BREECH BLOCK SIDE VIEW

BREECH BLOCK BOTTOM VIEW

rim of the firing pin body. Then thread the hole with a three-sixteenth inch by twenty-four tap. Of course you know to start with a taper tap, since the taper allows the tap to easily enter the hole. After taking a cut with the taper tap, remove it and take a second cut with a plug tap. Following this, use a bottoming tap to cut the thread as close to the bottom of the hole as possible.

The firing pin may now be made. It may be turned from suitable one-fourth inch round stock, such as drill rod. Since it may be hard for the inexperienced machinist to hold and cut threads on such a small part, a steel three-sixteenths inch by twenty-four bolt may be used. The one-fourth inch by one-tenth inch flange is formed from the head, with a hemispherical one-sixteenths inch firing pin machined in the center.

Drill two opposing one-sixteenth inch holes, one on each side of the firing pin, from .080 inch to one-tenth inch deep and make a suitable tool to attach and remove the firing pin using the afore-mentioned method.

I suggest that you go ahead and make up at least one spare firing pin now while you are set up for it, since you will probably need it somewhere down the line.

Tightly screw the firing pin in place, using the tool you made for this purpose. Hopefully, the forward flat will be flush with the bolt face. If it is not, the breech block should be chucked in the lathe so another cut can be taken across both the firing pin body and the bolt face. This should result in a smooth, flat bolt face with only the firing pin proper projecting.

Now reverse the breech block in the lathe and bore the rear end to a one-tenth inch wall thickness to a depth of one and three-tenths (1.300) inch. After doing that, drill another hole one-half inch deep with a three-sixteenths inch drill.

A cocking lever retainer is needed to enter this opening. It may be made either in one piece or with the 1.295 inch portion turned to a one-sixteenths inch wall thickness. The bottom left portion should be turned to a one-eighth inch thickness. Drill a three-sixteenths inch hole in the center of this portion and either thread or weld a three-sixteenths inch diameter by one-half inch long plug in place.

A three-eighths inch hole should now be drilled on the exact center line of the bolt body, one and nine-tenths (1.900) inch from the front bolt face to the center of the hole. It should be one and one-fourth (1.250) inch deep. The cocking lever fits into this hole.

The cocking lever is made from three-eighths inch round stock approximately two and three-eighths (2.375) inches long. Probably the easiest way to make

An unfinished breech block, showing bored out rear end, cocking lever hole, and magazine opening. Also note that the center portion is turned to a slightly smaller diameter to reduce friction.

Bottom view of unfinished breech block. More polishing should be done prior to using

The breech plug, mainspring, breech block, and cocking lever.

this part is to insert the rod in the hole in the bolt body. Run your three-sixteenths inch drill into the hole you already have in the rear center of the bolt body and drill through the cocking lever material, thus making an opening for the cocking lever retainer.

The end projecting from the bolt body should be flattened and formed with a slight forward curve, with the end tapered and rounded off. The inner curved surface should then be checkered (there are metal checkering files available from gunsmith supply houses) or stippled, matted, or otherwise roughed up to help prevent the fingers from slipping when cocking the gun.

An additional one-eighth inch next to the bolt body should be left full diameter to fit the cocking lever in the receiver.

Now we will begin the most difficult operation of the entire job.

Turn the bolt bottom side up. The cocking lever should be in the three o'clock position when viewed from the front or firing pin end. Locate and scribe a center line down the top (bottom when in proper position) from front to rear. This may be done in the lathe the same way we did the receiver. Locate and scribe two other lines, three-eighths inch from the center line

The breech plug, mainspring, and breech block as they relate when assembled.

on each side. Draw these lines parallel to the center line from the front edge of the breech block to a point one and seven-tenths (1.700) inches to the rear. Draw another line connecting the two. Now, scribe another series of parallel lines one-eighth inch inside these lines at one-eighth inch intervals.

A template may be made either from the drawings or by measuring directly from the magazine you intend to use. The template and dimensions shown in the drawings are correct for a Sten gun clip. An outline of the opening to be made should be scribed on the bolt face.

The material inside these scribed lines must be removed by some means. If a vertical milling machine is available, it is not much of a job. If, however, you have to do it by hand, you can figure on most of a day's work, several blisters, some sore muscles, and assorted

1.375"
1"
.375"
3/16"
HOLE
COCKING LEVER FRONT VIEW
COCKING LEVER TOP VIEW

FRONT
END
.1875"
.3125"
.500"
.100"
SIDE

EXTRACTOR

3/16

BREECH BLOCK
SPRING
FOLLOWER
EXTRACTOR

cuts and bruises. You will probably decide it cannot be done several times before you finish, but don't give up. It can be done! The reason I am so sure is because I did it on the first gun of this type that I made.

Some type of depth stop is needed to prevent drilling deeper than one-half inch. If a drill press is used, there will be no problem. Simply use the depth stop on the drill press. However, if a hand drill is the only kind available, some sort of stop must be put directly on the drill bit. A collar may be made for this purpose from a piece of tubing epoxied or soldered in place, or a nut or washer that will just slip over the drill. Make up both a one-eighth inch and a one-fourth inch drill in this manner, by soldering the collar in place.

Holes are drilled on the punch marks (that we made around the inside scribe lines) with the one-eighth inch drill first, and then with the one-fourth inch drill. The holes parallel to the center line must be angled inward toward the center at an angle of sixteen degrees. The included angle of the finished sides will be thirty-two degrees.

After these are drilled on both sides and the end, stand the breech block on end, face up, and drill another series of holes one and seven-tenths (1.700) inches deep. There should be enough material left to form the radiused portion as shown in the drawing. I highly recommend that you get a drill press with a good drill press vise for this job.

With all the outline holes drilled to the proper depth and properly spaced, there will be very little, if any, metal remaining in the portion that we want empty. To remove any left-over metal just slide a one-fourth inch or three-eighths inch chisel under a corner and tap it with a hammer. You should be able to remove it with the chisel without too much trouble.

What do you do now? You remove enough metal to make an opening in the shape of the template. This will enable the template to slice freely over and around the loaded magazine, allowing the radiused portion to pick up a cartridge and chamber it. Put a good sturdy handle on a ten inch file and wrap several layers of tape around the four or five inches adjacent to the handle. Then, by putting both hands near the handle end, the end of the file may be used to greater advantage, together with cold chisels, to properly form and smooth this opening

After the opening is finished, drill a hole with a Number 31 drill through the bottom of the radiused portion about three-eighths inch rearward from the bolt face and five-sixteenths inch deep, or into the firing pin

COCKING LEVER
BOLT FACE
RIGHT SIDE
BREECH BLOCK
EXTRACTOR
32°
SHOWN BOTTOM SIDE UP
FOR CLARITY
BOTTOM VIEW

The breech block is retracted and locked in the safety position. The small button at the upper rear of the grip locks the stock in open and closed positions

body. It should be tapped to take a six by forty-eight headless screw which will lock the firing pin in place, thus preventing it from inadvertently working out.

A slot must be cut to clear an ejector. This should be a continuation of the right side (viewed from the bolt face) of the magazine opening. It should extend into the bolt face counterbore approximately .080 inches and run back some one and nine-tenths (1.900) inches from the bolt face itself. This slot should be approximately three-thirtyseconds inch wide and may be formed by drilling connecting holes and filing to shape as we have done before.

An extractor must be installed in the bolt face in an eleven o'clock position (when viewed from the front). This is best done by cutting a "T" slot three-sixteenths inch wide at the bolt face and five-sixteenths inch wide at the bottom of the cartridge head, counterbore to the outside edge. File a slot one-tenth inch deep and not quite three-sixteenths inch wide with a small square file. The bottom "T" portion may be cut partly with a three-cornered file and finished with a small flat file such as an automotive point file. It may be necessary to grind these files thinner in order to accomplish this.

Center a three-sixteenths inch hole, three-fourths inch deep, in this extractor slot, three-eights inch from the outer diameter. Insert a coil spring that will slip freely into the hole behind a follower made from three-sixteenths inch round stock. The head should be angled at approximately thirty degrees and the stem should fit freely inside the spring.

The extractor proper is made from one-eighth inch flat stock, filed to a slip fit inside the "T" slot. It should be one-half inch long with a one-fifth inch radius on the end that contacts the cartridge head. Drill a matching hole with thirty degree shoulders. This will enable the spring loaded follower to engage itself, forcing the extractor rim into the extractor groove in the cartridge head.

Chapter Five

Barrel

In today's market, there are at least ten barrel manufacturers who can supply .35 caliber barrel blanks. These blanks are available in many configurations, ranging from feather-weight blanks to Bull barrels of up to one and three-eighths inch diameter for entire lengths of thirty inches or more. Since our project requires an eight inch section with a five-eighths inch diameter, it would seem to make sense to acquire a barrel blank slightly over twenty-four inches long. (Unthreaded and unchambered blanks are usually somewhat over twenty-four inches long.) This length, with a minimum diameter of five-eighths inch, will give you enough material to make three barrels.

At the present time there are several companies that manufacture and sell chamber reamers. These range in price from a low of around ten dollars to a high of thirty dollars. For our purposes, a finish reamer will suffice. Specify that it will be used in a rifle barrel when you order it. If you don't, the company many send you a reamer with a pilot too big to enter the bore. This may happen because many pistol caliber reamers are made with the pilot ground to groove diameter or slightly larger for use in revolver cylinders. (I realize the nine millimeter cartridge is used in automatic and semi-automatics, but there are revolver cylinders chambered for it on occasion. To avoid a foul-up, go ahead and specify that the reamer will be used for a rifle barrel.)

Incidentally, the higher priced reamers will usually have an integral throat reamer included, allowing you to work the entire chambering operation with a single reamer. The cheaper ones often require the additional use of a separate reamer for the throat portion. In most cases the higher priced reamer, such as those made by Clymer Manufacturing Company, will prove to be the

cheapest in the long run. The barrel proper is rather simple to construct. Cut a section of the barrel blank to the proper length and square the ends in the lathe. After turning it to a diameter of five-eighths inch, thread one end eighteen threads per inch by one and one-half inches long. This will enable the barrel to screw into the receiver with the end flush against the inside face of the barrel bushing, leaving enough extra threads to accept a five-eighths inch by eighteen lock nut.

The muzzle end should be crowned with a lathe tool ground for this purpose, and finished with a file and emery cloth. Follow this by finishing with 400 grit wet or dry sandpaper.

Feed the chamber reamer into the breech end of the barrel, with the barrel chucked. By turning at the slowest back gear speed pressure from the rail stock ram will push the reamer into the bore. Do not hold the reamer in a rigid tail stock chuck. It should be kept from turning with a hand-held tap wrench, a clamp, a small wrench, or some similar arrangement which will release and turn with the barrel if the reamer should suddenly decide to seize. The reamer should be well lubricated and removed and cleaned frequently. Another method of operation is to secure the barrel in a vise and turn the reamer in by hand using a proper tap wrench or reamer drive. If this method is used, care must be taken to feed the reamer straight, with no side pressure exerted in any direction.

An ideal chamber will result in this particular gun if you cut to a depth that will leave about a .010 inch gap between the breech block and barrel, when the breech block is in the closed (fired) position. Therefore, you should try cartridges (or a headspace gauge) in the chamber frequently as you approach the finish depth. When the cartridge head protrusion from the chamber equals the depth of the breech block counterbore (supposedly one-tenth inch), plus fifteen or twenty thousandths, you should screw the barrel in place in the gun. Tighten the lock nut, and after removing the firing pin, push the breech block forward as hard as you can. (It will be better to wait until the main spring is in place, allowing the spring to shove the bolt closed.) The chamber will be of a satisfactory depth when a feeler gauge of .010 inch to .012 inch passes without resistance between the breech block and the barrel. A cartridge should be in the chamber when you make the feeler gauge test, of course, and the extractor and firing pin should be removed from the breech block. You should also make absolutely sure that your chamber is

BREECH END SHOWING
CHAMBER DIMENSIONS.

Sections of military rifle barrels, such as those pictured, may be reamed to size and rifled if no commercial blanks are available.

clean, with no metal cuttings or other foreign material present while checking this clearance.

That was the easy way to obtain a barrel. If no barrel blanks or chamber reamers are available when you have a need to make this gun, you will have to make the needed tools to drill, ream, and rifle the barrel yourself.

Around almost every town of moderate size, there is a gunsmith or some serious gun nut who has removed one or more barrels from some of the bolt action military rifles to rebarrel them to a caliber he considers more suitable. If you can acquire one of these old discarded barrels, you are a third of the way home. The hole will undoubtedly be drilled, ready to ream and rifle. This does not mean that you can take any old .22 barrel, or barrels from low intensity calibers, and rework them. These would not last long enough to make the project worthwhile. Barrels used for such cartridges as the eight by fifty-seven millimeter, .303 British, 30/60, and 7.62 are the kind you want.

It might be a good idea, at this time, to define exactly what is required for the barrel we need. The nine millimeter Luger or Parabellum cartridge requires a bore diameter of .346 inch to .350 inch. The groove diameter will be .354 inch to .358 inch. The rifling twist may be anywhere from one turn in nine and one-half (9.500) inches to one turn in sixteen inches. The chamber diameter should be .397 inch at the breech and .382 inch at the forward end of the chamber, with a depth from the bolt face of .745 inch. These measurements should be as precise as possible. The barrel may have as few as two grooves to as many as you care to make. However, in this particular instance, a four or six groove barrel is recommended.

A section of military rifle barrel, or a length of suitable steel (automobile axle material is often acceptable) should be cut to a length at least one-half inch longer than the finished barrel length. If you are only making a few barrels, a simple rifling head can be made by casting a lead slug around a steel rod. The rod should be notched and slotted to keep the slug in place before inserting the bore. When you have the rod and slug inserted, mark the bore to insure inserting it again in the same position. Then carefully push the slug out of the barrel and cut a slot in one of the grooved impressions in the slug, (one of the raised ridges). This slot will accept a simple hook type rifling cutter as shown in the drawing. Cellophane shims are used under this cutter until the cutter removes a tiny amount of metal when replaced in the barrel and pulled through. Pull the

HOOK TYPE RIFLING HEAD, CALIBER 9 MM

LAPPING ROD

RIFLING HEAD DRIVE, FOR USE WITH ANOTHER BARREL AS RIFLING GUIDE.

cutter through each groove, removing it and rotating it to the next groove until the complete circle is made. Then add another shim and make another cut through each groove. This should be repeated until the proper groove diameter is reached, after which the bore should be reamed to size and lapped as described later in this chapter.

This is a very slow, drawn out means of rifling a barrel. If possible, you should take a close look at the hook-type rifling cutter shown in the drawing. This cutter may be rotated at the proper rate of twist by a spiral groove cut in a suitable rod or by casting a lead slug around a rod inside a barrel with a proper twist rate. This cutter is used in the same way as in the previous description, making a cut through each groove before raising the cutter. However, with this set-up, the bore is reamed to the proper diameter before the rifling cutter is used, so considerably less metal must be removed by the rifling cutter.

Regardless of the rifling method used, the bore must be reamed to size. This is best accomplished by chucking the barrel blank in the lathe and by drilling the bore out with progressively larger drills, beginning (assuming we started with a .30 caliber hole) with a "P" size drill of .323 inch diameter, followed by a "Q" and then an "R" drill which measure .332 inch and .339 inch respectively. An eleven-thirtyseconds inch reamer will get the bore diameter up to .3438 inch, after which a reamer will have to be made to finish it to the proper size. A 23/64 inch reamer is .3594 inch and may be ground or stoned to ream the hole to .346—.350 inch. This is a reather difficult process and really should not be tried unless you know what you are doing.

It is also possible to grind a pilot that will just enter the bore on one end of a three-eighths inch square lathe cutting tool. Grind and stone the square body to the proper size, then blaze an extension to the end and push or pull it through the revolving barrel. It must be fed very slowly, using plenty of lubricant; as should be done with all cutting, drilling, and reaming operations.

After the bore is reamed to the proper size and rifled, it should be lapped to remove any fine wire burns or chips left from the barrel tools. This may be done by casting a lead slug, some two to four inches long, around a rod inside the bore. Push the slug almost all the way out of the bore, and coat it with a mixture of oil and fine emery flour. The unoccupied portion of the bore should also be coated with oil through the opposite end. A stop should be inserted in each end of the barrel to insure against accidentally pushing or pulling out the

9"
#10 X 1" BOLTS
BICYCLE FRONT AXEL
LAPPING ROD AND RIFLING HEAD DRIVE HANDLE. MADE FROM HARDWOOD.
ADAPTER , THREADED TO FIT AXEL ON ONE END. THREADED TO FIT LAPPING ROD ON OPPOSITE END.
LOCK NUTS

RIFLING BENCH USING BARREL SECTION AS GUIDE.

RIFLING BENCH USING BARREL SECTION AS GUIDE

RIFLING CUTTER (SCRAPE TYPE) TO DEEPEN EXISTING GROOVES IN BARREL USING EXISTING RIFLING AS GUIDE.

lapping plug. This plug should never be removed from the bore until its work is finished. The lap should now be pulled (and pushed) back and forth through the bore for about ten minutes, with additional abrasive and oil being added frequently. After the lap is removed, the barrel should be cleaned thoroughly with gasoline and patches, and then examined. If more lapping is needed, the old lap should be melted off the rod and a new one made. Do not try to put the old lap back in the barrel.

The drawings show, in addition to the rifling heads and lapping rod, how to make a ball-bearing handle. This handle should be used both with the rifling head and the lapping rod so that each may follow the rifling twist freely.

It is hoped that you will be able to secure barrel blanks of the proper size if and when you need one. However, this business of drilling and rifling your own barrel or barrels is a fascinating and rewarding operation. And as knowledge and experience are gained through practice and experimenting, quite reliable barrels may be obtained in this manner.

Finished barrel with lock nut in place.

Finished barrel in place in the receiver.

Chapter Six

Trigger Assembly

A trigger and sear housing may be formed by bending one-eighth inch sheet stock to shape. However, it may be considerably easier to saw or grind one side of a section of angle iron (bed frame material is ideal for this) to the proper width and then to weld a flat piece to the side. This will form a box shape which should be left open at the top. The inside dimensions of this housing should be five-eighths inch wide by one inch deep with a finished length of eight inches. Make it at least eight and one-fourth (8.250) inches long to allow a little space for fitting. Weld a plate of the same material across one end to form the rear end of the trigger housing.

Beginning two and five-eighths (2.625) inches from the outside rear of the housing, make an opening three-eighths inch wide by three-fourths inch long in the bottom surface by drilling two three-eighths inch interconnecting holes. Following that, file the sides and ends to a rectangular shape. The trigger will project through the hole thus formed.

The trigger guard may now be made from a strip of one-eighth inch by one-half inch steel. Bend it to the shape shown in the drawing or to a reasonable facsimile, and weld it in place on the bottom side of the housing, over the trigger opening.

The top of this box, which fits against the bottom of the receiver, should be filed to match the contour of the receiver as closely as possible so that when the takedown bolt is drawn up tight, the two pieces will fit together closely, keeping the joint as dust and dirt-proof as possible.

If three-eighths inch inside diameter steel tubing is available, two pieces should be cut to a length approximately two inches long. The length of these is not crit-

TRIGGER AND SEAR HOUSING

TRIGGER AND SEAR HOUSING

ical since their purpose is to hold the telescoping stock in place. If no tubing is available, a three-eighths inch hole may be drilled lengthwise through either round or square stock to obtain the two needed pieces. The wall thickness should be at least three-thirtyseconds inch, since these will take a considerable beating when the stock is in the extended position.

When the two sections of tubing, which we will refer to as stock retainers, are completed, the trigger housing should be clamped in its finished position against the receiver. Then place the stock retainers in position, the rear end flush with the back end of the trigger housing and the upper side nestled against the receiver. When located in this position, they may be tack welded, with the trigger housing separated from the receiver. Weld the two retainers securely in place, but only to the trigger housing.

A hole, one-half inch in diameter, must be located two and three-fourths (2.750) inches from the outside rear of the trigger housing and one-half inch from the top edge. These measurements are for the center of the hole, naturally. Carefully drill this hole completely through both sides, making sure that it is square with the housing, since the fire selector mechanism will be located at this point.

The trigger should be made from three-eighths inch flat stock of high quality steel, capable of being hardened. It may be formed by drilling interconnecting holes around the outline and filing to shape as previously described, or it may be sawed and bent to shape from a piece three-fourths inch wide by three-eighths inch thick by four inches long. Drill a .191 inch hole with a Number 11 drill for a pivot pin at the point shown in the drawing. Following that, drill a one-fourth inch hole approximately one-fourth inch deep in the bottom side about half way between the pivot pin hole and the trigger nose. The upper portion of a trigger spring will be located in this hole.

The trigger nose should be shaped as shown in the drawing. Since this is the part of the trigger that engages the sear with a close, precise fit, it should only be rough shaped at this time. It should not be finished until the sear is completed.

The fire selector (that is, the switch to select either full automatic, in which the gun will continue to fire as long as the trigger is held down, or semi-automatic in which case a single round will be fired with each pull of the trigger) as well as the trigger pivot pin should be made from round stock as indicated in the drawing. Turn both sides to size and shape them into one piece.

The rear end of the sear. Note the shoulders at the extreme right. These shoulders will mate to the trigger.

15/16"
11/16"
3/8"
1/4"
1/2"
1"
1/4"
3/8"
1/4"
.191" #11 DRILL
1/4" DIA.
1/4" DIA.
5/8"
30°
2 1/8"
1 5/8"
1/2"
3/16"
2 1/4"
1/4"
1/4"
TRIGGER
SEAR
1/4" X 5/16" DEEP

FIRE SELECTOR SWITCH

1/8" PIN, THREADED or
RIVETED IN PLACE.
STOP PIN, TO LIMIT ROTATION OF FIRE SELECTOR SWITCH TO
180 DEGREES. IF LOCATED ONE TO FIVE DEGREES ABOVE THE
CENTER LINE, SWITCH WILL REMAIN IN SELECTED POSITION
UNTIL FORCIBLY ROTATED.
FIRE SELECTOR SWITCH

After drilling an 11/64 inch hole, spaced one-sixteenth inch from the center, completely through, cut the piece apart and face off each section to the proper width. Enlarge the hole in the right hand section to .191 inch with the Number 11 drill and counterbore it to take a screw head. Tap the left hand section with a ten inch by thirty-two tap to receive a threaded screw which will hold both sections together and serve as a pivot pin for the trigger. This assembly can be said to fit properly when the left and right sides are fitted into the housing, the retaining flanges pulled snug against the housing with the screw tight, and with the trigger on the screw between them working freely, but without side play.

A stop pin must be located in the left side to limit the rotation of this fire selector to 180 degrees. When in full automatic position, the trigger pivot pin will be toward the rear of the gun (in a three o'clock position when viewed from the left side) and directly opposite (180 degrees to a nine o'clock position) for semi-automatic fire. Rotating the fire selector switch 180 degrees should move the nose of the trigger forward or backward one-eighth inch.

The bottom of the sear. The relieved portion in front of the shoulders will allow the trigger to disconnect in semi-automatic fire.

The sear return spring rests in the hole at the front end of the sear. The oblong slot in the side permits fore and aft movement, required for the disconnector to work.

The sear proper should be made from five-eighths inch material. A piece one inch wide and three inches long is required and should be of quality tool steel. It should be sawed, ground, and filed to the shape shown. The portion which projects into the receiver and engages the bolt should be narrowed to slightly under three-eighths inch. It will have less drag, resulting in an easier trigger pull, if it is narrowed to one-fourth inch. However, it would also have less strength, so I suggest you leave it at three-eighths inch.

Establish a center two and one-fourth (2.250) inches from the rear and one-fourth inch from the bottom of this sear and drill a one-fourth inch hole through for a retaining and pivot pin. Place a close fitting steel plug in this hole and drill another hole one-eighth inch forward of the center of the first hole (centered on the seam between the plug and rim of the first hole). If this is properly done, the remainder of the plug will form a radiused slot when removed. This will allow the sear to slide forward and backward one-eighth inch over a one-fourth inch pivot pin. If the sear will not slide back and forth freely, file and polish it until it does.

Drill another one-fourth inch hole from the front end, centering it between the sides, one-fourth inch from the bottom. This one should be close to one-fourth inch deep. Construct a coil spring and follower as shown, and insert them in the hole. After the pivot pin is installed, the spring should have enough compression to hold the sear firmly to the rear. Then, when the fire selector is set on semi-automatic, the trigger nose will be in the forward position. With the breech block in the cocked position, its spring tension holds the sear forward, causing the trigger nose to bear against the sear. Then, when the trigger is pulled, the breech block moves forward, relieving the pressure on the sear. With this pressure relieved, the compressed spring within the breech block moves it to the rear one-eighth inch, disengaging it from the trigger before it will again engage the sear.

Conversely, when in full automatic mode, the trigger nose is moved to the rear one-eighth inch, and remains in this position, in constant engagement with the sear, thus permitting the breech block to continue to move forward without interruption until the trigger is released.

This probably sounds somewhat complicated; but after you study and understand it, you'll find that it's one of the simplest selective fire trigger mechanisms found anywhere.

BREECH BLOCK FORWARD (FIRED POSITION)
NO FORWARD PRESSURE IS ON SEAR ALLOWING IT
TO MOVE TO THE REAR , DISENGAGING TRIGGER
BREECH BLOCK REARWARD (COCKED)
FORWARD PRESSURE CAUSES SEAR TO MOVE
FORWARD, ENGAGING TRIGGER WITH SEAR.
TRIGGER AND SEAR MECHANISM
IN SEMI-AUTOMATIC POSITION

TRIGGER IS MOVED REARWARD 1/8" BY ROTATION OF
FIRE SELECTOR SWITCH. IS NOW IN CONTINUOUS
ENGAGEMENT WITH SEAR.
BREECH BLOCK FORWARD (FIRED POSITION)
BREECH BLOCK REARWARD (COCKED)
TRIGGER AND SEAR IN FULL
AUTOMATIC POSITION.

The slot at the back of the sear should be roughed in, leaving the shoulders (that contact the trigger nose) longer than necessary. After the hole for the one-fourth inch pivot pin is located, drilled, and tapped, these shoulders and the trigger nose should be adjusted by filing, stoning, and polishing. When the fire selector is turned to semi-automatic, and the trigger is in the forward position, the spring inside the sear should push it to the rear, thereby disengaging it. When the sear is then pushed forward, as it would be with the breech block pressure against it, the trigger nose should firmly engage the sear shoulders with one-sixteenth inch to three-thirtyseconds inch bearing surface.

One more one-fourth inch hole must be drilled as close to the front of the sear as possible to receive a sear opening. This is simply another small coil spring with enough compression to hold and return the sear to its engaging position.

The forward end of the housing should be shaped as shown to enter its receptacle in the rear of the magazine housing. Then drill a three-eighths inch hole through the bottom center of the trigger housing, one and one-eighth (1.125) inch from the outside rear to the center of the hole. With the trigger housing clamped in place on the receiver, locate and drill a corresponding hole in the receiver. A three-eighths inch by twenty-four steel nut may be welded over the hole to receive the stock bolt, which will eventually hold the completed assemblies together.

Left side of complete gun is pictured at right. The fire selector switch on this gun is different from the one shown in the drawings and described in the text. The one mentioned in the text is much more reliable than the one on this gun.

Chapter Seven

Stock and Pistol Grip

A four inch section of tubing, with an inside diameter that will accept a three-eighths inch bolt, should be aligned with the hole at the rear of the trigger housing. This tubing does not have to be very strong, since it is used mainly as a spacer and to reinforce the wooden pistol grip. Any material that will weld to the trigger housing may be used, including iron pipe. If these materials are not available, cut a four inch section from an old rifle barrel and drill a hole with a three-eighths inch drill. If a .375 inch or slightly larger reamer is accessible follow the drill with it. If not, it might be necessary to file the interior of the tubing until a three-eighths inch bolt enters freely.

The pistol grip may be made from any close grained hardwood such as walnut, wild cherry, maple, gum, and others. Pick a piece that is as straight grained as possible and try to stay away from brittle wood that will crack easily. The grip blank should measure at least one and three-fourths (1.750) inches by three inches by four and three-fourths (4.750) inches.

Drill a lengthwise hole through the grip blank, one and three-fourths inch from the front edge, centered in the width of the grip blank. The hole should be just big enough to slip over the tubing, which you welded to the trigger housing in the process mentioned above. It is important that this hole be square with the top side, so take care to make it so.

After the hole is drilled, slip the grip blank over the tubing and push it as far as it will go. With it in place, the outline of any material to be removed may be marked with a pencil. Some of the wood will have to be removed from the top, to allow the grip to slip up over the sides of the trigger housing. This can be done by carefully marking the outline and by making parallel saw cuts to the required depth, as close together as possible. After which any remaining wood can be removed

Upper left: Trigger housing and grip-Knurled bar at extreme upper left is stock latch. Slot at front engages in magazine housing.

Left: Slot partially engaged in magazine housing.

Above: Trigger group in position-When the bolt extending from bottom of grip is screwed home, assembly is locked firmly together.

with rasps or files and a flat wood chisel. The top of the grip should fit closely against the bottom of the stock retainers.

The rear of the trigger guard is also inletted into the wood with a narrow wood chisel to allow the guard to fit properly.

If the metal parts are given a thin coating of lipstick and pushed as far as they will go into the wood, high spots or wood to be removed will be easily detected through traces of the lipstick on the wood. Work slowly removing only a little wood between each fitting of the metal parts until there remains as little gap between the wood and metal as possible.

A thick washer with a three-eighths inch hole should then be inletted into the bottom of the grip, on line with the hole in the tubing.

The outside of this pistol grip should now be shaped similar to the contour shown in the pictures and drawings, or until it feels comfortable in your hand. When shaped to suit you, sand it smooth, beginning with coarse gritt sandpaper, followed by progressively finer grits, and finished with 400 grit paper. After the sanding is completed, a stain or varnish may be added to suit your fancy. I suggest that you use a waterproof finish. If you have no special preference, try brushing on several coats of "Flecto Varithane." When the last

Side view of receiver-Trigger assembly and magazine in foreground

WELD
HARDWOOD GRIP
3/8" INSIDE
DIAMETER TUBING
WASHER 1/8"
THICK
3/8" X 5"
STEEL BOLT
PISTOL GRIP

coat is thoroughly dry, sand back the grip nearly to the surface of the wood. Several coats of "Tru-oil" or "fin-speed" may then be added, making an extremely durable and waterproof finish.

After you are satisfied with the finish and after the trigger housing has been polished and colored (blued, painted, etc.), this wood grip should be firmly cemented to the metal. This may be done by giving the interior surfaces of the wood and the outside surface of the tubing section a liberal coating of epoxy cement and by pressing the parts together, with clamps or with your hands, until dry. Any surplus cement should be wiped off both metal and wood, simply to keep the job from looking sloppy. The washer should also be cemented into the bottom of the grip with the same epoxy cement.

Purchase a three-eighths inch by five inch N.F. machine bolt from an automotive parts store, or machinery supply house, to be used to attach the pistol grip to the receiver. This bolt should extend through the grip and thread into the nut that is welded to the receiver body. In addition to the hexagon head which a five-eighths inch wrench fits, a screwdriver slot should be sawed or filed across the head of the bolt, wide enough to accept a twenty-five cent piece. This will enable you to take it apart later, even if a wrench is not available. Better still, if the bottom plate of the magazine or the end of one leg of the stock frame is shaped to fit the screw slot, then no extra tools will be needed to take it apart. With the end cap removed from the receiver, tighten the trigger housing bolt and make sure the bolt does not protrude into the receiver.

If you can find a jack handle from the screw jack of standard Ford half-ton trucks, you will have an ideal piece of material to make your stock. One from a fairly late model is required, since the older trucks came with a jack handle that folded in the middle and had shorter pieces. For the last few years, however, they have tried to economize by making a long, one piece handle. This is the one you should be looking for.

A section approximately thirty-six inches long will be necessary. It should be marked at the middle and bent into a "U" shape with the bottom of the "U" having a radius of three-eighths inch to one-half inch. It may be bent to shape freehand, but a neater job will result if it's heated to a bright red or orange color before bending to shape around a three-fourths inch to one-half inch diameter section of round stock.

About five inches up from the bottom of the "U," bend both legs downward ninety degrees. Again, a neater job will result if heat is applied first. The butt end, or the end that goes against your shoulder, should be slightly curved to fit your shoulder. Keep the legs

Left: Trigger group with telescoping stock in place.

Right: Stock may be formed from ½" rod. Screw jack handle as furnished with ½-ton truck is ideal for this.

TELESCOPING METAL BUTT STOCK

BUTTSTOCK LATCH

BUTTSTOCK
TRIGGER
HOUSING
STOCK
LATCH

parallel with a proper width to fit into the stock retaining sleeves.

A latch or lock to keep the extended stock in place is made from three-eighths inch flat stock to the shape shown in the drawing. It should be pinned in place after drilling a one-eighth inch hole through the trigger housing and the forward end of the latch. Drill a spring retaining well in the bottom side center, close to the back end, to accept a short length of coil spring. This will keep the latch engaged in a slot on each leg of the stock. These slots may be filed to shape after the exact location is determined on each leg. When the parts are assembled, note the location where the latch bears against the stock legs. This is where the slots should be made.

If it is possible to checker each end of this stock latch with a metal checkering file (and to deepen the checkering with a triangular needle file), not only will a neater looking job result, but the rough, no-slip surface will also make it easier to manipulate.

The wooden pistol grip may be checkered as shown in the pictures, left smooth, or otherwise roughed up by carving, stippling, etc., as you so desire.

Right side of gun, stock extended.

Chapter Eight

Sights

The front and rear sights for a weapon of this type may range from a crude front post and fixed open rear sight to the precision, fully adjustable sights illustrated in the drawings and pictures. If desired, the front sight may be adjusted for horizontal movement by sliding it in the opposite direction to the desired point of impact. Vertical adjustment may then be made by raising or lowering the rear sight. However, since it would require a hammer and punch or similar tools to move the front sight, it would be better to make a rear sight, fully adjustable for both elevation and windage.

If available, the rear sight assembly from a United States 03A4 rifle, or similar rifle, can be used. It should be fitted as close to the rear of the receiver as possible, by making a mounting bracket and brazing or screwing it in place, in the center of the top of the rear receiver.

A satisfactory front sight can be obtained by sawing the lower part of the barrel band from the front sight of an old World War I or II military rifle. File the bottom to the same radius as the receiver and fasten it in place by brazing, or with screws, or through a combination of both.

In the event that these sights are not available, it will be necessary to make a set from scratch, with sheet metal as I illustrated with the other parts. The front sight may be made from sheet metal in one of two ways; by filing or milling from a solid block, or by welding separate sections together. I personally believe that a front sight, filed from a solid block with an integral protective ear on each side of the sight blade, will prove to be sturdier, and therefore the most dependable. It should be fastened to the receiver with two screws and silver solder.

File one side of a block of steel, three-fourths inch square, to the same radius as the receiver body. This will be the bottom of the sight. Turn it over and lay out

MILITARY MAUSER
FRONT SIGHT

MANUFACTURED FRONT SIGHT

FRONT SIGHT ASSEMBLY

BASE TO ADAPT 0345
REAR SIGHT TO GUN
DOVETAIL TO FIT
SIGHT
3/4"
7/8"
RADIUS TO FIT
RECEIVER
1/8" THICK
8 X 40 X 1 1/4"
SIGHT ELEVATOR
LOCK
SCREW
1/8"
1/2"
SPRING
7/16"
DRILL .17HW 29
TAP 8 X 40
1"
19
DRILL
3/4"
7/16"
1/8" FALSE BASE
WELD
BASE FORMED BY WELDING
BASE FORMED BYBENDING
TO SHAPE
SPRING
TO FIT SLOT IN
ELEVATOR
TAP
3 X 56
APERTURE
REAR SIGHT ASSEMBLY

Left: Rear and front sight in place. Rear is from U.S. O3A3 rifle with adapter plate. Front is from 98 Mauser.

Below: Top view showing front and rear sights in place.

four lines along the top. Two will act as guide lines to mark a one-eighth inch blade in the middle of the sight body. Lay these out, one-sixteenth inch on each side of, and parallel to, the center line. The other two lines should be made on each side, one-eighth inch inside the outside edge. Now, with a series or parallel saw cuts, finished with a file or with file cuts only, remove the metal between the blade in the middle and the outside walls to a depth of three-eighths inch.

The center blade can be filed to an inverted "V" shape, with the top left square, rounded, or filed to whatever shape you desire. The outside walls should be beveled or rounded toward the top, and flared slightly outward by beveling. These outer walls serve only to protect the sight blade. They should be rounded at the front and rear corners to create a better appearance and to prevent the sight from catching on clothing.

The rear sight is a little more complicated. Since I feel that adjustment for both windage and elevation is mandatory, this is the type I will illustrate. If you think you can get by with less, then it is a simple matter to form a fixed rear sight by bending sheet metal to shape and fastening it to the top rear of the receiver.

The rear sight shown here is quite similar to the U.S. 03A3 rear sight. It is very sturdy because the outside walls guard the sight proper. The main body may be bent to shape from one-eighth inch sheet stock. Another piece must then be used on the bottom as a fillet between the bottom of the sight and the curved surface of the receiver.

If this method is used, cut a strip seven-eighths inch wide by three inches long, and bend it around a three-fourths inch wide block of steel to form a square "U" shaped box. The sides should be shaped as shown in the drawing. The bottom fillet must be cut to approximately the same shape as the bottom of this sight body and filed to the radius of the receiver body. This will be "sandwiched" between the sight and receiver to make a close fitting installation.

Another method, probably better in the long run, would be to make a bottom section from one-fourth inch thick stock, three-fourths inch wide and seven-eighths inch long. The bottom radius should fit the receiver and an outside wall of one-eighth inch sheet, that should be welded or brazed to each side of the bottom section.

After the rear sight is properly shaped, through either method, a .166 inch hole should be drilled through the sides with a Number 19 drill, on a spot midway between the front and rear and one-eighth inch above the inside bottom edge. The windage adjustment screw goes in this hole.

Left: Front view of receiver-Note protective ears on each side of front sight.
Above: Top view of receiver.

The sight elevation and mounting block is made from a block of steel one-half inch by one-half inch by seven-eighths inch, as shown in the drawing. It may be formed completely with files. However, a small, flat pillar file is necessary to cut the slot in each side. If one is not available, slowly and carefully grind the back side of a hacksaw blade until it is narrow enough to fit between the sides of the sight block, and then cut the slots with it. Be careful not to get the saw blade hot enough to affect its heat treatment while grinding it narrow.

Drill a corresponding hole through the sight block crosswise to receive the windage screw. This hole should be drilled with a Number 29 drill and tapped with an eight by forty, or whatever thread pitch fits your screw. Drill another hole from the bottom side in the center, close to the rear of the sight block, to house a small coil spring. This serves to keep looseness or play to a minimum between the block and sight body.

A Number 8 steel screw, one and one-fourth inch long, is used as a windage screw. Turn the head down until only a small flange remains. This flange should be countersunk slightly into the sight body. Make a knob to screw on the projecting end of the screw with a lock screw to secure it to the windage screw. The outer rim of this knob should be knurled if possible. A small spring, made as shown, will keep tension on the windage screw

The rear sight itself is made by bending a three-eighths inch wide strip of one-eighth inch flat stock to an "L" shape. The sight aperture may be drilled with whatever size drill you desire. I recommend a one-eighth inch aperture.

The flange on each side of the sight should closely fit the slots in the sight body. Also, a keeper, or retainer, made from flat spring stock, should be fastened to the top of the sight with a screw. The outer edges of this retainer will engage the shallow notches in the sight block preventing accidental movement of the elevation setting.

I have purposely avoided mentioning any click values, wherein one click or partial turn of the windage knob (or fore and aft movement of the elevation slide) would equal so much at a given range. There are too many variables to consider to make this practical. The distance between the front and rear sight, the number of threads per inch on the windage screw, and the angle of the elevation slide would all have to be exact to accurately predict this. Therefore, you must practice shooting your gun, moving the sights until they are in line with the same point that the bullet strikes, at whatever range you choose.

REAR SIGHT
SCREW OR SILVER
SOLDER (OR BOTH)
IN PLACE
FRONT SIGHT
SCREW OR SILVER
SOLDER (OR BOTH)
IN PLACE
RECEIVER

Chapter Nine

Magazine Manufacture

When this book went to press, there were several magazines or clips available from a number of submachine guns, both from current and discontinued models. Various dealers, in surplus and junk, advertise these parts in many of the gun magazines and trade papers, such as **Shotgun News**.

One of the best buys on the current market is the Sten Gun Clip. Presently available for around four dollars, these clips are truly a bargain for anyone having any use for such a magazine. They hold thirty-two rounds of nine millimeter ammunition and the entire upper portion, including the lips which hold the cartridges in place, is reinforced with an extra thickness of sheet steel on the back and sides. This results in a strong, virtually indestructible magazine.

Assuming these are still available when you need one, I recommend that you buy at least one extra, and more if your budget permits.

If there comes a time when these are no longer available, an alternate source must be found. This means making your own, which at first glance may seem almost impossible. However, a closer look will reveal that perhaps it isn't so difficult after all—only time consuming.

If a clip needs to be made to approximately the dimensions and capacity of the Sten, then a piece of nineteen or eighteen gauge sheet steel, five inches wide by ten inches long will be needed. The eighteen gauge material is .0478 inch or approximately .048 inch thick, while the nineteen gauge measures .0418 inch or almost .042 inch in thickness.

If the double thickness is used in the upper portion, an additional section three inches by three and one-half inches would be required as well as a one and one-fourth inch by one and five-eighths inch piece for a bottom cap or floor plate.

Left: Complete Magazine-Originally made for British Sten Gun. The clips are currently available as surplus at about $4.00 each.

Above: Magazine disassembled-consists of body, follower, floor plate and spring. Floor plate latch is fastened to end of spring.

MAGAZINE TEMPLATE

Above: Floor plate partially removed.

Below: Stamped follower from sten clip may be made by welding legs to block and filing to shape.

Below: Floor plate-Readily formed by folding sheet steel to shape.

RETAINER

MAGAZINE FOLLOWER

MAGAZINE BUTTON

A female forming die should be made with a "U" shaped cross section formed by bolting, riveting, or welding two lengths of three-eighths inch or thicker steel to a center section of the same material which will be .800 inch wide. The sides should be one and one-half inch high, measured from the inside bottom section. The length should be at least twelve inches. Slightly bevel or chamfer the inner top wall and polish it until it is as smooth as possible. This will facilitate the sheet steel being formed to enter with as little friction as possible. If only a few magazines will be formed, angle iron may be used to make this forming die, provided that another piece is welded across each end to prevent it from spreading open.

A male die must be made to fit exactly the opening in the female die, less double the thickness of the material being formed, less another .003 inch to .010 inch for clearance. This simply means that if the opening in the female die is .800 inch and you are using eighteen gage sheet metal, you add .048 inch plus .048 inch plus .005 inch (or whatever clearance you deem proper) which totals .101 inch, which when subtracted from the .800 inch, leaves .699 inch. In this case, the male die would have to be .699 inch. There should also be .048 inch subtracted from the 1.500 inch depth to make an overall depth of 1.452 inches.

A longitudinal slot five-sixteenths inch wide and one-fourth inch deep should be filed in the top or back side of this male die with a round or radiused bottom. In addition, all four corners should be slightly rounded.

Place the male portion of the die inside the female portion, with a shim of sheet metal on each side. This shim should be of the same thickness as the magazine material to keep it centered. Then drill a three-eighths inch hole at each end, close enough to each end so that there is room for the ten inch magazine to be formed between them. The holes should be drilled through both the male and female dies simultaneously while they are together.

A close fitting guide pin should be used in each of these holes, to keep the die in line while the magazine is being formed. If the dies are to be used more than once, a slightly oversize pin should be pressed into each end of the female die and the holes in the male die should be reamed to a close slip fit over them. If you only plan to use the dies a few times though, loose pins will suffice.

After greasing lightly, center the sheet metal blank across the top of the female die. The male die (also lubricated lightly) should be centered on top of the sheet metal blank, and then the whole business should be squeezed together either in a press or with a large vise.

MALE DIE

MAGAZINE FORMING DIES
DIMENSIONS WILL VARY ACCORDING TO THICKNESS
OF MATERIAL, ETC.

DIES FOR FORMING MAGAZINE BODY

You may also force them together by wrapping a chain around the dies and another bar of metal, leaving enough space between them for a hydraulic jack. The jack will force the die together, forming the sheet metal into the shape of the magazine. Either method will form the front and both sides of the magazine body.

Then the back side must be formed. After placing a bar of steel along the side of the sheet metal, still extending from the top of the die, tap it smartly, bending it toward the middle. Do this on both sides. Then form a three-sixteenths inch lengthwise ridge on a flat steel place by grinding three-sixteenths inch diameter rod to half thickness. This rod should be brazed, soldered, riveted, or otherwise fastened to the plate. To complete the outside form, place the plate, with rod attached, over the top of the die and press them together. When the bend is secure, remove the form from the die by pushing the male die out from one end. The seam should be sweated (solder), brazed, or riveted together, after which the lips should be cut to shape and bent inward to the shape shown.

The reinforcing section is made in the same manner except it only has three sides with the front left open. When formed to the proper shape, with the lips cut to shape and bent inward, it is placed over the magazine body and welded or silver soldered in place.

The bottom sides must be flared at right angles outward from the magazine body, leaving a one-sixteenth inch lip projecting from each side. The bottom plate will slide onto these lips. This can be done with a hammer and a flat bar of steel, but the male die should be placed back inside the magazine while forming, to prevent it from being bent out of shape. Clamp a flat plate to the side, flush with the bottom of the angle. While holding the flat bar against the bottom, make the bend by tapping it with a hammer.

The bottom plate is made to the dimensions shown (it should just slip over the bottom of the magazine) by bending to shape in the same manner or by forming it in the small die. After it is shaped, drill a three-sixteenths inch hole somewhere close to the center and make a matching keeper by drilling through a plate which is sized to fit inside the bottom of the magazine body. Then rivet a three-sixteenths inch diameter projection in place.

The purpose of the bottom of the magazine spring is to bear against this keeper, pressing it firmly against the bottom plate with the stud engaging the hole. This will prevent the bottom plate from being removed unless the stud is pushed inward.

The magazine follower may be made from one-half inch flat stock. By filing and grinding a proper bevel as

SEAM
BRAZED, SOLDERED,
OR RIVETED
BOTTOM CAP
CAP LOCK
(RETAINER)
SPRING
FOLLOWER
SLOT FOR MAGAZINE
LATCH
DEPTH STOP

shown, and by welding a eg of one-eighth inch flat stock at both the front and rear to serve as guides, you will have a follower that will be kept from binding.

In most cases, factory made magazine followers are stamped and drawn to shape. This requires rather complicated, complex shaped dies though. So, unless a large number of magazines are to be made, I recommend the welded-up follower.

The only way I know of to wind a magazine spring, with the minimum of tools that we have available, is to make a mandrel from a ten or twelve inch length of three-eighths inch by one inch flat stock. Start by grinding the front and back edges until they are round. Also, drill a one-sixteenth inch hole near one end. Then, with one end of a length of one-sixteenth inch music wire (or spring stock) fastened in the hole, feed the remainder through a groove filed in a one-half inch square bar some ten inches long. A useable spring will result if the bar is wound around and around the mandrel. Note: I said a **useable** spring. It may not be particularly pretty.

Somewhere between five and six feet of wire will be required to wind such a spring. If music wire or spring stock is not available, a screen door return spring or similar spring will have to be straightened out and reworked. This will not be easy, but it can be done, if nothing else is useable.

Chapter Ten

Assembly and Adjustment

By row, all the parts and components of your gun should be completed. However, before the parts are heat treated and before beginning the final polishing and bluing, the gun should be assembled and tested. Whatever additional fitting and adjustment necessary for proper functioning should be done at this time.

The working parts should all have a smooth finish, free from burns and scratches. The flat parts, such as the trigger and sear, should have flat smooth sides, square with the top and bottom and finished until they feel slick when handled.

A good way to accomplish such a finish is to place a sheet of abrasive cloth on top of a piece of plate glass, and firmly rub the part to be polished back and forth across the mounted abrasive cloth. An extremely fine finish may be obtained in this manner.

With all interior parts finished to your satisfaction, begin assembly of the gun by screwing the five-eighths inch N.F. lock nut onto the barrel shank. Then thread the barrel into the receiver until the breech end is flush with the inside front wall of the receiver. With this accomplished, the lock nut should be tightened firmly against the front face of the receiver, locking the barrel in place.

The firing pin should be removed from the breech block simply as a safety precaution. This being done, slip the breech block into the rear of the receiver, insert the cocking lever and the cocking lever retainer in the rear of the breech block, and attach the action spring. Following these steps, screw the breech plug into the rear of the receiver.

To assemble the trigger group, insert the trigger, with its return spring in place, into the trigger housing. Then, with the trigger held forward as far as possible, slip the fire selector switch through the hole and fasten it in place with the threaded pin.

The sear may now be installed in the trigger housing. A small punch or screwdriver may be used to depress the longitudinal spring and follower inside the sear by inserting same in the hole in the front of the sear body. You should be pressing in while starting the threaded sear axis pin from the side. After the end of the axis pin slips past the spring and follower, continue pushing in on the pin while slowly withdrawing the punch or screwdriver until the end of the pin contacts the threaded hole in the opposite side of the trigger housing. The pin is then screwed tightly into place.

Now insert the stock latch, with its spring, and pin it in position.

The trigger housing may then be fastened in place by inserting the front end in its seat at the rear of the magazine housing. The wooden pistol grip should be in place, but not yet cemented I hope! (Cementing is done after the bluing.) The washer should also be in place, in the bottom. The three-eighths inch bolt is then inserted in the hole through the bottom and tightened, drawing the trigger housing snug against the bottom of the receiver.

Then slide the magazine, with one or more dummy rounds of ammunition enclosed, into place in the magazine housing as deep as it will go. Secure them by wrapping with tape or wire or even heavy string. Cycle the action slowly by hand. If the magazine housing has been left a little longer than the finished depth requires, the bullet nose will strike the front wall of the receiver instead of entering the chamber. This being the case, note about how much you think it lacks and carefully file a little off the bottom of the magazine housing and try it again. Keep filing and trying, a little at a time, until the butt, when allowed to move forward, strips the top cartridge from the magazine and feeds it into the chamber in the end of the barrel.

Go slow with this since it is easy to take off too much metal. If too much is taken off, the bullet nose will hit the barrel or receiver wall above the chamber and refuse to enter. When and if this happens, about the only thing you can do to salvage the job is to weld a strip of metal along the bottom of the magazine housing and start the fitting all over again.

When the magazine is fitted to where cartridges feed properly with the action worked by hand,and when the bolt snaps forward after pulling the trigger, you should pin the magazine latch in place. If you manufactured your own magazine, wait until now to cut the notch to engage the latch. With the magazine properly fitted, use some sort of spotting compound such as Prussian blue or lipstick on the face of the latch to imprint its

MADE FROM 1/8"
FLAT STOCK
SPRING
1"
DRILL #33
TAP 6 X 40
6 X 40 X 3/4"
SCREW FOR
HINGE PIN
5/8"
5/8"
5/8"
7/16"
1 5/8"
FOLD 90°
WELD TO MAGAZINE HOUSING
MAGAZINE LATCH

contact point on the back of the magazine. Then cut the notch to fit.

Dummy cartridges can be easily made by drilling a small, one-eighth inch hole through the side of the cartridge case. Shake out the powder, fill it with oil, and let it soak for a day or two, to inactivate the primer. Do not let a firing pin hit these primers even then. Keep the firing pin out of the breech block until you are ready to test-fire the gun.

If you are satisfied with the way the gun feeds by hand cycling, you are now ready to test-fire the gun. Reinstall the firing pin in the breech block and tighten the lock screw securely against it. After re-assembly, place the fire selector on semi-automatic and load a round (that's one, a single round) in the magazine. Cock the action and while holding the damn thing well away from your face and body, touch her off!

If everything works the way it should, the round will be stripped from the magazine and fired by the forward moving breech block when the trigger is depressed. After firing, the breech block should have traveled rearward far enough for the sear to catch and hold it in the rearward or cocked position.

If it did, congratulations! Now try it with two cartridges, still as a semi-automatic. We will get the full automatic functioning soon, but some of the parts should be hardened first to prevent them from being battered or worn out of shape.

If the breech block did not remain open, a little more filing will be necessary. Try working the action by hand with the trigger depressed, or held back. The sear should catch the breech block in its rearward position. If it does not, you may not have the trigger mechanism made or fitted properly. Check it carefully.

If the trigger mechanism is working properly, which is probably the case, then either the breech block is too heavy or the spring is too strong. In either case, the breech block would not be able to travel far enough to the rear for the sear to catch it. Try cutting one coil off the recoil spring and then try another test-fire, again using only one round. If the breech block does not remain open after firing, cut off another coil and try it again. Repeat a third time if necessary.

If it still doesn't work after cutting off a third coil, something else must be wrong, or else you had one hell of a stiff recoil spring to begin with. Try polishing the breech block and the inside of the receiver body to reduce friction. If it still doesn't work properly, turn the breech block to a smaller diameter (only one-sixteenth inch or so), leaving a full diameter band, approximately one-fourth inch wide at each end.

Be careful not to weaken the spring or lighten the

30
3/8"
5/8"
5/16"
FORM FROM
1/8" SHEET
Steel
.800"
1 3/4" DIA.
7/8" RADIUS
FACE OF EJECTOR EVEN
WITH REAR OF MAGAZINE
WELD OR RIVET

EJECTOR

breech block too much, or it might recoil far enough to the rear, allowing the cocking lever to hit against the end of its slot. To check against this happening, wrap a layer of tape around the receiver, covering the last one-half inch of the cocking lever slot, before trying to fire again. If the cocking lever does not tear the tape completely to the end of the slot, it should be considered satisfactory. If it does, a slightly stronger spring is needed.

When you are satisfied that you have it adjusted and working properly, try firing with two rounds in the magazine. The trigger must be released and pulled again to fire subsequent shots. Anything else is unacceptable and must be corrected.

Assuming that it does work correctly, the gun should now be disassembled and the parts heat treated as described in the next chapter. After finishing the parts, assemble the gun once again and test it thoroughly, both on semi-automatic fire and then on full automatic.

When test-firing as a full automatic, start by loading only two or three rounds in the magazine. This will prevent having a run-away gun if something should break or fail to work properly. It isn't my idea of fun to have a full automatic with a full magazine continue to fire after you release the trigger. At that point, all you can do is hold the damn thing and hope it runs dry before you hit anybody. So, test it thoroughly with only a few rounds in the magazine before stuffing it full!

Another important part that deserves special mention is the nut that you welded to the bottom of the receiver that the trigger housing retaining bolt threads into. Matching threads should continue on through the hole above the nut. The bolt should be long enough to screw in almost flush with the inside of the receiver. Do not neglect this! I once saw a submachine gun receiver and barrel unit break loose from the grip and trigger mechanism while the gun was being demonstrated. The barrel fell to the ground and continued to fire, jumping and kicking in every direction. The four spectators and demonstrator scattered to find something to hide behind. Luckily no one was injured or killed, but they very easily could have been. So, take care!

Chapter Eleven

Heat Treatment

The subject of heat treatment could fill a book in itself if explained by an expert on the subject, but since I am not an expert, it won't take many pages to put down what little I do know about the subject. Even though there is probably little point in doing so here, I will attempt first of all to give a brief description of what takes place during the heat treatment of carbon steel.

In carbon steel that has been fully annealed, we would normally find two components apart from impurities such as phosphorous, sulpher, and others. These components are a chemical compound, iron carbide, in a form metallurgically known as **cementite**, and the element iron in a form metallurgically known as **ferrite**. Cementite is made up of 6.67 percent carbon and 93.33 percent iron. A certain proportion of these two components will be present as a mechanical mixture. This mixture, the amount depending on the carbon content of the steel, consists of alternate layers or bands of ferrite and cementite. When examined under a microscope, it frequently resembles mother of pearl and, therefore, has been named **pearlite**. Pearlite contains some 0.85 percent carbon and 99.15 percent iron, not counting impurities. A fully annealed steel containing at least 0.85 percent carbon would consist entirely of pearlite. Such a steel is known as eutectoid steel.

Steel having a carbon content above 0.85 percent (called hypereutectoid steel) has a greater amount of cementite than is required to mix with the ferrite to form pearlite, so both cementite and pearlite are present in the fully annealed state.

When annealed carbon steel is heated above a lower critical point, a temperature in the range of 1335 to 1355 degrees Fahrenheit depending on the carbon content, the alternate layers or bands of ferrite and cemen-

tite which make up the pearlite will begin to flow into each other. This process continues until the pearlite is thoroughly dissolved forming what is known as **austenite.**

If the temperature of the steel continues to rise, any excess ferrite or cementite present in addition to the pearlite will begin to dissolve into the austentite until only austenite is present. The temperature at which the excess ferrite or cementite is completely dissolved in the austenite is called the **upper critical point**. This temperature has a far wider range, depending on the carbon content, than the lower critical point.

If the carbon steel, which has been heated to a point where it consists entirely of austenite, is cooled slowly, the transformation process which took place during the heating will be reversed. The upper and lower critical points will occur at somewhat lower temperatures than they did during the heating.

Assuming the steel was originally fully annealed, its structure upon returning to atmospheric temperature after slow cooling will be the same. By structure I'm referring to the proportions of ferrite or cementite and pearlite present with no austenite remaining. However, as the steel's cooling rate from an austenetic state is increased, the temperature (at which the austenite begins to change into pearlite) drops more and more below the slow cooling transformation temperature of approximately 1300 degrees Fahrenheit. As the cooling rate is increased, the laminations of the pearlite, formed by the transformation of the austenite, become finer and finer until they can no longer be detected even under a high-power microscope, while the steel itself increases in hardness and tensile strength.

As the cooling rate is further increased, this transformation suddenly drops to around 500 degrees Fahrenheit or lower, depending upon the carbon content. The cooling rate of this sudden drop in transformation temperature is referred to as the critical cooling rate. When a piece of carbon steel is cooled at this rate or faster, a new structure is formed. The austenite is transformed into **martensite** which is characterized by an angular needlelike structure and an extreme hardness.

If the steel is subjected to a severe quench or to extremely rapid cooling, a small percentage of the austenite may remain instead of being transformed into martensite. Over a period of time, this remaining austenite will be gradually transformed into martensite even if the steel is not subjected to further heating and cooling. Since martensite has a lower density than austenite, such a change or "aging," as it is called,

often results in an appreciable increase in volume and the setting up of new internal stresses in the steel.

The process of hardening steel consists fundamentally of two steps. The first step is to heat the steel to a temperature usually at least 100 degrees Fahrenheit above its transformation point so that it becomes entirely austenitic in structure. The second step is to quench the steel at a rate faster than the critical rate to produce a martensitic structure.

The critical or transformation point at which pearlite is heated into austenite is also called the decalescence point. If the temperature of the steel was observed as it passed through the decalescence point, you would notice that the steel continues to absorb heat without appreciably rising in temperature, although the immediate surroundings become hotter than the steel.

Similarly during cooling, the transformation, or critical point at which austenite is transformed back into pearlite, is called the recalescence point. When this point is reached, the steel will give off heat so that its temperature will momentarily increase instead of continuing to fall.

The recalescence point is lower than the decalescence point by anywhere from eighty to 210 degrees Fahrenheit. The lower of these points does not manifest itself unless the higher one has first been completely passed. These critical points have a direct relation to the hardening of steel. Unless a temperature sufficient to reach the decalescence point is obtained, so that the pearlite is changed into austenite, no hardening action can take place. And unless the steel is cooled suddenly before it reaches the recalescence point, thus preventing the changing back again from austenite to pearlite, no hardening can take place. The critical points vary for different kinds of steel and must be determined by testing each case. It is this variation in critical points that makes it necessary to heat different steels to different temperatures when hardening.

After the hardening process, most, if not all, steel parts will require tempering or drawing. The purpose of this is to reduce the brittleness in the hardened steel and to remove any internal strains caused by the sudden cooling in the quenching bath. The tempering process consists of heating the hardened steel to a certain temperature and then cooling. With the steel in a fully hardened state, its structure is made up mostly of martensite. However, when it is reheated to a temperature of about 300 to 750 degrees Fahrenheit, a tougher and softer structure known as troosite is formed.

If the hardened steel is instead reheated to a temperature between 750 and 1285 degrees Fahrenheit, a structure known as sorbite is formed. This has some-

what less strength than troosite, but it also has considerably greater ductibility.

Actually, all this boils down to simply this; many of the parts that you have made or will make will require hardening. In certain instances this is required only to prevent undue wear, and in others, both to increase strength and to prevent battering or other malformation.

So it will be necessary for you to heat the part to be hardened to a temperature above the upper critical stage (forming austenite), then rapidly cool it by pumping it into a quenching bath which may be oil, water, brine, etc. (forming martenite). The hardened steel is then heated once more to a temperature somewhat between 300 and 1290 degrees Fahrenheit and cooled (forming either troosite or sorbite). The exact temperature required for this tempering or drawing operation varies considerably, depending on both the carbon content of the steel and the strength and hardness requirements.

A gas or electric furnace is almost a necessity for this type of heat treatment, and if you anticipate treating many parts, I suggest that you either try to buy a commercial furnace or build one. A usable gas furnace may be built by simply lining a steel or iron shell with firebrick, and then by adding a vacuum cleaner motor for power and a fan for a blower. A pyrometer is also necessary to measure and regulate the temperature.

It is also possible to harden and temper parts by using the flame of an oxy-acetylene torch, a forge, or by hot bath. The latter method may be either a chemical solution or molten metal. This method is especially well suited to irregularly shaped parts, parts with holes, and parts varying in thickness or mass. All these parts will heat uniformly to the desired temperature in a bath.

There are times, however, when the only available method will be the torch. While this method may be far from foolproof, satisfactory results may be obtained if sufficient care is taken.

In many cases you will not know the exact composition of your steel, so a bit of experimenting with a scrap of the same material is in order before beginning. Since most of the medium and high carbon steels must be heated to between 1400 and 1650 degrees Fahrenheit for hardening, try heating the scrap to a bright, clear, glowing red, devoid of any yellowish tinge. This is the "cherry-red" so often mentioned in connection with heat treating activities. Then promptly plunge it into a quenching bath of water, at approximately seventy-five degrees Fahrenheit, or a bath consisting of SAE 10 motor oil. It should now be so hard a file won't

:ouch it. If it is not, try another scrap with a little hotter :emperature and when the proper combination is found, apply it to the part to be hardened.

Nearly all carbon steels change color in the same way and at almost the same temperatures, so the hardening and tempering colors which appear while heating will ndicate the approximate temperature of the metal. The chart at the end of the chapter gives a fairly broad color range and may be used as a guide.

There is currently a product on the market called "Temilag" that will take much of the guesswork out of :he temperature control. It is available from gunsmith supply houses, such as Brownell's. A thin coat is applied to the surface to be heat treated. Actually, only a thin smear is required. After it drys to a dull finish, begin heating the metal. When the proper temperature s reached, the Temilag will melt sharply and should be quenched immediately. Temilag is available to ndicate temperatures from 350 to 1550 degrees Fahrenheit and is the most foolproof temperature indicator have found besides the expensive pyrometers.

Regardless of the temperature indicator used, the hardened steel must be drawn or tempered after quenching. So, either wipe on a smear of Tempilag or heat the meta to the color indicating the temperature desired, then allow to cool. It would be wise to again experiment with a hardened scrap of the same material before attempting to temper the actual part, and test it again after tempering with a file and a punch.

Another method which may prove useful for drawing at temperatures up to 500 degrees Fahrenheit is the use of the kitchen oven. Simply place the parts in the oven and set to the desired temperature and let it heat for thirty minutes to an hour.

Still another method which works well on firing pins, sears, pins, and other small parts, is the use of a hardening compound such as "Kasenit." By heating the part to be hardened to a cherry red, coating with the hardering compound, and then reheating to the same cherry red and quenching in water, a hard surface will result with a softer inner core. This is similar to the case-hardening process, which I will not attempt to explain here, since the Kasenit process will give similar results with less equipment.

It might be helpful to include a brief breakdown of the SAE numbers used in drawings and specifications to indicate a certain kind of steel. We read about 2340, 4320, 1035, etc., and to the average man these numbers mean little or nothing. The first figure indicates the class to which the steel belongs. Thus, "1" indicates a carbon steel; "2"—nickel steel; "3"—nickel-chromium

steel; "4"—molybdenum steel; "5"—chromium steel; "6"—chrome-vanadium steel, etc.

In the case of the alloy steels, the second figure generally indicates the approximate percentage of the predominant alloying element. Usually, the last two or three figures indicate the average carbon content in hundredths of one percent or "points." Thus, 2340 means a nickel steel of approximately three percent nickel and 0.40 (forty-hundredths) percent carbon.

The following color chart may come in handy when tempering by the color method. Brightly polish the part to be tempered so that the color will show and place it on a red hot steel plate until it reaches the desired color, then remove and cool the part.

It should be remembered that the methods and descriptions in this chapter apply to carbon steel only. Certain alloy steels may require entirely different methods of heat-treatment.

Hardening and Tempering Colors	Degrees Fahrenheit	Tempilag Available
Pale Yellow	425	400-413-425
Pale Straw	450	438-450
Pale Straw	455	463
Yellowish Brown	500	475-488-500
Light Purple	525	525
Purple	530	
Blue	550	550
Dark Blue	600	575-600
Bluish Green	625	650
Barely visible Red	900	
Blood Red	1200	
Cherry Red	1400	1350-1400-1425
Light Red	1500	1480-1500
Orange	1650	
Yellow	1800	
Light Yellow	2000	
White	2200	

Chapter Twelve

Finishing and Bluing

It seems that every six months one of the national gun magazines publishes an article revealing the "secrets" behind obtaining the blue or black color on finished firearms. Unfortunately, most of these articles and many of the gunsmithing books themselves are lacking in their explanations of how a good blue—black finish is obtained. In this respect, they are actually perpetuating the "mystery" instead of ending it.

Probably one of the most misunderstood notions is the most basic, what to look for in a good bluing job. A shiny coloring on the metal does not necessarily indicate a job well done. A good blue job will have an even color, all tool and abrasive marks polished out, and all corners and sharp edges still cornered and sharp. Flat surfaces should be flat, without low places. When the finished job is held at arm's length and sighted, true straight lines, without ripples or waves, should be apparent. Above all, screw and pin holes must **not** be dished or rounded.

It is indeed desirable to have power polishing equipment—but only as a timesaving measure. Power polishing will result in top quality, but only after extensive practice. By using your set of files, strips or sheets of abrasive cloth in progressively finer grits, and a couple sheets of crocus cloth for the final finish, a finish equal to, or better than, that obtained by power polishing equipment may be obtained.

Files are used to smooth the component parts, clearing up toolmarks, dents, etc. The correct grit cloth is then applied, using stips of the cloth around the curved surfaces of barrel and receiver alike. Any dents or low places will be revealed through this process.

After this cross polishing, the parts should be flat-polished by wrapping strips of cloth around files or

blocks and by moving them lengthwise along the metal, parallel to the bore. Then turn the covered files to polish the curves. Lateral depressions and circular machine marks will show up when this is done.

Continue this process, crosswise followed by lengthwise polishing, until all pits, dents, depressions, and toolmarks are removed. Finally, after carefully polishing with the finest grit cloth available, polish all surfaces with the crocus cloth. Rub the cloth in both directions but finish with lengthwise strokes, as you did with all the filing mentioned above.

Power polishing is done in the same manner. Begin by aplying a coarse grit abrasive compound to either felt or cloth wheels and follow it with progressively finer grits. Felt wheels should be used when polishing over screw or pin holes and on flat surfaces, especially where straight lines must be maintained. When polishing with the power wheels, crosswise polishing must be avoided wherever possible. The parts should be held at an angle to the wheel and polished lengthwise wherever possible.

When the metal is polished to your satisfaction, examine it in the sunlight to make sure no scratches or polishing marks remain. Following this final check, the individual parts must be degreased. While at least fifty percent of getting a good blue job depends on polishing, another twenty-five percent will depend on its being absolutely free of any trace of oil or grease.

There are several types of grease-cutting compounds or detergents on the market today, available in grocery, paint and hardware stores. Mix these compounds with water and boil the parts in the solution for a few minutes. After rinsing the parts in clear water they will be ready for the bluing process. With all the parts degreased and clean, they should no longer be handled with bare hands but with metal hooks or tied on wires because the oil in the skin of your hands may contaminate them.

Most of the present day bluing jobs (or blacking jobs, as some insist on calling them), are done with the hot bath chemical solution. With this process, the parts are polished, cleaned, rinsed, and immersed in a solution which is heated to a temperature of 290 to 350 degrees Fahrenheit, depending on the mixture used. After the color develops, the work is rinsed and oiled. Since this system involves less time than most other methods, we will look at it first.

A minimum of two tanks will be needed for this system, but five or six are desirable. These tanks must be long enough to hold the longest barrel and receiver that you expect to process and should be at least six inches wide and six inches deep. The tanks must not be gal-

My own bluing tank set-up From left: cold water rinse tank, bluing tank (with thermometer); degreasing tank, and hot water rinse tank. Not shown is oil tank which sets along the wall behind these tanks.

vanized, but made from stainless or black iron sheets, preferably eighteen gauge or thicker. The seams should be welded, not brazed or soldered, since the solution will eat through any lead solder or aluminum if it is in direct contact for more than a very short time. Brass and copper should also be avoided since their presence will prevent the solution from working.

Burners must be made or bought to heat at least two (preferably three) of the tanks. Do not try to get by with only one burner, switching tanks over it. I tried this once and spent a week in the hospital wondering whether or not I would be able to see again out of my left eye. The flimsy wire handle on one end of my bluing tank broke while I was attempting to switch the tanks and the solution splashed to my face and eye when the end of the tank hit the floor. The doctor and hospital bills amounted to much much more than the cost of the couple more burners. Obviously, I picked a poor way to save money.

Burners may be made from one inch pipe long enough to heat the entire length of the tank. Drill two rows of one-eighth inch holes, one half inch apart, with approximately three-fourth inch between the rows for the individual gas flames. Cap one end of the pipe and attach a mixing valve to the open end. Mixing valves are sometimes available as salvage from old gas stoves or heaters.

I am assuming that you have either natural or bottled gas at your disposal. If this is not the case, another source of heat such as oil, electricity, or even wood fire will have to be considered.

A three to four foot high angle iron rack should be made to support the tanks. A crosspiece should then be fastened across the rack about three inches below the tanks, to support the burners. An ordinary deep fat thermometer may be used to check the temperature of the solution; however, a thermometer purchased from one of the gunsmith supply houses will last considerably longer.

By the way, all this needed equipment may be purchased from gunsmith houses. In fact, Brownell's of Montezuma, Iowa can furnish everything you'll need, including polishing compounds, wheels, abrasive cloth, tanks, burners, bluing salts, and degreasing solutions, as well as just about anything else you might have a use for.

There are several different formulae for mixing bluing solutions. One of the most foolproof formulae and the one that I myself have used for years is as follows: five pounds lye mixed with two and one-half pounds ammonium nitrate per gallon of water. The ammonium

Left: Bluing tank burners made from pipe with mixing valves salvaged from gas stoves, hot water heater, etc. If you look close you can see the two rows of holes in each pipe.

Above: Buffing & polishing wheels may be mounted on arbor attached to motor. Shown here is 8" wheel on one horse power motor.

This buffing wheel is 12" diameter with three horse power motor. Use the biggest motors you can get for this purpose.

nitrate is available from feed and seed stores where it is sold as fertilizer. Lye may be obtained at the grocery store or sometimes from radiator repair shops where it is used in the cleaning of radiators.

The solution should be mixed either out of doors or in a well-ventilated room, since a considerable amount of ammonia gas is generated while mixing. After mixing, a couple ounces of tri-sodium phosphate may be added to the solution. This is often used to accelerate the bluing process.

The solution should be allowed to boil after the initial mixing for at least thirty minutes before using. The temperature should then be adjusted to between 290 and 295 degrees by adding a small amount of water if it gets too hot or by allowing some to boil away if it isn't hot enough. The parts to be blued may then be placed in the tank. It is a good idea to suspend them in the solution on wires or metal rods so that none come in contact with the bottom of the tank.

After twenty or thirty minutes at the proper temperature, remove the parts from the tank and rinse them in cold water. If the color is satisfactory, boil the parts either in clean hot water or water treated with a very small amount (two or three ounces per five gallons water) of chromic acid. This is done in an attempt to remove all traces of the bluing salts. If any salts remain in crevices or cracks, they will eventually "bloom" out when the weather gets damp and form a white powdery scale.

The parts are then dried and oiled, after which they should be hung up and left alone for at least 24 hours before handling and assembling. This is because the blued surfaces tend to get harder and tougher after about a day and will resist scratching or blemishing far better than when they first come out of the tank.

It will be necessary to add a couple cans of lye occasionally, and I believe it is a good idea to add between a half-gallon to a gallon of water after shutting off the fire under the tank each time.

Certain parts turn red, bronze, or chocolate brown. Usually, these parts will take on the same blue-black color as the rest of the gun by repolishing them until bright and again placing them in the bluing tank before it reaches operating temperature. Leave the parts in the solution until enough water boils away for the temperature to rise to 305-310 degrees Fahrenheit.

The color produced by the ammonium nitrate-lye process is almost jet black with a glass or sheen directly proportional to the amount of polishing done. If a bluer color is desired, sodium nitrate may be used instead of the ammonium nitrate. However, this solution is much more critical than the first one and will not wear nearly

as well; so I suggest that you stick to the ammonium nitrate-lye solution.

It might be well to mention the fact that these solutions will simply eat up aluminum alloys as well as lead and soft solders. Therefore, any part containing any of the above must be kept out of the tank, or it's likely you won't see it again.

At all costs, protect your eyes and bare skin from these hot solutions. Water should be added slowly with a long-handled dipper so that you are out of reach of any drops which spatter or pop out. Better still, place a funnel in the end of a five foot section of pipe and pour the water slowly through it. Remember, these chemicals are dangerous when handled carelessly.

Tap Drill Sizes

American National Form

Tap Size	Threads per inch	Diam. Hole	Drill
1/16	72	.049	3/64
**1/16	64	.047	3/64
1/16	60	.046	56
5/64	72	.065	52
5/64	64	.063	1/16
**5/64	60	.062	1/16
5/64	56	.061	53
3/32	60	.077	5/64
3/32	56	.076	48
**3/32	50	.074	49
3/32	48	.073	49
7/64	56	.092	42
7/64	50	.090	43
**7/64	48	.089	43
1/8	48	.105	36
**1/8	40	.101	38
1/8	36	.098	40
1/8	32	.095	3/32
**9/64	40	.116	32
9/64	36	.114	33
9/64	32	.110	35

U.S. and S.A.E. Standard

Tap Size	Threads per inch	Diam. Hole	Drill
1/4	32	.220	7/32
1/4	*28	.215	3
1/4	27	.214	3
1/4	24	.209	4
**1/4	20	.201	7
5/16	32	.282	9/32
5/16	27	.276	J
5/16	*24	.272	I
5/16	20	.264	17/64
**5/16	18	.258	F
3/8	27	.339	R
3/8	*24	.334	Q
3/8	20	.326	21/64
**3/8	16	.314	5/16
7/16	27	.401	Y
7/16	24	.397	X
7/16	*20	.389	25/64
**7/16	14	.368	U
1/2	27	.464	15/32
1/2	24	.460	29/64
1/2	*20	.451	29/64

Tap Size	Threads per inch	Diam. Hole	Drill	Tap Size	Threads per inch	Diam. Hole	Drill
5/32	40	.132	30	**1/2	13	.425	27/64
**5/32	36	.129	30	1/2	12	.419	27/64
5/32	32	.126	1/8	9/16	27	.526	17/32
11/64	36	.145	27	9/16	*18	.508	33/64
**11/64	32	.141	9/64	**9/16	12	.481	31/64
3/16	36	.161	20	5/8	27	.589	19/32
3/16	32	.157	22	5/8	*18	.571	37/64
3/16	30	.155	23	5/8	12	.544	35/64
**3/16	24	.147	26	**5/8	11	.536	17/32
13/64	32	.173	17	11/16	*16	.627	5/8
13/64	30	.171	11/64	**11/16	11	.599	19/32
**13/64	24	.163	20	3/4	27	.714	23/32
7/32	32	.188	12	3/4	*16	.689	11/16
7/32	28	.184	13	3/4	12	.669	43/64
**7/32	24	.178	16	**3/4	10	.653	21/32
15/64	32	.204	6	13/16	12	.731	47/64
15/64	28	.200	8	**13/16	10	.718	23/32
**15/32	24	.194	10	7/8	27	.839	27/32
				7/8	*18	.821	53/64
7/8	*14	.805	13/16	7/8	12	.794	51/64
**7/8	9	.767	49/64	15/16	12	.856	55/64
**15/16	9	.829	53/64	1	27	.964	31/32
1	*14	.930	15/16	1	12	.919	59/64

Tap Size	Threads per inch	Diam. Hole	Drill	Tap Size	Threads per inch	Diam. Hole	Drill
**1	8	.878	7/8	1 1/16	8	.941	15/16
1 1/8	*12	1.044	1 3/64	**1 1/8	7	.986	63/64
1 3/16	7	1.048	1 3/64	1 1/4	*12	1.169	1 11/64
**1 1/4	7	1.111	1 7/64	1 5/16	7	1.173	1 11/64
1 3/8	*12	1.294	1 19/64	**1 3/8	6	1.213	1 7/32
1 1/2	*12	1.419	1 27/64	**1 1/2	6	1.338	1 11/32
**1 5/8	5 1/2	1.448	1 29/64	**1 3/4	5	1.555	1 9/16
**1 7/8	5	1.680	1 11/16	**2	4 1/2	1.783	1 25/32
**2 1/8	4 1/2	1.909	1 29/32	**2 1/4	4 1/2	2.034	2 1/32
**2 3/8	4	2.131	2 1/8	**2 1/2	4	2.256	2 1/4
**2 5/8	4	2.361	2 3/8	**2 3/4	4	2.506	2 1/2
**2 7/8	3 1/2	2.598	2 19/32	**3	3 1/2	2.722	2 23/32
**3 1/8	3 1/2	2.847	2 27/32	**3 1/4	3 1/2	2.972	2 31/32
**3 3/8	3 1/4	3.075	3 1/16	**3 1/2	3 1/4	3.200	3 3/16
**3 5/8	3 1/4	3.325	3 5/16	**3 3/4	3	3.425	3 7/16
**3 7/8	3	3.550	3 9/16	**4	3	3.675	3 11/16

* S.A.E. Standard
** U.S. Standard

Manufacturers' Standard Gage for Sheet Steel

Standard Gage No.	Ounces per Sq. Ft.	Pounds per Sq. Ft.	Equivalent Thickness Inch	Standard Gage No.	Ounces per Sq. Ft.	Lbs. per Sq. Ft.	Equivalent Thickness Inch
3	160	10.0000	0.2391	21	22	1.3750	.0329
4	150	9.3750	.2242	22	20	1.2500	.0299
5	140	8.7500	.2092	23	18	1.1250	.0269
6	130	8.1250	.1943	24	16	1.0000	.0239
7	120	7.5000	.1793	25	14	0.87500	.0209
8	110	6.8750	.1644	26	12	.75000	.0179
9	100	6.2500	.1495	27	11	.68750	.0164
10	90	5.6250	.1345	28	10	.62500	.0149
11	80	5.000	.1196	29	9	.56250	.0135
12	70	4.3750	.1046	30	8	.50000	.0120
13	60	3.7500	.0897	31	7	.43750	.0105
14	50	3.1250	.0747	32	6.5	.40625	.0097
15	45	2.8125	.0673	33	6	.37500	.0090
16	40	2.5000	.0598	34	5.5	.34375	.0082
17	36	2.2500	.0538	35	5	.31250	.0075
18	32	2.0000	.0478	36	4.5	.28125	.0067
19	28	1.7500	.0418	37	4.25	.26562	.0064
20	24	1.5000	.0359	38	4	.25000	.0600

Chemical Compositions of SAE Standard Steels

SAE Number	AISI Number	Carbon C	Manganese MN	Phos-phorus P (Max)	Sulphur S (Max)
1006	C1006	0.08 max.	0.25-0.40	0.040	0.050
1008	C1008	0.10 max.	0.25-0.50	0.040	0.050
1010	C1010	0.08-0.13	0.30-0.60	0.040	0.050
1015	C1015	0.13-0.18	0.30-0.60	0.040	0.050
1016	C1016	0.13-0.18	0.60-0.90	0.040	0.050
1017	C1017	0.15-0.20	0.30-0.60	0.040	0.050
1018	C1018	0.15-0.20	0.60-0.90	0.040	0.050
1019	C1019	0.15-0.20	0.70-1.00	0.040	0.050
1020	C1020	0.18-0.23	0.30-0.60	0.040	0.050
1021	C1021	0.18-0.23	0.60-0.90	0.040	0.050
1022	C1022	0.18-0.23	0.70-1.00	0.040	0.050
1024	C1024	0.19-0.25	1.35-1.65	0.040	0.050
1025	C1025	0.22-0.28	0.30-0.60	0.040	0.050
1026	C1026	0.22-0.28	0.60-0.90	0.040	0.050
1027	C1027	0.22-0.29	1.20-1.50	0.040	0.050
1030	C1030	0.28-0.34	0.60-0.90	0.040	0.050
1033	C1033	0.30-0.36	0.70-1.00	0.040	0.050
1034	C1034	0.32-0.38	0.50-0.80	0.040	0.050
1035	C1035	0.32-0.38	0.60-0.90	0.040	0.050
1036	C1036	0.30-0.37	1.20-1.50	0.040	0.050
1038	C1038	0.35-0.42	0.60-0.90	0.040	0.050
1039	C1039	0.37-0.44	0.70-1.00	0.040	0.050

SAE Number	AISI Number	Carbon C	Manganese MN	Phos-phorus P (Max)	Sulpher S (Max)
1040	C1040	0.37-0.44	0.60-0.90	0.040	0.050
1041	C1041	0.36-0.44	1.35-1.65	0.040	0.050
1042	C1042	0.40-0.47	0.60-0.90	0.040	0.050
1043	C1043	0.40-0.47	0.70-1.00	0.040	0.050
1045	C1045	0.43-0.50	0.60-0.90	0.040	0.050
1046	C1046	0.43-0.50	0.70-1.00	0.040	0.050
1049	C1049	0.46-0.53	0.60-0.90	0.040	0.050
1050	C1050	0.48-0.55	0.60-0.90	0.040	0.050
1052	C1052	0.47-0.55	1.20-1.50	0.040	0.050
1055	C1055	0.50-0.60	0.60-0.90	0.040	0.050
1060	C1060	0.55-0.65	0.60-0.90	0.040	0.050
1062	C1062	0.54-0.65	0.85-1.15	0.040	0.050
1064	C1064	0.60-0.70	0.50-0.80	0.040	0.050
1065	C1065	0.60-0.70	0.60-0.90	0.040	0.050
1066	C1066	0.60-0.71	0.85-1.15	0.040	0.050
1070	C1070	0.65-0.75	0.60-0.90	0.040	0.050
1074	C1074	0.70-0.80	0.50-0.80	0.040	0.050
1078	C1078	0.72-0.85	0.30-0.60	0.040	0.050
1080	C1080	0.75-0.88	0.60-0.90	0.040	0.050
1085	C1085	0.80-0.93	0.70-1.00	0.040	0.050
1086	C1086	0.82-0.95	0.30-0.50	0.040	0.050
1090	C1090	0.85-0.98	0.60-0.90	0.040	0.050
1095	C1095	0.90-1.03	0.30-0.50	0.040	0.050

Free-Cutting Steels

S.A.E. Number	A.I.S.I. Number	Carbon (C)	Manganese (Mn)	Phosphorus (Max.)	Sulphur (Max.)
*1111	B1111	0.13 max.	0.60-0.90	0.07-0.12	0.080-0.15
*1112	B1112	0.13 max.	0.70-1.00	0.70-0.12	0.16-0.23
*1113	B1113	0.13 max.	0.70-1.00	0.07-0.12	0.24-0.33
1109	C1109	0.08-0.13	0.060-0.090	0.040	0.08-0.13
1114	C1114	0.10-0.16	1.00-1.30	0.040	0.08-0.13
1115	C1115	0.13-0.18	0.60-0.90	0.040	0.08-0.13
1116	C1116	0.14-0.20	1.10-1.40	0.040	0.16-0.23
1117	C1117	0.14-0.20	1.00-1.30	0.040	0.08-0.13
1118	C1118	0.14-0.20	1.30-1.60	0.040	0.08-0.13
1119	C1119	0.14-0.20	1.00-1.30	0.040	0.24-0.33
1120	C1120	0.18-0.23	0.70-1.00	0.040	0.08-0.13
1126	C1126	0.23-0.29	0.070-1.00	0.040	0.08-0.13
1132	C1132	0.27-0.34	1.35-1.65	0.040	0.08-0.13
1137	C1137	0.32-0.39	1.35-1.65	0.040	0.08-0.13
1138	C1138	0.34-0.40	0.70-1.00	0.040	0.08-0.13
1140	C1140	0.37-0.44	0.70-1.00	0.040	0.08-0.13
1141	C1141	0.37-0.45	1.35-1.65	0.040	0.08-0.13
1144	C1144	0.40-0.48	1.35-1.65	0.040	0.24-0.33
1145	C1145	0.42-0.49	0.70-1.00	0.040	0.04-0.07
1146	C1146	0.42-0.49	0.70-1.00	0.040	0.08-0.13
1151	C1151	0.48-0.55	0.70-1.00	0.040	0.08-0.13

Because of the nature of the process, acid bessemer steels are not furnished with specified silicon content.

SAE Number	AISI Number*	Carbon C	Manganese Mn	Nickel Ni	Chromium Cr	Phos. P (Max.)	Sulphur S (Max.)
			Manganese Steels				
1320	1320	0.18-0.23	1.60-1.90	.....	.....	0.040	0.040
1330	1330	0.28-0.33	1.60-1.90	.....	.....	0.40	0.40
1335	1225	0.33-0.38	1.60-1.90	.....	.....	0.40	0.40
1340	1340	0.38-0.43	1.60-1.90	.....	.....	0.40	0.40
			Nickel Steels				
2317	2317	0.15-0.20	0.40-0.60	3.25-3.75	.....	0.040	0.040
2330	2330	0.28-0.33	0.60-0.80	3.25-3.75	.....	0.040	0.040
2340	2340	0.38-0.43	0.70-0.90	3.25-3.75	.....	0.040	0.040
2345	2345	0.43-0.48	0.70-0.90	3.25-3.75		0.040	0.040
2512	E2512	0.09-0.14	0.45-0.60	4.75-5.25	.....	0.025	0.025
2515	2515	0.12-0.17	0.40-0.60	4.75-5.25	.....	0.40	0.40
2517	E2517	0.15-0.20	0.45-0.60	4.75-5.25	.....	0.025	0.025

Nickel-Chromium Steels

3115	3115	0.13-0.18	0.40-0.60	1.10-1.40	0.55-0.75	0.040	0.040
3120	3120	0.17-0.22	0.60-0.80	1.10-1.40	0.55-0.75	0.040	0.040
3130	3130	0.28-0.33	0.60-0.80	1.10-1.40	0.55-0.75	0.040	0.040
3135	3135	0.33-0.38	0.60-0.80	1.10-1.40	0.55-0.75	0.040	0.040
3140	3140	0.38-0.43	0.70-0.90	1.10-1.40	0.55-0.75	0.040	0.040
3141	3141	0.38-0.43	0.70-0.90	1.10-1.40	0.70-0.90	0.040	0.040
3145	3145	0.43-0.48	0.70-0.90	1.10-1.40	0.70-0.90	0.040	0.040
3150	3150	0.48-0.53	0.70-0.90	1.10-1.40	0.70-0.90	0.040	0.040
3310	E3310	0.08-0.13	0.45-0.60	3.25-3.75	1.40-1.75	0.025	0.025
3316	E3316	0.14-0.19	0.45-0.60	3.25-3.75	1.40-1.75	0.025	0.025

* American and Steel Institute

Molybdenum Steels

SAE No.	AISI No.	Carbon C	Manganese Mn	Nickel Ni	Chromium Cr	Moly. Mo
4017	4017	0.15-0.20	0.70-0.90	.....	.....	0.20-0.30
4023	4023	0.20-0.25	0.70-0.90	.....	.....	0.20-0.30
4024	4024	0.20-0.25	0.70-0.90	.....	.....	0.20-0.30
4027	4027	0.25-0.30	0.70-0.90	.....	.....	0.20-0.30
4028	4023	0.25-0.30	0.70-0.90	.....	.....	0.20-0.30
4032	4032	0.30-0.35	0.70-0.90	.....	.....	0.20-0.30
4037	4037	0.35-0.40	0.70-0.90	.....	.....	0.20-0.30
4042	4042	0.40-0.45	0.70-0.90	.....	.....	0.20-0.30
4047	4047	0.45-0.50	0.70-0.90	.....	.....	0.20-0.30
4053	4053	0.50-0.56	0.75-1.00	.....	.....	0.20-0.30
4063	4063	0.60-0.67	0.75-1.00	.....	.....	0.20-0.30
4068	4068	0.63-0.70	0.75-1.00	.....	.....	0.20-0.30
4119	.....	0.17-022	0.70-0.90	.....	0.40-0.60	0.20-0.30
4125	.....	0.23-0.28	0.70-0.90	.....	0.40-0.60	0.20-0.30
4130	4130	0.28-0.33	0.40-0.60	.....	0.80-1.10	0.15-0.25
4137	4137	0.35-0.40	0.70-0.90	.....	0.80-1.10	0.15-0.25
4140	4140	0.38-0.43	0.75-1.00	.....	0.80-1.10	0.15-0.25
4145	4145	0.43-0.48	0.75-1.00	.....	0.80-1.10	0.15-0.25
4150	4150	0.48-0.53	0.75-1.00	.....	0.80-1.10	0.15-0.25
4317	4317	0.15-0.20	0.45-0.65	1.65-2.00	0.40-0.60	0.20-0.30

SAE No	A SI No.	Carbon C	Manganese Mn	Nickel Ni	Chromium Cr	Moly. Mo
4320	4320	0.17-0.22	0.45-0.65	1.65-2.00	0.40-0.60	0.20-0.30
4340	4340	0.38-0.43	0.60-0.80	1.65-2.00	0.70-0.90	0.20-0.30
4608	4608	0.06-0.11	0.25-0.45	1.40-1.75	.....	0.15-0.25
4615	4615	0.13-0.18	1.45-0.65	1.65-2.00	.....	0.20-0.30
4617	....	0.15-0.20	0.45-0.65	1.65-2.00	.....	0.20-0.30
4620	4620	0.17-0.22	0.45-0.65	1.65-2.00	.....	0.20-0.30
X4620	....	0.18-0.23	0.50-0.70	1.65-2.00	.....	0.20-0.30
4621	4621	0.18-0.23	0.70-0.90	1.65-2.00	.....	0.20-0.30
4640	4640	0.38-0.43	0.60-0.80	1.65-2.00	.....	0.20-0.30
4812	4812	0.10-0.15	0.40-0.60	3.25-3.75	.....	0.20-0.30
4815	4815	0.13-0.18	0.40-0.60	3.25-3.75	.....	0.20-0.30
4817	4817	0.15-0.20	0.40-0.60	3.25-3.75	.....	0.20-0.30
4820	4820	0.18-0.23	0.50-0.70	3.25-3.75	.....	020-030

General Applications of SAE Steels

Application	SAE No.
Adapters	1145
Agricultural steel	1070
" "	1080
Aircraft forgings	4140
Axles, front or rear	1040
" " " "	4140
Axle shafts	1045
" "	2340
" "	2345
" "	3135
" "	3140
" "	3141
" "	4063
" "	4340
Ball-bearing races	52100
Balls for ball bearings	52100
Body stock for cars	rimmed*
Bolts, anchor	1040
Bolts and screws	1035
Bolts, cold-headed	4042
Bolts, connecting rod	3130
Bolts, heat-treated	2330
Bolts, heavy-duty	4815
" " "	4820
Bolts, steering-arm	3130
Chain pins, transmission	4320
" " "	4815
" " "	4820
Chains, transmissions	3135
" "	3140
Clutch disks	1060
" "	1070
" "	1085
Clutch Springs	1060
Coil springs	4063
Cold-headed bolts	4042
Cold-headed steel	30905
Cold-heading wire or rod	rimmed*
" " " "	1035
Cold-rolled steel	1070
Connecting rods	1040
" "	3141
Connecting-rod bolts	3130
Corrosion resisting	51710
" "	30805

Application	SAE No.
Covers, transmission	rimmed*
Crankshafts	1045
"	1145
"	3135
"	3140
Brake levers	1030
" "	1040
Bumper bars	1085
Cams, free-wheeling	4615
" " " "	4620
Camshafts	1020
"	1040
Carburized parts	1020
" "	1022
" "	1024
" "	1320
" "	2317
" "	2515
" "	3310
" "	3115
" "	3120
" "	4023
" "	4032
" "	1117
" "	1118

Application	SAE No.
Forgings, heat-treated	6150
Forgings, high-duty	6150
Forgings, small or medium	1035
Forgings, large	1036
Free-cutting carbon steel	1111
" " " "	1113
Free-cutting chro.-ni. steel	30615
Free-cutting mang. steel	1132
Crankshafts	3141
Crankshafts, Diesel engine	4340
Cushion springs	1060
Cutlery, stainless	51335
Cylinder studs	3130
Deep-drawing steel	rimmed*
" " "	30905
Differential gears	4023
Disks, clutch	1070
" "	1060
Ductile steel	30905
Fan blades	1020
Fatigue resisting	4330
" "	4640
Fender stock for cars	rimmed*
Forgings, aircraft	4140

Application	SAE No.
Forgings, carbon-steel	1040
" " "	1045
Forgings, heat-treated	3240
" " "	5140
Key Stock	1030
" "	2330
" "	3130
Leaf springs	1085
" "	9260
Levers, brake	1030
" "	1040
Levers, gear shift	1030
Free-cutting mang. steel	1137
Gears, carburized	1320
" "	2317
" "	3115
" "	3120
" "	3310
" "	4119
" "	4125
" "	4320
" "	4615
" "	4620
" "	4815
" "	4820

Application	SAE No.
Gears, heat-treated	2345
Gears, car and truck	4027
" " " "	4032
Gears, cyanide-hardening	5140
Gears, differential	4023
Gears, high-duty	4640
" " "	6150
Gears, oil-hardening	3145
" " "	3150
" " "	4340
" " "	5150
Gears, ring	1045
" "	3115
" "	3120
" "	4119
Levers, heat-treated	2330
Lock-washers	1060
Mower Knives	1085
Mower scetions	1070
Music wires	1085
Nuts	3130
Nuts, heat-treated	2330
Oil-pans, automobile	rimmed*

Application	SAE No.
Pinions, carburized	3115
" "	3120
" "	4320
Piston-pins	3115
" "	3120
Plow Beams	1070
Plow disks	1080
Plow shares	1080
Propeller shafts	2340
" "	2345
" "	4140
Races, ball-bearing	52100
Ring gears	3115
" "	3120
" "	4119
Rings, snap	1060
Rivets	rimmed*
Rod and wire	killed*
Rod, cold-heading	1035
Roller bearings	4815
Gears, transmission	3115
" "	3120
" "	4119
Gears, truck and bus	3310
" " " "	4320

Application	SAE No.
Gear shift levers	1030
Harrow disks	1080
" "	1095
Hay-rake teeth	1095
Shafts, cyanide-hardening	5140
Shafts, heavy-duty	4340
" " "	6150
" " "	4615
" " "	4620
Shafts, oil-hardening	5150
Shafts, propeller	2340
" "	2345
" "	4140
Shafts, transmission	4140
Sheets and strips	rimmed*
Snap rings	1060
Spline shafts	1045
" "	1320
" "	2340
" "	2345
" "	3115
Rollers for bearings	52100
Screws and bolts	1035

Application	SAE No.
Screw stock, Bessemer	1111
" " "	1112
" " "	1113
Screw stock, open hearth	1115
Screws, heat-treated	2330
Seat springs	1095
Shafts, axle	1045
Steel, cold-heading	30905
Steel, free-cutting carbon	11111
" " " "	1113
Steel, free-cutting chro.-ni.	30615
Steel, free-cutting mang.	1132
" " " "	0000
Steel, minimum distortion	4615
" " "	4620
" " "	4640
Steel, soft ductile	30905
Steering arms	4042
Steering-arm bolts	3130
Steering knuckles	3141
Steering-knuckle pins	4815
" " "	4820
Studs	1040
"	1111

Application	SAE No
Spline shafts	3120
" "	3135
" "	3140
" "	4023
Spring clips	1060
Springs, coil	1095
" "	4063
" "	6150
Springs, clutch	1060
Springs, cushion	1060
Springs, leaf	1085
" "	1095
" "	4063
" "	4068
" "	9260
" "	6150
Springs, hard-drawn coiled	1066
Springs, oil-hardening	5150
Springs, oil-tempered wire	1066
Springs, seat	1095
Springs, valve	1060
Spring wire	1045
Spring wire, hard-drawn	1055
Spring wire, oil-tempered	1055

Application	SAE No.
Stainless irons	51210
" "	51710
Steel, cold-rolled	1070
Studs, cold-headed	4042
Studs, cylinder	3130
Studs, heat-treated	2330
Studs, heavy-duty	4815
" " "	4820
Tacks	rimmed*
Thrust washers	1060
Thrust washers, oil-hardened	5150
Transmission shafts	4140
Tubing	1040
Tubing, front axle	4140
Tubing, seamless	1030
Tubing, welded	1020
Universal joints	1145
Valve springs	1060
Washers, lock	1060
Welded structures	30705
Wire and rod	killed*
Wire, cold-heading	rimmed*
" " "	1035
Wire, hard-drawn spring	1045
" " " "	1055
Wire, music	1085
Wire, oil-tempered spring	1055
Wrist-pins, automobile	1020
Yokes	1145

* The rimmed and killed steels listed are in the SAE 1008, 1010, and 1015 group.

WARNING

It is against the law to manufacture a firearm without an appropriate license from the federal government.

It is also illegal to own or possess a full automatic weapon except those that are registered with the Alcohol, Tobacco, and Firearms Division of the United States Treasury Department and until a tax is paid on the weapon.

There are also state and local laws limiting or prohibiting the possession of these weapons in many areas.

Severe penalties are prescribed for violations of these laws.

Be warned!

SBN 0-87364-085-3

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A PALADIN PRESS BOOK
ISBN 0-87364-085-3

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