THE MODERN RIFLE BARREL

This is the original book on making a modern gun barrel. We have many good mini and other books on Gunsmithing, knife making, and crafts. 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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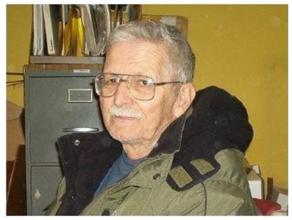


ABOUT THE AUTHOR

Harold Hoffman has through his 30 plus years of experience as a Gunsmith, Toolmaker and Custom Knife maker has passed on to you through his books information that soon may be lost or forgotten. His books are not intended for the person wanting to make a complete firearm, but for learning basic shop tool making.

The information found within his books is for instructional purpose only. -- The titles DO NOT actual cover gun repair on firearms, but how to make needed parts for firearms which is about 40% of all gun repair. Without this information you will be severely limited in gun repair. He first started gun repair when he was 18 years old doing minor repair for the farmers and local hunters in the Bucklin, Kansas area. His main interest was how to make rifle barrels, as he was an avid hunter. Moving into a bigger shop he bought a lathe and proceeded to learn how to use it. He wanted to find out how to make rifling buttons to rifle barrels, tool making, and learn everything about making barrels.

Over the years he became an expert toolmaker and how to build most everything that was needed in the shop. The information found in his books will show you how to make most of the equipment and tools needed in most shops. After an eye accident he quit Gunsmithing and started writing books on everything that he knew. He had so much difficulty finding any information that he wanted all this information that he had learned in over 30 years to be available to everyone otherwise it would be lost.

His books are now about the only books available on Gunsmithing/Tool making, as most publishers do not publish Gun or Gunsmithing books anymore.

INTRODUCTION

The Modern Rifle Barrel was written in 1965, and then I came out with Barrels and Actions, which covered much more. This manual covers the making of the modern button rifled barrel.

When I first became interested in how they made Gun barrels, I was a full time gunsmith in Bucklin, Kansas. I was doing a lot of Gunsmithing work, such as chambering and fitting actions.

I started to research the subject in all the different books that I could find. One thing that I found out very fast was that there was not any information on the process of making gun barrels.

This was in 1956, and I was always getting guns in that had damage or pitted barrels that needed repair. I was manufacturing rifle barrels at the time so I tried my luck at making the shotgun barrels. Except for different tooling and process, shotgun barrels were easy to make.

Many of the processes and methods used in the shop had to be learned as I went along, as I could find no information on them.

In 1962 I gathered all my notes and started putting together a manual on barrel making, and I included every process that I used in the shop.

My main purposes in writing this book is to give the readers an idea how they can make gun barrels in a small workshop. Most of the information in this book is not available to the average reader, and is a closely guarded secret by most shops. I have firmly believed that if this information is not passed on to future generations, it will be forgotten, so I have decided to share it with you. This book may seem to be a little vague at times being unfamiliar with this type of work, but once the reader starts it will all fall in place. In my shop, most of the equipment I made in the shop. I used a 12-inch Clausing Lathe with a 3' bed for the deep hole drilling and a 6' bed South Bend lathe for making the shotgun barrels.

If the reader follows the instructions, you can build a first class barrel that will compete with the best. I have many readers tell me it sounded to simple. Well making barrels is a simple process, much simpler than other barrel makers would like it known. If you decide to make barrels, all that is required is the basic machines that we discussed in this book. Harold Hoffman

EQUIPMENT AND TOOLS

In the introduction, I listed a few machines that you need, which will allow you to make gun barrels, but I am not considering speed, number of operations, or number of barrels produced.

WELDER

If you are going to build any of the machines that I describe, or many of the fixtures, you will need an Electric or arc welder. An acetylene welder works OK, but it is difficult to do any welding on heavier metal. About any type of arc welder will do, as long as it is 150 amp or larger.

LATHE

Your lathe should have at least a 3-foot bed. If you are planning to make muzzle-loading barrels, a 4 ft. bed is preferable. The hole through the head stock should be at least 11/2 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 to center the blank. Tap the collars for four, 1/4 inch set screws that center the blank. The lathe should be able to turn at least 2000 RPM or higher, and It needs to have tapered bearings in the head stock spindle.

You will have to get extra gears for your lathe so you can slow the feed to give you the minimum of .0004 inch of feed per revolution, when you drill barrels for 17-22 caliber. Any higher feed will cause the deep-hole drill to plug up and possible twist off.

OIL PAN

There should be some type of oil pan under the ways to catch the returning cutting oil that is strained before it is returned to the oil reservoir. This tray should extend full length of the lathe. For drilling barrels, you will need a pump that will turn out at least 400 lbs. of oil pressure to clear the chips.

TOOL POST GRINDER

If you are going to make your tools, such as reamers, rifling buttons, and other special tools or cutters, a tool post grinder for your lathe. 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 be able to grind your own reamers; deep hole drills, rifling buttons, and your own chambering reamers. In general, be able to make any caliber of barrel with any desired chambering.

MILLING MACHINE

You will need a milling machine with an indexing attachment for making rifling buttons, and reamers. A vertical mill would be the best choice, as you can do much gun work with it. You will also need a coolant pump, and this can be from an air conditioner pump, the evaporative type.

This is used when you grind carbide tools such as rifling buttons, and deep hole drills. The coolant that you use is water-soluble type that most machine supply house or oil bulk plants sell.

DRILL PRESS

Most shops have these, as you will use this for most of your die and fixture making. There will be quite a few fixtures needed to drill barrels, ream barrels, as well as other useful tools in the shop.

SHAPER

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

Most of the work that can be done on a shaper can also 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 11/4 piece of bar steel with a hacksaw. It will come in handy also in the fixtures that you will be making.

HEAT TREAT FURNACE

This is necessary to have, and there are many small furnaces available on the market that would work for what we want. It should go up to at least 2000 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, use the furnace to draw the temper of the reamers and cutters also. You can make this furnace easily, and a blower from a vacuum cleaner can provide the air.

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 zero 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-inch and equipped to give a reading in thousandths.

GAUGES

An additional gauge that you need is a bore gauge for measuring the finished reamed bore of the barrel. You should have a bore 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, and they can be made easily after you gain a little experience in tool making.

HEAD SPACE GAUGES

You also need head space gauges for each of the calibers you chamber for in your shop, and you can make them easily.

ANGLE AND RADIUS GAUGE

An angle and radius gauges are needed, but these are not used to often, but are handy when you need them. You need a thread gauge, as in every barrel you pull you will have to know how many threads per inch there is on the shank. This gauge useful for all types of threading.

LEVELS

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

TOOL STEEL

A good supply of tool steel in different sizes for the many different tools (oil Hardening) for your reamers. You can experiment with different makes until you find what will fit your needs. In more than 30 years, I have found O1 hard to beat.

SILVER SOLDER

A good high strength, low melting point silver solder comes in handy for joining various tools. It is used this to attach the rifling buttons to the pull rod, and for attaching the round carbide to short steel rods for centering.

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.

There in another machine that you may need and that is a rifling machine, which I will show you how to make in a later chapter. There is also the deep hole drilling attachment that we will cover later.

If you do not want to go to the trouble of making the deep hole drills, or rifling buttons, they can be purchase from various suppliers (listed in the back of this manual).

Deep-hole drills are expensive, and making them can cut the cost by about 1/2 of the new cost.

Reamers can, if you want to make them from worn out hand reamers by grinding them down and resharpening them. All that is necessary is to regrind them to the size needed. All sizes and dimensions will be given in later chapters, along with all other information and sketches. I might point out that the drilling of the rifle barrel is one of the simplest operations of all the processes that go into making a gun barrel. It will take about 20 minutes to drill through a 26 inch steel bar.

If you follow the directions carefully, you will be able to turn out a high precision rifle, pistol, or shotgun barrel. They will be as accurate as any rifle barrel on the market and much better than the ones turned out on the new computer machines.

In the big barrel making shops most barrels are mass-produced and inspection is not as good as it could be. You will also understand firearms better when you finish this manual, why some barrels shoot better than others do.

You will learn of some of the sales gimmicks that are used to sell supposedly better barrels.

If you make your own barrels, be able to select better steel from which to make your barrels.

Factories use the type of steel that requires the least amount of inspection and rejects, not the steel that will necessarily give the longest life and greatest accuracy.

In the following chapters, we will break down each step of the operation that goes into making a rifle barrel.

CONVERTING THE LATHE

You will need a lathe with a hole through the head stock of at least 11/4-inch. This is so you can take the 26-inch or longer barrel blank through the spindle and a gear train so you can reduce the feed of the lathe down to at least .0005 feed per revolution.

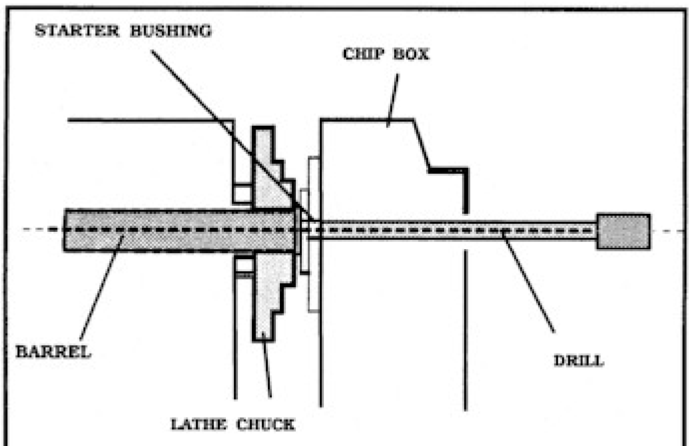
This slow feed is necessary to be able to drill the 17 Cal. Barrels. From the 17 Cal barrels, and up to the larger calibers, the feed increases, as the caliber gets larger.

In addition, if you have plans to make quite a few barrels it would be wise to get the right size pulleys to be able to increase the speed of the spindle up to 3000 RPM. Some of the people who manufacture the bearings for the lathe, that the bearings will not take this kind of speed.

My drilling lathe was a 10-inch Clausing, 36-inch bed, which I used 8-9 hours a day, sometimes 7 days a week for almost 5 years before I had to change the bearings.

The Key to this is **GOOD OIL AND PLENTY OF IT**. There is little pressure on the bearings when drilling or reaming.

In addition, if you have plans to make quite a few barrels using cut rifling and it would be wise to get the right size pulleys. This will enable you to be able to increase the speed of the spindle up to 2000 RPM to handle the smaller calibers such as 30 caliber. My drilling lathe for reboring was an older South Bend with a 60-inch bed, which I used 8-9 hours a day. This lathe was excellent for reboring and liner making, and proved excellent for cut rifling.

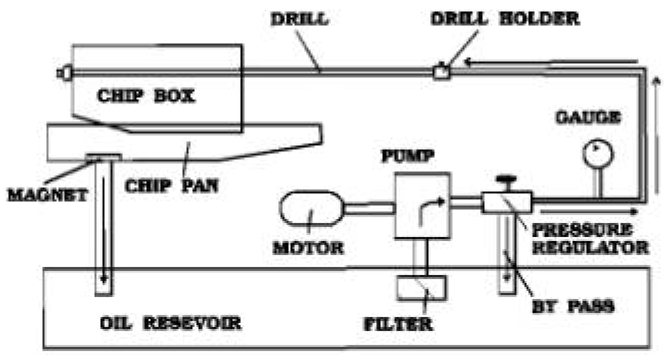


DRILLING SETUP

You want everything to be easy to change so when you go back to reaming or regular lathe work there will not be any problems.

OIL TRAY

If your lathe does not have an oil tray or chip pan underneath, you will have to construct one. The tray needs to extend a few inches past the head stock spindle. If it does not, it will not be too much of a problem to build a cover that will fasten to the lathe or tray to catch the oil from the barrel and return it to the tray. This cover needs to be high enough to cover the spindle hole with a piece of canvas with a hole in it to keep the oil from splattering all over everything.



COOLANT SETUP FOR DRILLING

CHUCK COVER

A cover is made that will go over the 3-jaw chuck, or collet, as there will be quite a bit of oil thrown out there. This cover can be made to rise straight up and on the front there should be a long slot to clear the drill or reamer tube. You will also need an oil container, of at least 55 gallons; this can be the 55-gallon drum that the oil comes in.

There will also need to be a container of at least 20 gallons to catch the oil and chips before it returns to the main oil container. You will need some kind of baffles that can be 1-inch angle iron laid flat in the tray in the lathe. This is to help separate the chips from the oil, and help to settle the fine chips. From there, it goes to a 11/2-inch return pipe on the tray, down to about a foot off the bottom of the 20-gallon container, this help separate the chips from the oil. From this container the oil over flows through a 1 1/4 inch pipe to the 55-gallon drum, which is laying on its side. In front of the overflow pipe is a large magnet that will trap the very fine metal that did not have time to settle, and this will prolong the life of your pump.

HYDRAULIC PUMP

A hydraulic pump is needed that will turn out at least 500 lbs. of pressure, and a good flow rate. You need the high pressure for drilling to get the required flow to remove the chips. In the reaming operation, you will also need a large volume of oil to keep the flutes clear. Not enough oil flow and the flutes of the reamer and ruin the reamer and barrel.

COOLANT VISCOSITY

Coolant viscosity for drill sizes 1/4 to 3/8 inch should be 80/125 Saybolt Seconds at 100 degrees.

COOLANT VOLUME REQUIREMENTS					
VOLUME					
DEPTH OF HOLE					
	6"	12"	18"	29"	36"
HOLE DIA. INCHES					
3/16 - 1/4"	2	3	3	3	3
5/16 - 1/8"	4	4	5	66	6
15/32 - 1/2"	5	6	8	10	11
17/32 - 3/4"	7	8	10	13	17

COOLANT VOLUME REQUIREMENT

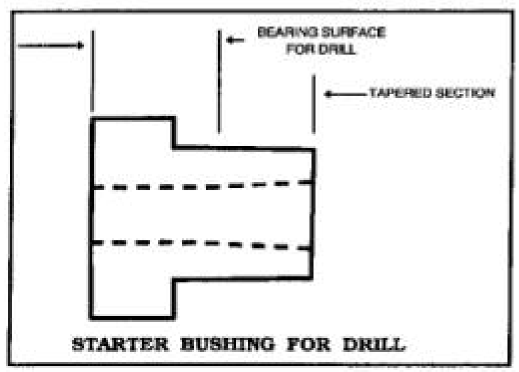
If you have an Army and Navy Store, there you might be able to pick up a pump there, along with other valves, etc. Farm stores carry stock pumps that will work for some operations. If you have 3-phase electric power, it would be wise to use a 3-phase motor of at least five horses for the coolant pump. The pump does not have to be a big one as the .062 hole keeps the pressure at 500 lbs. of pressure, and as the drill size increases the pressure goes down.

After you have completed the plumbing, connected the electrical switch, which should be very close and handy to where you will be standing, and all electrical connections done. You will then be ready to make the chip box starter bushing.

STARTER BUSHINGS

This is the most important part of your conversion, as without this you would not be able to get the drill started. If you were able to start the drill, it would either drill a crooked hole, or come out the side.

On the chip box in front, you will have to bore a hole at least 11/2 inch. To this, you will need to bolt a self-aligning bearing and flange. To make sure it is on straight when you bolt it on, you will have to chuck a 1-inch bar in the lathe. Turn down the end of the bar so it will be a slip fit inside the bearing on the self-aligning flange. Slide the housing up against the bearing housing and mark the holes. Once marked and the holes are drilled and tapped, slide the housing back up against the bearing flange and bolt it in place.



Make the chip box so it can be removed and then returned and still line up exactly in the same place. On mine, I took the tail stock apart and mounted the chip box on it. That way I was able to keep perfect alignment. Let me explain the reason it is so important to have the starter bushing and bearing in exact alignment with the head stock spindle. In later chapters, you will see the design of the deep hole drill. It is a single lip drill on the end of a long hollow V drill tubing.

There is no support for the drill except the starter bushing. We make the starter bushing from tool steel. It fits into the flange bearing, and the starter bushing will then fit up snugly up against the trued and square end of the barrel blank.

The clearance between the hole of the bushing and the deep hole tip is only about .0003 of an inch. These is the only way that you can start the drill with any degree of accuracy, and expect the drill to come out within a 32nd of an inch or less on the other end of the barrel.

MAKING THE STARTER BUSHING

Make the starter bushing from oil hardening tool steel. Make it out of 1 /18 inch stock; the shank should be turned to fit the I.D. of the flange bearing. The fit needs to be a snug hand press fit, or it will rotate while in use, and thus wear on the outside. Drill the hole for the starter to the next size smaller drill than what the deep hole drill is, finished except heat-treating.

Put a barrel blank in the lathe that has the end squared and trued, press the unhardened starter bushing into the bearing. Then very carefully, move the chip box with the starter bushing and bearing up flush against the end of the barrel. Make sure that the bushing is flush with the barrel, and not canted. Tighten down the chip box; turn on the machine to make sure all is running true. If everything is running true set in the deep hole drill the size you are making the bushing for, turn on the oil set for low pressure, and just start the drill point in the bushing.

Turn on the lathe, slowly feed the drill tip into the bushing, and then feed it into the barrel for a depth of about a 1/4-inch. Back out when you reach this depth, shut off the oil, and turn off the machine. Use this method if you cannot obtain a correct size reamer. This method will not give you the closest fit, but if starting the drill very carefully will usually give you a straight hole.

HEAT TREATING BUSHING

After you drill the barrel to size, stamp the size on it, and then heat-treat it. Bring up the temperature in the furnace to proper temperature, which is 1550 degrees. Coat the bushing with a compound that will stop scaling, and put in the furnace. I have used a surface-hardening compound for this purpose with excellent results, and Hard and Tuff is very good for surface hardening. As soon as the bushing has reached the proper temperature, remove and quench in a good quenching oil, or 5-weight oil. You will not need to draw the temper on the bushing, as we need all the hardness we can get.

This bushing will last for many barrels, when it starts to wear, you will know, as you will get crooked or off center holes showing up on the end of the barrel.

DIMENSIONS FOR THE STARTER BUSHING HOLE

Caliber	Drill Diameter
172	.164
224	.212
244	.228
257	.244
264	.250
270	.264
284	.270
308	.293
303	.297
323	.304
338	.322
350	.343

375	.360
44	.415

DIMENSIONS FOR THE STARTER BUSHING

Normally in any deep hole drilling operation, the barrel turns, and the drill is stationary. Looking at the drawing of a single-lip deep hole drill, you can see the reason for this. You will notice that with the single lip gun drill that it only cuts on one edge, and as it drills in the barrel it's makes its own center. Due to the high RPM of the barrel, it makes its own center as it drills. This is the reason an accurate starter bushing is so important.

The drilling of a rifle barrel is actually the simplest and most trouble free operation of all. If you do not start the drill straight, it will try to pick up the center of rotation, and the hole is one long curve.

We normally turned out 100 or more completed rifle barrels per week, and in the drilling operation, we could use low skill help. All that was necessary was for the operators to set up the machine, turn it on.

They only had to watch so the drill would not plug up with chips, shut it off when done, and then reload it and start again. When you get everything set up right, you will be able to turn out 3-4 completed barrels a day with no problem on one lathe, this is a completed barrel that is drilled, reamed, and rifled.

DEEP HOLE DRILLING

Now about the last thing that you need is a special Steady Rest to support the drill tubing as it drills. This will help cut down the vibrations that will some times start in the drill.

You CAN NOT allow these vibrations to start. If it does, it can cause the carbide drill tip to chip, and if you do not catch it in time, it can cause the drill to plug up and twist the tip off.

I want to point out that this drilling setup is not limited to just gun barrels. You can use it for many other industrial operations, where you require extremely accurate holes, in addition, with carbide drill tips; you can drill very hard steel. For odd shaped items where you are unable to rotate the drill, you can set up the operation where the drill is rotated by using special tooling.

These will give you the pressure and Viscosity for your Oil Coolant for different types of materials. Do not forget to put the shield over the end of the barrel, so when you drill through the barrel the oil will not be sprayed over the entire shop.

TOOLS FOR REAMING

You will have to make a few additional fixtures for the reaming operation now. This will not have to be much of a job, as everything that you have done so far will work with the reaming operation. About the only thing, that you need is a reaming adapter for the chip box housing. With the adapter completed, it will fit in place where the chip box housing was.

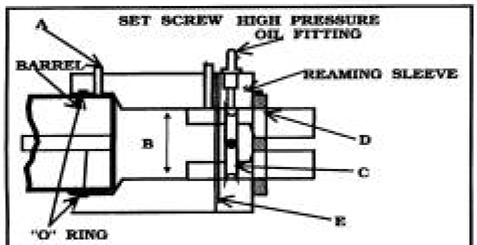
The high-pressure oil line that we fitted to the drill driver on the deep hole drill is fastened to the reaming adapter. The reamer rod will have to be made, so cut it now to correct length. A drill driver is made to fit the reamer rod; this is the same size as the deep hole drill driver.

REAMING FEED

With this done and in place you will have to change the feed of your lathe to a faster feed, somewhere in the range of .015 to .004 inch feed PER FLUTE PER REVOLUTION. The speed of the lathe will is changed to the back gear for slow RPM. In reaming, the reamer is pulled through the barrel.

REAMER ADAPTER

Now for the construction of the reamer adapter, first you will need a short bar of steel 12-inch in diameter if you are using 11/8-inch piece of steel for your barrel blanks. This piece when completed should be 7 to 8 inches long. The end that fits over the barrel blank should be a very close fit to the barrel, just a few thousands larger. Next, cut an "O" Ring groove to fit an "O" ring, which we use to seal the oil from leaking.



REAMING ADAPTOR

The bore (B) should be bored to .755 to fit the reamer guide (C). Make this guide out of tool steel, to just fit over the reamer rod should be very close, as this is what seals the oil. I have tried in the past to use "O" rings to seal the oil but they do not last long. Drill Rod size .750 works very well, as there is no turning of the outside to fit the sleeve (A).

Another way to do this is to bore (D) to 2 inch and make a harden bushing to fit inside it, so the bushing can be changed to the different size rods. You can easily change the bushing when it wears out, without the expense of the higher priced 3/4-inch Tool Steel. The bushing bearing (E) is a close fit in the bushing.

The bushing has a groove turned on the O.D. and 4, 1/8 holes drilled to let the oil be pumped inside (B). The sleeve (E) has a fitting tapped into the outside so the high-pressure hose can be attached. There is also a retaining sleeve (F) to hold (E) in place. The sleeve (E) is free to rotate when the lathe is turning.

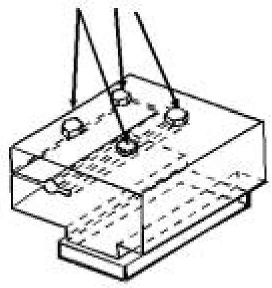
All the parts when completed are Heat Treated and drawn at 500 degrees. This will just about complete the setup for drilling and reaming.

Except for one other item, you will want to mount a high-pressure oil gauge in the line to the Drill and Reamer fittings. Have this handy so you will be able to see it always. Oil pressure will tell you quite a bit what is going on inside a barrel. If a Drill or Reamer is plugging up the pressure will go up. For information on carbide tips, write the Metallurgical Products Dept, General Electric Co, Detroit, Michigan.

DEEP HOLE DRILLS

Let us talk a little about the deep hole drills, sizes, and the grinding of the drill. In addition, what a deep hole drills looks like, and some of the terminology of the carbide drills.

I will not go into the grinding too much of the deep hole bits, as most will buy the sizes that they need. When you have to buy the 'V' tube, drill tip, drill driver, and tip, it is just about as cheap to buy the completed drill. If you want to grind your drill tips, the various makers if carbide tools will be able to supply you with the several sizes of Carbide deep hole drill tips that you will need. The grade of carbide usually supplied for deep hole tips is 883, and is 21/2 inches long.



CARRIAGE BLOCK FOR HOLDING TUBING

GRINDING TIPS

To set up for grinding the deep hole tips, all that is necessary is to turn 2 short pieces of drill rod, about 1 inch long, center one end of each piece. The drill rod should be the same size as the drill tip that you are planning to grind. Get a small V way, or a piece of finish angle. Lay the tip and the 2 pieces of drill rod, with the centers out to each end of the tip. Get some low melting silver solder and join the 3 pieces.

Use the lowest flame possible to melt the silver solder, as to much heat will or can crack the carbide tip. When completed, let it cool in the fixture. Then when cool set up between centers of the lathe, set tail stock over so you will have a 1 degree included taper per inch from the front or cutting edge of tip to the back.

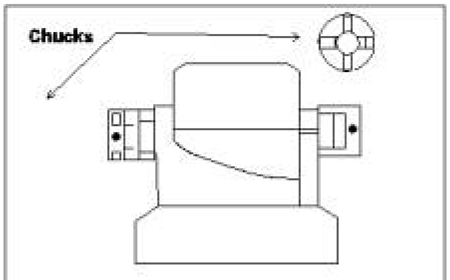
After this, grind the primary land; this will be ground on the absolute center. After this is completed, heat the drill tip up and remove the centered ends. Grind the remaining silver solder from the carbide tip, and if the holes are plugged, drill them out. I have found that welder's chalk rubbed into the holes of the tip will help to keep the solder from plugging it.

The drill is now soldered to the drill tubing, which can be purchase from, Danjon; the address is in the back of the book under suppliers. I would recommend that you buy the first one from the suppliers. This will save you some headaches on your first barrel. The drill will last for several hundred barrels if you have no accident, and you take care of them.

DRILLING THE RIFLE BARREL

In this chapter, we will cover the process of making the rifle barrel. By now you know how the tools are constructed, and have a basic idea of how the rifle barrels is made. I will now tell you step by step how to go about making a rifle barrel.

First, I would start with a 1 1/8 inch x 26-inch long piece of 1350 or stress proof. This steel will drill, ream, and rifles beautifully, and almost never gives any trouble. The first thing to do is to put this bar in the lathe, face off one end, and center drill it, on the other end, you should face it off also.



CENTERING CHUCKS FOR LATHE

Make sure that the end that you center drilled is flat and smooth, and after the barrel is faced off, leave it extended, from the chuck about 6 inches.

If the barrel is sticking from the end of the lathe, make a collar, with four setscrews, so the barrel can be centered and rigid. At the high speed that the barrel is drilled at, the end of the barrel will start to run out and cause the barrel to vibrate badly.

The chip box is installed with the starter bushing in place, and the starter bushing is very carefully flushed up against the barrel blank. Connect all the shields; do not forget the one on the end of the lathe that will return the oil when you go through the barrel with the drill. Bolt the drill driver holder, centering it with the center of the tail stock. It would be more accurate if it is done with a shaft chucked in the head stock, through the opening that holds the drill driver.

Set the deep hole drill in the drill driver on the carriage; connect the hydraulic hose to the fitting, now very carefully start the drill tip into the starter bushing. Before you turn on the oil to test it out, double-check the setscrew that holds the drill in. If you turn on the oil and turn up the pressure, you will blow out the drill and possible chip the tip, and possibly get an oil bath.

Turn on the oil, but before you do, make sure that the pressure valve is open all the way so there will not be any pressure in the line. If everything is OK you are pumping the oil back to the tank, with very little oil going through the drill. Now close the valve slowly, watching the pressure on the gauge, when it gets up to 600 to 700 lbs., which is about the right pressure for 30 caliber barrels.

Let it run for a minute or so to check for leaks, look and see how much oil is coming out of the tip as there should be quite a bit. This is important, as when you are drilling this is one way that you watch to see if your drill is plugged up. Any time the flow slows, stops, or the pressure goes up, shut down the feed fast, or you will ruin the drill.

PRESSURE AND VISCOSITY				
MATERIAL		.156	.250	.500
LOW ALLOY	VIS. - P.S.I.	100 - 800	100 - 800	125 - 700
HIGH ALLOY	VIS. - P.S.I.	100 - 800	100 - 800	125 - 800
HIGH SPEED	VIS. - P.S.I.	100 - 800	100 - 800	125 - 800
300 STAINLESS	VIS - P.S.I.	100 - 800		

I will assume that you have already changed the quick-change gears so you can get a slower feed. A good starting point would be .0008 feed per revolution.

STARTING THE DRILL

Now if you are ready, have all the shields up, no leaks, turn on the lathe, but before you do this make sure that the drill tip is not touching the barrel. The lathe should be running about 4000 rpm, but you can run it at its regular speed. It will take longer to drill the barrel, and the drill might tend to wander a little on the slower RPM. Now with the oil on, feed the drill into the barrel blank very slowly by hand. The drill and tubing will probably chatter, but unless the drill tube starts to buckle, keep feeding it in and after it goes in 1/8 in or so it will stop chattering.

Once it stops chattering engage the feed, it should start drilling with no chatter. I would recommend that you keep your hand on the drill tubing for two reasons.

(1) If your hand is on the tubing, you will be able to fill what is going on in the barrel. There is a certain fill to the tubing when the drill is cutting right.

(2) Your hand will act as a vibration damper for the drill.

Remember to keep your hand on the drill all the time to feel the vibrations on the drill. After a short while you will be able to tell exactly how the drill is doing. After a few barrels, you will be able to tell when the drill is dull, or if it is chipped. Under normal conditions, the drill should be sharpened about every two barrels. To sharpen it is only necessary to just touch the cutting surface with the silicon carbide (green wheel), or diamond wheel, rather than grinding all the surfaces.

SPEEDS AND FEEDS

MATERIAL		TO .250	TO .500	TO 750
LOW ALLOY	RPM I.P.R.	6700 .0003	4300 .001	2100 .001
HIGH ALLOY	RPM I.P.R.	3400 .001	2100 .001	1500 .001
HIGH SPEED	RPM I.P.R.	2910 .0004	2100 .0004	1800 .0005
300 STAINLESS	RPM I.P.R.	2900 .0003	2100 .0003	1800 .0004
400 STAINLESS	RPM I.P.R	3400 .0003	2100 .0003	1800 .0004

Figure 14 Speeds and feed for drilling

The angle on the face of the drill is critical, as they will change, there may be spots rubbing the drill because lack of clearance, may cut curved holes, or may turn out ribbon chips. These problems can be usually be traced to an improperly sharpened drill. You should not have any trouble on the drilling if you have followed instructions. By now, you will have probably noticed that as the pressure of the oil goes, so does the temperature.

On small caliber's, the drill tubing gets very warm but this is normal, but by now, you should be about all the way through the barrel. When the drill comes through the end of the barrel, your flow of oil in the chip box will stop abruptly. Open the valve on the bypass line to drop the oil pressure. Let the drill travel about another 1/4 inch and disengage the feed lever and back out the drill, when it all the way out shut everything down.

Well, you have done it, you have drilled your first barrel, and the rest should be easy now. If you have done everything right, the barrel should be perfectly straight. Leave the barrel in the lathe, as the next operation will be reaming the drilled barrel.

REAMING THE DRILLED BARRELS

Change the feed on the lathe to the proper feed. Usually start a little slow and increase it to where you are getting a good job and yet not plugging up. Sometimes if you have too fast a feed, you will have trouble with the reamer plugging up.

Remove the starter bushing and the chip box. Install the reamer adapter to the barrel blank, and tighten the setscrew. Connect the oil line to the fitting on the reamer adapter. On your reamer pull rod; unscrew the driver from the end of the rod. Now slip the rod into the barrel, all the way through the barrel, and out the bushing on the reamer adapter.

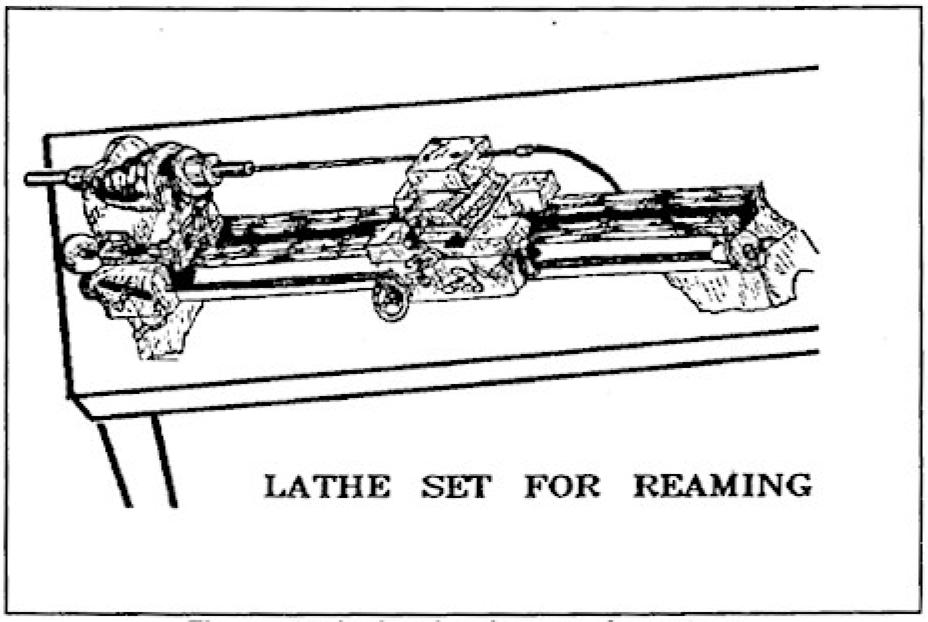


Figure 15 Lathe showing reaming set up

Screw the driver back on the rod and slip into the driver holder on the lathe carriage, and tighten the setscrew. Replace the shields on the end of the lathe. Be very sure it is on good as there will be much oil coming from the barrel in reaming.

You should now be ready to start, the first reamer that you use is the rough reamer, and its purpose is to remove the excess metal from the bore, smooth and true up the bore.

The finish reamer does not remove much; it takes the bore to size, and gives the mirror finish to the bore. Double check to see if the oil pressure valve is opened all the way. Double check the hoses to be sure they are on tight, and turn on the oil. Turn on the pump and let it run for a few minutes and turn the pressure up to about 300 lbs. The pounds of pressure are not important as the amount of oil coming from the end of the barrel.

CHIPS

It has to be shooting out under enough pressure to get rid of the chips so they will not plug up the reamer. If it plugs up it could ruin the barrel, and probably break the reamer. Start up the lath in back gear. Make sure that the pilot of the reamer is inside the barrel, and engage the feed lever. As the reamer is starting to feed into the barrel, it may cut a little rough but it should straighten out soon.

It will if is sharpened right start cutting smooth from the start, or after it is in the barrel about 1 inch. Keep your fingers on the reamer rod as through the rod you will be able to know if everything is cutting good, if it isn't, you will be able to feel chatter. If it is cutting smooth set back and let it ream the barrel.

It is a wise practice always to keep your fingers on the reamer rod, as a flute could plug up. If the reamer plugs up, more than likely the oil pressure will go up slightly.

If for any reason the reamer plugs up or starts to act up, disengage the feed lever and while the lathe is still running, back out the reamer. It is wise to have something lying across the ways of the lathe, as the carriage travels down the ways of the lathe, it will move it along with it, and I use a wrench as a marker. This way if you have to take out the reamer you will know where to start the reamer cutting again.

DULL REAMERS

When you back out the reamer do not shut off the lathe; if you do you will leave long marks in the barrel. As you back the reamer from the barrel, you will be able to see if it was plugged or not. If it is not plugged, it is probably getting dull, and rubbing instead of cutting, remember when looking for trouble spots on the reamer, get it in a good light and look for bright spots.

This will usually show you where the trouble spots are. If everything is OK, as it should be, you should be about through by now. As the reamer starts to come out of the barrel, it will start to chatter slightly, as the pilot is not supporting the reamer any more. These are common, but do not let the reamer travel so far that it will stick in the bushing.

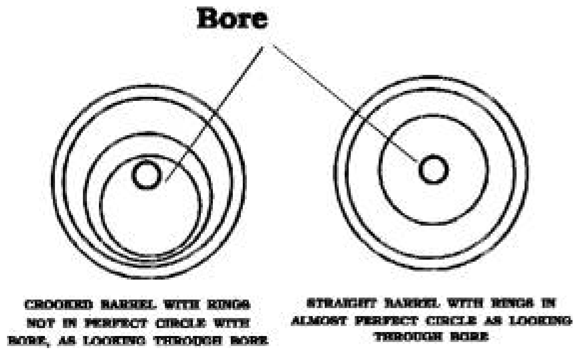
When the pilot leaves the bore the oil pressure will drop and there will be more oil coming from the end of the barrel. When the oil pressure drops, let it go about 1 inch and disengage the feed. Shut off the oil and slide the reamer back down the barrel to where it was sticking out. Shut the machine off now. Disconnect the driver, or if you want unscrew the reamer rod from the driver, and remove the reamer.

Put the finish reamer in the barrel, screw in the driver and repeat the process. When you finish the final step of reaming shut everything down. Loosen the setscrew, from the reamer adapter, and remove the reamer. Do not take the chance of the reamer marking the barrel by sliding it back down the barrel.

When the last reaming operation is completed, you will remove the barrel, then let the oil drain from it for a few minutes, wipe out, and inspect. Hold the barrel up to a light, a window is best and check for smoothness. Also make up a -no-go-no-go gauge to check for correct size, and if everything is OK, you are ready to rifle.

BARREL STRAIGHTENING

If you properly sharpened your, had a good starter bushing, and the starter bushing was in good alignment, the bore should be straight. In most cases, the barrel will shoot as good if it is slightly crooked, as it would if it was straight. However, if it was slightly crooked, and you finish it that way, it would probably walk the bullets as the barrel heated up.



In turning a barrel if you do not get the cutting tools sharp, take too heavy a cut, let the barrel get too hot, let the centers get too hot, or out of round, the stress will warp the barrel. Then you will have to straighten the barrel.

I will try to cover the main points in barrel straightening, and give you a guideline as what to do and what to look for. You must realize that barrel straightening must be self-taught, and to accomplish this, it will be advisable to practice on old barrels.

A shotgun barrel is good to practice on, as it is big, and smooth with no rifling to confuse you. It is next to impossible to straighten a barrel with a rough bore. I will also show you here how to make barrel-straightening equipment necessary to straighten the barrels,

Let me point out that a large percentage of the factory barrels, to the trained eye are not perfectly straight. Any barrel maker will tell you that a slightly crooked barrel will shoot as well as a straight one, and a rifle used for hunting a crooked barrel makes little difference.

As long as, (1) you let the barrel cool between shots when sighting in, (2) as long as you do not shoot more than three consecutive shots, as it will then start to walk.

No amount of bedding will stop this, when we turn the barrels, we checked them at ever pass on the turning lathe. Now, the blanks are finished completely on tape machines before being removed from the machined, then it is checked for straightness, and if crooked it will be straighten.

I have gotten several factory barrels in the last few years that when I put it between the centers of the lathe, it ran out as much as 1/8 inch on the OD, although the bore was straight. These barrels would walk as much as 6 inches at 100 yards after five shots.

BARREL WALKING

Why does a barrel walk? If the bore is concentric to the outside, the thicker side will lengthen more than the thin side and the barrel will bend. In most cases there was enough metal on the barrel to return the barrel to make it even.

PREMIUM BARRELS

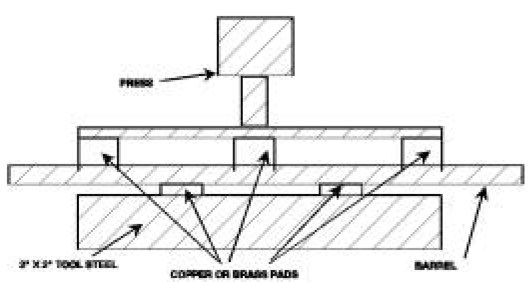
Let me point out that premium barrels are barrels that are straight after drilling. They have no loose or tight spots in the bore due to hard or soft spots in the barrel, and they do get a higher price. Even with good steel, some times, you find some bars with much stress left in the bar, and this steel will warp with every pass of the cutting tool. There is not much you can do to stop it, except straighten it on every pass.

These if you keep them straight up to the final pass will shoot good and will never give any problems later. They are just a pain in you know where. On barrel straightening equipment, the one type that I used is the overhead screw press. You can see the bore as you are making corrections on it.

BARREL PRESSES

You can make this type of press easily in the shop with nothing more than a cutting torch, arc welder, and old farming equipment. Why the farming equipment, almost everything you need, can be found in used farming machinery. The wheel is nothing more than a big flywheel with handles fastened to it.

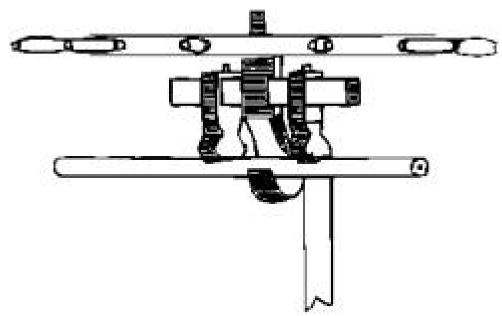
Another is the type that you use an overhead hydraulic press to make correct it. This is a good type but I have found that it is better if you can feel the pressure when you straighten the barrel. Both will do a good job, but the over head screw press is faster, and if you plan to make quite a few barrels, certainly go to the over head press.



BARREL STRAIGHTNER

The oldest method employed by the barrel makers was to stretch a fine wire inside the barrel. This is stretch from one end to the other, and touching the sides at each end. They hammered one side of the barrel until the wire touch all the way.

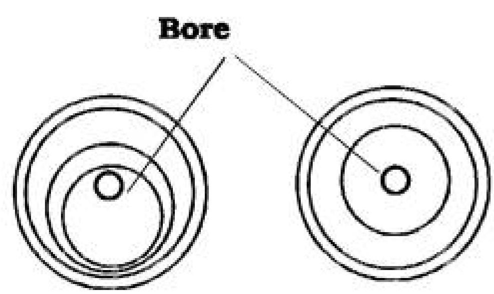
This was used on barrels that was soft, and used lead bullets. The methods that I will describe in this chapter will be the one I have used for years, and have found it easy for others to use. Lets put a barrel to test to see if it is straight.



BARREL STRAIGHTING PRESS

When you look through a bright finish barrel, the interior surface appears to be spread out in a circular disc as far from the eye to the other end of the barrel. As you look through the center of the disk, is a circular (the bore) orifice, and surrounding it, like the rings of a target, at equal distances, (if it is straight).

These circles are well-defined circles around the bore. When you do this look at the edge of a door or window, not an open light. If the second, third, or fourth rings are perfect circles around the bore, you can consider that the barrel is straight.



CROOKED BARREL WITH RINGS NOT IN PERFECT CIRCLE WITH BORE, AS LOOKING THROUGH BORE

STRAIGHT BARREL WITH RINGS IN ALMOST PERFECT CIRCLE AS LOOKING THROUGH BORE

You will see that these images are located at a certain point in the bore nearest to the eye. About two thirds of the length of the barrel is the part of the bore that you must direct your attention to. This is where by using the reflection, which will show you where the bore is crooked.

LONG BENDS

In long bends, you will work from 1/2 to 2/3 of the bore, then turn around the barrel and repeat the process. If you notice a distortion of the circles or rings, revolve the barrel slowly, and you will see what side the bend is on. The hardest part is next.

It will take a little practice and time to tell exactly how far, and at what point the bend is. You do this by looking down the barrel, and at the same time touching on the outside of the barrel. When you think you have the correct spot where the center of the bend is, move the barrel so that the center jaw or hook is in that spot. Rotate the barrel so the big part of the rings is at the bottom, and apply a little pressure.

If you are at the correct place in the barrel, and as you apply the pressure, the barrel will go straight. The rings will form a perfect circle around the bore. If this does not happen, release the pressure, and rotate or move the barrel forward or back and repeat the process.

When you get the perfect circle put more pressure until when you release the pressure the barrel will remain straight. The barrel is like a spring and it will take quite a bit of pressure, when completed, the interior will look like the above drawings. When you mount the screw press, have it face the window, so you will see half of the edge of the window in the bore.

With a little practice, you will be able to straighten the barrel in a few minutes. The second method is with the blocks. This method works fine but is more difficult to get the barrel straight and is time consuming. This method is best used for full size barrel blanks, or if you do not have an overhead press.

To straighten a liner, large lead hammer can be used, find where the bend is, and set the liner on the blocks with the bend to the top, then give the barrel a good tap with the lead hammer. Check to see if you have made any progress, if not repeat the above with a harder tap, the secret of this process is to hit the barrel hard enough to straighten it past it's elastic limits.

Your skill in using this process lies in your ability to judge by the eye, the exact location where the bend, its proper location, and then slide the barrel to that location.

To straighten the barrel it must be bent past its elastic limits, so when it springs back it will be straight. If you bend it too far, it will be bend to far the other way, then you will have to rotate the barrel and straighten it back.

With a little practice, you will be able to straighten the barrel in a few minutes, so use this for full size blanks due to their large size. The second method is with the blocks; this method works fine but is more difficult to get the barrel straight and is time consuming.

RIFLE BARREL STEEL

There have been many different types of steel used in rifle barrels over the years. There is much claims by individual barrel makers that there steel that they use in there barrels is better and give more life and accuracy than other makers. Most if not all people are greatly misled on rifle barrels and the types of steel that is used in their manufacture.

You may be surprised to know that the steel used in the past is very similar or is the same as is used today. Most manufactures use steel that works easily, machines good, one that gives good tool life, and good barrel life. Most of the steels that was used 70 to 80 years will be suitable for the barrels today.

In the old days, where lead bullets were being used, almost any bar of iron was satisfactory for a barrel for black powder and lead bullets, as long as it was easy to work.

Black powder gave a breech pressure of about 25,000 pounds per square inch, and the lead bullets gave little wear. Wear came from the black powder and corrosive primers in the form rusting.

They did not have to worry about pressure, just corrosion. Now at the present, smokeless powder will give pressures more than 70,000 pounds per square inch, extremely hot gases, and bullet jackets of much harder material than lead.

Now they need steel that will machine good so they can get a very smooth finish in the bore to eliminate fouling from the jacketed bullets. This requirement is easy to meet in the steels of today, and the early 1900's. It must be free machining, stress free, and a hardness of 28 to 33 Rc.

All the steels that are used in barrel making are all about the same except the trade names tacked to them to give the shooter the idea it is something special. All steels today are manufactured under SAE or WD numbers, the SAE numbers refer to standard specifications issued by the Society of Automotive Engineers and publish in the SAE Hand book.

What does this tell you? It simply states that when a barrel maker wants steel for rifle barrels, he picks up a phone book and orders the type of steel that meets the requirements for a rifle barrel. If he buys standard steel such as Stress Proof, 1350, 4140, 4142, or 4150, it will not make much difference, which steel company he buys it from as it is regulated by the SAE.

It might have a different trade name, but it will be the same as the other steel manufactures. Steels and Irons To help you understand steels better I will use the following information on how steel is graded.

Chrome, Vanadium Steel is considered to be an alloy when the maximum of the range given for the content of alloying elements exceeds one or more of the following limits,

Manganese 1.65%, Silicon 0.60%, Copper 0.60%, or in which a definite range or a definite minimum quantity of any of the following elements is specified or required within the limits of the recognized field of constructional alloy steels,

Aluminum: boron, chromium up to 3, 99%, cobalt, and so on.

Manganese: Contributes to strength and is major importance in increasing harden ability.

Silicon: Increases the resiliency of steel for spring applications and raise the critical temperature for heat treatment.

Nickel: Lowers the critical temperature of steel and widens the temperature range for successful heat treatment. Nickel is used to promote resistance to corrosion, and chromium, is used in steels to increase hardness, improve harden ability, and is the essential element in stainless and heat resisting steels.

Molybdenum: In common with manganese and chromium, has a major effect on increasing hardenability, and a strong effect in increasing the high temperature tensile strength, Vanadium, produces a fine grain.

STAINLESS STEELS

I will not go into this type of steel too much as we find that the barrel life with stainless is not much greater than other barrel steels such as 4150.

Its value comes in with the over bore cartridges, where barrel life is a little better, but Stainless steel is also harder to drill, ream, and will give lots of trouble in rifling.

It has a tendency to gall, when it is button rifled. I have not found there is not enough additional barrel life to warrant its use, except for a person that insists on it and is willing to pay the added cost. A barrel maker can use any kind of steel and call it any name he wants.

To state a particular type of steel is chrome-moly, chrome-nickel, or similar term, is more illuminating, because a trace of the alloying elements in the smallest amounts can justify using these terms. There are trade names such as Ryerson, Crucible, and many others, which does not mean anything except that it tells of the company that made the steel.

TYPES OF STEEL

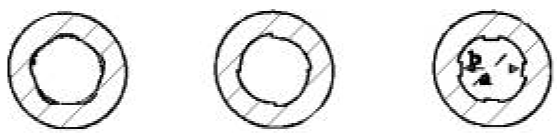
I will give you some of the commonly known names of the better steels used in barrel making, all of these I have used. Ryax or Stress Proof are commonly designated as carbon manganese (1350), and are very free machining but at the same time possess the required physical requirements needed for rifle barrels.

Rycut 40 or Rycut 50 is a modified 4140 or 4150. Modified 4150 contains about 1.65% manganese. This manganese definitely increases the machine ability. For a barrel maker to say his barrels cost more does not mean he is using better steel than his competitors.

Steel cost about the same from all suppliers. The bottom line is that it hardly pays the average shooter to worry about the steel in his barrel. If a certain type, or make of barrel is what you want, then get what makes you happy.

IMPORTANCE OF RIFLING

In a rifle the grooving is of the utmost importance; for velocity without accuracy is useless. To determine the best kind of groove has been, accordingly, the object of the most laborious investigations. The projectile requires an initial rotary motion sufficient to keep it spinning, and it they have found it gains accuracy by increasing this rotary speed. If the pitch of the grooves be too great, the projectile will refuse to follow them, but being driven across them, strips the lead in the grooves is torn off, and the ball goes on without rotation.



Types of Rifling

A. Segmental B. Parabolic C. Four Groove
a. is groove diameter, b. is bore diameter

The English gunsmiths avoided the dilemma by giving the required pitch and making the grooves very deep. They even cast wings or lugs on the ball to keep it in the grooves expedients that increase the friction in the barrel and the resistance of the air enormously.

The American gun-makers solved the problem by adopting the gaining twist, in which the grooves start from the breech parallel to the axis of the barrel. It gradually increases the spiral, until, at the muzzle, it has the pitch of one revolution in three to four, the pitch being greater as the bore is less. This gives safety from stripping, and a rapid revolution at the exit. There is comparatively little friction and shallow groove marks on the ball, accomplishing what is demanded of a rifled barrel, that no other combination of groove and form of missile ever had.

There is no way of rifling so secure as that in which the walls of the grooves are parts of radius of the bore. They should be numerous, that the hold of the lands, or the projection left between the grooves, may divide the friction and resistance as much as possible, and so permit the grooves to be as shallow as may be.

THE AMOUNT OF TWIST IN THE RIFLE BARREL

A rifle bullet is much like a top; it has to be spun at a certain rate of speed to remain stable and point on. If you spin the top too fast, at first it wobbles, before it settles down to a smooth spin. Then as its speed of rotation diminishes, it finally begins to wobble again. The forward velocity of a bullet, however, diminishes more rapidly than its rotational speed.

The longer the bullet and the slower it leaves the muzzle, the faster the pitch of the rifling must be to keep the bullet point on and accurate. Short bullets like the 30-30 Winchester, which weighs 150 grains, can be stabilized in a twist having 1 turn in 12 inches, or a 1-12 twist. The twists in barrels chambered for the black powder cartridges, used bullets that were relatively short in proportion to their diameter, were quite slow. The standard twist for the .45-70, for example, was 1-20, the twist for the Winchester .50-95 was 1-60, and for the .50-110, was 1-54.

Here is a list of finish sizes of the sizing button, the rifling button, and the degree of angle to get that twist.

RIFLE BARREL TWIST

CALIBER	MAKE	BORE DIA.	GROOVE DIA.	TWIST
.30 WCF (30-30)	Winchester	.300	.308	12 inch
.30 Remington	Remington	.300	.308	12 inch
.30 US (30-40)	Springfield Armory	.300	.3085	10 inch
.30-06	Springfield Armory	.300	.308	10 inch
.30 Newton	Newton	.300	.309	10 inch
.300 Savage	Savage	.300	.308	12 inch
.300 H & H	Winchester	.300	.308	10 inch
.303 British	British	.303	.312	10 inch
.303 Savage	Savage	.300	.308	12 inch
.32-20 WCF	Winchester	.300	.311	20 inch
.32-40	Winchester	.312	.320	16.
.32 RF	Stevens	.2985	.314.	25 inch
.32 Remington	Remington	.312	.319	14 inch
.32 Win.Special	Winchester	.315	.320	16 inch
.32 Win.S.L.	Winchester	.312	.321	10 inch
8mm Mauser	Mauser	.312	.324	10 inch
.33 Winchester	Winchester	.330	.338	16 inch
.348 Winchester	Winchester	.340	.348	12 inch
.35 Winchester	Winchester	.350	.358	16 inch
.35 Remington	Remington	.349	.356	16 inch
.35 Win.S.L.	Winchester	.344	.351	12 inch
.351 Win.S.L.	Winchester	.345	.351	16 inch
.35 Whelen	Private	.350	.3575	14 inch
.35 Newton	Newton	.350	.359	12 inch
.375 H & H	Winchester	.368	.375	12 inch
.38-40 WCF	Winchester	.395	.400	36 inch
.38-40 WCF	Remington	.395	.400	20 inch
.38-55	Winchester	.370	.379	36 inch -20 inch
.38-56	Marlin	.370	.379	20 inch
.38-70 WCF	Winchester	.370	.380	24 inch
.38-72 WCF	Winchester	.370	.380	22 inch
.38-90 WCF	Winchester	.370	.380	26 inch
.40-50 Sharps	Winchester	.397	.404	18 inch
.40-60 Win.	Winchester	.397	.404	40 inch
.40-65 Win.	Winchester	.397	.403	20 inch
.40-70 Win.	Winchester	.397	.403	20 inch
.40-82 Win.	Winchester	.397	.403	28 inch
.40-90 Sharps	Winchester	.397	.403	18 inch
.40-110 Win.	Winchester	.397	.403	28.
.400 Whelen	Private	.400	.410	14 inch
.401 Win, S.L.	Winchester	.400	.408	14 inch
.405 W1n.	Winchester	.405	.413	14 inch
.44-40 WCF	Winchester	.4225	.429	36 inch
.45-60 Win.	Winchester	.450	.457	20 inch

.45-70 U.S.	Springfield Armory	.450	.457	22 inch
.4-5-75 Win.	Winchester	.450	.457	20 inch
.45-90 Win.	Winchester	.450	.457	32 inch
.45-125 Win.	Winchester	.450	.457	36 inch
.45-32 Sharps	Sharps	.450	.458	18 inch
.50 Sharps	Sharps	.500	.509	36 inch
.50-95 Win.	Winchester	.500	.512	60 inch
.50-110 Win.	Winchester	.500	.512	54 inch
.50-70 U.S.	Springfield Armory	.500	.515	42 inch
.505 Gibbs	British	.495	.505	16 inch

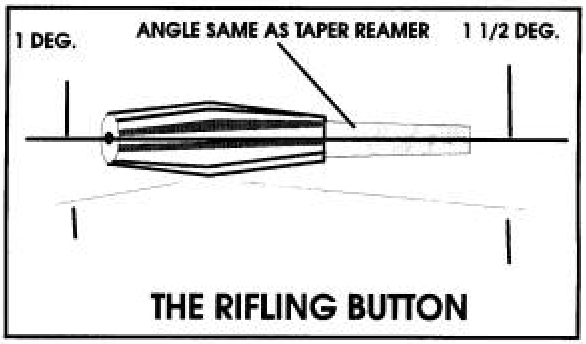
PISTOL & REVOLVER

Caliber	Bore Dia.	Groove Dia.	Arm	Twist
.22 L.R.	.2175	.223	Colt	14 inch Left
.22 L.R.	.2175	.2235	s&w	15 inch Right
.25 ACP (6.35mm)	.24.95	.2515	-	16 inch either
.30 Luger (7.65mm)	.300	.310	DWM	9.85 inch Right
.30 Mauser (7.63mm)	,300	.310	Mauser	8 inch Right
.32 ACP (7.65mm)	.300	.311	-	16 inch L (Colt)
.32-20	.300	.311	S-W	12 inch Right
.32-20	.300	.311	Colt	16 inch Left
.32 S & W	.300	.312	S&W	18 3/4 inch Right
.32 Colt	.300	.311	Colt	16 inch Left
.357 Magnum	.350	.357	S&W	18 3/4.inch Right
.38 Special	.350	.357	S&W	18 3/4 inch Right
.38 Special	.348	.354	Colt	16 inch Left
.38 S&W	.351	.361	S&W	18 3/4 inch Right
.38 ACP	.350	.356	Colt	16 inch Left
.380 ACP	.350	.356	Colt	16 inch Left
9mm	.348	.354	Luger	10,6 inch Right
.38-40	.395	.401	Colt	16 inch Left
.41	.395	.401	Colt	16 inch Left
.44-40	.4225	.427	Colt	16 inch Left
.44 Russian	.425	.427	S&W	20 inch Right
.44 Special	.4225	.427	s&w	20 inch Right
.45 ACP	.445	.451	Colt	16 inch Left
.45 Colt	.445	.452	Colt	16 inch Left
.455 Webley	.450	.455	Colt	16 inch Left

MAKING RIFLING BUTTONS

The invention of the rifling process using a swaging button to impress the rifling into solid metal has been the biggest boon to the barrel making industry since the invention of gunpowder. Where it normally took hours to rifle a barrel, now it will only take seconds.

Button rifling is a cold forming process. A small carbide button or swage, with lands cut in the button cold forms the grooves in the steel, it is pulled through the barrel bore, and embosses the rifling in the bore. They make the button a few thousands larger than the finish size that is required, since the metal will return .001 to .0015 thousands.



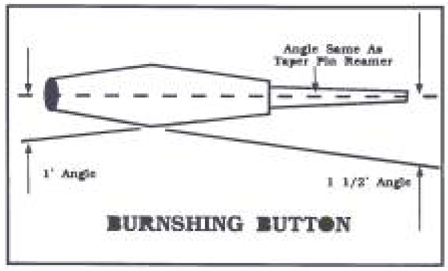
Button rifling is a surface forming process; no metal is removed in the rifling process. With button rifling, barrels can be rifled much more efficiently and much cheaper than any other process except possibly with hammer rifling, or forging.

All rifling styles can be duplicated by this method. Oddball rifling styles that would be difficult to attain with any other type of cutting or scraping process can be easily done with carbide swaging process. Button rifling will give a much smoother, harder, and more uniform bore than can be obtained with cut rifling and in turn gives much longer barrel life.

On cut rifling the barrel has to be shot several hundreds rounds to be lapped in, or has to be lapped by hand to get top accuracy. With button rifling, the barrel will shoot from the very first, and there is no wasted shots trying to get it to group good. The old way of rifling that was done in the past hundred or so years were done with single cutters. They cut out each groove separately, and required several passes to remove the required of metal. It is an extremely slow process and the finish that is produced is not that good usually.

The main improvement in cut rifling came just about at the start of World War 1. This was the start of using broaches. Since far more metal must be removed from the grooves than can be cut out with a single broach, a series of broaches, each a trifle larger than its predecessor was used. This varied in number from 10 to 60, and could be pushed or pulled through the bores.

These gang broaches are machined from a single piece of tool steel, gang broaching, although much faster than the older single cutter method or single broaching is costly in tools. Gang broaches are difficult and complicated to make, expensive to keep sharp, resharpened, and easily damaged.



With button rifling, you can rifle the hardest barrel steels, with very little difficulty. It produces the smoothest and uniform surface yet attained, and a single pass is sufficient to finish the entire bore. The button is difficult to fashion accurately, is sensitive to breakage, nonetheless simple, and normally has a long life.

RIFLING BUTTON SIZES

CALIBER	SIZING	RIFLING	TWIST	ANGLE
172	.169	.1735	10	3 deg 10 min
22 short	.2195	.2255	20	2 " "
22 LR	.2195	.2255	16	2 " 30 "
22WRF	.2205	.2285	14	2 " 55 "
22WCF	.2195	.226	16	2 " 31 "
22 Hornet	.2195	.226	16	2 " 31 "
218 Bee	.2195	.226	12	2 " 31 "
221 Fireball	.2195	.226	12	3 " 25 "
222 Rem	.2195	.2265	14	2 deg 53 min
223 Rem	.2195	.2265	12	3 " 25 "
222 Mag	.2195	.2265	14	2 " 53 "
219 Wasp	.2195	.2265	14	2 " 53 "
219 Zipper	.2195	.2265	14	2 " 53
224 Wea.	.2195	.2265	14	2 " 53 "
225 Win	.2195	.2265	14	2 " 53 "
22-250	.2195	.2265	14	2 " 53 "
220 Swift	.2195	.2265	14	2 " 53 "
22 Savage	.2225	.2285	12	3 " 50 "
243 Win	.2375	.246	10	4 " 20 "
244 Rem	.2375	.246	10	4 " 20 "
6mm	.2375	.246	9	4 " 46 "
6mm284	.2375	.246	10	4 " 20 "
25-20	.2515	.260	14	3 " 20 "
25-35	.2515	.260	10	4 " 33 "
256 Win	.2515	.260	14	3 " 20 "
250-3000	.2515	.260	15	3 " 20 "
257 Roberts	.2515	.260	10	4 " 33 "
257 Roberts Imp	.2515	.260	10	4 " 33 "
25-06	.2515	.260	10	4 " 33 "
257 Wea. Mag.	.2515	.260	12	3 " 49 "
6.5 Jap	.2575	.266	9	5 " 15 "
6.5mm M.S.	.2575	.266	8.5	5 " 31 "
6.5x55	.2575	.266	7.5	6 " 20
6.5 Rem Mag.	.2575	.266	9	5 " 15

264 Win Mag.	.2575	.266	9	5 " 15 "
270 Win	.2715	.2805	10	5 "
270 Wea Mag.	.2715	.2805	12	4 " 12 "
7mm Mauser	.2775	.287	10	5 " 5 "
284 Win	.2775	.287	10	5 " 5 "
280 Rem	.2775	.287	10	5 " 5 "
7x61 S&H	.2775	.287	12	4 " 15 "
7mm Rem Mag	.2775	.287	9.5	5 " 23 "
7mm Wea Mag	.2775	.287	12	4 " 15 "
7.5 Swiss	.3015	.311	10	5 " 30 "
30 Carbine	.3015	.311	16	3 " 29 "
30-30 Win	.3015	.311	12	4 " 35 "
300 Sav	.3015	.311	12	4 " 35 "
308 Win	.3015	.311	12	4 " 35 "
30-40 Krag	.3015	.311	10	5 " 30 "
30-06	.3015	.311	10	5 " 30 "
30-06 Imp	.3015	.311	10	5 " 30 "
300 H&H Mag.	.3015	.311	10	5 " 30 "
308 Norma Mag	.3 015	.311	10	5 " 30
300 Win Mag.	.3015	.311	10	5 " 30
300 Wea Mag.	.3015	.311	10	5 " 30 "
7.65mm Mauser	.3045	.315	9.8	5 " 40 "
303 British	.3045	.315	10	5 " 43 "
7.7 Jap	.3045	.315	9.5	5 " 53 "
32 Win Spc.	.3165	.323	16	3 " 35 "
8mm Mauser	.3135	.327	9.25	6 " 7 "
8mm-06	.3135	.327	9.25	6 " 7 "
338 Win Mag.	.3315	.341	10	5 " 30 "
340 Wea Mag.	.3315	.341	10	5 deg 30 min
348 Win	.3415	.351	12	5 " 12 "
35 Rem.	.3515	.361	16	4 "
358 Win	.3515	.361	12	5 " 22 "
350 Rem Mag.	.3515	.361	16	4 "
35 Whelen	.3515	.361	16	4 "
358 Norma Mag	.3515	.361	14	4 " 32 "
375 H&H Mag	.3695	.3785	12	5 " 33 "
378 Wea Mag.	.3695	.3785	12	5 " 33 "
44 Rem Mag	.424	.430	38	2 "
444 Marlin	.424	.430	38	2 "
45-70	.4515	.4605	22	3 " 41 "
458 Win Mag.	.4515	.4605	14	5 " 48 "
460 Wea Mag.	.4515	.4605	16	5 " 8 "

PISTOLS AND REVOLVERS

CALIBER	SIZING	RIFLING	TWIST	ANGLE
22 LR	.2195	2255	14	2 deg 52 min
25 ACP	.251	.2525	16	2 " 49 "
30 Luger	.3015	.313	9	6 " 12 "
32 ACP	.3015	.314	16	5 " 37 "
32-20	.3015	.314	16	5 " 37 "
32 SW	.3015	.315	18	5 " 34 "
357 Mag.	.3515	.360	18	6 " 28 "
38 Spec.	.3515	.360	18	6 " 28 "
38 SW	.3525	.364	18	6 " 26 "
38 ACP	.3515	.359	16	4 "
380	.3515	.359	16	4 "
9mm	.3495	.357	11	5 " 45 "
38-40	.3965	.404	16	4 " 30 "
41	.3965	.404	16	4 " 30 "

44-40	.424	.430	16	4 " 45 "
44 Russian	.424	.430	20	3 " 52 "
44 Spec.	.424	.430	20	3 " 52 "
45 ACP	.4465	.454	16	5 " 2 "
45 Colt	.4465	.455	16	5 " 2 "
455 Web.	.4515	.458	16	5 "

The twists that are used in the above listing are standard factory twist. The finish groove size given by the rifling button will give the correct diameter if the steel that is used falls in the range of 30 to 32 Rc. If you use a steel of 28 to 30 Rc, the groove diameter will be slightly larger, and harder steel will be slightly smaller Diameter.

The twists given are standard, but the button could be made with any twist. You will find there are far more accurate combinations than the factory twist, but they are a good starting point.

TWIST FORMULA

The formula for finding the correct angle for the twist that you want for the rifling button is the diameter of the groove, which is .308 (30 Caliber); 308 x pie is 96761054, this answer divided by the twist gives you an answer of .080634.

Now look at a sine chart and find that figure, it will be 4 degrees and 37 minutes. That is the angle that you want to cut the grooves on the button to get a 1 in 12 twist.

In a 17 caliber for example you will find that the 1 in 10 twist is fairly well standard. I have done quite a bit of experimenting and have found that a 1 in 14 twist for me has been very accurate. It has given me consistently 1/2 minute or under groups at 100 yards. The main trouble in accuracy in 17 calibers seems to be the bullets.

I have found that the slightest air pocket in the bullet had a tendency to throw the bullet off in the 1-14 twist. With good bullets, the 1-14 will be found superior for top accuracy.

The 1-10 twist will usually shoot the poor made bullets better with considerable accuracy on the average. This is also true of the other calibers. Take the 30 calibers for example. The 150-grain bullet will shoot like a house afire with the 1-14 twist.

One of my most accurate and favorite game rifle was a 243 with a 1-14 twist. The rifle was used for long range on coyotes, crow, etc. I used a 75-grain bullet for the best accuracy.

If you want to experiment, you will probably come up with a far more accurate rifle by doing this. You can tailor your rifle to shoot the bullets and speed that you want. The main problem you may have is with bore tolerance. This will be with the steel that you use. Every barrel maker is plagued with this problem.

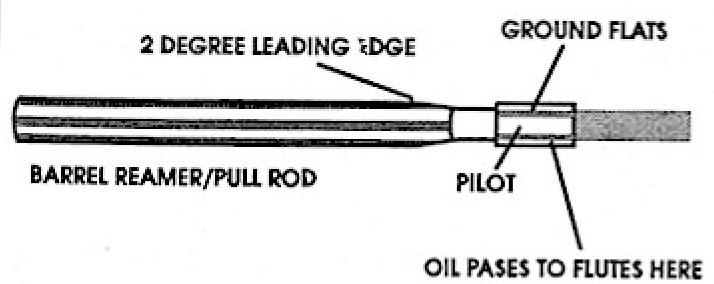
If you have hard spots in the barrel, you will come out with tight spots in the barrel, and if there are soft spots, there will be loose spots. I have got such bad steel that when the barrel push it a short ways, and then it would drop 8 to 10 inches before stopping. What you had is a junk barrel.

MAKING REAMERS & BARREL REAMING

This is the most important part of making the rifle barrel. If you do not have a true and smooth bore, you do not have anything. I will show you how to make reamers for finishing the barrels. On barrel reamers, you will need two reamers. One a rough reamer for removing and cleaning up the drilled bore, and the finish reamer to take the bore to the correct size.

INFORMATION ON REAMERS

Reamers are made with both straight and helical flutes. The latter provided a shearing cut, and is useful in reaming holes that has key ways or grooves cut in it, and are bridged over by the helical flutes, thus preventing binding or chattering. Hand reamers are made in both solid and expansion forms.



BARREL REAMER

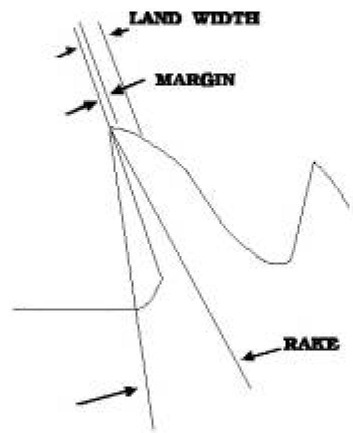
SHAPE OF FLUTES

Style and shape of the flute determine its ability to carry away chips and the relative strength of the tooth. For manufacturing, a straight shank may be used. With fluting reamers, the cutting edge is set to the center or slightly below of the reamer blank so the tooth gets a slight negative rake. The amount is set so that a tangent to the circumference of the reamer at the cutting point makes an angle of about 95 degrees with the front face of the cutting edge.

When fluting reamers, it is necessary to break up the flutes that are to space the cutting edges uneven around the reamer. The difference in spacing should be very slight and need not to exceed about .004 either way.

The way that you break up the flutes if the reamer is to set the cutter anywhere from .002 to .004 in front of the center of the reamer blank, and changing it a .001 or so on each flute.

The relief of the cutting edges should be comparatively slight, and it can be relieved on the tool post grinder and stoned flat with an Arkansas stone. The flat relief is what I have used all along, because the reamer has a keener cutting edge.



REAMER FLUTE SHAPE & DESIGN

CHATTER

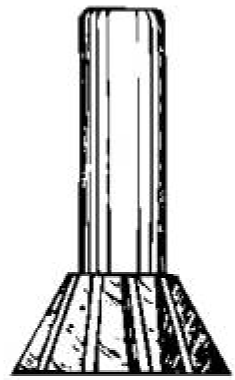
Chatter can be the one thing in barrel making that will cause you the most trouble. Even if the reamer and relief are perfect, you can still get chatter. The first thing you need to do when using a new reamer is to spray the reamer with layout fluid. If the reamer is chattering, when you remove the reamer and you will be able to see if you have enough clearance, etc.

Sometimes a too sharp a reamer will chatter, or it may have too much clearance. If the pilot on the reamer is not a close enough a fit, that can cause chatter. Sometimes reducing or increasing the speed or feed will help. I cut all of my reamers on zero rake I have very little trouble with chatter. If you are using commercial reamers, there can be too much positive or negative rake, and that can cause chatter.

In most of my reaming I find that a good starting point is about two-thirds the drilling speed for a given material. If you ream to slow, it takes too long to ream a barrel, and very few barrels can be turned out. If too high a feed or speed, premature dulling, chatter, and usually a rough finish is the result.

REAMING FEEDS

In reaming, feeds are usually much higher than those employed for drilling, often 200 to 300% greater, to low a feed may result in excessive reamer wear. The feed must be high enough so that the tool cuts, rather than rubs. I find that too high a feed will cause the hole to be oversize, and rough. I also have found that a good starting point is somewhere between .0015 to .004 feed per flute per revolution. The smaller bores such as .17 or 224-caliber .001 to .003 per revolution are a good start. I can only recommend that you find the highest feed that will produce the required finish and accuracy.



THE DOVETAIL
CUTTER

STOCK ALLOWANCES

This is covered in the chapter on barrel reaming and reamers. This is very an important item in barrel making, as the type of lubricant that you use for reaming will determine the quality of the reamed bore.

The lubricant is used to cool the reamer, remove the chips from the barrel, and to improve the finish of the work. Normally for most steel, a sulfurize oil, or a high E. P. value mineral oil. Contact a business that supplies cutting oil and they will be able to help you. You will have times when you are unable to get a smooth reamed hole.

LUBRICANTS

When the flutes are not evenly stoned, or flutes cut back of centerline, stoned with too great a clearance. Chips clinging to the flutes caused by to high a revolving velocity.

CHATTERING

Reamers plugging up by not having enough oil pressure to flow past the flutes, flutes not being stoned out, and allowing saw teeth to form on the cutting edge. The reamer being oversized causes enlarged holes.

ARKANSAS STONE

The cutting edge of the reamer is kept sharp by honing with an Arkansas stone over the cutting edges. The reamer should be touched up about every two barrels.

REAMER PLUGGING

The surface speed for reaming should be rather slow, on a regular barrel-reaming machine; the reamer turns, but on the lathe the barrel turns and the reamer is stationary. Instead of using an open belt and higher speed, the lathe is set in back gear, and run at the slowest speed.

FEED RATE

The feed can be made faster than that used for drilling. The barrel reamer is pulled through the barrel and has more cutting edges in contact with the barrel during reaming.

For the roughing reamer you can use a feed twice as fast as that for finishing. After the drills and reamer are made, and kept in good shape, many barrels can be turned out with them. Reaming is a simple operation, and with this information and the tools to produce the barrels, you will turn out high-grade barrels.

BARREL REAMER SIZES

Listed below are the Caliber, size of the rough Reamer, and the size of the finish reamer.

Caliber	Rough Reamer	Finish Reamer
172	_	.168
224	.215	.218
244	.233	.236
257	248	.250
264	.254	.256
270	.268	.270
284	.274	.276
308	.298	.300
303	.301	.303
32	309	.311
358	348	.350
375	.365	.367
44	.419	.422
457	.448	.450

I will go through all the steps of making reamers, from the start of reamer blanks from a piece of tool steel, to the finish reamer, that is ready to ream the barrel. To start you will need a vertical milling machine, and an indexing fixture. These two items are the two main pieces of equipment necessary to make cutting tools

I will go through with you on making a complete set of tools for a 308-barrel. You will need two each, 5/16 inch (.312 inch) drill rod, and 6 inch long. Once you have the two - 5/16 inch drill rod cut, go to the lathe.

Chuck up one of the pieces and using a 1/4-inch center drill, center one end just deep enough to get a good center. The other end, uses a 3/8-inch center, and centers it to the outside edge of the drill rod.

The reason for this is that on this end you will attach the pull rod to the reamer. In most reamer, operations using the lathe you will note that tubing is used instead of a solid rod. The reason that I use a solid rod is that, (1) it is much cheaper, (2) it is more rigid than tubing and seems to eliminate the chattering that you get from time to time.

Also if the reamer gets dull or it should plug up, with the tubing, it would wind up the tubing and ruin it. With a solid rod, you will be more able to stop the machine before it ruins the reamer. If it should freeze up in the barrel, the worst that will happen is that the reamer will pull out of the sweat joint that attaches the rod to the reamer. Then all that is necessary is to drive the reamer from the barrel, resharpened, and sweat the reamer to the pull rod.

Once you have the centers in the drill rod, you will need to drill the end of the drill rod that you centered with 3/8-inch center drill to 1/4 inch by 3/4 inch deep. You will need to drill the hole first with a next smaller drill size. Then clean it up with a 1/4-inch drill, now do the second one and the drill rod is ready for rough turning.

Center up the drill rod between centers on the lathe, with the counter bored end next to the tail stock, with a small lathe dog holding the other end. The .312 drill rod is just about the right size for the .308-fluted end, so it will not need to have anything done to it.

The other end where the pull rod is attached will have will have to be turned. The drilled hole will measure .293 in the rifle barrel, so you will end up with a .290 pilot on the reamer. Turn the pilot, (the end where the pull rod is attached) to about .010 larger than the finish size and the recessed area between the pilot and where the reamer flutes start, about .260 to .280.

The pilot area will be on most of the reamers about 11/4 inches long, the recess will be about 2 inch long. If you make the reamers for smaller calibers, they can be made shorter.

The .224 caliber the overall length of the reamer would be 4 inches, the pilot would be 1 inch, and the recess would be 3/8 inch wide. The recess should be about .040 smaller than the pull rod when completed, after grinding. The recess is there to get an even oil flow to the flutes when reaming.

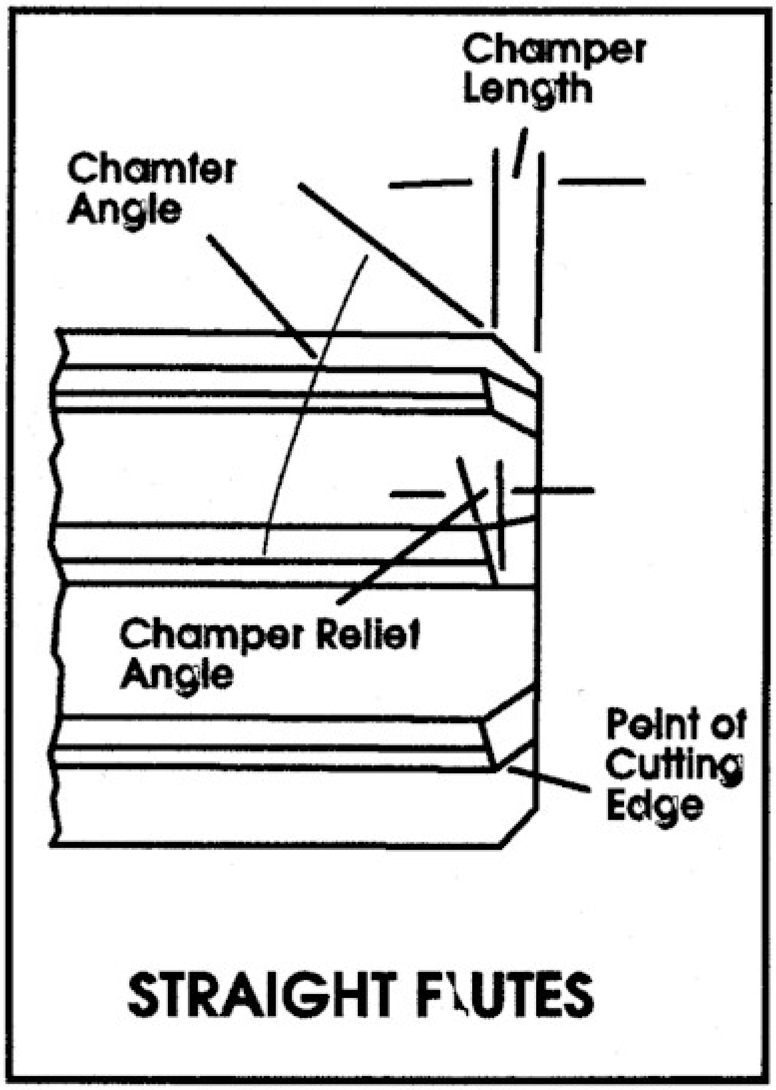
Once you have the reamer blank completed, go to the milling machine and set up the indexing head. This should have centers also with some way to attach a small lathe dog to hold the reamer blank solid. If the indexing head supports a collet, the stock can be held with a collet.

ANGULAR CUTTER

Next chuck up a 60-degree angular cutter in the mill, the diameter of the cutter should be at least 1/2 inch. Slow down the mill to about 100 to 150 rpm, as the tool steel tends to get hot.

Measure the drill rod on the flute end; in this case, it has not been turned so it is .312. Bring down the cutter on the milling head while it is running and just touch the drill rod and stop.

Half of that size is .156; we do not want to cuts the flutes half way as the reamer would probably chatter. The first flute should be cut .002 in front of center, the next should be cut .004 ahead of center, and the third should be cut .006 ahead of center.



After the third flute is cut, the fourth should start back at .002, then .004 and the finish cut is .006 ahead of center.

THE FLUTE THICKNESS

The wall of the flute should have a thickness of about .060 to .080. This would be thinner on the smaller reamers and thicker on the larger reamers. You do not want to make flute walls to thin as they tend to break if the reamer gets to dull, and when this happens the barrel will more than likely be ruined.

You want to use an ample supply of coolant when cutting the flutes. Depending on the reamer size you will go in about 3/4 of the depth on the first cut and then finish to the correct depth the second pass. Watch for bowing as you cut the flutes. If the blank is bowing you are either taking too heavy a cut, or the cutter is dull, or you may be cutting to fast.

Whatever the reason you do not want this to happen as it is putting internal stress in the reamer blank. When heat treating the blank, it will probably warp badly. If you fill there is stress in the reamer blank, I would suggest that when you get ready to heat-treat the reamer, that you put the reamer in the furnace when you turn it on.

Bring the temperature up to 1000 degrees, and let it set for 30 to 40 minutes. Remove and bury it in lime until cool, or turn off the furnace and let it cool over night.

DEPTH OF FLUTES

Bring the temperature of the furnace up to the temperature that is recommended by the maker of the tool steel. Coat the reamer blank with some decarbonizing powder and put the reamer blanks in the furnace and let it set for 10 minutes at the proper temperature. Remove from the furnace, and quench in the oil tank or what other quenching medium the manufacture recommends.

When you quench the blank make sure that you go straight in the quenching tank, if you quench the reamer at an angle, you will warp it. If you do warp a reamer you will have to bring the reamer up to 1500 degrees and let it cool in the oven, then straighten it when cool.

When you have both reamers quenched, lay them down on a towel where they will not roll off. They are very hard and brittle, and if they fell on the cement floor, they would probably break.

TEMPERING THE REAMERS

Turn off the furnace, close it up, and let it cool down to 350 degrees. We will then put the hardened reamers into the furnace to draw the hardness, and remove internal stress. Leave the blanks in the furnace until the furnace reaches 100 degrees, or better yet leave them in over night. The reamers will be about 61 to 62 Rc in Hardness.

The reamer blanks are now ready to be ground to size, and we will grind the flutes first. Set up the tool post grinder on the lathe. Get everything lined up, put the small lathe dog on the reamer blank, on the pilot end, and grind the flute end first.

Clean out the centers on the blank, and set between the centers, and cover the bed of the lathe up to keep the grinding dust off the ways. Set the lathe in back gears drive; turn on the lathe so it will run in reverse. Then, turn on the tool post grinder, starting at the tail stock end and touch the grinder to the blank.

Move the grinder past the blank and set it in about .005 then engage the feed. It will not clean up completely, but it will start to clean up any part that is warped, make one pass and if it is cleaned up enough so you can get a measurement, check the size of both ends. There should be about a .002 taper from the pilot end to the end of the blank.

The tail stock end should be the smaller end, this is very important to have or you will get a rough bore. We are grinding the rough reamer first, so you want to end up with the pilot end of the reamer .298. When you get this size, remove the reamer blank from the lathe. While the lathe is set for the .002 taper, we will do the other blank. It is done the same way except that the final size should be .3005. We will allow the .0005 to hone in to size.

Now that the second reamer blank is ground, we will grind the leading edge taper. Set the compound on the lathe to 11/2 degrees. This will be your cutting edge next to the pilot. Turn the lathe on in reverse and the grinder and start feeding the wheel by hand on the cutting edge of the reamer, and grind this angle down a few thousands into the recess. Do the other reamer also; it will take several passes to do this. Take light passes not much over .005 so you will get a good finish.

GRINDING THE REAMER

When you have completed this on both reamers, take the blank from the lathe. Turn it around, put the dog on the other end, and put it back in the lathe. Before doing this, make sure you bring the tail stock back to "000" center.

Square the grinding wheel up, and where the recess is grind this down to about .040 smaller than the pull rod, which will be .250. When the recesses are completed, it is time to grind the pilots to correct size, the roughing reamer that is .298 diameter; the pilot will be ground to .290.

Do not take over .003 per side as it will heat the metal too much, so go slow and easy. The pilot on the finish reamer will be ground the same way, and the size of the pilot will be .003 smaller than the O.D. of the rough reamer, which will be .295.

GRINDING THE PILOT

When completed with the pilots there is one more operation to do, this is to grind four flats length ways on the pilot for the oil to pass. These flats can be ground on the lathe if the lathe is equipped with an indexing head, or you can grind them by hand if you are careful.

You should leave about .060 on each corner of the pilot; this is usually enough to give good oil flow to the reamer. If this should give trouble on chips plugging up the reamer flutes, turn up the oil pressure to get more flow, but the finish reamer will give no trouble if it is sharpened good.

GRINDING THE CLEARANCE

Now comes the time to relieve or grind the clearance on the back of the flutes for clearance. If you do not have indexing on your lathe, it will have to be ground by hand, but if you have indexing on the lathe, the tool post grinder will grind this clearance. To grind the relief by hand you will need a small hand grinder. Coat the reamer flutes with a lay out fluid. This will darken the metal so you can see how close you are getting to the cutting edge.

Grind the relief just back of the cutting edge, and up to within .005 to .010 of the cutting edge. It will not take much to give the necessary relief, as all you need is clearance so the reamer will not rub.

STONING THE CUTTING EDGE

Once the face has been honed, it will be necessary to hone the flutes. Hone right up to the edge watching the lay out fluid coating, this will tell when you have gotten it honed tight.

Start from the area where you ground the relief, and slowly go up to the cutting edge. It should feel sharp when completed.

ATTACHING THE PULL ROD

When you have both honed, it is time to sweat the pull rod to the reamer. It is best to use a 1/4-inch drill rod for this purpose, as it is smooth and uniform. Clean out the 1/4-inch hole in the reamer with some rolled up emery cloth, apply some paste solder in the hole. Insert the drill rod into the hole, and heat the shank until the solder melts.

When it melts, rotate the drill rod in the hole to get a good tinning job, then let cool and it is completed. This is one important reason for stress relieving the reamer while heating in the furnace. If the reamer warps then it will be crooked on the pull rod, which in turn will cause a rough and oversize bore.

Before using the reamer the first time, recoat the flutes and cutting edges with the layout fluid. The reason for this is when you use the reamer the first time, the lay out fluid will show up any rub spots, and any place you do not have enough clearance.

The main problem that you may experience will be chatter.

A new reamer has more tendencies to chatter than one that has been used for some time. Chatter may often be reduced by closer fitting pilots and guide bushings, or reducing the speed, also sometimes increasing the feed will eliminate chatter. If for some reason there should be to little clearance, the reamer will not cut freely, as the lands or margin will rub instead of cut against the walls of the barrel. In most cases the reamer will either lodge or break off a flute or two, or break off, in the case of a finish reamer the barrel will be ruined. This is why I always soft solder the pull rod on, rather than fastening it on solid.

THE BUTTON RIFLING MACHINE

This machine is very simple in construction, easy to build, and has given years of trouble free service. You will first need to get a few items to build this machine. The main item is a good low volume hydraulic pump, with at least 1000 pounds of pressure.

In addition, you will need two hydraulic cylinders, each with a stroke of at least 30 inches. Also find at an automotive part's house, two heavy duty thrust bearings, with a 11/4: bore. See Drawing.

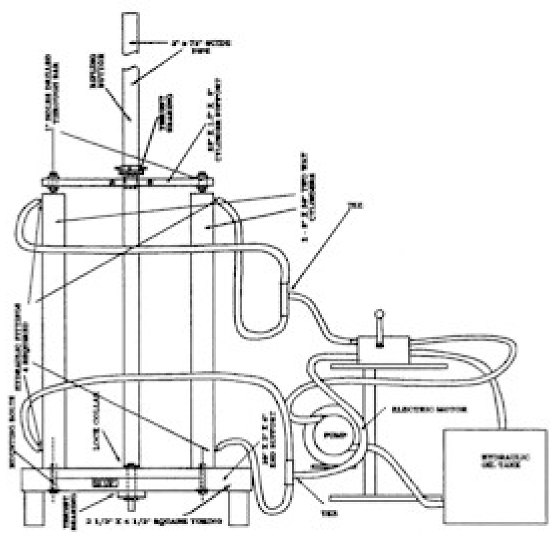


FIG. 9 TOP VIEW OF HYDRAULIC RIFLING MACHINE

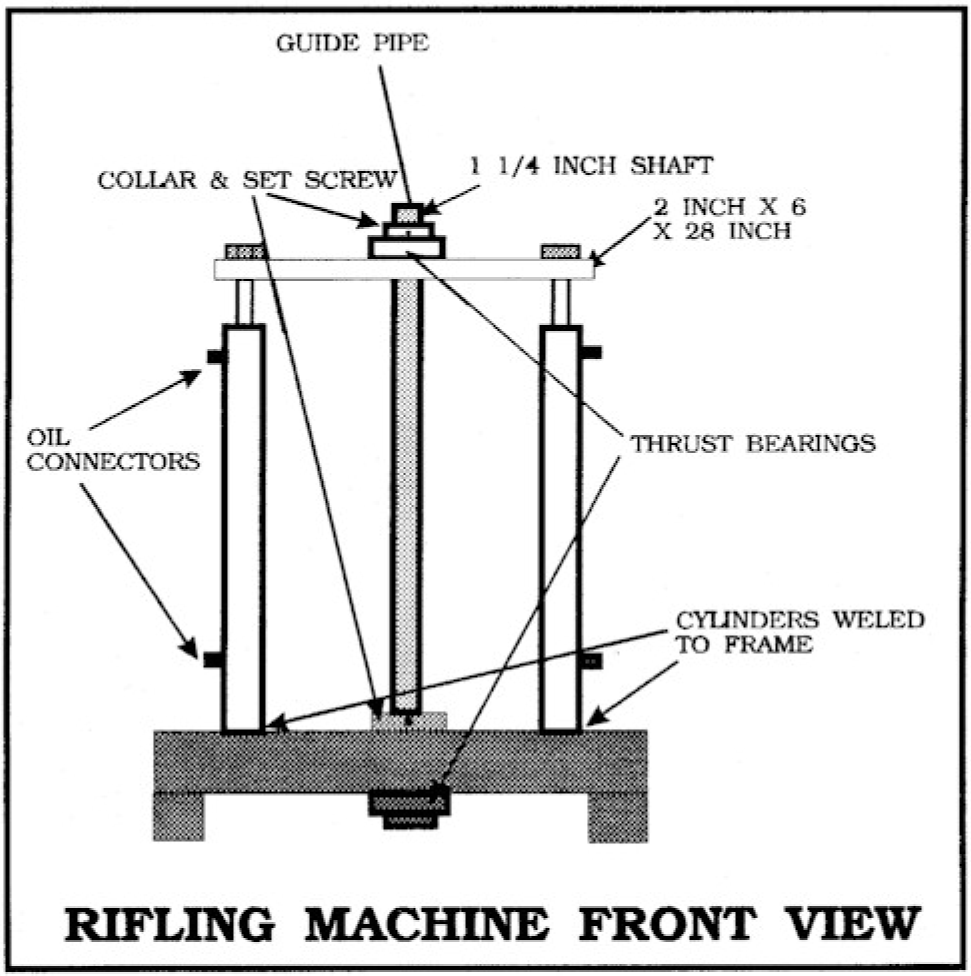
The thrust bearings are used to take care of the torque when rifling, and does a good job as the more expensive rifling head. You can buy a 2-way hydraulic control valve, which is used to raise and lower the hydraulic cylinders.

The metal that you use to make the frame should be rather heavy as it takes much pressure to rifle a 45-caliber barrel; Two-inch material is a good start. All the holes, and alignment should be drilled very carefully, or the cylinders will pull crooked, and bind up in use.

If you plan to rifle barrels over 30 caliber, I would suggest using a rifling head; my rifling machine had a variable speed, heavy duty, and gear reduction electric motor. With this, we could reduce or increase the rate of twist in seconds by use of a speed switch such as used by a light dimmer switch that is sold at any hardware store. For 30 caliber and smaller the thrust bearings were all that was needed.

ELECTRIC MOTOR

You will need at least a three-horse power electric motor to drive the hydraulic pump. It takes much power to pull the rifling button through the barrel. The drawing shows the machine without the guide pipe.



Rifling Machine, Front View

It has been omitted so as not to confuse the drawing, you will see a side view of the drawing showing the rifling machine with the guide pipe. The guide pipe when in use should be well greased so it will not bind or chatter as it is being raised. The top brace that connects the two hydraulic cylinders should be level and parallel with the bottom support.

This machine is very simple in construction, easy to build, and has given years of trouble free service. I will give you dimensions for two different types, one a vertical type and the other a horizontal machine. You will first need to get a few items to build this machine. The main item is a good low volume hydraulic pumplow volume hydraulic pump, with at least 1000 pounds of pressure.

This is a supplement book to the Barrels & Actions book that goes into the making of rifle barrels, and will go into more detail of the building of the machine. Also the drawings included will make it easy to cut out all the individual items, and assemble the machine.

Also, you will need two Hydraulic cylinderShydraulic cylinders 2 to 3" diameter, each with a stroke of at least 30 inches. Also find at an automotive parts house, two heavy duty thrust bearings, with a 1 ¼" bore diameter and with an O.D. of not over 3". See Drawing.

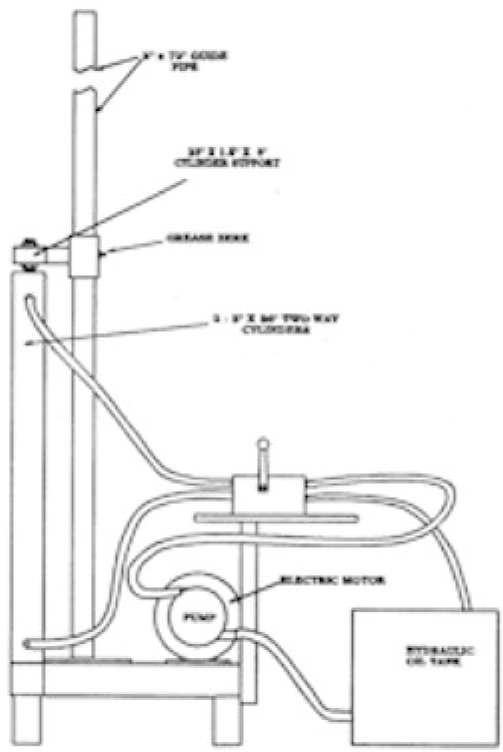


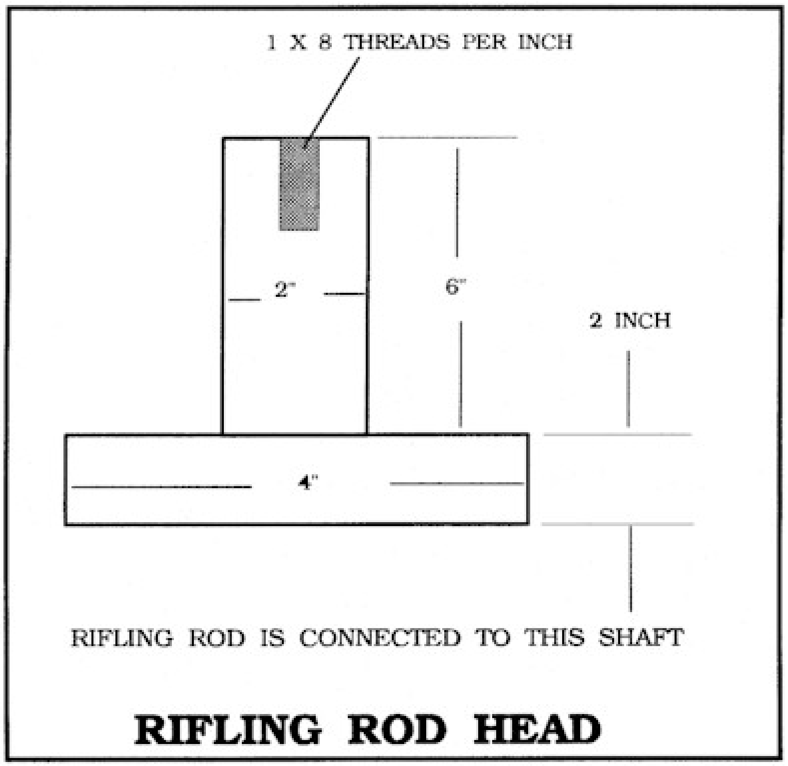
FIG. 11 VERTICAL RIFLEING MACHINE SIDE VIEW

The Thrust bearings are used to take care of the torque when rifling, and does a good a job as the more expensive rifling head. When you rifle with a rifling button, the twist that is on the button will cause that twist to be formed in the barrel, regardless if you use a rifling head. You need to buy a 2-way hydraulic Control valve, which is used to raise and lower the hydraulic cylinders. If you have a farm supply store, you can find most of the equipment needed to build a rifling machine.

The metal that you use to make the frame is heavy as it takes lots of pressure to rifle a 45 caliber barrel so I do not recommend going much lighter, so two inch material is a good start, 3" is better. All the holes, and alignment should be drilled very carefully, or the cylinders will pull crooked, and bind up in use.

If you plan to rifle barrels over 30 caliber, I would suggest using a rifling head. My rifling machine had a variable speed heavy duty, gear reduction DC electric motor. With this we could reduce, or increase the rate of twist in seconds by use of a speed switch such as used by a light dimmer switch sold at any hardware store. The switch was calibrated for each of the different twists that we used. In most of the smaller caliber's and up to 30 caliber, the pull was not great enough to use the rifling head, and the thrust bearings would take care of the thrust.

The hydraulic pump should be a high pressure, low volume pump, otherwise you will have to have a relief valve in the line to bypass the oil, or the pump will stop the electric motor. A needle valve in the line on a high volume pump will allow you to bypass some oil, and this is the reason for using a low volume pump.



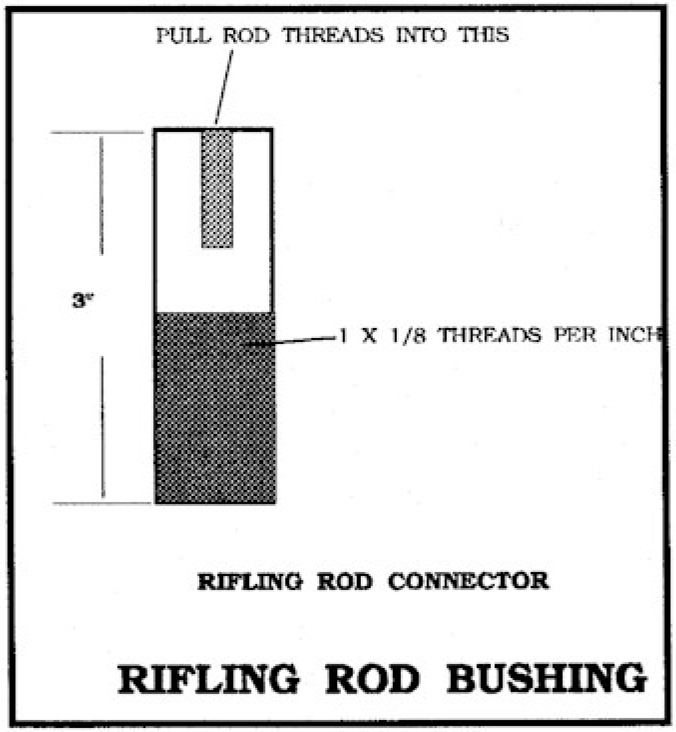
Rifling rod head

You will need at least a 3-horse power electric motor to drive the hydraulic pump, and a 5 horse would be better if you plan to rifle the large bores. It takes a lot of power to pull the rifling button through the barrel. The drawing for the vertical rifling machine shows the machine with the guide pipe, and the horizontal uses a 4” “I” I-beam to guide the head.

In some drawings on the vertical machine, the guide pipe has been omitted so as not to confuse the reader in reading the drawing. You will see a side view of the drawing showing the rifling machine with the guide pipe. The guide pipe when in use should be well greased so it will not bind or chatter as it is being raised. The top brace that connects the 2 hydraulic cylinders should be level and parallel with the bottom support.

This is very important as when you are rifling a barrel the rod is pulling straight, instead of an angle. This is very important when rifling 22 liners, as they have a tendency to warp anyway when rifled due to the extreme swaging operation. When the machine is assembled, make sure all the air is bled out of the cylinders and lines. If not, they will pull crooked if air is in the lines.

About the only other item that will have to be made and installed is the rifling head. The simplest one is the use of thrust bearings. This head will hold the rifling or pull rod, and the rod holder.



Rifling rod Bushing

You will need one for each size rod or caliber, such as 1/8” for 17 caliber, .187 for .224-.244-.257, and on up on the sizes. A heavy duty bearing clamp with at least 3 3/8” set screws to hold the barrel when rifling.

This is shown as a collar in the drawings. When rifling, the setscrew has to be **VERY TIGHT.**

There is a tremendous pull on the machine when the barrel is rifled, as you are pulling an oversize button through a hardened piece of steel. The Button rifling process swages the rifling in the steel, rather than cuts out the grooves.

If you plan to rifle barrels over 30 caliber, I would suggest using a rifling head. My rifling machine had a variable speed heavy duty, gear reduction DC electric motor. With this we could reduce, or increase the rate of twist in seconds by use of a calibrated speed switch such as used by a light dimmer switch sold at any hardware store. A small chain, such as a bicycle chain or pulleys is used to drive the rifling head at the proper rotation. Slight changes in the construction of the head will be needed to adapt to the Rifling Head, and a sprocket on the head can be used to rotate the head. The thrust bearings are still used when using the Rifling Head in case the setting is not exactly right.

The first machine is a horizontal rifling machine. This is a good choice if you have the space in the shop. The 4” “I” Beam is 80” long and should be straight as possible as the slides follow it. You will need to get a 30” piece of solid steel 3” X 4” bar. This is for the

Hydraulic Cylinder end of the machine. See Figures 1 through 5.

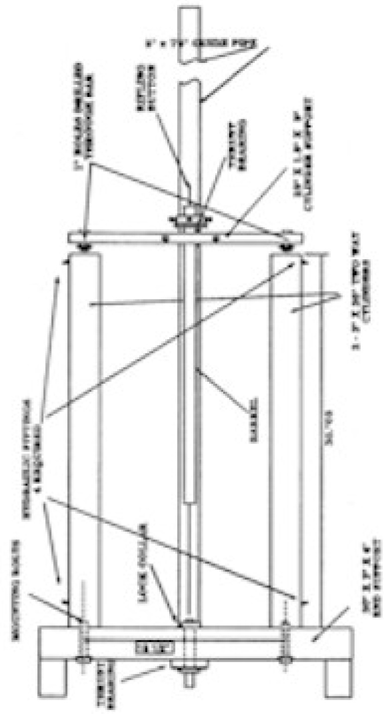


FIG. 10 TOP VIEW OF HYDRAULIC RIFLING MACHINE

There will be three holes drilled through this bar, two are for attaching the Hydraulic Cylinder, and the third hole is a 1” hole in the center for the rifling head. You need a piece of three or four inch square tubing 30” long for the other end of the rifling machine. See Figure 1 for more details.

You also will need a length of 2” pipe for the legs of the rifling machine. You need four, 24” long. After getting all the materials, cutting to length, and drilling the holes you are ready to start to assemble the machine. Look at Figure 1,2, and 3 to get an idea on how to put the machine together. The 3” X 4” bar that you mount the Hydraulic to **MUST BE ABSOLUTELY SQUAR**E to the “I”” Beam, or it will not pull straight. This is the most important step on the machine and great care should be used. See Figure 4 & 5.

Once you have the parts bolted or welded in place, you need a bar of steel 23” X 1 ½” X 3”. This is for mounting the two Hydraulic Cylinder shafts together. See Figure 6. There are three holes drilled on the three-inch side, for the cylinder shafts, and a 1 5/16” hole for the Barrel to go through. In the top or 1 ½” wide, there will be 2 holes drilled for 3/8” bolts that is used for mounting the slide to. These holes can be used as a pilot to spot the slide that travels up and down the “I” Beam. See Figure 7.

The item that you must build is the slide that supports the cylinders and the barrel during rifling. See Figure 7 for the dimensions and construction of the slides. Both slides will have tracks welded or held with screws so they will follow the “I” Beam. The tracks can be from ½” key stock and must be aligned accurately on the slides so they will run true. Once the tracks are fastened in place, they need to be connected by two pieces of ¼” X ½” cold rolled steel. See Figure 7. The two, 16” strips can be welded on while the slides are in place on the “I” Beam. The slides and “I” Beam should be greased during use to minimize the chance of binding.

The barrel support is next fastened to the rear slide, and it is you must get it aligned very accurately, for when you start pulling the button through the barrel, as it cannot bind the barrel. What I mean by binding is it **HAS TO BE EXACTLY CENTERED** so the barrel is just lying on it, and not on an angle? See Figure 1.

The rifling rod head is made next. You will need a lathe to make this, as it is turned from 3 ½” X 7” bar stock. See Figure 8. The rifling head shown, when used with 30 caliber or smaller will be all that is needed in rifling a barrel. The thrust bearing is nothing more than a heavy-duty throw-out bearing that is used in automotive industry.

If you mount an adjustable rifling head, it will be connected to this shaft via a sprocket or gear. The threaded end of the shaft is drilled and tapped for a rifling rod bushing. You must make several bushings for the various sizes of rifling rods. The bushing should be made from tool steel and hardened, so the threads are not stripped out under the extreme pull pressure.

LOCKING COLLAR

The locking collar is used to hold the barrel when rifling. The collar should have at least 3 - 3/8” set screws (square head) to hold the barrel and 4 if you rifle over 30 caliber barrels. There is a thrust bearing under the collar, the same heavy type that is used on the head. See Figure 2.

COMPLETING THE MACHINE

After all, the parts are made and assembled (See Figure 1 and 2) the Hydraulics can be set up. The drawings for the Hydraulics are shown for the Vertical machine, but are the same for the Horizontal machines. See Figure 9 through 11.

The Vertical machine is usually the best choice, especially if you are short on room. The main difference is the guide pipe that serves the same purpose as the "I" Beam. You must get it mounted in perfect alignment so there is no binding or bending when the Cylinders are raised, and it very important to keep it well greased during use.

RIFLING HEAD

You can also use an assortment of sprockets of different sizes to get the correct twist for the different twists that you will use. If you do not rifle many barrels this is probably be the best solution. A single or three speed electric motor can be used, but you will have to use a jack shaft to reduce the speed down to about 500-RPM, and then by using different sizes of sprockets you can get the correct twist.

If you have an old lathe, the quick gear changes can be adopted to regulate the twist. This is probably the best arrangement for the shop that is making many barrels. A stand is made and bolted or welded to the rifling bench so there is no movement or spring when in use. The rifling head shown with the thrust bearings is used as shown, with the sprocket mounted to it. The sprocket in my experience should be 6 to 8 inches in diameter, and the driver sprocket is the size that you use for the correct twist.

SETTING THE TWIST

On the rod I bend over a piece of masking tape with about a 1" edge sticking out. I have it right on the edge of the machine or flat so I have a starting point. I mark the spot where it is at, and then turn on the DC Motor as well as the hydraulic pump motor. The tape will start to rotate, and when it comes to the exact spot where you marked it, pull back the lever that controls the cylinders. As the cylinders come out, watch the tape so when it comes to the starting place then release the lever. If you measure the distance the cylinders traveled, you will have the amount of twist. You may want to do this a couple times to get an exact reading.

You can now either change the sprockets or pulleys or dial the speed up or down on the DC Motor until you get it right. The Vertical rifling is set up the same as the horizontal rifle machine, but when you put the legs on it you may want to give it some thought on their length if you mount the rifling head.

The rifling of the barrel is the climax of barrel making. In the past this was a very time consuming operation. Not so with button rifling. It should not take over three minutes to do now what it took several hours or days in the past. The important part now is to get proper lubricant for the rifling operation.

The best lubricant that I have found is Molykote Z, made by Dow Corning Corp, Midland, Mich. This can be purchase in various forms, but the powder is the best, and is what I always used, and with very good results. It looks like graphite but don't let that fool you in think that graphite will work because it won't. It is necessary to mix it with oil and swab the bore.

This is a pressure lubricant, and they say it takes over 50,000 pounds of pressure to break it down. It works great on lathe centers too. If the rod the rod ever pulls off do not think you can get a rod and a big hammer and drive it out.

Don't even tempted to try. If you should be so lucky to drive the button out, it will be shattered. To remove a stuck button stick a short rod down inside the barrel to find where the button is, mark the outside of the barrel, add another 1 ½ inch and saw it off.

Then saw the back end off so you will have a short piece of barrel with the button in it. Next get old hacksaw out and split it length ways on both side, and remove the button. You will notice there will be metal welded on the button, which you will have to remove very carefully.

When you saw it out be careful that you don't hit the button with the blade, as it will ruin the blade. All that is necessary is to redo the rod and re-sweat the button back on. In button reaming you will not need any special lubricant, just some heavy oil like STP. If you have not left the barrel undersize, you should not have any trouble. It is wise to check each bore with a go-no-go gauge before rifling.

After checking the bore, and lubricating the bore, you are ready to rifle the blank. Set the barrel in the center hole in the rifling machine. Tighten the clamp around the barrel to hold it in place. Make sure the thrust bearing is centered and in place. Turn on the machine, and pull the control lever back and hopefully watch the barrel being rifled.

DO NOT STOP ONCE YOU STARTED, AS WHEN YOU START UP AGAIN YOU WILL PROBABLY PULL THE BUTTON INTO.

On the smaller calibers you will see the barrel rotating on the thrust bearings as the rifling button makes the proper twist in the barrel, but in button reaming they won't move. When through lift the barrel from the top frame, without removing the clamps unscrew the button and remove from the machine. Then lower the frame back down. The barrel is through with button reaming. If you are using 1350 or stress proof don't button ream, only on 4150 do you need to do this.

Lubricate the bore with MolyKote Z, put the barrel back in the machine, slide the rifling button back down the bore, and screw it into the head. Be sure the thrust bearing is centered under the clamp. Pull the lever back, and the barrel will rotate by itself as the button passes through the bore. If the barrel doesn't rotate, help it. If you have a rifling head, this won't be necessary. The smaller calibers do not pull that hard, but on 45's, the motor slows down and breathing ceases until the button comes out the barrel.

I would not recommend that you try to rifle any stainless steel at first, as on them you will need to leave the bore slightly oversize. When the button has come out of the barrel, remove the barrel, wipe out and you should have as good a barrel as any produced by a manufacture.

RIFLING THE BARREL

The rifling of the barrel is the climax of barrel making. In the past, this was a very time consuming operation, not so with button rifling. It should not take over three minutes to do now what it took several hours or days in the past. The important part now is to get proper lubricant for the rifling operation.

WITHOUT THIS, WHEN YOU START TO RIFLE THE BARREL THERE WILL BE A LOUD CRACK, AS THE ROD PULLS BREAKS WITH A LOUD SNAP.

LUBRICANT

I do not know of any commercial lubricant that will do the job, so after doing much experimenting and cutting many buttons out of the barrel. I came up with one that served me well for years. What happens is when the button starts down the barrel; it starts to gall then sticks. Therefore, if you decided to try some lubricant you will probably have to cut the end off the barrel. You will then split the barrel to get the button out, as the button will be in the barrel an inch or so. The best lubricant that I have found is MolyKote Z, made by Dow Corning Corp, Midland, Michigan. This can be purchase in various forms, but the powder is the best, and is what I always used, and with very good results. It looks like it is graphite but do not let that fool you in think that graphite will work because it will not. It is necessary to mix it with oil and swab the bore.

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