

BUILDING FIREARMS



BUILDING FIREARMS

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We have many good books on Gunsmithing, Knife making, History, Out of date, and Crafts books. The purpose is to give you the basic information on subject that is covered here. I hope you enjoy and learn from these books. H. Hoffman

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Zaibatsu Release

I am the alpha, the omega,
the beginning and the end

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INTRODUCTION

This book will give you the general idea and information on building the simple guns that are listed below. With the blueprints you will be able to turn out a working model. The frames for the guns can be machined from steel or cast from aluminum or brass. I have listed several methods in the following chapters.

You will need most if not all of the equipment listed in Equipment and Tools listed below. Building firearms is not difficult, but if you plan to make more than one I would suggest making a completed frame as a pattern and casting the frame. The frames can be made from Aluminum or Brass for 22's or any low-pressure cartridges.

Above all, be careful when making and test firing any weapon. I cannot accept responsibility for accidents caused by a person not being careful when shooting or test firing any weapon.

Rifled barrels can be gotten from old 22 barrels and turned to the correct size. Therefore, I will not go into the making of barrels here.

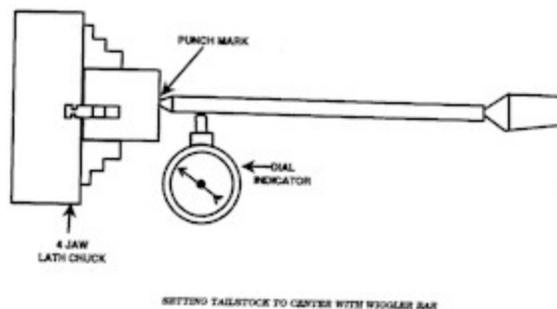
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TURNING STEEL

Turningstock usually makes up most lathe work. The work usually is held between centers or in a chuck, and a right-hand turning tool is used, so that the cutting forces, resulting from feeding the tool from right to left, tend to force the work piece against the head stock and thus provide better work support.

TEST BAR OR WIGGLER BAR

Before you start the turning operation, set the tail stock back to 000 using a 18-inch bar that is turned to exactly the same diameter on each end. To make this bar, get a 1-inch bar 18 inches long, center it and set it up between centers.



Make a light pass and check both ends to see if they measure the same. If not, adjust the tail stock and make another pass. Repeat the above operations until the bar measures the same on both ends.

This bar, you save, as you will be using it again each time you true up the tail stock. Once you have the bar completed, all that is necessary is to put it between centers. Clamp a dial indicator to the carriage on the lathe.

With the plunger of the indicator on the bar, start from the head stock end (without the lathe being turned on) and move the carriage to the tail stock end. If there is any difference in size, adjust the tail stock and repeat until the dial indicator reads the same on each end.

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THREAD CUTTING IN A LATHE

Set the lathe for a 14 TPI feed, put it in back gear drive and you are ready to cut the threads. The tool is set so its centerline is at a right angle to the axis of the work piece. This setting can be obtained by the use of the center gage as shown.

When the tool point fits uniformly into the v notch of the gage, the tool is at a 90° angle.

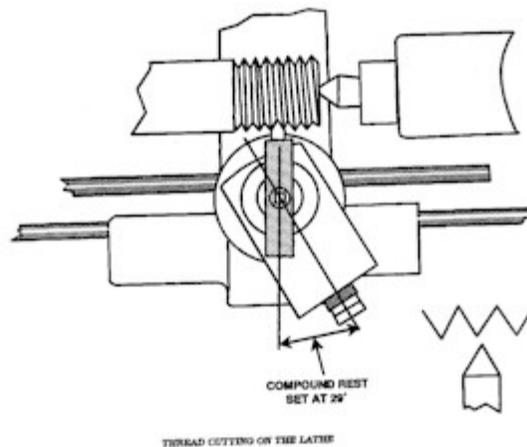
The cutting tool is ground to the shape required for the form of screw thread being cut.

For cutting 60° V threads, a center gage is used for checking the angle when grinding the tool to shape.

In cutting a right-hand exterior thread, the compound is turned in the direction of the head stock and set at an angle of 29°.

NOTE: The point of the tool should be at the same elevation as the centerline of the work piece.

The compound slide is set to an angle of 60°, and the tool is set square with the work, using the “V” notch of the thread gauge to set the tool. The point of the tool must be at the same height as the lathe centers. The tool is run up to the work with the cross feed, and the cross-feed stop is set to always bring the cross feed back to the same position after backing out the tool to return for another cut.



The compound slide is used to feed the tool into the work. By feeding the tool on the 60° angle to which the compound slide is set, the tool cuts on one side only, and it can be given a side rake to make the chip clear the thread groove. If the tool is fed in square with the work, it must cut on both sides. No side rake can be used, and the two opposing chips will interfere and jam in the cut.

The compound is adjusted so the micrometer dial on its collar is at zero. The tool is then

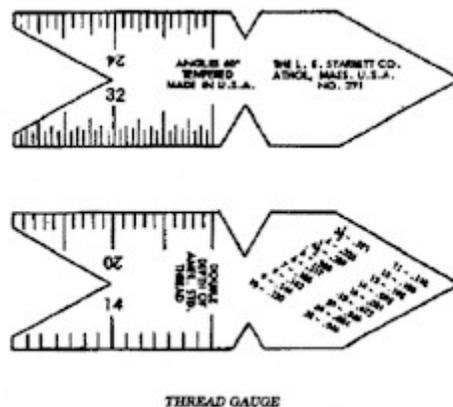
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brought into contact with the work piece by adjusting the cross-slide and setting its micrometer dials to zero. All adjustments for depth of cut can be made from these settings.

It is a practice to use both the cross-slide, and the compound. The tool is backed off the work piece and the carriage is moved to where the tool is, at a point beyond the end of the work piece. The cross-slide is then advanced until the micrometer dial reads the same as where the tool was touching the work piece.

Next, the compound is advanced .002 to .003" and a trial cut is taken. At the end of the cut, the cross-slide is backed off and the tool returned to its starting point. The cross-slide is then adjusted to its zero reading and the compound advanced a distance equal to the next cut. The operation is repeated until the proper depth of thread is obtained.

The carriage is attached to the feed screw by closing the half-nuts. There is a safety interlock between the friction feed for turning and the half-nuts for thread cutting, so the two cannot be engaged simultaneously, which would wreck something.



At the end of each cut, the half-nuts are opened, and the tool is withdrawn from the cut, so the carriage can be returned to the start for another cut. To be successful you must work quickly with both hands, back the tool out with one hand while you open the half nuts with the other.

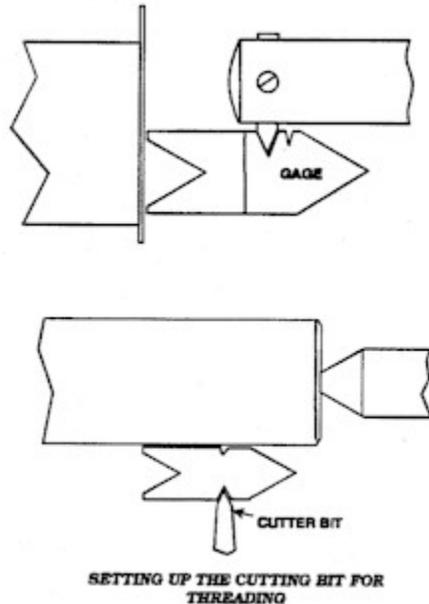
When you return the tool for another cut, advance the compound slide by the amount of the chip. Never change the setting of the cross-feed stop after you have started to cut a thread or you will throw the tool out of alignment with previous cuts. If the tool is not withdrawn from the cut, the backlash of the feed gears would leave the tool out of line with the thread and if the lathe was reversed, the tool would damage the thread.

If your lathe is not equipped with a thread cutting dial, you must reverse the lathe to return the tool to the start for another cut. Without the thread dial, the half-nuts cannot be opened until the thread is completed.

The thread-cutting dial indicator is a dial geared to the lead screw. When the carriage is

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stationary, the dial revolves, but when the carriage is cutting a thread, the dial is still. There are several graduations on the dial, each numbered. As the dial revolves, the half nuts are closed when the correct number comes up to the index mark. For most even numbered threads, there are several places on the dial that can be used to close the half nuts. For odd-numbered threads there is only one position, and the half-nuts must always be closed on the same number used to start the first cut.



Start the first cut, close the half-nuts on the number “1” line of the dial and feed the tool with the compound until the tool just scratches a fine line, indicating the thread. Shut down the lathe and test this line with the thread-pitch gauge to see that the lathe is cutting correctly. The cross feed of the carriage must always be up tight to the cross-feed stop before moving the tool with the compound feed.

When you are getting close to the final size, use a pre cut nut (which you can get from a factory loading die) to check the size. If the nut will not screw on make another light pass and try again. When the nut will just screw on, make two or three additional passes at the same setting to finish cleaning up the threads.

Lock the spindle and with plenty of oil on the tap work it in with a small wrench, backing it off about every full turn. A cut off tool is used to cut off these nuts so they will be cut straight.

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EQUIPMENT AND TOOLS

In the introduction, I listed a few machines that are needed, to make what you need. What is needed will allow you to make the necessary parts for the guns and parts listed below.

LATHE

Your lathe should have at least a 3-foot bed, but a 6-foot bed is better if the spindle hole is smaller than 1 1/2". The hole through the head stock should be at least 1 1/2 inch, as you will need to center the barrel blank in the head stock.

There will need to be a collar on each end of the head stock so the blank can be centered. The collars will need to be tapped for 4-1/4 inch set screws, which will be used to center the blank.

The lathe should be able to turn at least 2000 rpm or higher. It should have tapered bearings in the head stock spindle.

OIL PAN

There should be some type of oil pan under the ways to catch the returning cutting oil, so it can be strained before it is returned to the oil reservoir. This tray should extend full length of the lathe.

For boring barrels, you will need a pump that will turn out at least 400 lbs. of oil pressure. This pressure is needed to clear the chips. More on this later.

TOOL POST GRINDER

If you are going to make your tools, such as reamers and other special tools or cutters, a tool post grinder is necessary. With a tool post grinder, you can cut your expenses down to a very small percentage of what it would be if you had to buy them or have them special made. You will probably not be able to buy any tools for making shotgun barrels so most will have to be made.

You will be able to grind your own reamers and your own chambering reamers. In general, be able to make any gauge of barrel with any desired chambering.

MILLING MACHINE

You will need a milling machine with an indexing attachment for making reamers, however a milling attachment for a lathe should work. A vertical mill would be the best choice, as you can do much gun work with it. You will also need a coolant pump.

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This can be from an air conditioner pump, the evaporative type.

This will be needed in some cases when you grind the reamers. The coolant that you should is a water-soluble type that can be found at any machine supply house or oil bulk plants.

A good small mill can be bought from wholesale tools. See listing at back of manual under suppliers.

DRILL PRESS

Most shops have these. You will need a drill press for most of your fixture making. There will be quite a few fixtures to be made to drill barrels, and ream barrels.

SHAPER

A shaper is not a necessary item to have but it will save quite a bit of time in making the necessary fixtures that will be needed.

Most of the work that can be done on a shaper can be done on a milling machine. However, some special shapes can best done with a shaper. It is easy to shape a lathe bit to what you want rather than to try to reshape a milling cutter.

SAWS

A good band or cut off saw is necessary when you are working with barrel steel. It gets old very quick cutting off a 1-1/4 bar steel with a hacksaw. It will come in handy also in the fixtures that you will be making.

Wholesale Tool has a good one that works as a cut off saw or a vertical band saw.

HEAT TREAT FURNACE

This is absolutely necessary to have. There are many small furnaces available on the market that would work for what we want. It should go up to at least 2300 degrees, if you are planning working with high-speed steel.

I have found that oil hardening tool steel (O1) works just about as good. You will need to have good control to hold precise temperatures of the oven. This can be used to draw the temper of the reamers and cutters also. The furnace can be made easy, and a blower from a vacuum cleaner can provide the air. This is well covered in the book Barrels & Actions or The Gunsmith and Tool Making Book.

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MEASURING AND LAYOUT TOOLS

The following listing includes all the tools and instruments of this category that are essential to good Gunsmithing and tool making. Some of these precision items are a bit on the expensive side when one has to go out and buy them all at once.

Considering the years of good service they will render, if properly taken care of, one can scarcely consider them as being costly.

MICROMETER

You will need a micrometer from 0 to one inch, and one to two inches. They should be of a type so you can read down to ten thousandth of an inch.

MICROMETER (DEPTH)

Most of these come equipped with three interchangeable rods giving a range of measurement from 0-3 inch by thousandths of an inch.

MICROMETER (INSIDE AND OUTSIDE)

These should have a capacity of at least 6" and equipped to give a reading in thousandths.

GAUGES

Some of the gauges that will be needed are a bore gauge for measuring the finished reamed bore of the rifle barrel. There should be a gauge for each caliber that you make.

Each gauge should have a go and no go gauge on it. They can be turned out on a lathe. The no go gauge should be .015 larger than the go gauge.

HEAD SPACE GAUGES

You will also need also head space gauges for each of the gauges you chamber for in the shop. They can also be made in the shop.

ANGLE AND RADIUS GAUGE

Another of the gauges that you will need will be angle and radius gauges. These are not used to often, but they do come in handy when you need them. You will need a thread gauge, as in every barrel you pull you will have to know how many threads per inch there is.

LEVELS

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You will need a very accurate machinist level, one that will have the adjustable degree base; so correct angles can be achieved.

TOOL STEEL

You will need a good supply of tool steel, (oil Hardening) for your reamers. You can experiment with different makes until you find what will fit your needs. In 30 years, I have found O1 hard to beat.

SILVER SOLDER

You will need a good high strength, low melting point silver solder. As you can see from the above, that most shops have about all the machines needed to make rifle barrels, except for a few specialize tools and machines.

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MAKING PARTS AND GUNS

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This is one of the interesting parts of making guns, is the making of the actual parts. There will be some machines that you will need to do the machining of the parts. A band saw will come in handy for cutting out the working parts of the gun. There are many blue prints below that will allow you to make simple guns.

Probably the single most important machine will be the Milling Machine, as about 90% of the work will be done on it. There are many types of Milling Machines available to the craftsman. The most common is the Horizontal Mill, and in most cases you will be able to do all the necessary operation that is needed to make a firearm.

Probably the most common is the Bridgeport Milling machine. It is an excellent machine, and many accessories are available for it. Wholesale Tool makes an excellent Milling/Drilling machine, and I have found that most work of the can be done on it, if you have the accessories with it.

There are a few hobby mills, but in most cases they are to light to do a satisfactory job, except miniature work. If you own a medium size Mill, it should be OK for most of the operation described in the book.

Another possibility is the Milling Attachment for the Lathe. These are an excellent substitute for the full size Milling Machine, but they are limited to what they can do.

ACCESSORIES FOR THE MILL

You will need a good assortment of End Mills, as well as Woodruff Cutters, and other types of cutters. A good Fly Cutter comes in handy for removing excess metal, or making an octagon barrel, and will take the place of some other milling operations.

MILLING VISE

A milling Vise is one of the most important pieces of equipment for the Milling Machine. It will be used almost daily, and can hold other fixtures while machining the parts. Many of the fixtures and jigs can be supported in the vise.

ROTARY TABLE

A Rotary Table is also the next most useful piece of equipment. Many of the parts will be made on the Rotary Table, both in the vertical as well the horizontal position. With it parts can be machined with out removing them from the mill, as an example the octagon barrel.

ANGLE PLATE

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With the angle plate clamped to the bed of the mill, you will be able to machine, or drill holes at any angle on the part. The angle plate is not used that much, but it does come in handy at times.

A good drill chuck for drilling, as well as collets in several sizes should be at hand. A good supply of cutting oil will help to maintain good tool life. You will need a few good measuring tools, such as a dial indicator, edge finder, center finder, etc. Most of these tools can be purchased from machinery suppliers, some of which are listed in the Appendix.

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NOTES ON MAKING PARTS

Making the Frame will be the first item to start on, and if you look closely, you will see that in most cases I have omitted the thickness of the parts. The reason for this is that the availability of suitable steel in your area may be limited. Get the available steel and build the parts around this. You should know this before you start on the frame.

Making the frame can be as simple as cutting out the parts, and then riveting or silver soldering them to together. If you plan to make more than one, by all means make a master pattern out of wood or aluminum to be used as a pattern for investment casting.

The reason for this is the many different machining and drilling processes involved. However, the basic barrel pattern could be made from wood, cast, and then the machining operations completed. The finish-machined barrel could then be used as the master pattern for the wax mold.

On many short barrel guns, the barrel assembly works out very well cast. If you plan to cast the barrel assembly, be sure to center drill the pattern where you will drill it out for the liner before making the master mold for wax. When completed, it will be a simple matter to center the barrel in the lathe and drill the barrel (see chapter on barrel turning.)

Sights, in most cases can be installed on the barrel after finishing, but if you want they can be cast in one piece either separately or on the barrel. On the short barrel guns, the sights can be cast with the barrel, which saves much machining time.

Any parts that will be used continually should be made from steel. This includes triggers, sears, barrel latches, hinges for the barrel, and extractors. Many parts can be cast and then the holes that are used continually bushed with a steel bushing.

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STEPS IN MAKING PARTS

To be on the safe side in designing a firearm that will work right the first time you need to do the following.

1. Cut out the outline of the frame from aluminum and leave it flat as cut. From this main pattern you can fit all the parts, such as hammer, springs that has holes drilled through the frame.
2. Determine what the thickness will be on the hammer and trigger.
3. Cut out the hammer and trigger from either aluminum or steel. Finish out these parts as close as you can leave a little extra metal for final fitting. Drill the hinge or pivot holes in their proper location.
4. Place these parts on the outside of the frame. The hammer and trigger pivot hole can be already drilled at their exact locations if you want. Otherwise, with the parts on the frame (start with the hammer) in the proper place, clamp the parts and drill a hole through the frame. Place a pin the correct size into the frame and place the hammer over it. You now have a hammer that will rotate as it would in use.
5. Next locate where the trigger should be and repeat the above step. Once the trigger and hammer are mounted on the frame, they can be hand fitted to work properly in relation to each other.
6. On the inside of the frame can be machined Out to fit all the inside parts. Most of it can be machined out using end mills, but in the corners you will probably have to square it up with a file. When milling, use a slightly smaller mill than the finish width as in most cases if the parts were .250 thick and you use a .250 mill it would cut oversize. After the final milling is completed, move the end mill over a few thousands for a cleanup pass. There should not be over .003 to .005 clearance when completed.
7. Take all the inside parts that you have made, and try them to be sure that they all fit, doing any final fitting on the frame that is necessary. Make sure that you have sufficient room for the springs.

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SPRINGS

The springs can now be made for your gun. Soft spring stock can be purchased from Brownells (see appendix) in various size and thickness. Springs will give you the most problems until you learn how to temper them properly. Shape out the spring with a file and grinder, smooth and polish it. Drill any holes that you need in it and then carefully bend it to the shape that you need. Be careful that you do not twist the spring. Now you can heat treat the spring.

HEAT TREATING THE SPRING

If the spring is small, it can be heat-treated with a butane torch, otherwise it must be done in a heat treat furnace. You will need some quenching oil, which can also be purchase from Brownells, otherwise use Olive Oil, or 5 to 10 weight machine oil.

On a small spring barely hold the thick part of the spring with a pair of needle nose pliers. Light the Butane torch, and heat the spring to a cherry red, or about 1550 degrees and immediately quench the spring into the oil. The process is the same for larger springs, as well as for hammers, triggers, etc. After quenching, the part is glass hard and will break easily.

TEMPERING THE PARTS

Springs, you will find are easy to temper after you find out how to do it. Polish the spring to get a bright polish, then carefully holding the spring with the Needle Nose Pliers start heating the spring from the thick end.

Use a small flame on the torch and just play it on the metal. Watch the colors as you heat it up, as they will go from a straw to a dark blue, to a light gray blue. When the color reaches the dark blue move the tip of the flame down the spring. The reason for going to dark blue a moving it down the spring is that as you move it down it goes to the light blue-gray.

If you hold it on the spring till it turned a light blue and moved it, you would go to the next level of hardness and the spring would be too soft. I have found it wise to repeat the process twice, as when I have done this I have almost eliminated spring breakage.

Once the springs are tempered you will need to fit the springs to the action, and drill and tap the frame to fasten the springs in place. When this is done, the hammer can be cocked, and all the parts should work.

Make all the other parts and fit them as above. If you do not want to drill holes now, center punch the places on the barrel or frame at the exact location. When you cast the frame or barrel, these punch marks will still be there and it will be a simple job to drill them.

Now with all the parts fitted, finish out the frame to the shape and polish it to a high finish.

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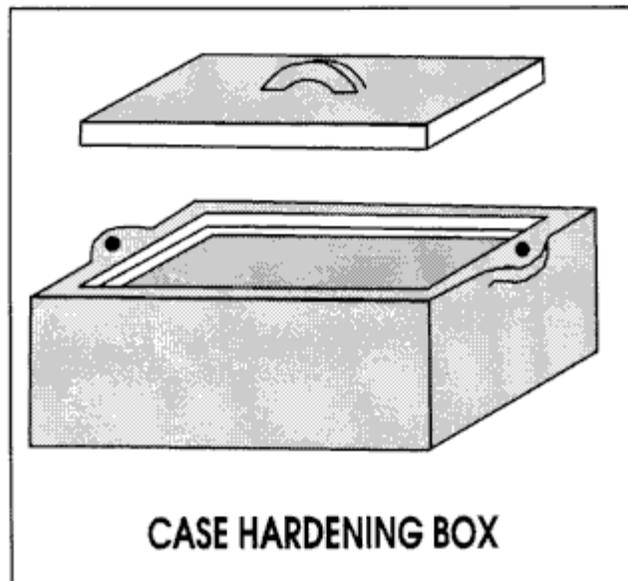
Now you can use the finish part and make a mold for wax patterns and make a duplicate frame as many times as you like.

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CASE HARDENING

One of the oldest known heat-treating processes is carburizing. History tells us that sword blades and primitive tools were made by the carbonization of low-carbon wrought iron. When you are making a firearm, case hardening is a good way to finish many of the parts. Color case hardening will give a very attractive finish.

The following carburizing processes are commonly used in industrial applications: (1) pack carburizing, (2) gas carburizing, and (3) liquid carburizing.



Most mild steels do not come with enough carbon to enable them to be hardened by heating and quenching, as are the higher-carbon-content tool steels. However, if carbon is added to the steel, it can be made to harden upon quenching. There are many methods of adding carbon. In the processes, the heated steel absorbs the carbon from the outside. The interior of the metal does not absorb the added carbon and so remains soft after quenching. A hard carbonous surface, or case, is formed on the metal.

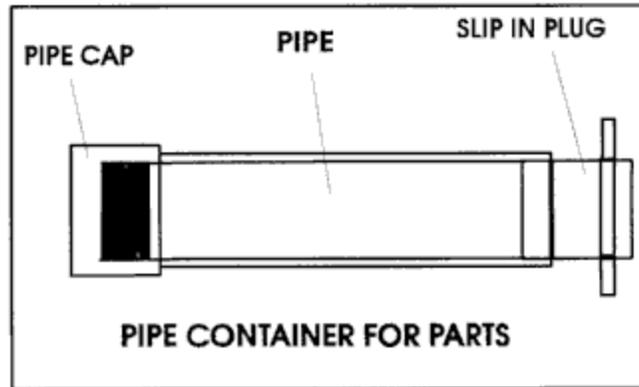
Case-hardening is accomplished by impregnating the surface of steel with carbon, by heating it at high temperatures while packed in an iron or steel box with proper carburizing materials, or by heating the steel in potassium cyanide in an iron pot,

The only practical method for the home shop is one of the cyanide processes. Melted sodium cyanide is a very good carbonizing agent, but it is also very dangerous to use.

There are several patented compounds on the market, such as Kasenit, Hard and Tuff, which give the same results and are safer to use. The steel is heated to a cherry red, then covered with the hardening compound and allowed to soak in it. This will form a paper-thin case that will be glass-hard when quenched.

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The case will not be thick enough for grinding. To form a case that can be ground, the steel must be heated several times and let soak in the melted compound until cool after each heating. In shops that do a lot of case hardening, the article is surrounded with the carbonizing agent-bone charcoal, molten sodium cyanide, or a nitrogen atmosphere, and held in a furnace at the carbonizing temperature until a case of the desired thickness has formed upon it.



The various parts of gun parts such as guards, metal butt plates, etc., and the different parts of locks, such as hammers, tumblers, triggers and plates, that the Gunsmith has to make will need some type of hardening. Many gunsmiths, particularly those in the country, finish the parts with a file and then hand polish. These parts can then be finished through the normal heat-treating, or case hardening.

Triggers, sears and various other small parts can be finish in this manner. As these parts are almost always made of soft iron, they would soon wear and have to be repaired if not hardened.

The gunsmith will thoroughly case-harden the parts when they are fitted and finished, and will turn out a good piece of work that will wear as well as hardened steel. Some gunsmiths, when such work is finished, heat it red hot, smear it with a good case hardening compound such as Hard-tuff, and while hot, plunge it into cold water, letting it chill. This produces a superficially hardness surface that is not "skin deep," and as soon as this surface becomes worn through use it will wear away rapidly.

If the casehardening of the experience Gunsmith, you will see that the surface of such work has a fine grayish appearance, and in many places mottled with colored tints that are pleasing and beautiful to the eye. On these parts the hardness is of such depth that it will wear for a long time. In fact it will wear better than hardened tool steel. The condition of the case hardened part is that of a hardened steel surface stretched over and shrunk upon the iron body of the work.

It is stronger and tougher than steel, for it has the tenacity of iron for its interior. It has the

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advantage of steel, in as much as it may be bent when cold to a limited degree, and case hardened it will not break as readily as steel.

The easiest and Perhaps the best way to case harden gun work is to have a number of short pieces of common gas pipe, such as will be adapted to the size or quantity of the work, and have one end of these pieces securely plugged or capped. A best way is to have a thread on the pipe and then screw on a plug, such as are used to close ends of gas pipe.

In the pack carburizing process, the operation is carried out by packing the steel in suitable containers such as steel boxes or pots, with a carbonaceous material.

The substances used are generally commercial solid carburizers that vary in composition; They generally consist of a hardwood charcoal to which an energizer, such as barium carbonate, has been bound by molasses or oil tar.

Mixtures of coke and charred leather, bone, and charcoal are also used. The energizer usually represents about 20% of the mixture. To increase the rate of heat transfer through the compound, an additional 20% is made of coke. Since the compound decomposes with use, it is common practice to add 12% to 30% new material to used compounds for a new operation.

In this process, the box, which is made of heat-resistant alloys, is packed and sealed tightly, then placed in the furnace and heated to between 1500o and 1750oR Within this range a transformation takes place in the steel forming austenite which has the capacity to dissolve large amounts of carbon.

The best case-hardening is done by the pack-hardening method, that is, packing the articles to be hardened in iron boxes in which the article is surrounded by powdered charcoal, coke, leather or bone and heated at a rather low heat over a long period of time. This method gives a deeper hardening and the temperature is more easily controlled.

The time required varies with the size of the pieces. Temperatures may be held at 1550 degrees Fahrenheit. Green bone should never be used as a carburizing material, as it contains phosphorus. Pack the work with the powder, the same as bone dust. Bone black may be used the same as bone-dust, but it is not as good, and will not give as good a results. It is also dirty to use and to have around a shop.

Gun guards, straps and long pieces of work will become shorter after case-hardening, and it is best not to fit such pieces into the stock until after they are hardening.

Case-hardening by heating the articles in liquid potassium-cyanide to a temperature of 1562 degrees Fahrenheit gives a quick and very even case, but it is superficial and won't stand any further finishing after being case-hardened as the hardening will be cut through.

Cyanide salts are violent poisons if allowed to come in contact with wounds or scratches and are fatal if taken internally. Poisonous fumes are generated when cyanides are brought into

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contact with acids.

As the cyanide gives off deadly poisonous fumes, this type of case hardening should be done in an open pot, under a hood attached to a flue with a good draft, and the operator should stand back from the pot.

Cyaniding is a process that involves the case hardening of machined steel parts by heating in contact with molten cyanide salt, followed by quenching in a salt bath, water, or mineral oil, depending upon the type of steel. The salt bath consists of a mixture of 30% sodium cyanide, 4-0% sodium carbonate, and 30% sodium chloride.

The cyaniding temperature is above the lower critical temperature of the steel, usually from 1400° to 1600°F. Direct quenching is employed. This process is capable of high production, as immersion periods require only 15 minutes to 2 hours. It requires about 30 minutes to caseharden a part from 0.003" to 0.005". The maximum case depth is rarely more than about 0.020". A very thin surface case can be obtained by dipping in a powdered cyanide mixture, followed by quenching.

CAUTION: A method of venting gases is a must during the operation and molten cyanide should never be allowed to come in contact with sodium or potassium nitrates, used in tempering operations, as the mixtures are explosive, extreme care is necessary at all times when using the material

If you want to have an area of the work left soft and the other parts hardened, securely cover the places to be left soft, with a coating of moist clay, and this will prevent the hardening material from coming in contact. It may also be observed that articles that are case hardened will not rust so readily as those not so treated.

If the parts are quite thin, there may be a chance of their cracking by sudden chilling. To prevent this the water may be warmed a little, or a film of oil may be spread on the water, which will tend to prevent fast cooling of the articles. If you want to have the work show the colors or mottled tints as seen on some kinds of case hardened gun work, the surface of the work before being put in the pipes containing the burnt leather, must be highly polished and then buffed. The higher the finish the more brilliant will be the colors.

In using a commercial compound to case harden, the work heated and dipped in, or if the work is large the compound must be spread over it. The work must be hot enough to fuse the compound, and if it become cold by removing from the fire it must be reheated, removed quickly from the fire and quenched in cold water.

Collect such articles cow's horns, or hoofs of either cows or horses, leather trimmings from about the local shoe shops, old boots or shoes, and burn them until sufficiently charred to admit of being easily pounded into a powder. Then finished up the parts to be hardened, and ready for the final polish, place them in an iron box, and surround it completely on all sides by a packing of the powder. Pour into the box, until the powder is moist, a solution of common salt. Then close the box and seal it until airtight, with wet and well-worked clay, then put it into the furnace and heat the furnace up gradually until it becomes a cherry red. Do not bring the

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heat any

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SOLDERING AND BRAZING

Soldering is a method of joining two pieces of metal together with an alloy of lead and tin. Soldering, which is known as soft soldering is the process of fastening two pieces of metal by means of an alloy having a fairly low melting point. When you want a low melting point solder bismuth is added. Lead has the highest melting point of the three solders. The solders containing a high percentage of lead and a lower percentage of tin, or a high percentage of lead and a low percentage of tin and bismuth have the highest melting point.

If you use lead it has a melting point of 620 degrees Fahrenheit, tin has a melting point of 445 degrees Fahrenheit. The most commonly used solder is called half-and-half. It is composed of 50 percent lead and 50 percent tin, and has a melting point of 428 degrees Fahrenheit. If you use a solder that is composed of 32 percent lead, and 15.5 percent tin 52.5 percent bismuth it has a melting point of 205 degrees Fahrenheit. This is below the boiling point of water as sea level.

In most cases, the craftsman or gunsmith does not have much use for solder except in sweating ramps, barrel bands, scope base blocks or rear sights to a gun. When a person tries the first time to Saunders two pieces of metal together their biggest difficulty is to get a solder to stick to the parts. Usually, instead of flowing and taking hold on the metal it usually formed little balls with roll off. Once a person learned how to apply solder, the solder will flow evenly over the work and has amazing holding strength. The joint will not be as strong as silver soldering due to the greater softness, however it will resist any normal strain is likely to receive and will remain solid until removed by melting. They also use this process at times when they make tools, such as when you sweat two different pieces of steel together temporarily for machining.

Probably the average gunshot will sweat on RAM front sights, swivel bands, and also slight bases, as well as other different type of jobs. Every so often a target shooter will want the telescope mounting blocks on his rifle sweated-on, and this is a head someplace to use the very soft solders. Just remember, that most of the bluing are blacking processes that are use today will live lead devour lead it left in the bluing solution to long.

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SWEATING

Sweating is a slightly different process than what you would use if you solder. It will approach brazing in its strength when properly used in sweating of two pieces of steel together; each piece is tinned, (this is giving a thin coating of solder to the parts that will be sweated together). Then the pieces are placed face-to-face with the tinned surfaces in contact. They are clamped tightly in this position, and are then heated with a torch so that the applied heat opens the pores of the steel.

When this happens, the solder enters these pores making a good joint between the two pieces. The clamped pieces are less clamped together until cool. Always remember in either soldering or sweating, keep the parts stationary and together while lead joint is cooling. Any movement of one-piece independent of the other that is being joined together causes the solder to crystallize in the joint, and when this happens its holding power becomes weak.

When you sweat two parts together the two surfaces that you want to join together should make as perfect a contact with each other as possible. Contours of the two surfaces must match closely to produce a good joint. When you solder, braze, or whales a joint the first saying to do is make sure that the surfaces are clean. They have to be free of bluing, rust, oil, or anything except raw metal.

The surfaces need to be polished with and abrasive clothes and then forced or wiped with alcohol gasoline, or advances solution made specially for soldering. Before you join two surfaces they must also be cleaned and not to highly burnished. You can scrape them with a knife or scraper, or a median course Carborundum cloth to free the surface of any corrosion. Above all, the surfaces must be free of any grease.

After the surfaces are cleaned coat them with a flux to prevent oxidation. If you are using steel, either one of two fluxes will serve the purpose. One of these is rosin that is usually used in powder form. Spread this on the surface to be tinned and the heat of the iron used in tinning the surfaces melts the rosin and flows it completely over the surface. If you want to eliminate any danger of rust, rosin is a fluxed to use.

The second flux that you can use for steel is zinc chloride, which is made by dissolving zinc chips or cuttings in hydrochloric acid. This flux is applied with a stiff brush over the complete surface. This flux will cause corrosion and rust on surfaces adjacent to the sweated or soldered joint. The surfaces should be well washed with water or ammonia after the parts have cooled, which will prevent rusting.

SOLDERING IRON

The soldering iron that we use in tinning the surfaces should be of a large size, which is normally a two pound copper iron. The solder should be well rubbed into the surface of the steel by the iron and to do this the iron should be large enough to retain its heat for quite a period of time. A small soldering iron will not do this, as it will cool too quickly. Soldering

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irons can be purchased at most plumbing businesses.

The soldering iron should come to a point and the sides of this point should be square and flat. You should tin the iron on these flat surfaces up to and including the point of the soldering iron. A block of salammoniac is use maintaining a coating of the soldering iron with solder the soldering iron is filed until the point and the surfaces back of the point are cleaned and smooth. The soldering iron is then heated, hot enough so that when you apply the sal-ammoniac the latter fumes and smokes melting under the tempter of the iron.

Small pieces of solder are dropped onto the block the Sal almanac and hot iron is rubbed on these to give a coating of solder. When I can the point on a soldering iron hyper for to do this by heating the copper and then flux seen it and rubbing against a bar solider until it is tinned. Flux is used to prevent oxidation of the surfaces that are to be joined until the solder flows, and it is very vital to soldering and brazing. We use flux, it makes a solder take hold and stick and can be any of a dozen types, has different metals and solders required different types of flux's. Plain rosin, which is probably the world's oldest fluxing material, also remains one of the best.

HEATING THE SOLDERING IRON

Win you heat of the soldering iron be sure to avoid overheating it, as this will burn and roughened the surface of the iron. Scale will form on it through which the heat does not pass very well to the surface being soldered. If you do overheat the iron, the iron must be filed cleaned in and then retained. When heating the iron, just before applying the solder, it should be dipped into a liquid flux such as zinc-chloride. This brightens it and enables it to hold more solder upon its surface.

SWEATING

There are many different types of solder which comes in all sorts of lead, can, and bismuth alloys. The 50-50 solders, which is half tin and half lead is most common and will handle most of the gunsmiths needs. When you sweat two pieces of steel together, such as a ramp or barrel bands to a barrel, all bluing must be removed from the surface and from the inner surface of the ramp or band if it is already blued. Put the ramp or band in place on the barrel and mark around it surfaces with a sharp scribe. Remove the ramp or band, and using a small scraper or file remove all bluing from the barrel within the scribe lines. If the ramp or band is blue on its inner surface, scrape all of the bluing off of this surface that will come in contact with the barrel.

The barrel bands, or the ramp if it is equipped with a band that is circles the barrel will need to be tinned on the inside also. You may have to use a smaller soldering iron to accomplish this.

After all of the parts have been tinned, heat them with a torch such as a butane torch can use a cloth to wipe all the excessive solder when the torch has softened the solder sufficiently. After cooling place the band or ramp on the barrel in the proper position, and if the item that you want to solder is a ramp, place a piece of sheet copper on the tail end of the ramp and

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clamp it. This is done to draw the tail in of the ramp down tight to the barrel.

When soft soldering the parts were pieces they are usually clamped or wired together in the correct position and the proper flux is applied. In the gunshot, sweating has more use than the other methods. There are many done processes which involve this system, and factories join the barrels of double-barrel shotgun together by sweating, for and lugs are often sweated on as well as ventilated ribs. When everything is lined up OK, apply the heat with a butane torch to the items that are being sweated on the barrel. Heat everything as evenly as possible until solder began to run at the edges. If a clamp is use tightened, clamp a little more and hold the heat on the work a little bit longer, then shut off the torch and let everything cool without moving it.

SMALL PARTS

Another method of tinning small parts when the inside of the ring is too small to get to with a soldering iron is to heat that piece with a butane torch. After applying the flux, then apply wire solder to the surface to be tinned. Turn the piece so that the solder coats the inside surface completely. You can use either acid-core or rosin-core wire solder to tin the surfaces.

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BRAZING

Brazing is a little different from soldering and is a method of joining two metals with molten brass. When you braze, a much higher heat than soldering is used. The metals that are to be joined together must be red-hot so it's use it limited to parts that will not be injured by the high heat required. The advantage in using brass for brazing is that it will withstand heavy strains, so long as it is not a bending strain at the point that is brassed.

Silver soldering or hard soldering is often confused with brazing but there is a big different between the two processes. While brazing brass, which will become molten at about 1660 degrees Fahrenheit. Silver-solders can be bought in many different mixtures requiring heat from 700-800 degrees Fahrenheit's up to 2000 degrees Fahrenheit to become molten.

Brazing requires the heat of the acetylene torch to get a good joint, as the steel or iron parts that are joined together must be brought to a good red heat at the joint. The parts that you want to join must be thoroughly cleaned as they are brought up to red heat. A good flux is Borax in powder form that is sprinkled on the surface to act as a flux. Borax will melt and cover the surfaces and the brazing spelter. Applied from a brass rod by the torch it is applied to the joint or it will run into the smallest crevices. When doing this type of work the piece should be turned so that the molten brass can run in from all sides. Borax we used as a flux will form a hard scale and may be ground off if there is excess material to be removed when finished. It may also be removed by placing the piece in an acid pickle of one parts sulfuric acid to 20 parts of water.

BRAZING OR HARD SOLDERING

One warning about brazing or hard soldering is that the process is not suitable for attaching parts to barrel the receivers. Even if the bore of the barrel is protected by file hardening compound to prevent oxidation under the high heat, the heat may cause the barrel to develop a kink in it. In most cases the heat treatment from the receiver and barrel will be removed and hard soldering to a barrel is use the barrel may develop a kink in it. You can use brazing or hard soldering for making or repairing parts that are removed from the guns if the joint is not visible when the part is in place. The brass and the joint will show and cannot be blued to match the other parts of the guns.

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SILVER SOLDERING

Hard soldering or silver soldering is done with silver-brass alloy, which is usually supplied in fine granulate form. It can be obtained in many different melting points. When attaching to parts ribboned form of silver solder is usually the best to use, as a piece of the ribboned is place between the two parts that our planned to be joined together. Clean the parts thoroughly and then coat with a paste made of Borax mixed with water. Clamp the parts together tightly and then apply the heat until the silver solder melts. Leave the parts clamped together until they are cool. Remove the Borax scale by placing the parts in the acid pickle bath.

Usually, very little if any of the white silver solder will show at the edge of the joint if the pieces are well fitted. Silver soldering is preferred for joint parts in gun work where the joint remains inside. Usually you can use silver solder to repair shotgun tangs, broken tangs or any parts such as this. Silver soldering is use also for joining spring steel, and most other brazing applications on firearms. Using silver solder is about the same as for brazing, but the lower melting points of the more common alloys make it handle better for sweating the joint.

I always use silver solder to attach the sweat-on ramp front sites for any rifle that I had to put sites on. I have found that it is more difficult to get an invisible joint line, due to the fact that alloy cool so much faster than soft solder and will complicate the squeezing-together-while-cooling process. However, you can be sure that the ramp will stay on. You do have to be very careful when using silver solder that you do not apply too much heat especially on light rifle barrels as it may cause scale to form in the bore. You silver solder with melting points of 1200 degrees Fahrenheit or lower for mounting ramps on rifle barrels.

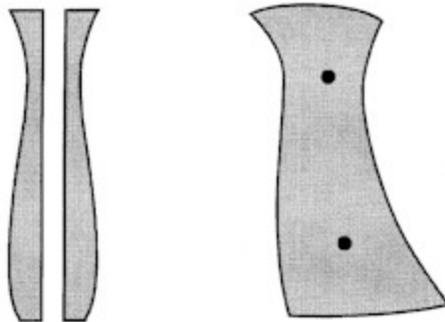
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PLASTER CASTING

If you decide to make a few special items, especially if the part takes quite a while to make, you will find it much easier to cast the parts, and then finish it to proper size. Machining the parts takes many hours, and cast parts will save you many hours.

When you needed special parts for a rifle, pistol, knife, etc. you can probably make them out of brass or aluminum. I have had to restore old rifles; mostly muzzle loaders that had broken trigger guards or butt plates using the following methods. On making some parts, we can make the pattern in two pieces from wood. It would take too much time to machine or file out the needed parts.

When we needed a special part, I found some soft pine and whittled out the pattern that I needed to have. I then got some gypsum plaster and made a mold. The wood pattern was sanded smooth, and we put a coat of lacquer on it to seal the wood.



STEP 1--MAKE THE PATTERN OR USE A ORIGINAL

When the pattern was ready to use, I added a good coat of paste floor wax to it to guarantee it not sticking to the plaster. I poured some fine sand in a box, and then smoothed it off, and then the patterns were pressed one half of its thickness into the sand. The patterns and parting surfaces are first sprayed with a suitable parting agent.

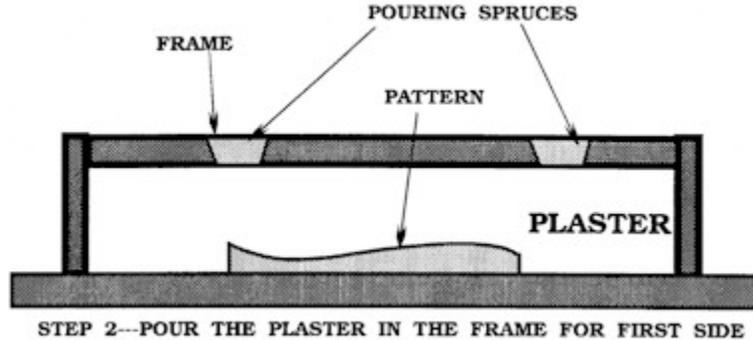
PLASTIC SLURRY

After mixing the powder with about 60 per cent water by weight, we pour the plaster slurry into the flask, or surrounding frame, over the pattern. This should be done carefully to avoid the entrapment of air. Be sure that the pattern is just at 2 of its depth, as if it is too deep, or not deep enough, you will stick it in the mold. We then poured the plaster over the pattern, and in ten to thirty minutes, the plaster will become hardened. Then we must carefully remove the patterns with lateral rapping.

After it was set up, I removed it from the sand and removed all the sand. I carefully removed the pattern from the mold, taking care that we have not nicked the pattern. One method for removing a pattern is to blow compressed air through a small hole that leads to the separation surface between the plaster mold and the pattern. Later during pouring, the hole

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may serve as a vent for the escape of air.



We must then heat the mold halves in an oven at or about 400 degrees F (this temperature may range from 300 to 1500 degrees F) to drive off all free water and convert the gypsum again to CASO. This may require twenty or more hours.

While the mold halves are still hot from the drying oven, we quickly assemble them, plaster cores are set if required, and we pour the mold. This is done without any delay to reduce the absorption of moisture from the surrounding air. Moisture must be kept at a minimum, because ordinary plaster molds have practically no permeability.

With plaster casting, producing castings with smoother surfaces and closer dimensional tolerance is possible. Small dimensions on one side of its parting line can be held, if required, too within tolerances of ± 0.005 inch. The molds are made of gypsum plaster, and they contain silica flour, silica sand, and other desired ingredients. Since water must not affect the patterns, I usually made them out of metal (Aluminum) when I had several parts to make.

There is a metal casting plaster available, which can be made permeable by whipping or mixing small air bubbles into the slurry with the use of a rapidly rotating, partially submerged disk or blade. Many small air bubbles thus formed become interconnected when the mold is dried, providing sufficient permeability. Small castings in nonferrous metals (aluminum, brass, bronze) can be produced in plaster molds with a surface finish as fine as .90 to .125 inch and accuracy as close as 0.005 inch.

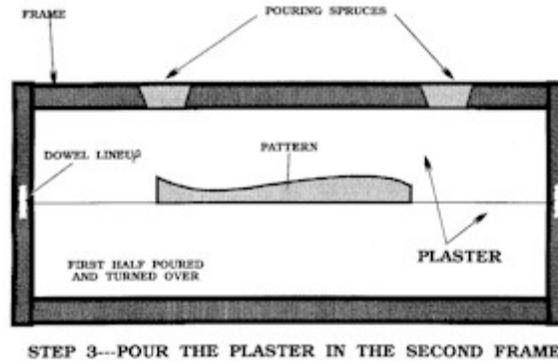
On small dimensions with an additional 0.002 inch per inch on larger dimensions. From 0.005 to 0.015 inch, we usually require more across the parting line. Molds are made of a special plaster

CORES

Cores, for holes and recesses, also can be made of the plaster composition. The size of the parts usually made in plaster molds ranges from a small fraction of an ounce to 10 lb. The plaster causes slower cooling of the casting than would occur in sand molds. This slowness has a tendency to improve the characteristics of bronze castings, but it is a disadvantage with aluminum, giving properties that are somewhat lower than those with sand or shell mold

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castings.



The pattern and the piece cost are much higher than for sand castings, but this cost is often justifiable because of the better finish and the elimination of machining. With these permeable plaster molds; eliminating the chemically combined water from the gypsum is not necessary, so drying requires less time.

One important application of plaster casting is the making of pressure cast fancy brass handles for pistols or knives, and frames for guns. In this application, the molten aluminum is first pored into a plaster lined, cylindrical metal receiver above the gate sprue

A asbestos disk about 1/16 inch, thick placed at the bottom prevents the metal from entering the sprue. When the metal is just beginning to solidify, we cover the metal receiver, and compressed air at or about 5 psi is admitted above it.

This breaks the asbestos disk and forces the solidifying metal quickly into the mold cavity.

This casting procedure produces smooth surfaces, excellent detail, and a minimum of shrinkage. Because of the limited refractoriness of gypsum, plaster casting is limited to metals with pouring temperatures below 2150 degrees F. Since the heat conductivity of plaster is lower than that of molding sand, solidification of the castings will be slower.

We accomplish this without altering mold-cavity surface smoothness. Additional drying time may be necessary to drive off free water. We recommend the use of metal patterns, especially if we make more than one part. This process is well suited for intricately shaped castings, especially of aluminum, where dimensional accuracy and surface smoothness are the main concern.

A plumber's propane lead metal melting pot can be used to melt most alloys. If higher temperature is required, you will need to make up a forge to melt the metal in. If we need much casting, a forge will speed up the casting. A split metal pattern is used, mounted on plates and so designed that we that can remove it in two halves from the mold. We pour around this pattern and allow the plaster to harden.

Then we remove the pattern, and the two halves of the mold are baked in an oven to harden

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them further, and to dry out all the moisture.

The nonferrous metals predominantly used for casting are alloys of copper, brass and bronze. Brass is generally identified by its color, and is said to be either red or yellow; color can serve as an indication of the temperature required for the melt.

FLUXES

When we melt a copper-based metal in a crucible, some of the metal will combine with oxygen to form cuprous oxide. To convert the cuprous oxide back to metallic copper, something has to be added to the melt to draw the oxygen. The one most commonly used for red metals is phosphor-copper: an alloy of copper and phosphorous. Phosphorous has such an affinity for oxygen that it will ignite upon exposure to air: to make it stable enough to use, we alloy it with copper in the form of "shot." When introduced into the molten metal, the copper melts and releases the phosphorous, which deoxidizes the cuprous oxide in the melt.

Nitrogen can carry out oxygen of a melt; we introduce the nitrogen gas (dry) through a hollow tube called a lance, which a rubber hose connects it to the gas cylinder. For red metals, the lance is carbon; for aluminum, it is iron or steel. We insert the tube into the molten metal too within an inch or so of the bottom of the crucible.

A very good deoxidizer for copper is 5 ounces of black calcium boride powder. It is sealed in a copper tube 2 inches long, with the ends crimped closed. The best flux for melting down extremely fine scrap pieces such as buffing or grindings is plaster of Paris.

There is another group of fluxes used to prevent the gases in the furnace from being exposed to the molten metal and oxidizing it. Because they are used as a protective cover, they call them cover fluxes. This flux is made by mixing five parts ground marble with three parts sharp sand, one part borax, one part salt and ten parts charcoal. Another one, Mix equal parts of charcoal and zinc oxide, add enough molasses water to form a thick paste; roll the paste into 2 inch balls and let them dry. When the alloy starts to melt, drop in enough balls to cover the surface.

Some fluxes are very detrimental to refractory linings, often eating away a ring around the inside of a crucible during a single heating. Check with your crucible and flux supplier to find out what is compatible before using a particular flux.

RED BRASS

Leaded red brass can be used with a simple gating system but it must be choked because these alloys flow quite freely. We require risers for heavy casting sections, and the melt must be fast (under oxidizing temperatures). No cover flux is necessary for these alloys, especially when clean materials are used. Deoxidize with 1 ounce of 15 percent phosphor-copper, for each 100 pounds of melt. Too much deoxidizer will make the metal too fluid, and can result in dirty castings.

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The average composition of red brass is: 85 percent copper, 5 percent tin, 5 percent Ann and 5 percent lead; they call this alloy eighty-five and three fives or ounce metal". They handle semi-red brass like red brass. Its composition is normally 78 percent copper, 2.5 percent tin, 6 percent Lead, and 7 percent zinc.

The pouring temperature range for this alloy is 1950 degrees Fahrenheit for very heavy sections, to 2250 degrees Fahrenheit for very thin sections. Generally, 2150 degrees Fahrenheit can be considered as an average pouring temperature.

Using leaded yellow brass requires gating similar to that used for red brass, with the exception that the sprue, gates, and runners must be somewhat larger. We must fill the mold cavity as rapidly as possible. If filled too slowly, the zinc in the alloy will produce a wormy surface on the casting. If melted in an open flame furnace, such as a rotary or reverberatory type, high zinc loss will result. Crucible melting is best for yellow brass.

The general pouring temperature is 2050 degrees Fahrenheit. We require no cover flux, but we should deoxidize the metal with 2 ounces of aluminum per 100 pounds of melt. (Never use aluminum and phosphor copper together.)

To prevent zinc from condensing in the mold cavity, the cause of the surface condition described, tip the mold so the sprue is at the low end of the mold.

The normal composition of yellow brass is 74 percent copper, 2 percent tin, 3.5 percent has and 20.5 percent zinc. High-strength leaded yellow brass (manganese-bronze) is characterized by high shrinkage, and the tendency to form dross (oxides) during pouring, or when agitated. We prefer bottom horn gating, and large risers and chills must be used. It is a tough metal o cast and requires considerable experience. We melt in crucibles and pour it at the highest possible temperature to prevent the excessive production of zinc fumes.

They also recommend that high temperatures reduce the risk of flaring, flames shooting up from the surface of the molten metal. Yellow brass will flare at about 185 degrees Fahrenheit. Approximately 155 pounds of zinc will be lost for every 100 pounds of alloy melted, and we must replace this.

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ALUMINUM ALLOYS

They melt aluminum alloys and they are handled much the same as copper-based alloys. They have, however, a high rate of shrinkage during solidification, we must pay attention to correct rise ring to prevent this. It is common to increase the strength of aluminum casting by as much as fifty to one hundred percent by redesigning or moving the gates and risers.

Cores must be low in dry strength and high in permeability. The pouring temperature range is usually between 1250 and 1500 degrees Fahrenheit. Deoxidizing is done with solid fluxes, or by bubbling nitrogen through the molten metal. We melt aluminum in crucibles, cast-iron pots, and in open flame furnaces.

CASTING A PATTERN IN PLASTER

This is a simple method to cast a few small parts in plaster. We will use a simple project like a grip on a revolver as a starting point, but a pistol frame is done the same way. The frame must measure 5 1/2"x 3 1/2 x 2 inch high. We mount it on a piece of glass that has first been rubbed with liquid soap or Vaseline. We then fill it slightly less than half-full with a thick paste of plaster of Paris.

To make the plaster harder, add a pinch of alum or some water glass. Use cold water for mixing warm plaster hardens too quickly. After the paste has been thoroughly smoothed with a spatula, wait two minutes until the plaster has started to dry. Press the grip, sideways on, halfway into the plaster, having previously coated it thinly with Vaseline or salad oil.

Be careful not to coat the fine detail too thickly, otherwise this detail will be missing from the mold. Make sure the model is pressed in only as far as the halfway mark to get no undercut forms in either half of the mold. Bits of plaster forced up around the edges or into the hollow parts of the model as it is pressed in, must be carefully scraped away with a small knife, after the plaster has hardened.

When we introduce the grip, a piece of doweling is pressed into the plaster to form a pouring channel leading to the mold. This should run obliquely from the top of the frame to the base of the figure so the mouth of the channel lies as low as possible. A second, thinner piece of doweling should run vertically upwards from the top of the grip, later, during casting, air can escape through this outlet. We must also coat these two pieces of doweling with grease so the plaster does not stick to them. Before the plaster has completely dried, make four conical holes in the surface of the half-mold with a blunt pencil.

When these are quite dry, carefully rub them smooth with a pumice stone. The lower half of the mold is now complete. We brush with graphite or wiped its surface and the four holes with Vaseline to separate them from the plaster of the upper half. For the latter, we use much thinner plaster that we should pour on gently from the side and allow to it cover the grip slowly and gradually.

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AIR BUBBLES

Be careful to prevent the smallest air bubble from forming in the plaster. Once the grip is covered with a thin layer of plaster, stop pouring for a moment. Then fill the frame to the top. Let the whole mold stand overnight so that the plaster can set properly, remove the surrounding frame, and separate the two halves of the mold, using a knife blade to remove the pieces of doweling.

This is why we made the four conical holes in the lower half of the mold. The upper half has pegs that fit into these holes and ensure the exact matching of the two halves. After taking out the model, remove any surplus plaster from the mold, clean out the mouths of the two channels, and develop the upper opening of the pouring channel into a funnel shape.

After a week of drying (we will not use heat on the first one), the mold is ready for use. It is sufficient to smear it lightly with soot before casting and to press both halves firmly together while pouring in the molten metal. We heat, but not overheated the metal, in a cast iron ladle. The mold may break at the first or second casting because of cavities due to small air bubbles just beneath the surface, the walls of which are burst by the hot metal. However, a carefully made mold can give some twenty castings before the edges begin to crumble, rendering the mold unusable.

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MAKING A MOLD OF A ONE PIECE PATTERN

The first step in making a mold on the bench is to place the pattern with the parting surface downward on the molding board. Tempering the sand means to add moisture so it will pack. Sprinkle the sand uniformly with water, and thoroughly mix with a shovel or trowel. Test for the proper moisture content as follows:

Make a lump of sand by squeezing a handful together in the hand. Break the lump into parts with the fingers, and if the edges at the breaks are firm and sharp, the sand is ready for use.

The pattern is checked to see that the draft is pointing upward so, when we turn the flask, we may remove the pattern without breaking the mold.

The drag half of the flask is placed on the molding board with the pins pointing downward. Place the pattern centrally on the old board with the largest dimensions down. A pattern must have draft (be tapered) so it can be withdrawn from the sand.

SET UP THE DRAG

The drag is the half of the flask used for the bottom half of the mold. Select either half of the flask for this purpose. In either case, place the drag down on the moldboard and over the pattern with the pins or the sockets down.

POURING THE MOLD

The actual pouring of molten metal into molds is a very important phase of the casting operation. More castings are lost due to faulty pouring than to any other single cause. Some basic rules for gravity casting a mold poured from a crucible or ladle is:

1. Pour with the lip of the ladle or crucible as close to the pouring basin as possible.
2. Keep the pouring basin full (choked) during the entire pour.
3. Keep the pouring lip clean to avoid dirt or a double stream.
4. Use slightly more metal than you think you will need.
5. Pour on the hot side, more castings are lost by pouring too cold rather than too hot.
6. Once a pour is started, do not reduce the stream of metal.
7. Do not dribble metal into the mold or interrupt the stream of metal.

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8. If a mold cracks and the metal starts to run out, don't try to save it.
9. If a mold starts to spit metal from the pouring basin or vents, stop pouring.
10. Wear a face shield and leggings.
11. When pouring several molds in a row with a hand shank, start at one end and backup as you go. Going forward to pour brings the knuckles of the hand closest to the ladle over the mold just poured.
12. When pouring several molds from a single ladle or crucible, pour light, thin castings first (the metal is getting colder by the minute).

If the metal in the ladle or crucible is not bright, clean, clear, and hot, do not pour it.

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WAX PATTERNS

Despite the origin of casting, the practice has evolved and refinement has brought it to its present state. With today's terminology, castings are possible within tolerances of one thousandth of an inch or closer. Not generally known is the fact that your dentist is a master craftsman in the casting art. Industry uses investment-casting techniques to produce many intricate mechanical parts that, without these processes, would require extensive machining at high cost.

Although the casting methods outlined here are simple adaptations, the basic principles of casting remain. Because of these simplified methods and the availability of the material, investment casting can become a most interesting and productive business. Using self-made tools and equipment, we can achieve satisfactory casting results.

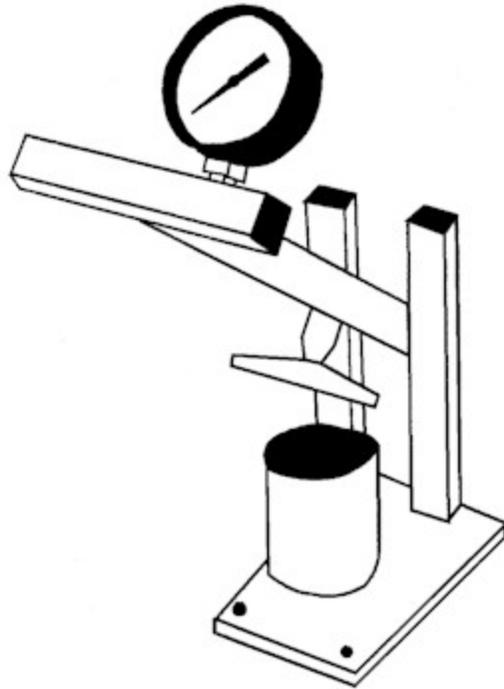
The prime area of investment casting to be covered is the casting of parts for firearms. You can use investment casting for other applications such as making small parts and fittings also. Casting, as with other forms of art, requires a knowledge of the basic step-by-step procedures to produce the desired results.

The technique described here involves the use of a self-made pressure-casting machine. Although centrifugal casting is more popular, the centrifugal machine is more complex, expensive and difficult to use. Pressure casting, besides its simplicity, need not be as elaborately safety guarded as a centrifugal machine. Also, pressure casting, has an inherent safety factor, as there is little risk of spilling molten metal. They create the metal directly in the flask cavity, poured directly into the pressure machine and then forced into the mold by air pressure. Centrifugal casting requires that the molten metal revolve at high speed to attain the needed casting pressure.

BUILDING FIREARMS

PRESSURE CASTING MACHINE

The necessary pressure needed to get finished size castings, must be done by one of several methods. I will describe the method that I believe will be the easiest and best suitable for the small shop, which is the use of air pressure.



Pressure Casting Machine

The initial pressure necessary to force the molten metal into the cavity is five pounds. The metal should flow into the cavity without turbulence to prevent air from entering the cavity ahead of the metal.

After about five seconds at five pounds of pressure, they turn up the pressure to 20 to 40 pounds, depending on the density needed in the metal. This pressure is what makes a perfect casting, with no shrinkage, and fills out all the holes, undercuts, etc.

On my pressure machine I used square steel tubing for the frame. We welded the handle where there are no air leaks, and has an air pressure gauge mounted to it. On the far end we mount an air hose coupler so an air hose can be snapped into place.

Under the lever where we mount the pressure cap, there is a 1/8-inch coupler welded to the lever and we mount the pressure plate to this. The pressure plate is a circular piece of aluminum 1/4 to 3/8 inch thick, one inch larger than the size of the flask. You will need several of these to fit the different sizes of flasks. We drill and tapped it for 1/8 N. P.T. pipe thread.

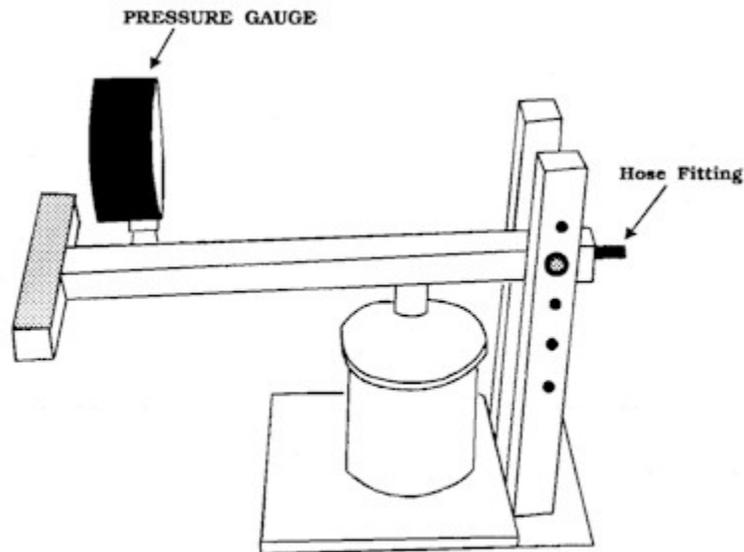
To this piece affix a good adhesive such as silicone for automobile engine gaskets, three

BUILDING FIREARMS

layers of sheet asbestos cut to size. This will seal the air pressure on the flask. We drill several holes in the up rights where we mount the lever. When you make the flasks, we should make them a certain height so the pressure plate will come down flat and seal it.

The flasks for pressure castings can be from any suitable tubing strong enough to withstand the pressure. After we invest the part, we make a reamer that will ream part of the top of the casting from the flask. This is done so the molten metal will flow directly into the mold. After the investment is set, we make a radius reamer, which can be any type of sheet metal or thin gauge metal, and we attach a rod to it for a drill.

The process also involves the use of other homemade equipment. We will start from the very beginning, which is the preparation of wax for a pattern and going through with each step necessary to complete a successful casting.



Side View Of Pressure Casting Machine

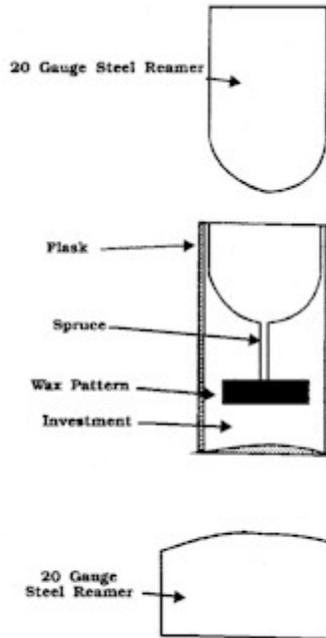
MAKING A WAX PATTERN

On larger parts, you will make the pattern from wood or aluminum. If you use wood it will need to be sealed so moisture cannot penetrate it. The finish needs to be flawless, as the finish castings will show all the marks that you have left on the surface. Making the finish part and then make a mold for it is best so you can make the wax patterns. By using investment castings and the pressure machine, you will not have to worry about shrinkage that you would have with sand or plaster castings. The finish part would be finished as it comes from the mold.

Besides, various wax wire shapes and sheet waxes, there are many other forms. Among these are hard carving wax, this wax yields readily to files and knives and can be sculptured into the most intricate designs and patterns.

BUILDING FIREARMS

Also available is a sticky wax, and this can be used to fasten the various shapes together.

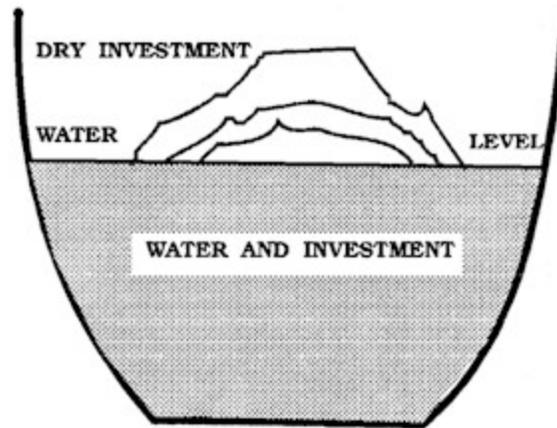


CROSS SECTION OF FLASK

The sprue piece must be fixed to the pattern. Holding the sprue wire in intimate contact with the pattern and fusing the two pieces together. We can apply the heat to the joint with a pointed probe that we have heated over a flame. Be sure that the wax sprue wire is securely fused to the pattern to prevent subsequent loosening.

If you have an unusually large wax pattern, multiple spruces may be necessary. Note that each sprue ends at the center of the circular bottom plate and there is a space between each sprue. This technique can also be used if more than one wax pattern is cast at one time. Instead of the one large wax pattern, each individual sprue could hold one ring. In this manner it is possible, depending on the size of the flask, to cast up to four or more rings or small patterns at one time.

BUILDING FIREARMS



MIXING INVESTMENT

BUILDING FIREARMS

INVESTING WAX PATTERNS

To reduce surface tension on the wax pattern and sprue, we must paint a debubbler over all the surfaces. Commercial debubblers are available. Equal parts of tincture of green soap and hydrogen peroxide make a very good debubbler.

Flow on an ample coat of debubbler, making sure it wets all corners and undercuts. Set the spruced pattern aside and permit the debubbler to dry thoroughly.

When the debubbler has dried, rinse the pattern in a beaker of clean water. Observe the pattern to be sure the water wets all surfaces. If the water forms small globules on the surface of the pattern, repeat the debubbling procedure. Again permit the pattern to dry thoroughly, rinse, and inspect. If we have not rinsed most of the debubbler from the pattern, an excessively heavy oxide will result on the finished casting.

Many flasks should be prepared in anticipation of the various patterns that may be cast. We can make the flasks from either brass or stainless steel tubing. Cutting several tubes approximately 2 inches in height. A good supply of flasks would range from 2 to 4 inches in height. The diameter of the flasks should vary according to the size of the casting that you need.

Select a flask at least 1/4 to 1/2 inch larger in diameter than the overall width of the wax pattern. The flask should be from 3/16 to 5/16 inch higher than the spruced pattern. A sufficient amount of investment should cover the pattern to prevent the molten metal from breaking through the bottom when the metal is cast. This thickness should not be so great, however, as to prevent the free passage of gasses through the bottom of the invested flask.

Next cut strips of sheet asbestos approximately 3 inch less than the height of the flask. Form these pieces over the outside of the flask to give them curvature. Insert enough pieces into the flask to cover the inside. A small amount of overlapping is permissible. We need the asbestos to absorb expansion of the investment during burnout. We should center the pieces with relation to the height of the flask. The exposed areas, both top and bottom, with no asbestos covering, will act as locks to retain the investment within the flask when we remove the flask from the burnout oven and transported to the casting machine.

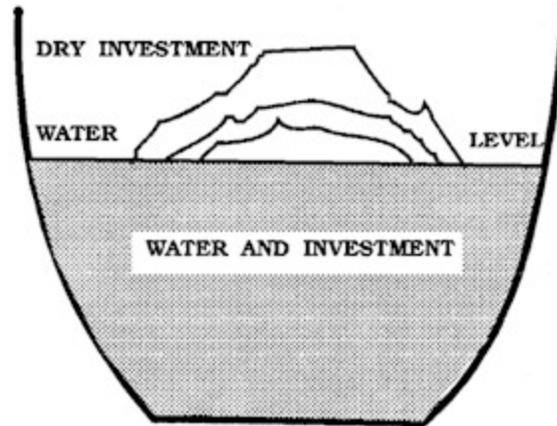
Dip the asbestos-lined flask into a beaker of water. Wetting the asbestos is necessary to prevent excessive absorption of water from the investment. After we have dipped the flask, iron out with the index finger any air bubbles under the asbestos. Set the flask aside and permit any excess water to drain.

Place the asbestos Lined flask over the spruced pattern. Center it with relation to the wax pattern. We can hold the flask in place with a small quantity of sticky wax around the bottom at the junction of the flask and base.

BUILDING FIREARMS

MIXING THE INVESTMENT

The next step is to mix the investment. If your flask is 1" inches high and 1" inches in diameter, measure out about one ounce of water at room temperature. Place the water into the mixing bowl. With a spatula, sprinkle the dry investment on the water.



MIXING INVESTMENT

Sprinkle on only small amounts of the investment at a time. At first the water will absorb the investment and it will sink to the bottom. Eventually the dry investment will begin to build on top of the water.

If the pattern is intricate and detailed, we will need a thin mixture of investment. If the pattern is bulky, we will require a thicker investment. Although a thinner investment will more readily conform to an intricate pattern, it is inherently weaker. No hard-and-fast rule can be used to determine the consistency. Begin with a consistency approximately that of a pancake mixture.

Next, mix the dry investment by hand to produce a homogeneous mixture. The dry investment will tend to adhere to the mixing paddle of the vacuum mixer if not completely mixed and this can result in a distorted investment.

We can vibrate the hand-mixed investment to dislodge air bubbles. The purpose of vacuum mixing or vibrating is to remove all air bubbles captured in the mixed investment. After casting, air bubbles against the pattern will appear as nodules of metal. We can usually remove these with pliers but sometimes they have become so firmly attached that we ruin an otherwise good casting.

Hold the flask containing the pattern and vibrate the investment into the flask. The thumb of the left hand is in intimate contact with the vibrator. The thumb acts as a dampening device from vibrations transmitted to the flask and prevents breaking the sprue or wax pattern.

BUILDING FIREARMS

The cup containing the investment is placed directly on the vibrator and tilted forward until a steady stream of investment flows into the flask.

When the flask is completely full of investment, we should again vibrate it directly on top of the vibrator with the little finger acting as a cushion. This additional vibration is an added safety measure to be sure that we have captured no air bubbles in the investing process. Naturally, if a vibrator is not available, we can pour the investment directly into the flask.

An alternate method of investing is to directly immerse the pattern into an investment-filled flask. This method is normally used if the pattern has severe undercuts, such as will be found on some frames.

If the pattern is extremely intricate, it is often a good idea to paint the investment on with a small brush. In this manner we can flow the investment into the most intricate cavities.

The painting of the pattern is an added safety measure and can be used with either of the two investment methods outlined previously.

Set the invested flask containing the pattern to one side for a minimum of one-half hour. This is necessary to give the investment sufficient time to absorb any free water.

If free water is present when the burnout schedule begins, there is a tendency for the water to form steam that will break down or distort the investment.

Remove the bottom plate from the flask with a twisting motion. The point at which the sprue attaches to the bottom plate will normally detach from the plate and be retained in the investment.

When the investment has set for one half hour, it should be hard to the touch. With a sheet metal reamer approximately c inch in diameter smaller than the inside diameter of the flask, ream a cavity into the investment. Use the wax sprue wire as a guide to center the reamer. Occasionally clean off the buildup of investment on the reamer. The reamed cavity will hold the casting metal after burnout.

The reamer should have a large radius so it will not cut too deeply into the investment. Reaming the top is necessary to provide a cavity for the melted metal. We ream the bottom to assure that none of the investment projects below the flask so the rim will present a flat surface to the casting machine. We now completely invest the pattern and ready for the burnout process.

BUILDING FIREARMS

BURNING OUT THE WAX

Since we must make the actual casting immediately after burning out the pattern, while the mold is still hot, burnout and casting are almost one continuous operation. So, the pressure-casting machine must now be set to the correct height. If you are using a large pattern you can probably get by without the pressure machine.

However for the best casting I would recommend the pressure machine. Center the invested flask with respect to the base and the pressure plate. Remove the fulcrum pin and select the correct hole so that the lever arm of the casting machine will be as nearly parallel to the base as possible. Replace the pin. Press the lever arm down so that the pressure plate firmly contacts the flask. Release the pressure and repeat the pressure application to the flask many times. We attach the pressure plate to a swivel and may not completely seat with the first application of pressure. We now adjust the casting machine to receive the flask.

Place the invested flask into the burnout oven, with the sprue opening down. Close the door of the oven and turn on the switch, Normally, the burnout sequence takes about one hour.

This is dependent on the wattage rating of the oven and the number of flasks being burned out at one time.

If your oven is equipped with a pyrometer, it is a simple matter to gradually bring the temperature to 1200 degrees. Hold the temperature at 1200 degrees for ten to twenty minutes. The initial heating of the flask should be with the sprue hole facing down.

As the heat penetrates, the wax will become molten and flow through the sprue hole onto the floor of the oven.

This operation of preheating, applying borax and reheating the metal should be done as quickly as possible to prevent excessive loss of heat from both the metal and the invested flask.

If you are using the pressure machine, begin pumping the foot pump to bring the pressure to approximately five to ten pounds. Hold this pressure for approximately two to three seconds and then bring the pressure to from twenty to forty pounds. We should maintain the higher pressure for approximately two or three minutes.

The initial pressure will gently force the metal through the sprue opening into the cavity. The higher pressure is necessary to attain density in the finished casting. Remove both the air pressure and the lever arm pressure from the flask. Permit the flask to cool for about five to ten minutes. At this point the casting operation has been completed.

Either a foot pump or a compressor can apply pressure to the casting machine. The compressor, if used, should have a rating of twenty to thirty pounds of free air per minute and a capability of generating at least thirty pounds of pressure. The use of an air compressor

BUILDING FIREARMS

will require the modification outlined in the section on how to build a pressure-casting machine.

After the initial cooling period, remove the flask from the casting machine using a pair of suitable tongs. Plunge the flask into a bucket of water at room temperature. As the water contacts the hot investment, steam will be generated and the investment will disintegrate into the water. Permit the flask to remain submerged until completely cooled.

BUILDING FIREARMS

CLEANING THE CAST PART

If the casting has not already dropped from the flask, when the flask is removed from the water, gently force the casting from the investment. Some investment will stick to the finished casting.

With a stiff bristled brush and a good laundry soap, scrub the casting thoroughly to remove all traces of investment. We can probe stubborn areas with a sharp nail to help remove the investment.

The casting must be pickled to remove the oxide. The pickling solution can be either a 10 percent solution of sulfuric acid in water. Although the acid-water solution is a little more dangerous, it does a better job. Also a safety reminder, if the acid water solution is used, always pour the acid into the water to prevent splattering of the solution. Pickle the casting until all traces of oxide have been removed. Remove the sprue with either a saw or a pair of nippers. The casting is now completed.

BUILDING FIREARMS

SUMMARY

Making the Frame will be the first item to start on, and if you look closely, you will see that in most cases I have omitted the thickness of the parts. The reason for this is that the availability of suitable steel in your area may be limited. Get the available steel and build the parts around this. You should know this before you start on the frame.

Making the frame can be as simple as cutting out the parts, and then riveting or silver soldering them to together. If you plan to make more than one, by all means make a master pattern out of wood or aluminum to be used as a pattern for investment casting.

If you are going to investment cast them, the parts (trigger, hammer, etc.) should be completed first. Then cut out the frame pattern, leaving it flat for drilling the holes for the hammer and trigger. The holes for these can be drilled with number drills of the right size. Set the hammer and trigger in the proper place, (this may take a little time) clamp them place and drill the holes.

When drilled the hammer and trigger should pivot and set at the correct angle. To save time if you use investment casting, you can use an old gun for a pattern, then the holes will be in the proper place. With Investment casting you can duplicate any firearm design.

BARREL PATTERNS

Barrels can also be Investment cast to finish size, and then drilled out and lined with a rifled steel tube, thus saving many hours of time. In making a barrel pattern, the pattern can and probably should be made from aluminum or other metal. The reason for this is the many different machining and drilling processes involved. However, the basic barrel pattern could be made from wood, cast, and then the machining operations completed. The finish-machined barrel could then be used as the master pattern for the wax, mold.

On many short barrel guns, the barrel assembly works out very well cast. If you plan to cast the barrel assembly, be sure to center drill the pattern where you will drill it out for the liner before making the master mold for wax. When completed, it will be a simple matter to center the barrel in the lathe and drill the barrel (see chapter on barrel turning.)

Sights, in most cases can be installed on the barrel after finishing, but if you want they can be cast in one piece either separately or on the barrel. On the short barrel guns, the sights can be cast with the barrel, which saves much machining time.

Any parts that will be used continually should be made from steel. This includes triggers, sears, barrel latches, hinges for the barrel, and extractors. Many parts can be cast and then the holes that are used continually bushed with a steel bushing.

BUILDING FIREARMS

STEPS IN MAKING PARTS

To be on the safe side in designing a firearm that will work right the first time you need to do the following.

1. Cut out the outline of the frame from aluminum and leave it flat as cut. From this main pattern you can fit all the parts, such as hammer, springs that has holes drilled through the frame.
2. Determine what the thickness will be on the hammer and trigger.
3. Cut out the hammer and trigger from either aluminum or steel. Finish out these parts as close as you can leave a little extra metal for final fitting. Drill the hinge or pivot holes in their proper location.
4. Place these parts on the outside of the frame. The hammer and trigger pivot hole can be already drilled at their exact locations if you want. Otherwise, with the parts on the frame (start with the hammer) in the proper place, clamp the parts and drill a hole through the frame. Place a pin the correct size into the frame and place the hammer over it. You now have a hammer that will rotate as it would in use.
5. Next locate where the trigger should be and repeat the above step. Once the trigger and hammer are mounted on the frame, they can be hand fitted to work properly in relation to each other.
6. On the inside of the frame can be machined out to fit all the inside parts. Most of it can be machined out using end mills, but in the corners you will probably have to square it up with a file. When milling, use a slightly smaller mill than the finish width as in most cases if the parts were .250 thick and if you use a .250 mill it would cut oversize. After the final milling is completed, move the end mill over a few thousandths for a cleanup pass. There should not be over .003 to .005 clearance when completed.
7. Take all the inside parts that you have made, and try them to be sure that they all fit, doing any final fitting on the frame that is necessary. Make sure that you have sufficient room for the springs.

SPRINGS

The springs can now be made for your gun. Soft spring stock can be purchased from Brownells (see appendix) in various size and thickness. Springs will give you the most problems until you learn how to temper them properly. Shape out the spring with a file and grinder, smooth and polish it. Drill any holes that you need in it and then carefully bend it to the shape that you need. Be careful that you do not twist the spring. Now you can heat treat the spring.

BUILDING FIREARMS

HEAT TREATING THE SPRING

If the spring is small, it can be heat-treated with a butane torch, otherwise it must be done in a heat treat furnace. You will need some quenching oil, which can also be purchase from Brownells, otherwise use Olive Oil, or 5 to 10 weight machine oil.

On a small spring barely hold the thick part of the spring with a pair of needle nose pliers. Light the Butane torch, and heat the spring to a cherry red, or about 1550 degrees and immediately quench the spring into the oil. The process is the same for larger springs, as well as for hammers, triggers, etc. After quenching, the part is glass hard and will break easily.

TEMPERING THE PARTS

Springs, you will find are easy to temper after you find out how to do it. Polish the spring to get a bright polish, then carefully holding the spring with the Needle Nose Pliers start heating the spring from the thick end.

Use a small flame on the torch and just play it on the metal. Watch the colors as you heat it up, as they will go from a straw to a dark blue, to a light gray blue. When the color reaches the dark blue move the tip of the flame down the spring. The reason for going to dark blue a moving it down the spring is that as you move it down it goes to the light blue-gray.

If you hold it on the spring till it turned a light blue and moved it, you would go to the next level of hardness and the spring would be too soft. I have found it wise to repeat the process twice, as when I have done this I have almost eliminated spring breakage.

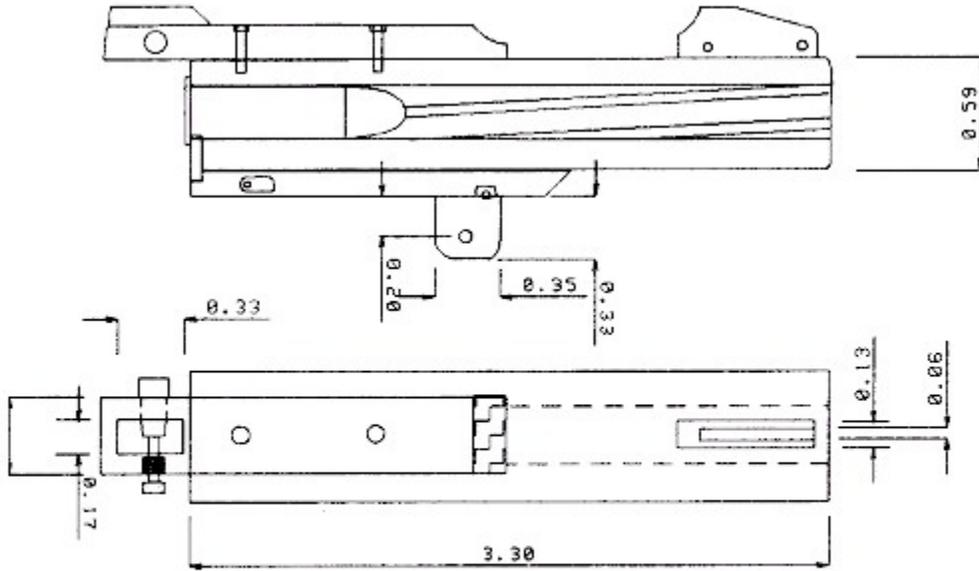
Once the springs are tempered you will need to fit the springs to the action, and drill and tap the frame to fasten the springs in place. When this is done, the hammer can be cocked, and all the parts should work.

Make all the other parts and fit them as above. If you do not want to drill holes now, center punch the places on the barrel or frame at the exact location. When you cast the frame or barrel, these punch marks will still be there and it will be a simple job to drill them.

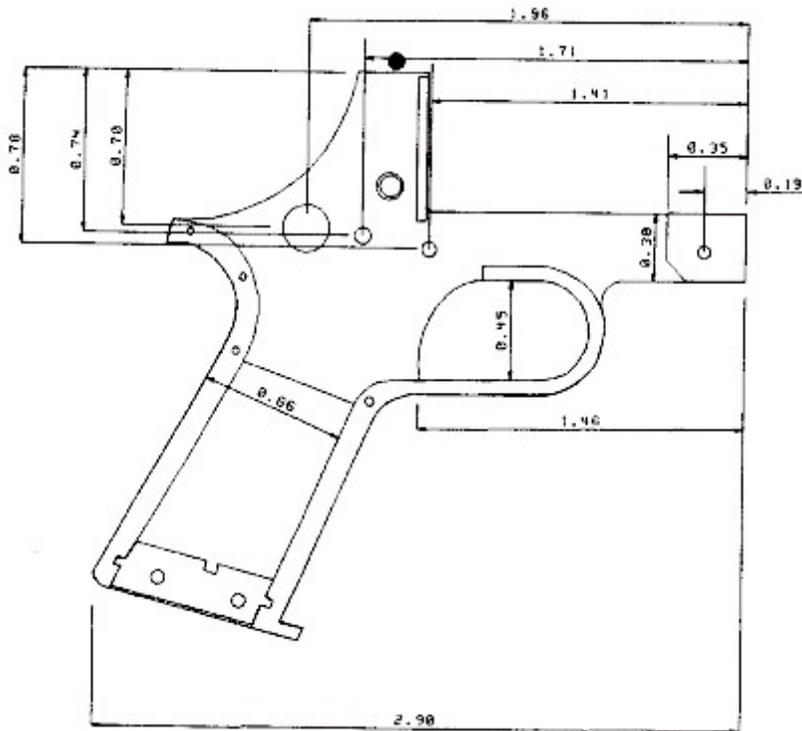
Now with all the parts fitted, finish out the frame to the shape and polish it to a high finish. Now you can use the finish part and make a mold for wax patterns and make a duplicate frame as many times as you like.

BUILDING FIREARMS

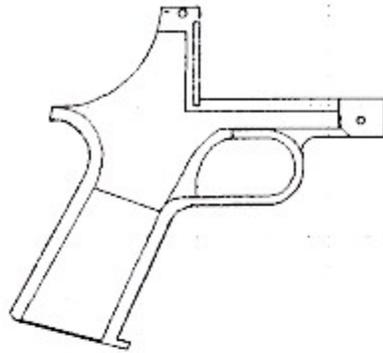
SINGLE SHOT 22 RF



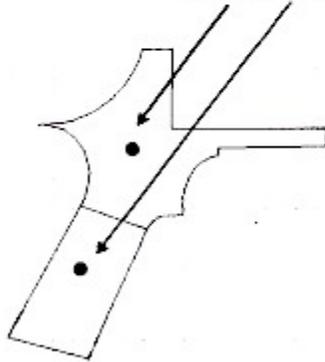
THE BARREL FOR 22 RF SINGLESHOT



BUILDING FIREARMS



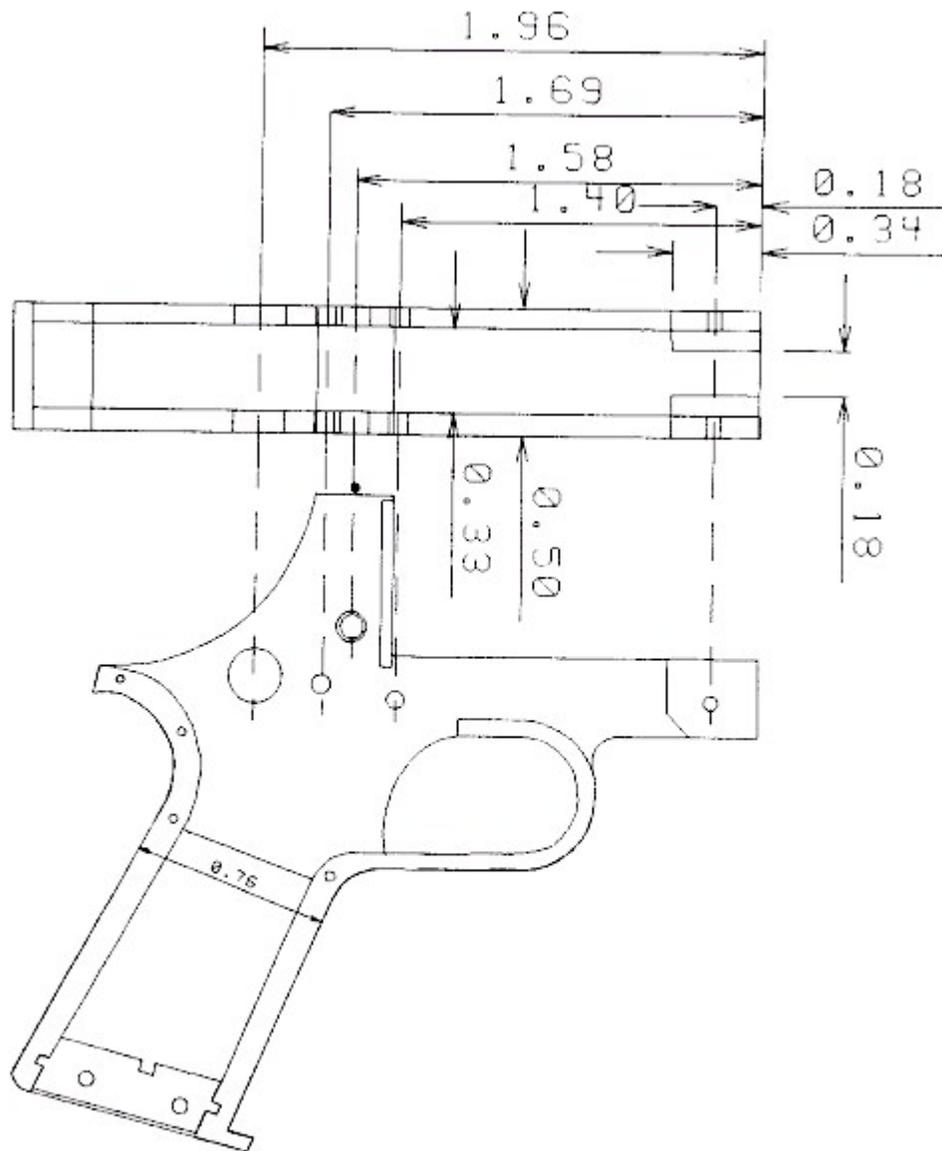
STAND OFF PINS



Frame Pattern
Grid Size is 1.000 inch

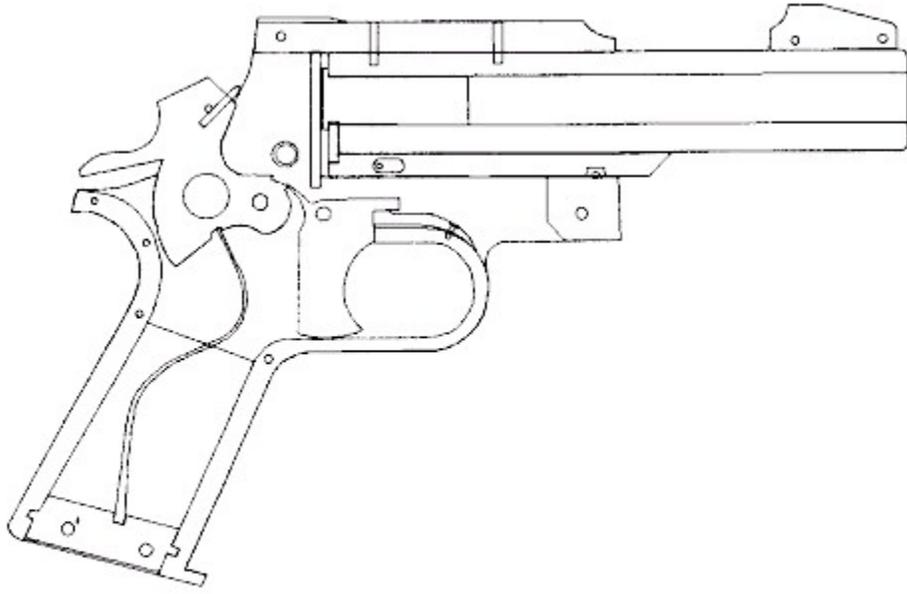
FRAME PATTERN

BUILDING FIREARMS

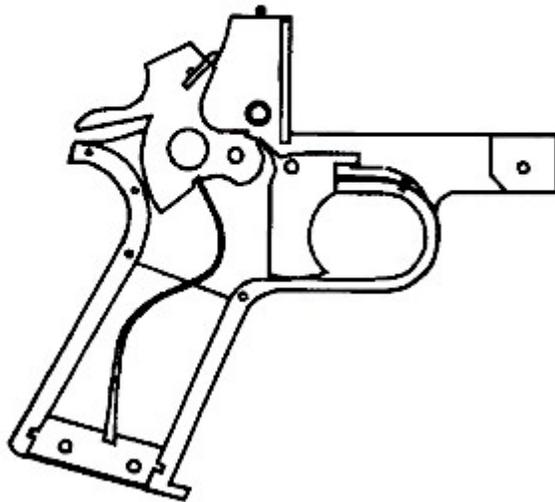
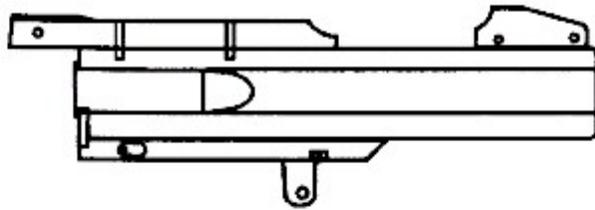


TOP AND SIDE VIEW OF FRAME

BUILDING FIREARMS

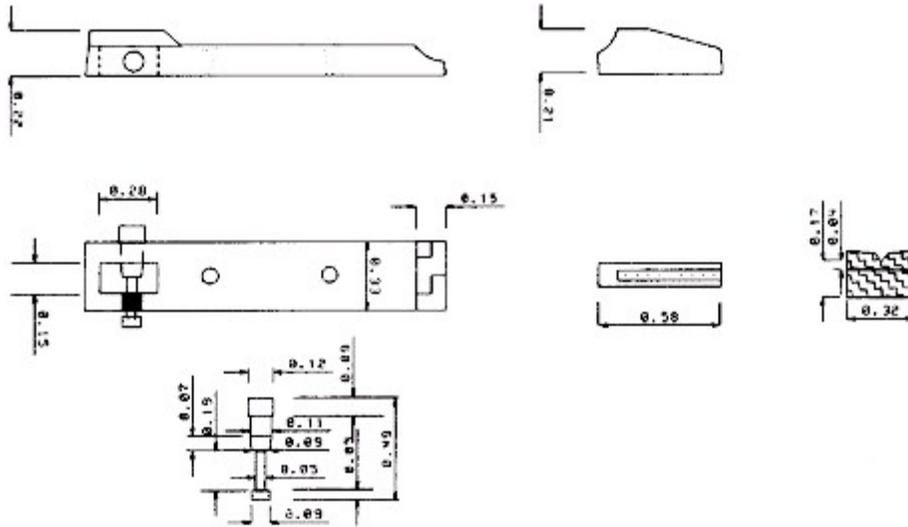


SINGLE SHOT 22 RF

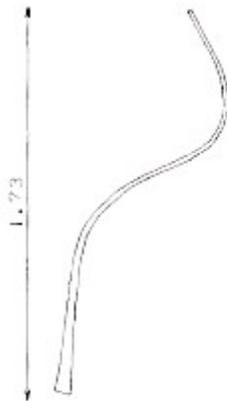


22 RF BARREL AND FRAME APART

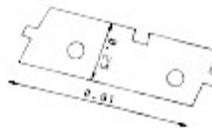
BUILDING FIREARMS



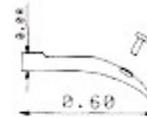
FRONT AND REAR SIGHTS



MAIN SPRING



MAIN SPRING RETAINER



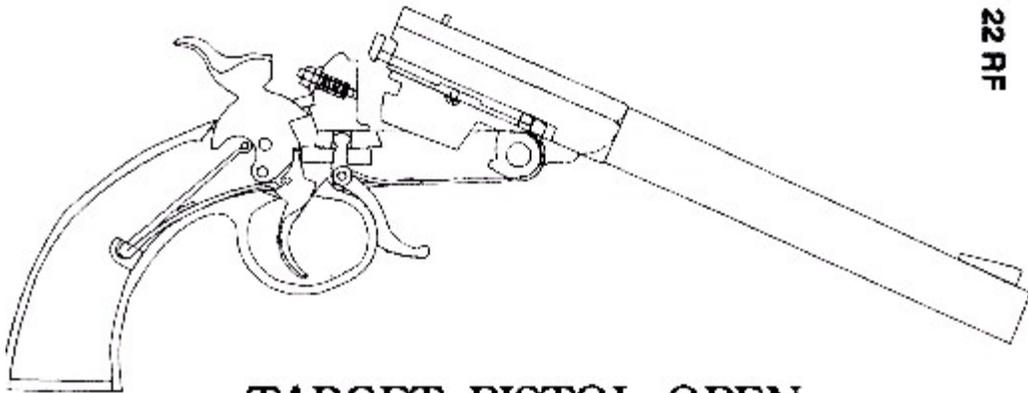
TRIGGER SPRING

SPRINGS FOR SINGLESHOT

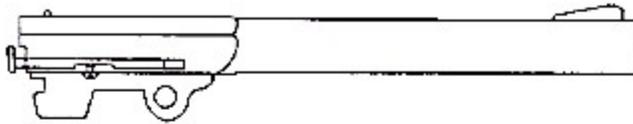
BUILDING FIREARMS

TARGET PISTOL

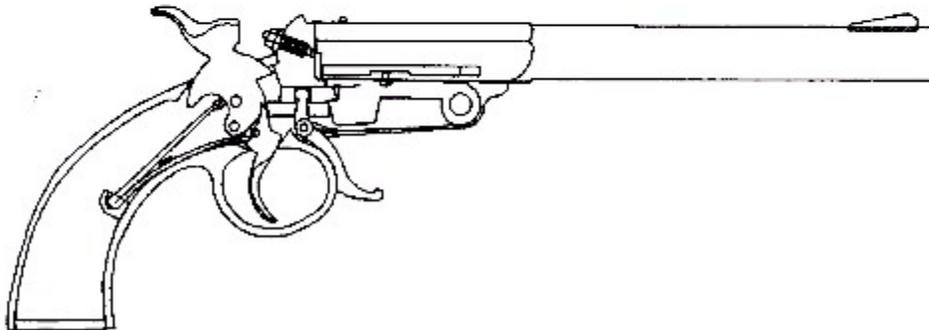
SINGLE SHOT 22 RF



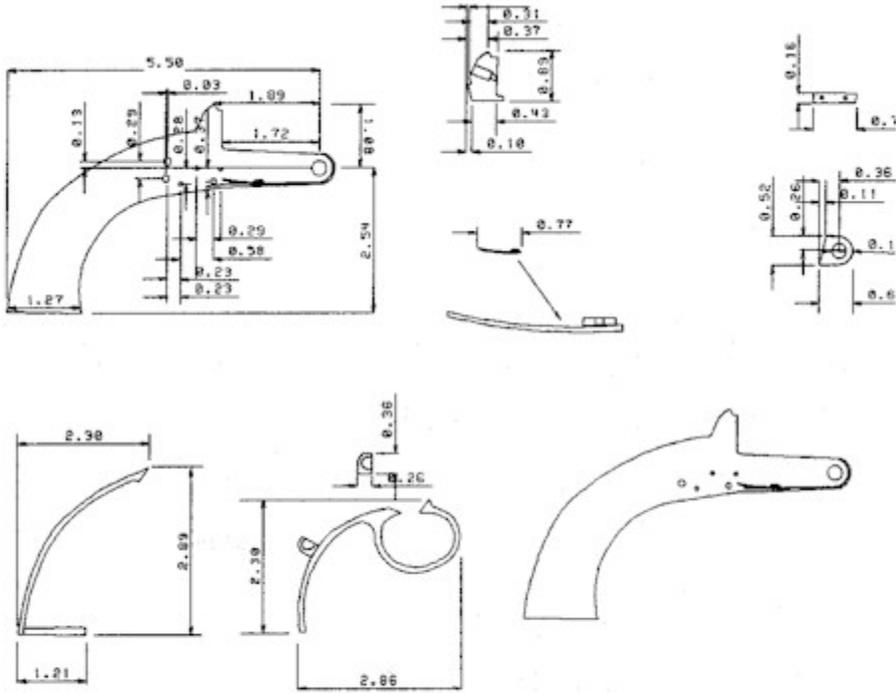
TARGET PISTOL OPEN



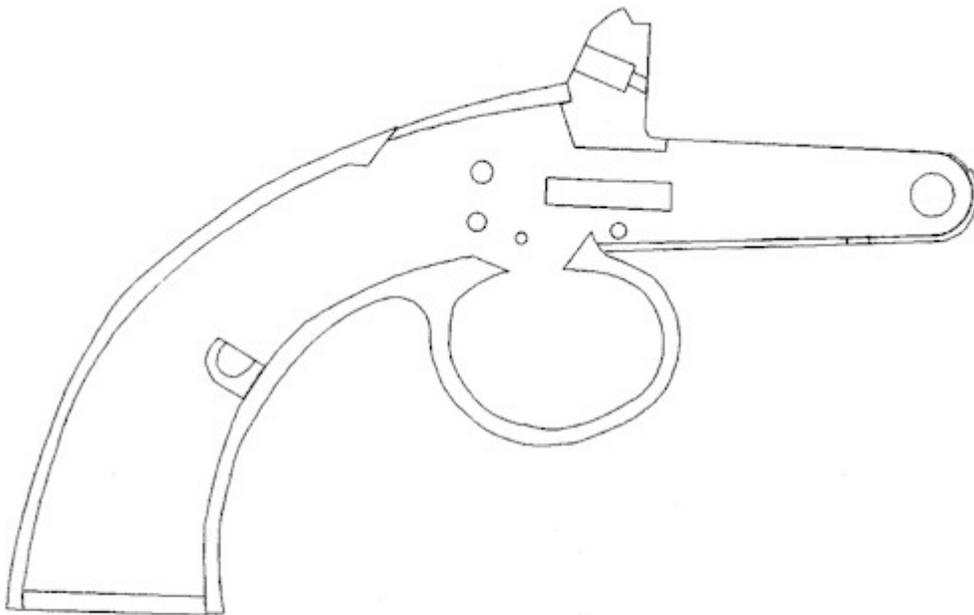
TARGET PISTOL AND BARREL



BUILDING FIREARMS

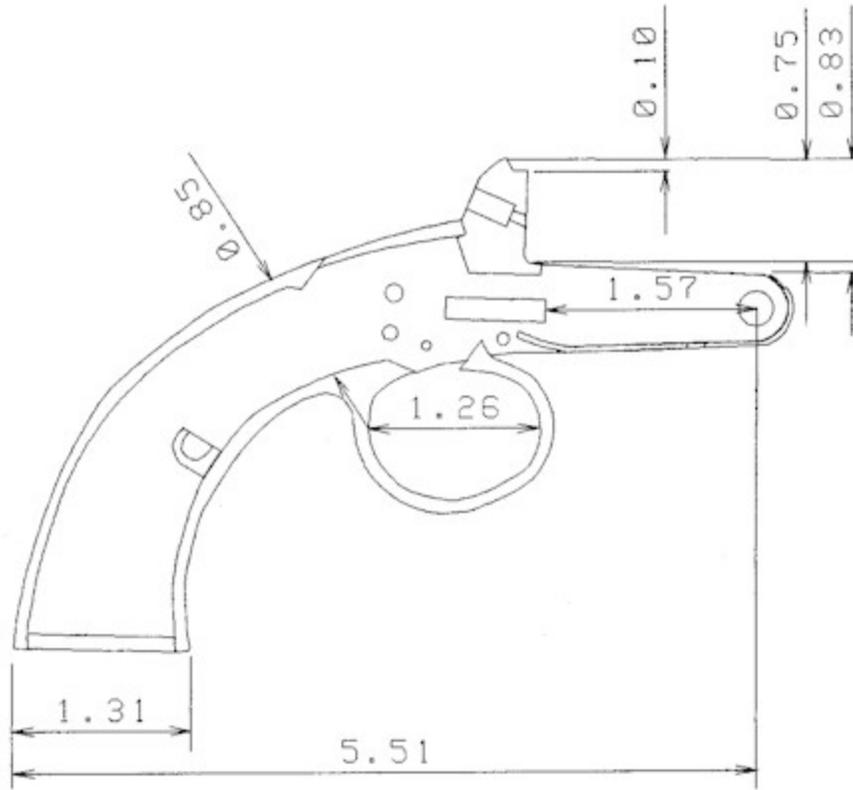


TARGET PISTOL PARTS

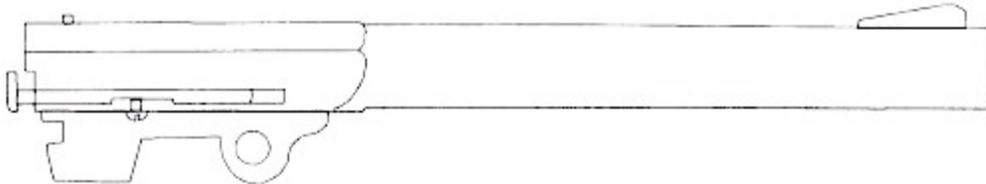


TARGET PISTOL FRAME

BUILDING FIREARMS

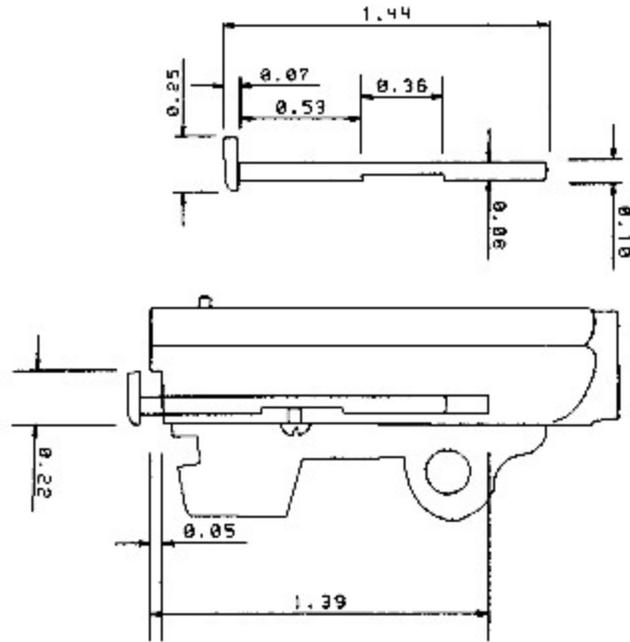


TARGET PISTOL FRAME

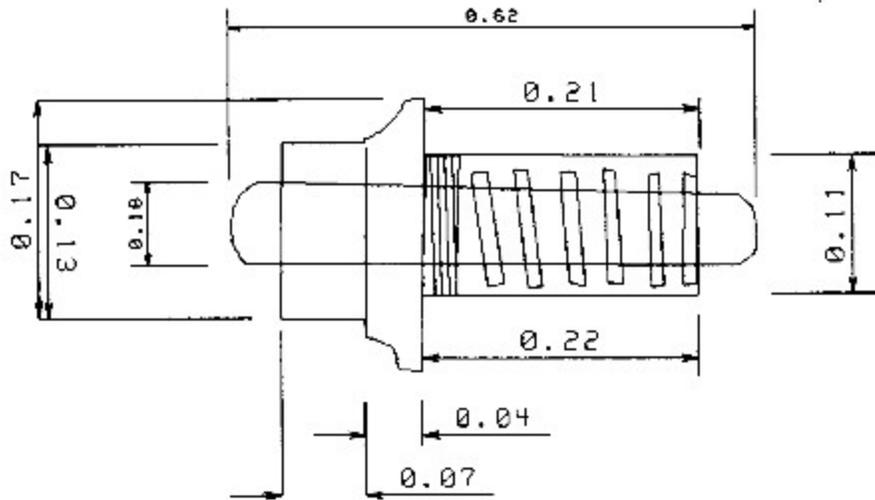


SINGLE SHOT TARGET PISTOL

BUILDING FIREARMS

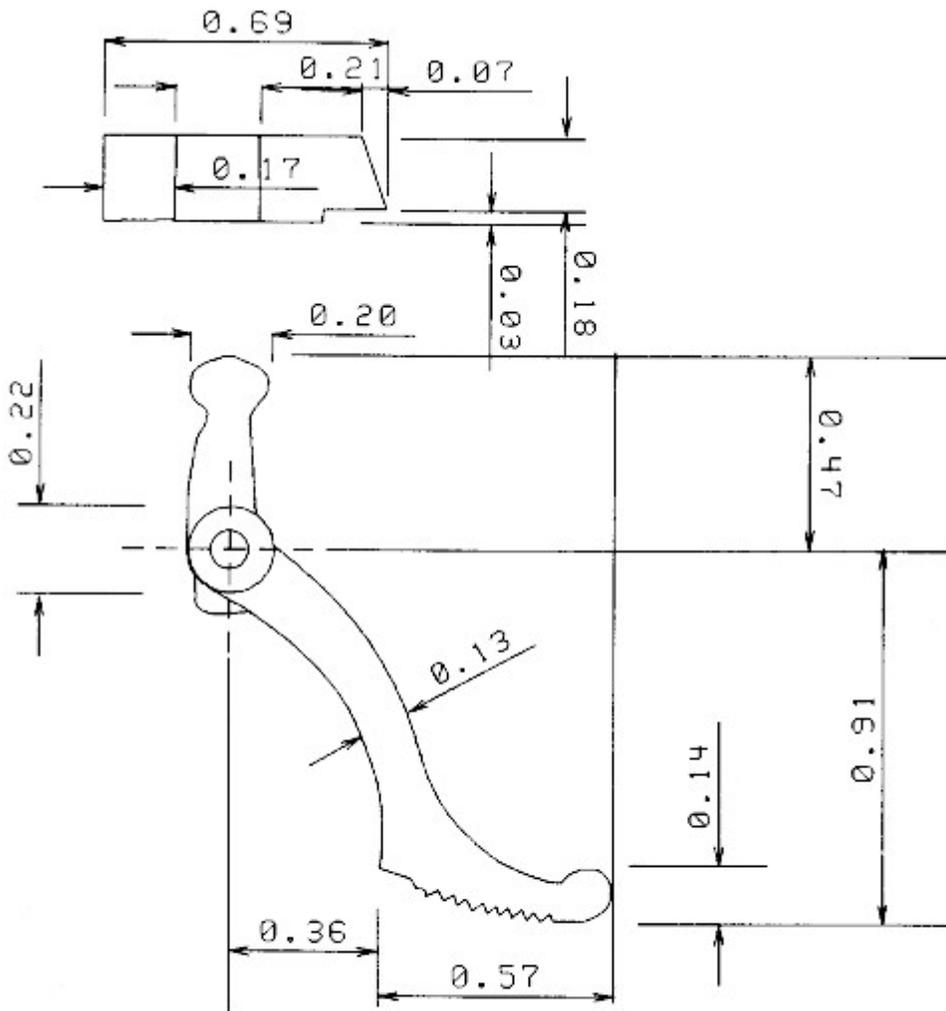


EXTRACTOR FOR TARGET PISTOL.



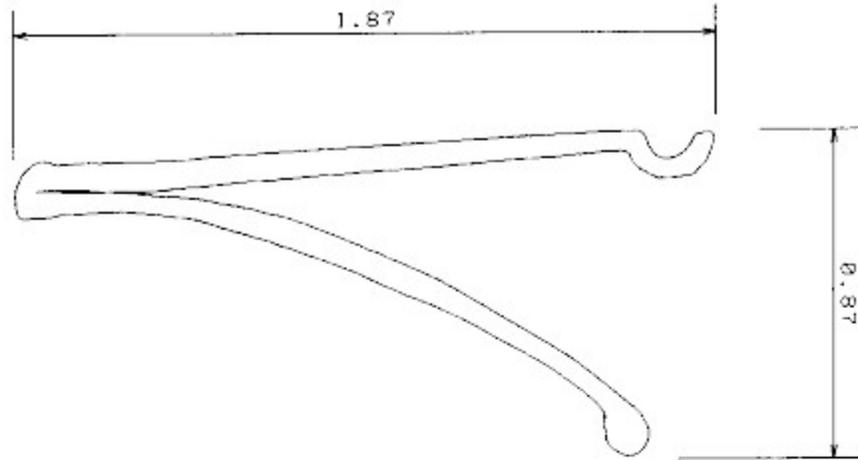
FIREING PIN FOR TARGET PISTOL

BUILDING FIREARMS

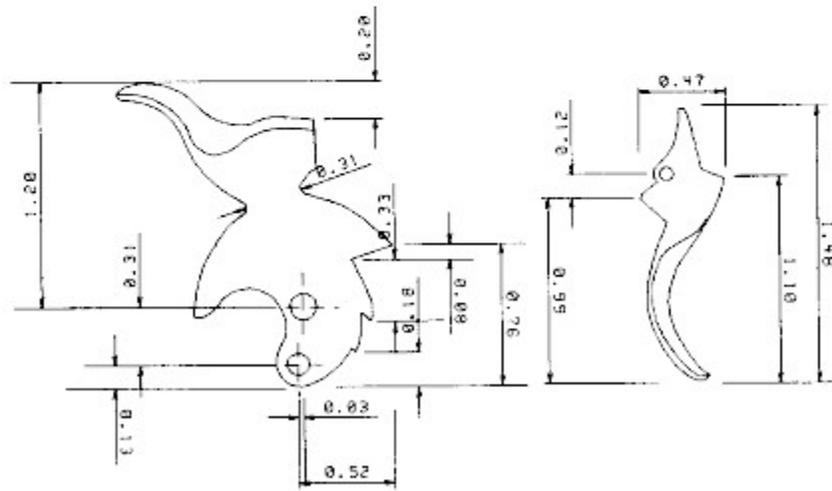


LEVER FOR OPENING BARREL

BUILDING FIREARMS



MAIN SPRING FOR TARGET PISTOL

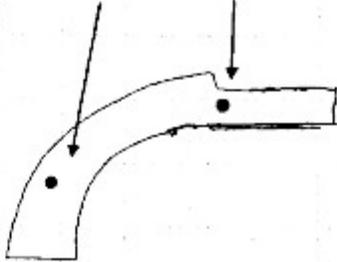


TRIGGER & HAMMER FOR TARGET PISTOL

BUILDING FIREARMS



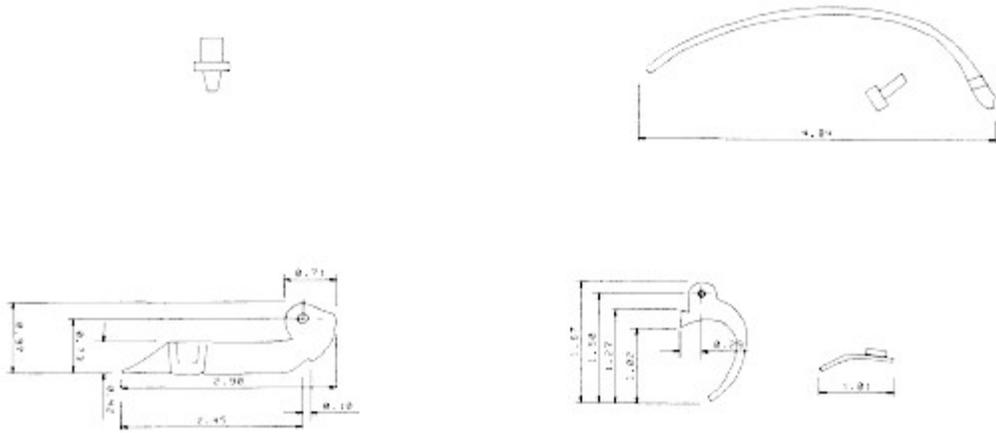
STAND OFF PINS



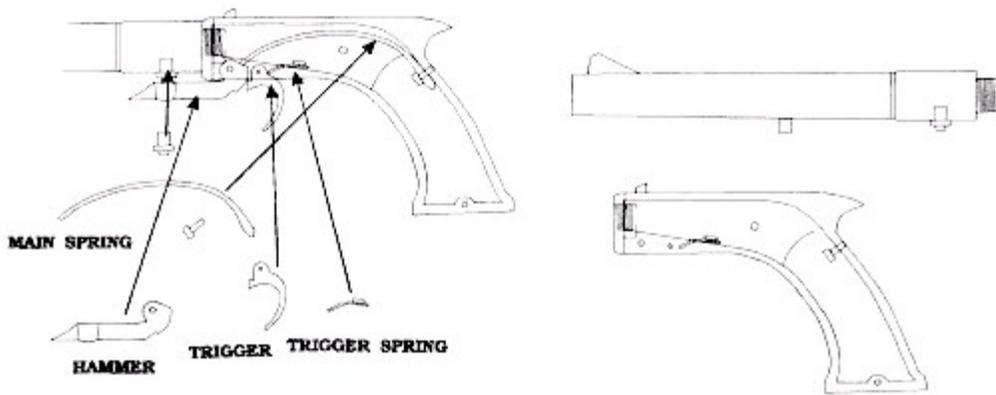
Frame for Larger Pistol
Grid is 1.000 inches

PISTOL FRAME FOR CASTING

BUILDING FIREARMS

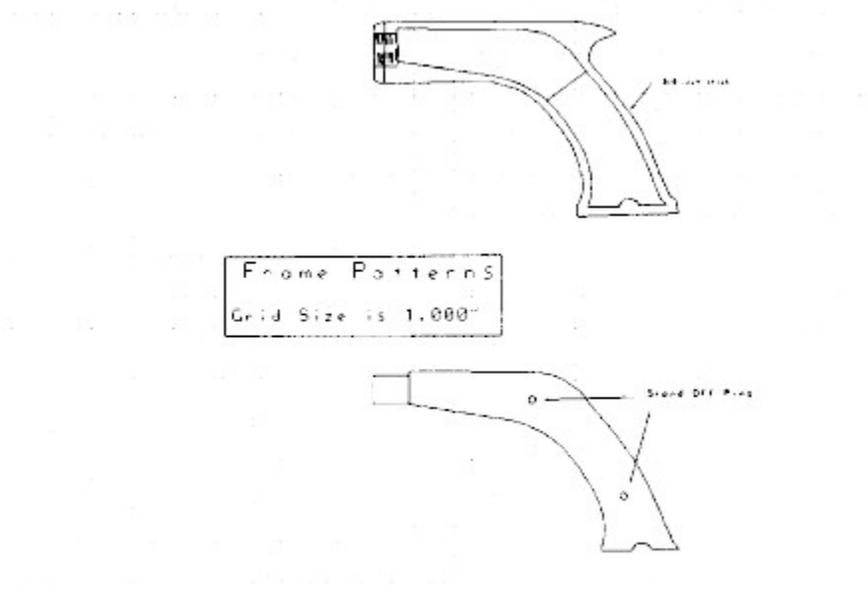


TRIGGER, HAMMER & SPRINGS



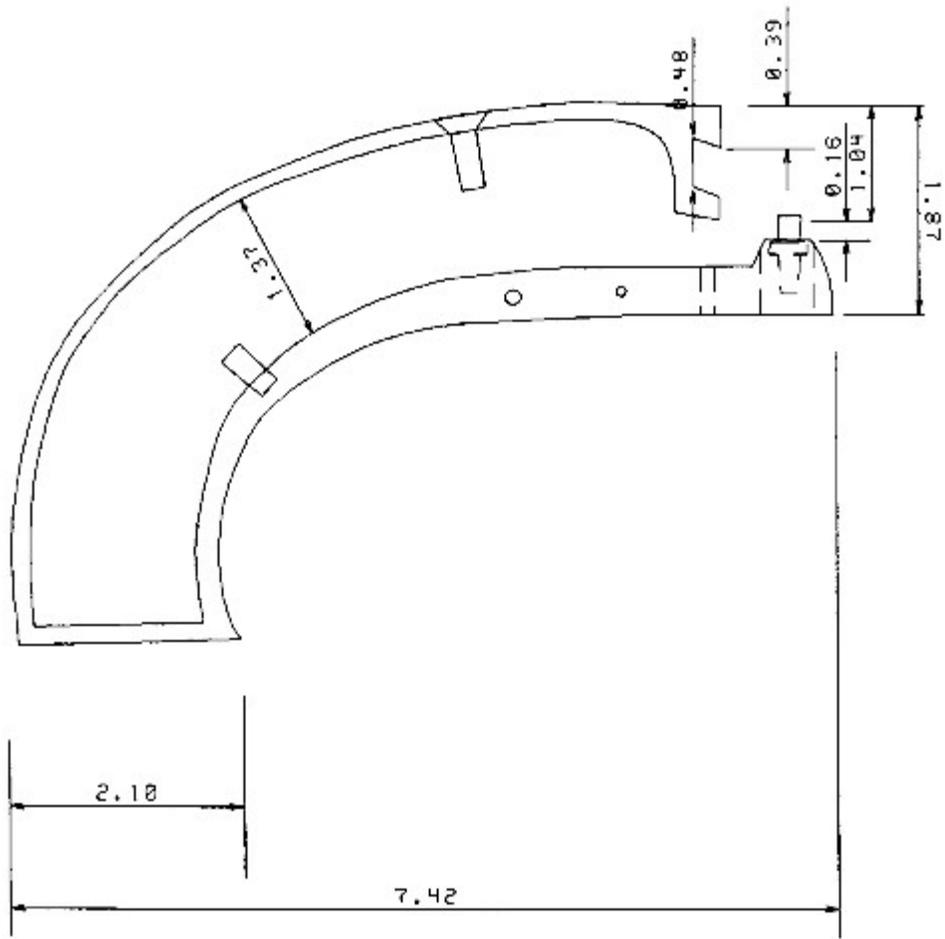
BREAKDOWN OF UNDERHAMMER PISTOL

BUILDING FIREARMS



UUNDER HAMMER FRAME PATTERN

BUILDING FIREARMS

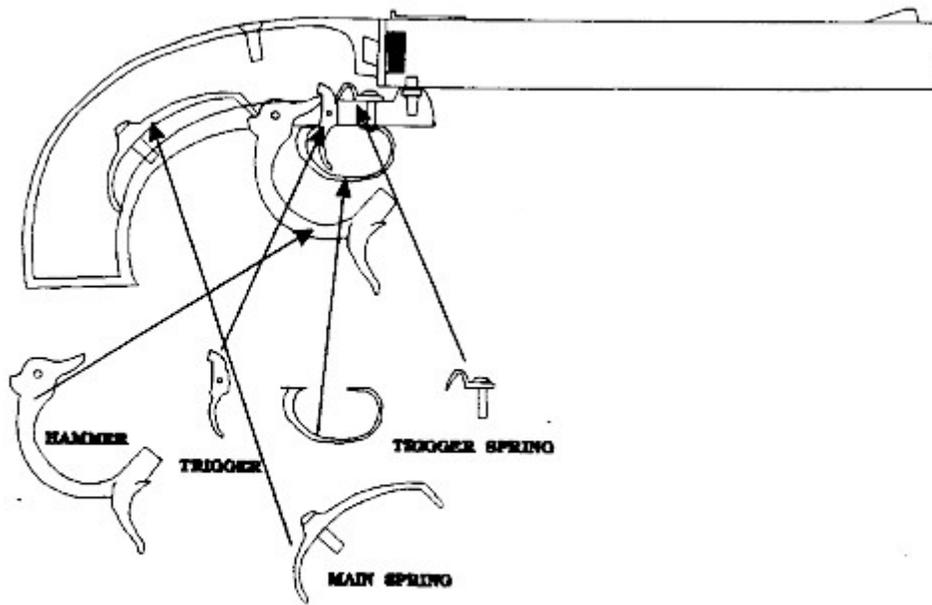


FRAME FOR UNDER HAMMER PISTOL

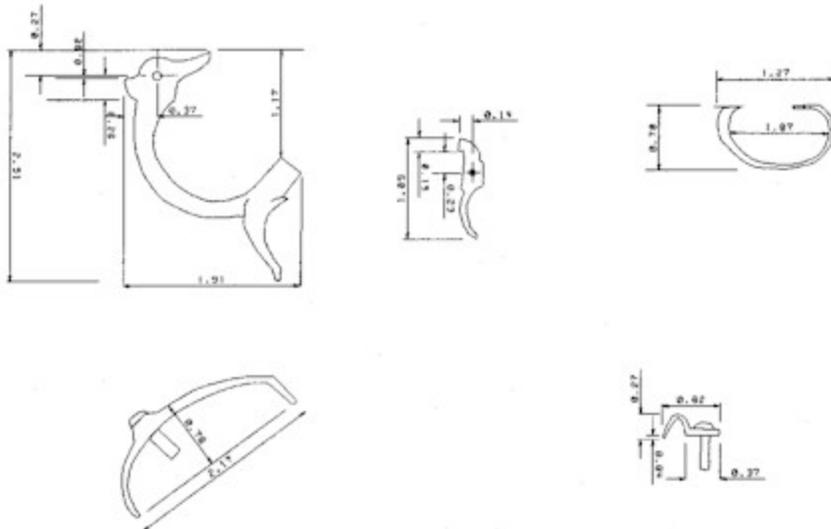


BARREL FOR UNDER HAMMER PISTOL

BUILDING FIREARMS

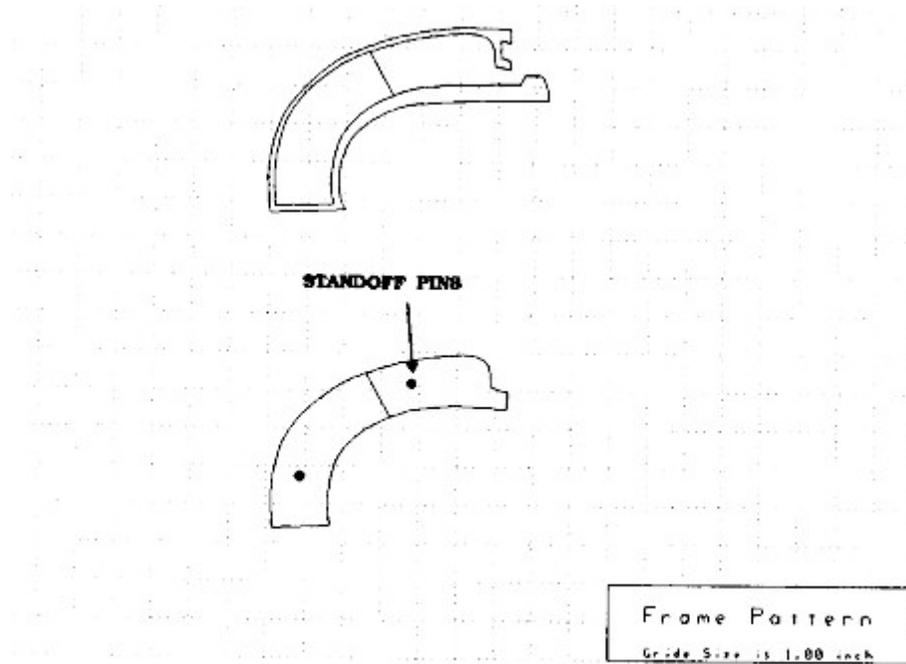


PARTS FOR UNDERHAMMER PISTOL



TRIGGER, HAMMER & SPRINGS

BUILDING FIREARMS

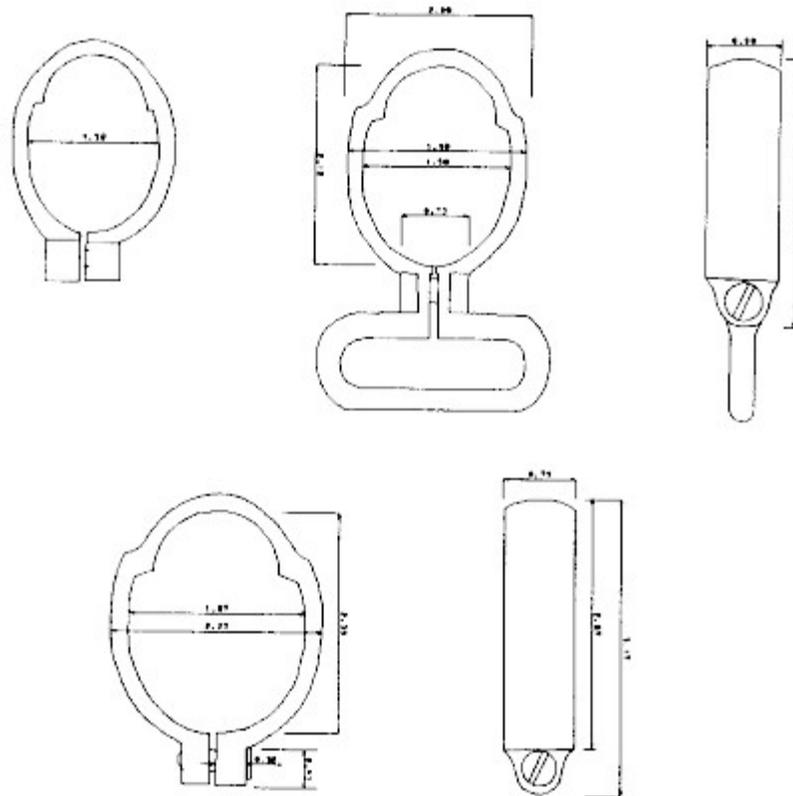


UNDER HAMMER FRAME

BUILDING FIREARMS

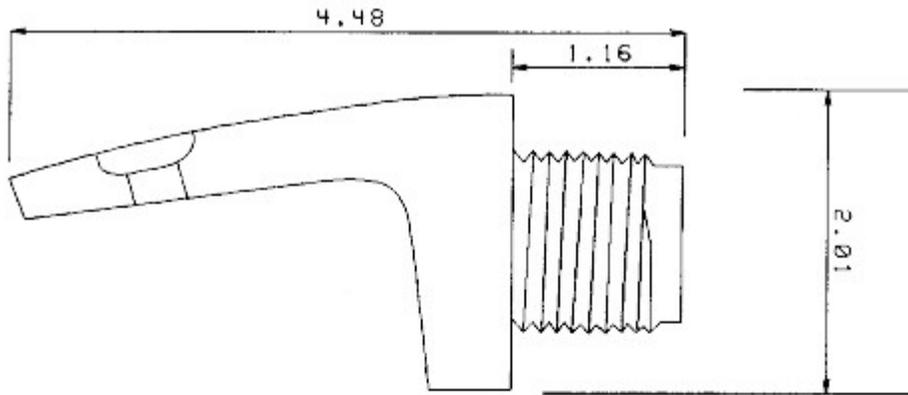
MUZZLE LOADING MUSKET

MUZZLE LOADING MUSKET

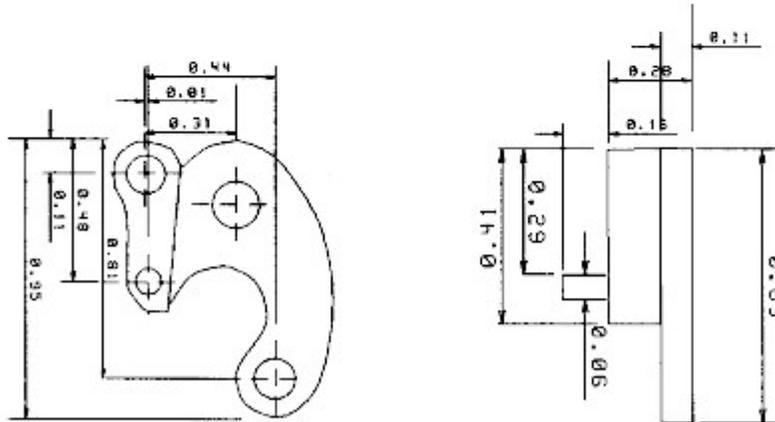


BARREL BANDS

BUILDING FIREARMS

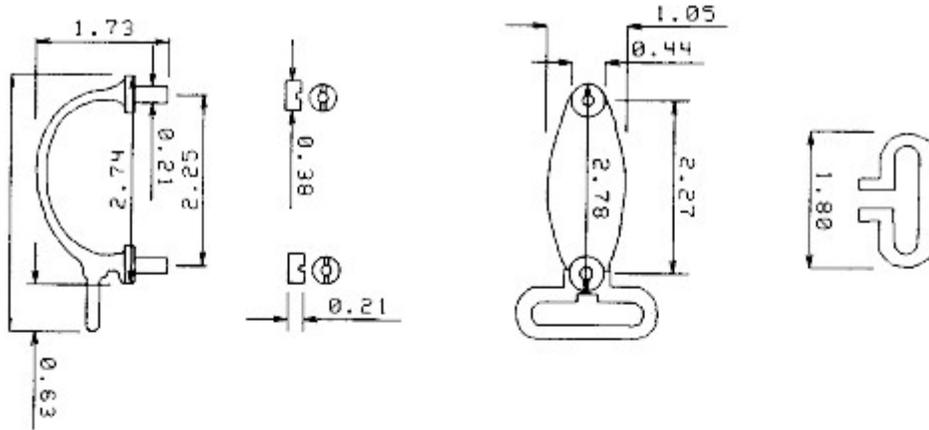


BARREL BREECH

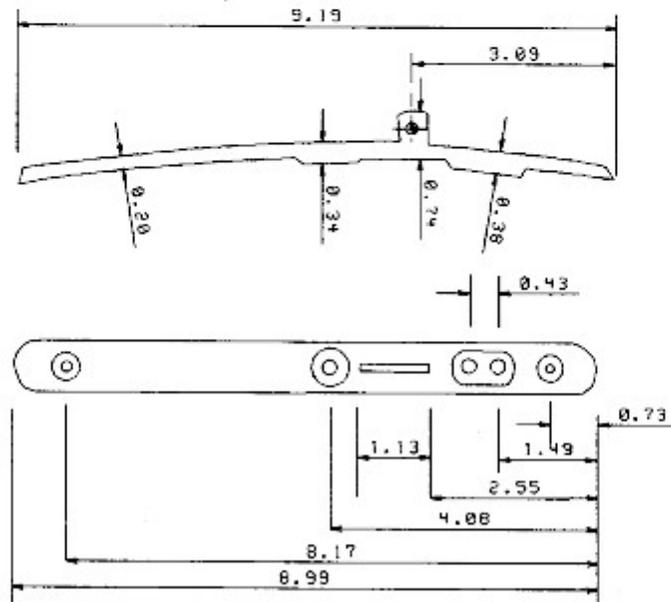


BRIDLE

BUILDING FIREARMS

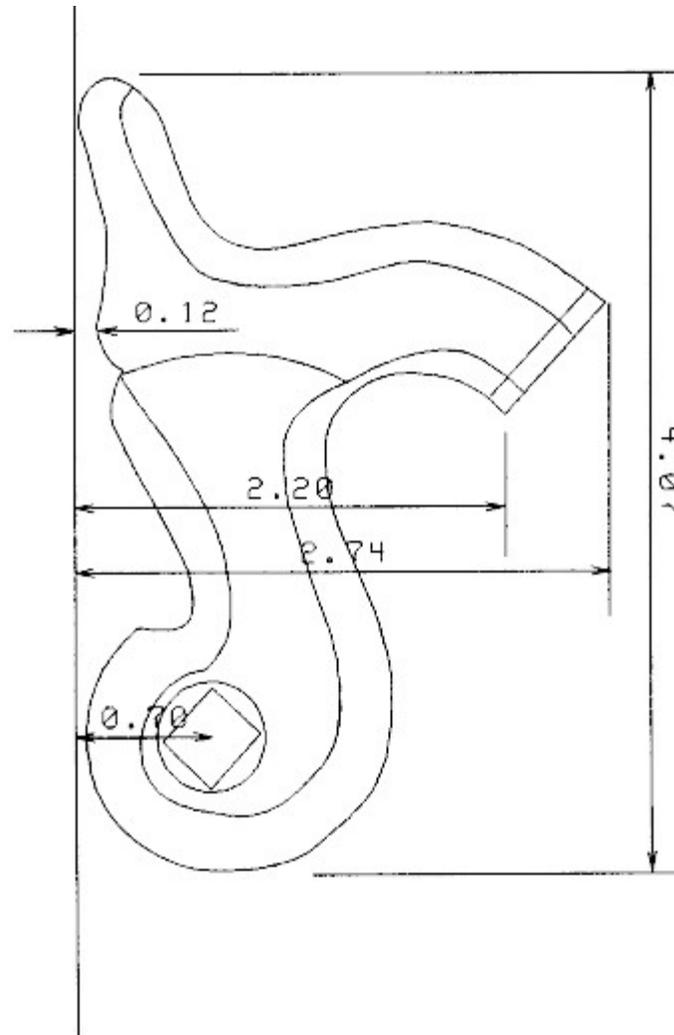


TRIGGER GUARD



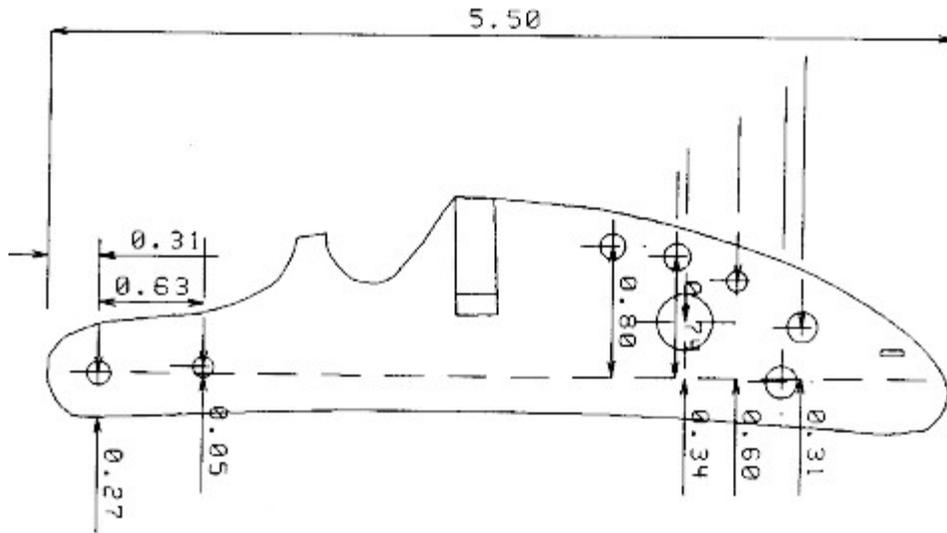
GUARD PLATE

BUILDING FIREARMS

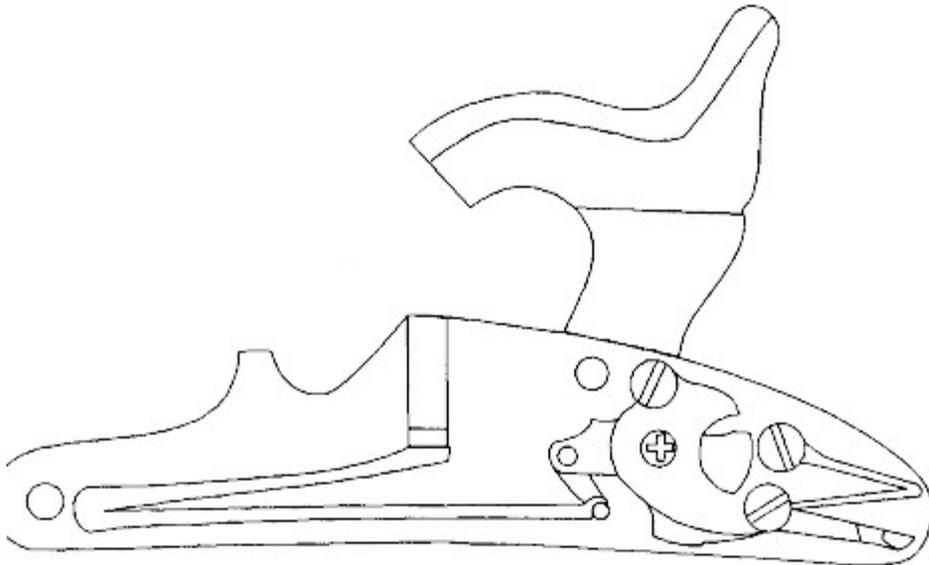


HAMMER

BUILDING FIREARMS

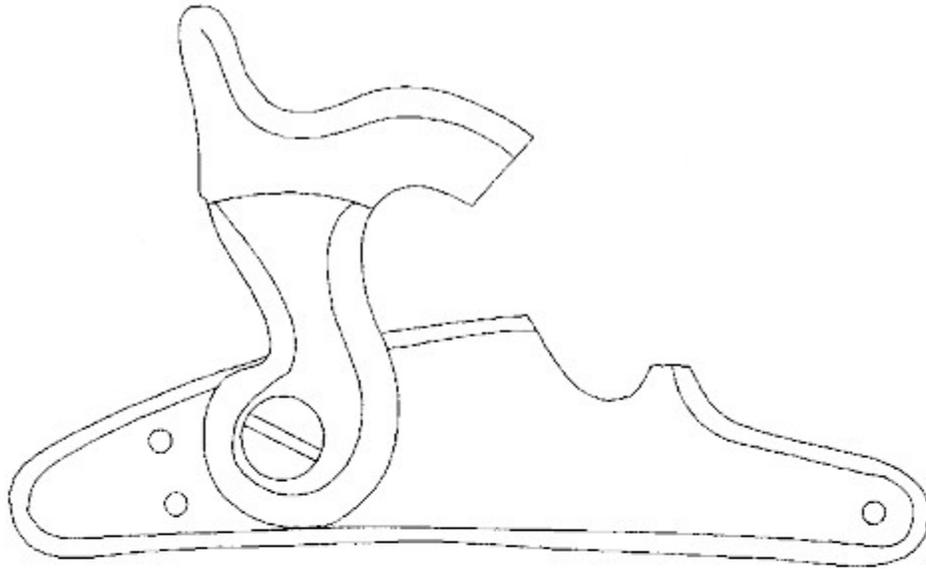


HOLE MEASUREMENTS OF HOLES

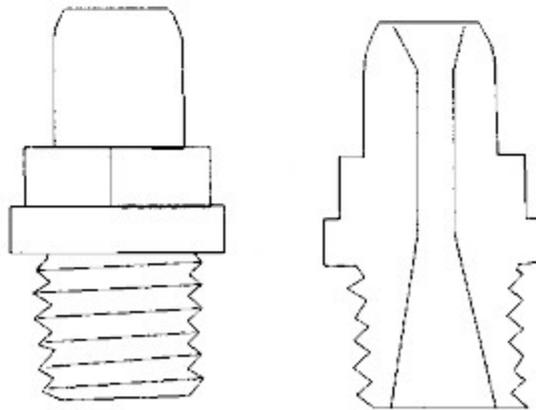


WORKING PARTS OF SIDEPLATE

BUILDING FIREARMS

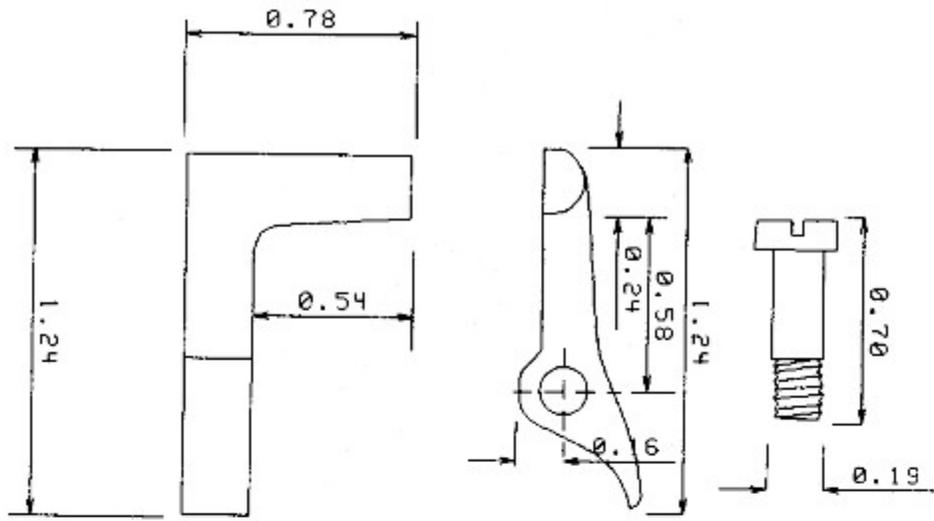


SIDE VIEW OF HAMMER AND PLATE

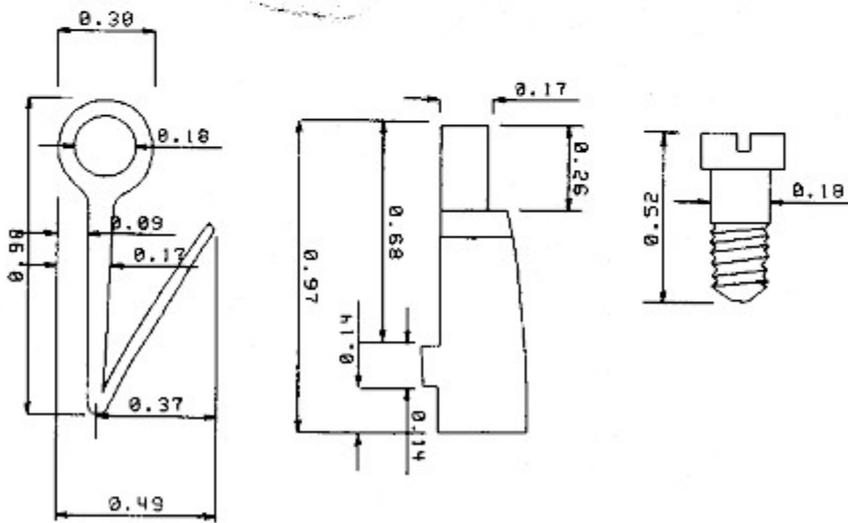


NIPPLES SHOWING THE WAY THEU ARE MADE

BUILDING FIREARMS

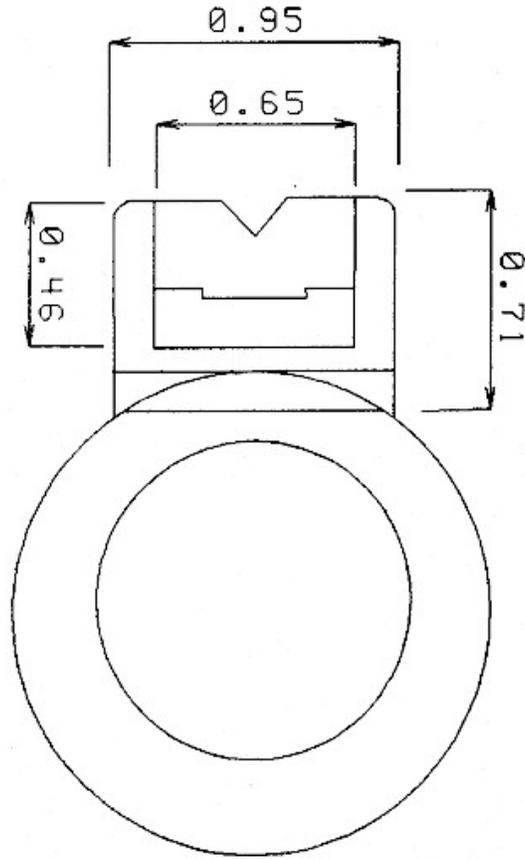


SEAR

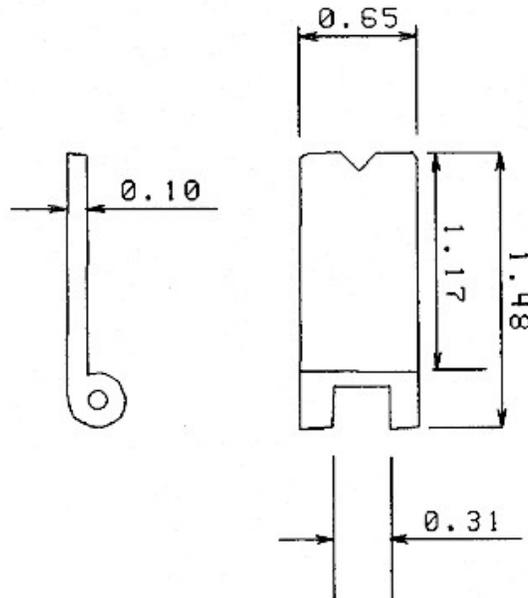


SEAR SPRING

BUILDING FIREARMS

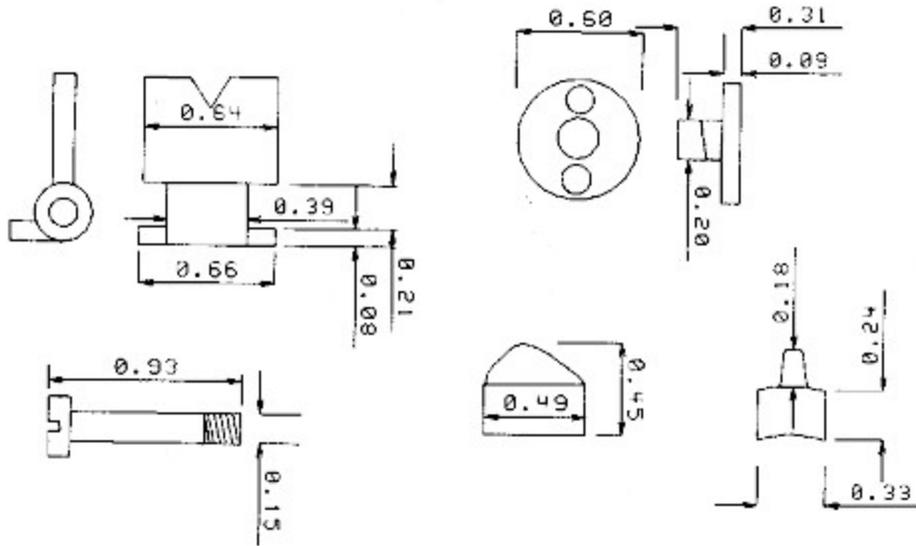


REAR SIGHT

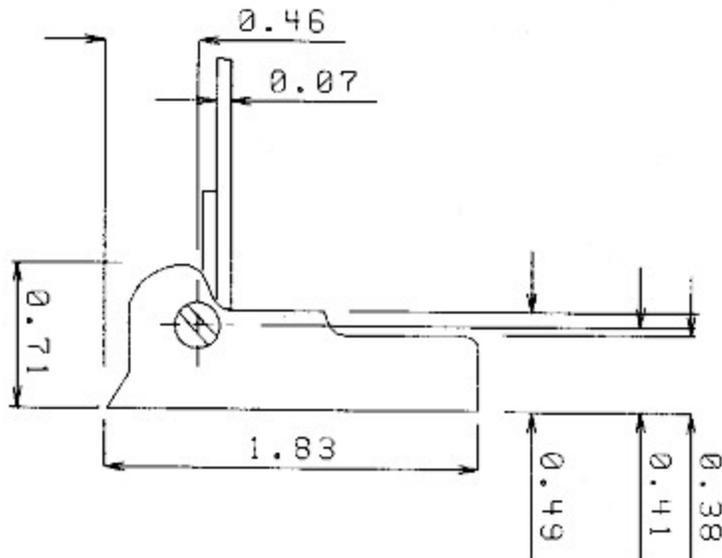


REAR SIGHT LEAF

BUILDING FIREARMS

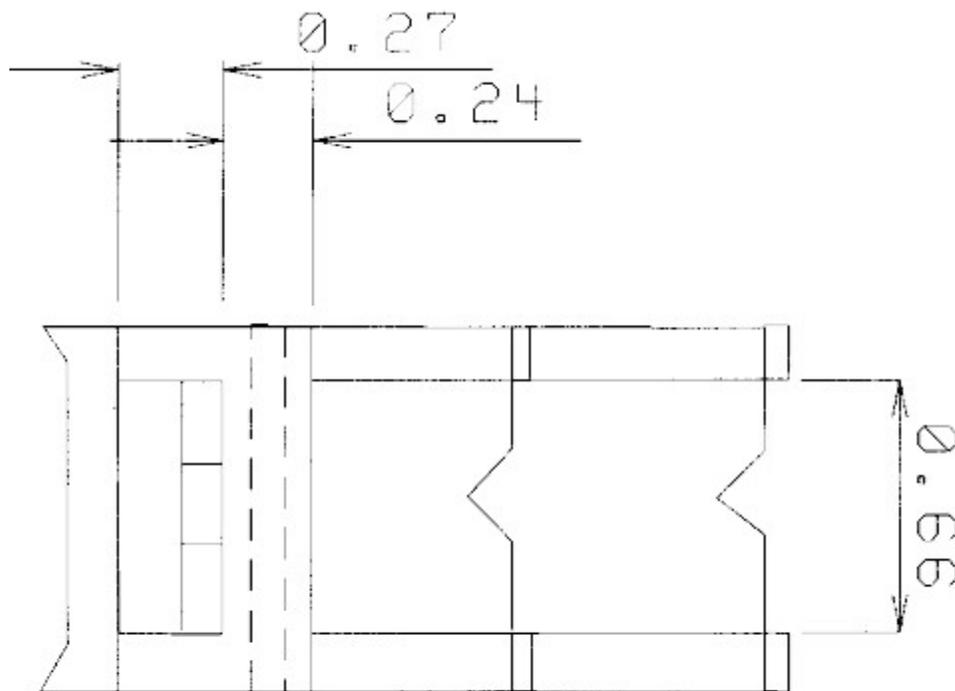


REAR SIGHT AND PARTS



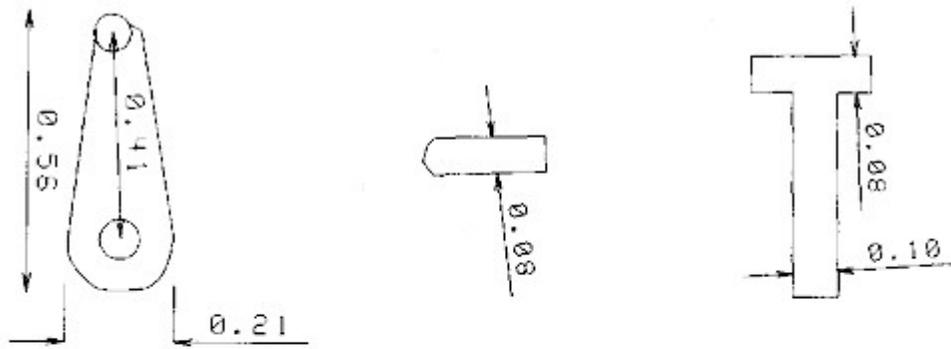
SIDE VIEW OF REAR SIGHT

BUILDING FIREARMS

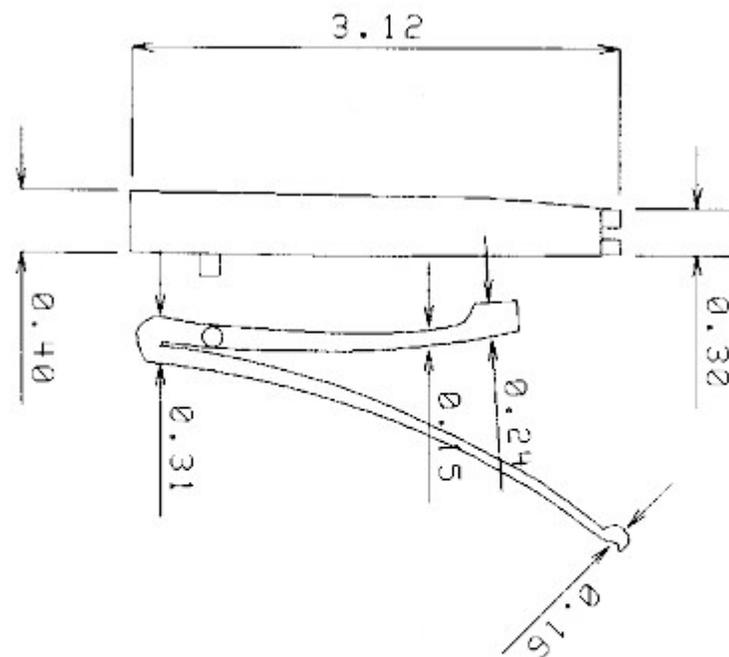


TOP VIEW OF SIGHT

BUILDING FIREARMS



SWIVEL FOR MAIN SPRING



MAIN SPRING