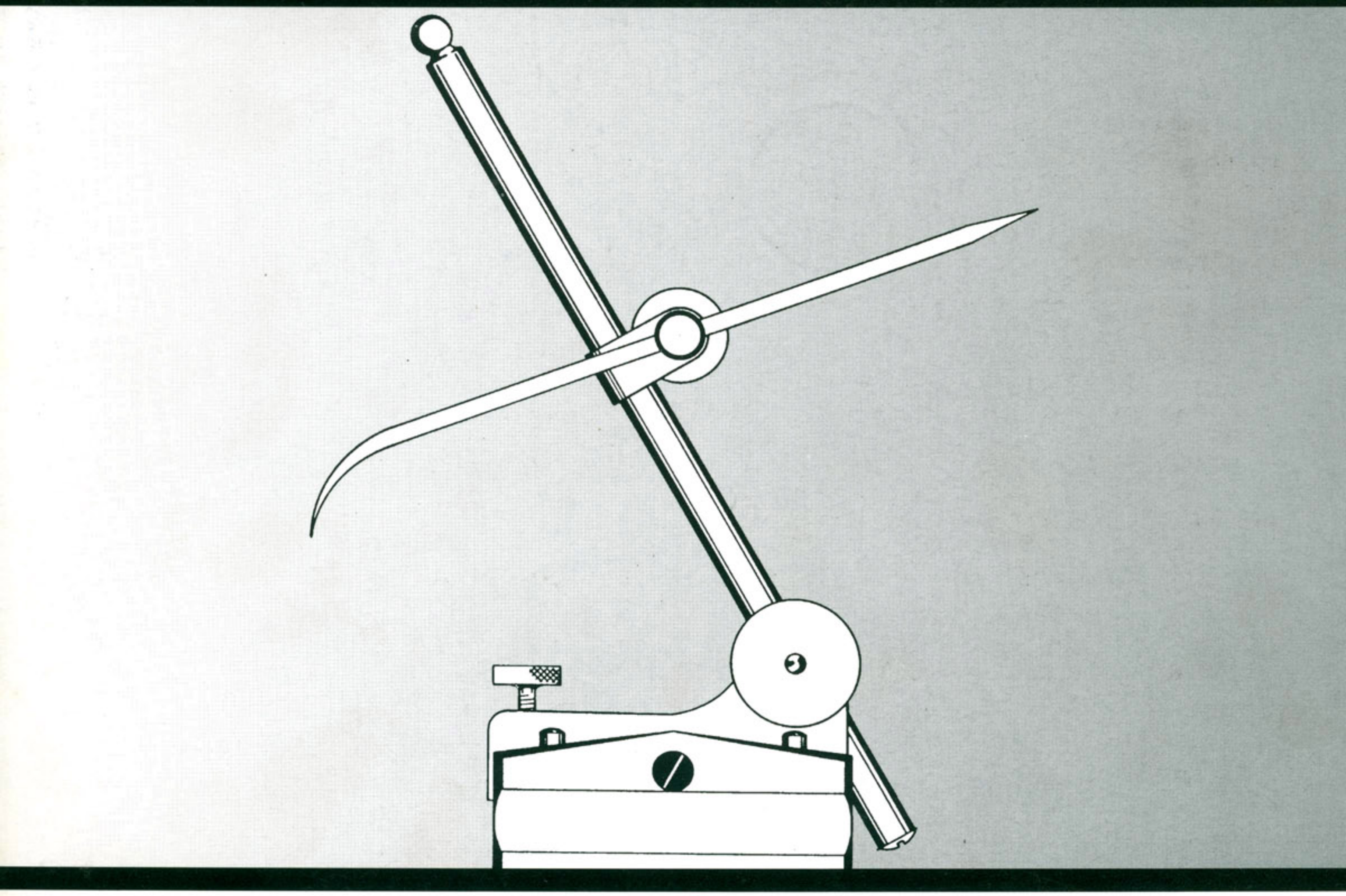
The MACHINIST'S BEDSIDE READER

Projects, hints, tips and anecdotes of the trade

by Guy Lautard



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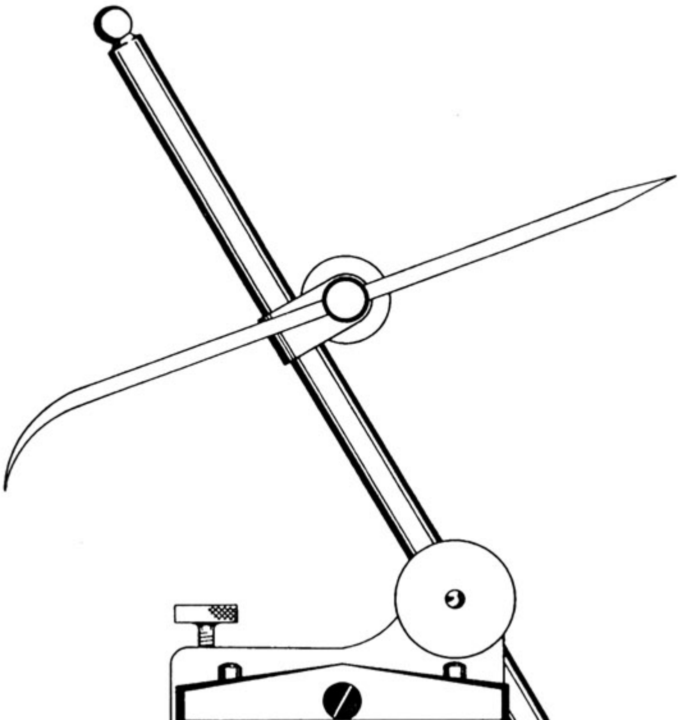

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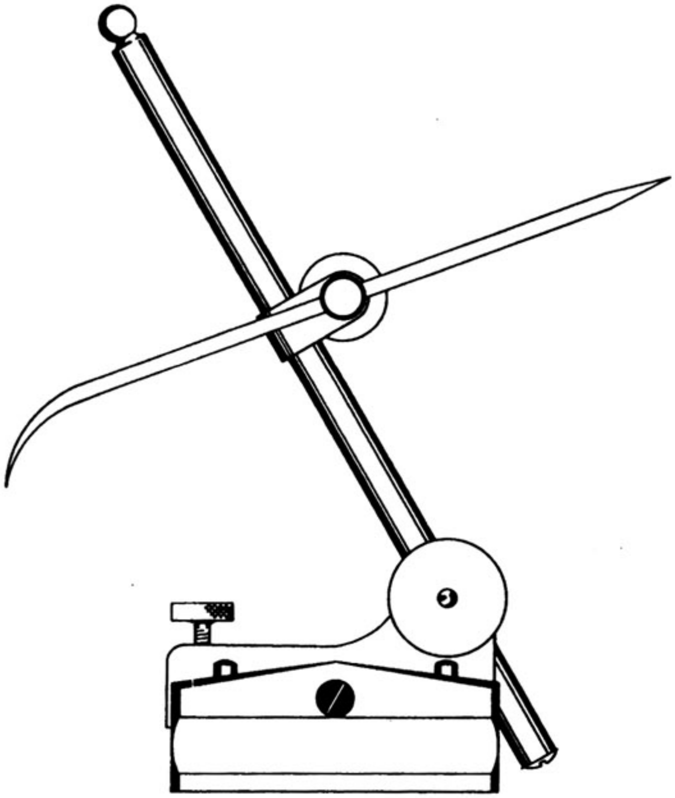

.......working drawings and ideas for tools for the machinist's toolbox, toys for himself and /or his grandchildren, plus other useful information, hints, tips and general dispensations of workshop wisdom, plus a sprinkling of machine shop anecdotes and other stuff you'll like.

written and published

by

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TABLE OF CONTENTS

ADDED TO THE 18th PRINTING, SEPTEMBER 2006:
Changes to the Table of Contents now include the following:

NOTE

The publication and sale of the Machinist's Bedside Reader series has resulted in a great deal of correspondence from and with customers. I enjoy this very much, but the time involved in writing replies is getting to be a real problem. If I can answer your question at all, I can do so faster on the phone than by writing a letter, and you'll have your answer immediately. My phone number is (604) 922-4909. Or, if you want to write to me and have me call you collect in reply, be sure to say so, and give your complete phone number in your letter.

Please note also that I am in the **Pacific Time Zone** (same as Washington/Oregon/California). Please call between 9 AM and 9 PM my time.

WARNING and DISCLAIMER

WE ALSO OFFER OTHER BOOKS, PLANS, VIDEOS, AND TOOLS OF INTEREST TO MACHINISTS

A VIDEO from Guy Lautard: BUILD YOUR OWN RIFLING MACHINE

This 3 hour video shows full technical details on the construction and use of a rifle barrel making machine the basement machinist can build, and use to produce match-quality cut rifled barrels, starting from the solid bar. Thorough explanations are given at every stage - deep hole drill geometry, reamer details, making your own rifling heads, etc. If you want to make your own rifle barrels, on a non-commercial basis, this is the way to do it.

This video will save you **endless** frustration and wasted hours. Just the part on sharpening your own deep hole drills will quickly save you the entire cost of the video. Comes with 36-page written supplement loaded with tips, drawings, info and suppliers' addresses.

A BRIEF TREATISE on OILING MACHINE TOOLS

Here's the 'mother lode' on a topic of major importance to every machinist - 25 info-packed pages on ▪ How to make a ***really*** good oil gun, in less than an hour, that will put oil where you want it, at 10,000 psi if need be! (It's a dream come true for Myford lathe owners!) ▪ How to arrange for centralized oiling of machine tools using a one-shot oil pump, or the shop-made oil gun described above, how to remove spring ball oiling points, how to make and mount a centralized oiling manifold, what to use for oil lines, etc.. ▪ Info on oiling machine tools - what types of oil are appropriate where, and why. ▪ Complete working drawings for a handsome variable feed drip oil cup to fit lathes, mills, etc. Permits you to see that oil is definitely being fed, and shuts off tight so you don't waste oil when the machine is off. You'll like it. ▪ Complete drawings for pea-sized drip feed oil cups for model work. ▪ And more, including a recipe for a good leadscrew lube, and how to go about grinding in a lathe without harming it.

A UNIVERSAL SLEEVE CLAMP

An interesting exercise in machining, boring and screwcutting, the Universal Sleeve Clamp provides a clever means of hinging and clamping two rods together. It is the ideal accessory for your magnetic dial indicator base and/or surface gage, and can also be used as the hinge joint for a large capacity compass, or inside or outside caliper, much like a firm joint caliper. Scale up the design just a little and use it as the basis for a universal lamp for your lathe, mill or workbench. Made slightly larger again, you could use it to make a handsome and unusual living room lamp. (The drawings are arranged in such a way as to make designing new ones at any size an easy matter.) Also includes working drawings for a height adjustable tool holder for small boring tools and internal screwcutting jobs, plus a sheet showing the sort of boring tools I make. These incorporate a minor but significant feature not everybody thinks of when making tools of this type.

3.75"ϕ ROTARY TABLE

Even if you own a larger, geared rotary table, you will find this little ungeared Rotary Table (shown in **TMBR#1** at page 193) a most useful accessory for small jobs in your vertical milling machine: ▪ mill a radiused end on a part, or round the ends of a set of loco conrods ▪ space out holes accurately around a pitch circle ▪ mill a circular slot ▪ mill two or more slots at an angle to each other... and so on. If you make it at the sizes given in the drawings, the base will be 4" square, and the table will be 3.75"ϕ. Of course, you may want to scale it up, (or down, for the ultimate paperweight). Whatever size you make it, it's an interesting and instructive exercise in machining, and will be a prized addition to your shop tooling when done.

LAUTARD'S OCTOPUS

Part bench block, part V-block, part vernier protractor, part direct indexing fixture, part tilting angle plate, part rotary table, part layout jig, this multipurpose workholding fixture has more ways of holding a job than an octopus. Not for heavy work, but just right for small (and some not-so-small) and tricky jobs that come up every so often in every shop. Fully detailed drawings, machining instructions and how-to-use info are provided. Several 'extras' are included, like how to make a lathe sub-faceplate that thinks it's a magnetic chuck: if you have a piece of 3/8" or 1/2" aluminum plate handy, it'll cost you about $2 for the "power supply", and it'll hold non-ferrous as well as ferrous materials with a "ferro-cious" grip - this info alone is worth the price of the drawings! We can also supply an octagonal casting, if you can't scrounge up a suitable piece of steel.

A MICROMETER BORING HEAD FOR YOUR MILLING MACHINE

Based on a classic design by the well known George Thomas, this boring head's generously proportioned dovetail slide and dowelled gib, coupled with a large diameter graduated dial, make for precise and silky smooth adjustments; if well made, its repeatability is phenomenal. Takes 3/8"ϕ shank cutters, and, via adaptor sleeves, smaller ones as well.

You can use this boring head with simple shop-made cutters to machine washer seats, cut counterbores for socket head cap screws down to 0-80, etc.

The drawings give all dimensions for making the Boring Head in 2 sizes, to suit both larger and smaller mills. This is a quality project that will serve you for a lifetime. The instructions are very detailed, to enable anyone to make this valuable and versatile milling machine accessory, *providing he is willing to take the necessary time*. You can be justifiably proud of yourself when it's done, and you'll learn a few things in the course of making it, too.

The COLE DRILL

A versatile, hand-cranked drill that will do most things that your drill press can do, and quite a few things your drill press won't do, including such feats as drilling right through a 1" square HSS lathe toolbit! Broken engine block studs, wheel studs, farm, logging and mining machinery, and vehicle repairs, grain elevator maintenance work, boat building -- if you are involved with any of these types of activities or problems, you may find the Cole Drill very useful. For more details and ordering information, see TMBR#3, or contact us.

VERNIER PROTRACTOR

We now stock and sell very nice quality 2-minute vernier protractors made in mainland China. As one customer said, "Every other protractor I own was designed wrong in the first place." He likes this one a lot better.

INTRODUCTION

THE MACHINIST'S BEDSIDE READER is a book for machinists and gunsmiths. Both professional workers and amateur machinists should find it useful as well as entertaining. Although the prospective reader should understand that it was written more with the amateur or hobby machinist in mind, even men with many years in the trade will find ideas herein that will make them say, "That alone was worth the price of the whole book!"

Maybe I ought to clarify what I mean by an "amateur machinist". I do not entirely like the term, because to some it might suggest an inept bungler in metal. The term 'model engineer' is the common British term. In Britain a machinist is often called an engineer, a machine shop an engineering works, and so on. Thus someone who builds small scale replicas of full size machinery (locomotives, traction engines, etc.) is called a model engineer.

The other name, which I am inclined to favour, is home shop machinist. Inasmuch as he may build models, make tools, fix or make stuff for his car, build an airplane, or a telescope, or a rifle, or whatever, 'model engineer' does not say it all. "Home shop machinist" is suitably descriptive, and it is the term most often used hereafter in this book.

Now, as most who buy this book will know, there is a wonderful little magazine called *Home Shop Machinist,* (see Appendix for address). Well, we don't want to steal their thunder, so let's do it this way. If we're talking about guys who are home shop machinists, we'll use the abbreviation hsm. If we're talking about *Home Shop Machinist* magazine, we'll write it out, or put it down as HSM.

There is another matter I want to get straight. This book isn't intended to be the be-all and the end-all. You aren't going to agree with everything I say. You may regard as routine something to which I give considerable space. Another might think I didn't elaborate enough on the same point.

I'm not a professional machinist. I never served my time as an apprentice. There are lots of things I don't know. However I have, over the years, acquired a fair amount of knowledge through dedicated effort, voracious reading, listening to advice and instruction from as many machinists as were willing to share their know-how, and through doing it myself, always with the goal of making a first class job of whatever I was doing.

The purpose of this book is to share with you some of what I've picked up about this best of all trades. So if I say something you don't agree with, or which reveals a lack of knowledge or experience on my part, remember these lines from **"The Secret of The Old Master"** by Lucian Cary (which see elsewhere herein):

> "What's your trade?" he asked.
> "I'm a toolmaker."
> "How old are you?"
> "Twenty six."
> The old man looked at him sharply. "They used
> to say it took twenty years to make a toolmaker
> out of a good mechanic."
> "I'm still learning."
> "So am I."

ACKNOWLEDGMENTS

Some of the material in this book is original. Some is taken, with permission, from other sources. Some is adapted from ideas or information I've seen or read. I have tried to acknowledge all sources.

I would like to say a sincere "thank you" to all those who have contributed, in one way or another, to the contents of this book - people who shared their anecdotes and/or know-how, and editors and authors who gave their permission to use or adapt material previously published elsewhere.

A SPECIAL ACKNOWLEDGMENT

This book would not have been written without the unfailing help, encouragement and patience of my wife Margaret. She did the typing, proofread everything at least 4 times, discussed changes, variations, and ideas, and kept me organized in spite of all my protestations that I didn't want to be organized.

NOTES TO READER

You will encounter the phrase "elsewhere herein" throughout this book. It means "To be found somewhere else in this book".

"See Appendix" means that the address of a company mentioned will be given in the Appendix at the back of the book.

The symbol "Ø", used in both text and drawings, means "Diameter" - i.e. the part is round.

Some of the drawings herein are somewhat unconventional. For example, the Box Latch and the Small Scribing Block are dimensioned sectional assembly drawings, and while at first glance they may seem complex, a little study will reveal that all the info required for each part is given.

In many cases, an end view of round parts is not given. Some drawings of round parts are split at the centerline, to save drawing the same thing on both sides of the centerline.

THE SCRAP PATROL

How to Scrounge like a Pro

or should that be

"How to Scrounge like an Amateur"?

The home shop machinist is always on the lookout for likely pieces of metal. One problem we run up against in trying to buy from a steel supplier is the large 'minimum purchase' policy many of them necessarily have. The following ideas may be helpful.

If you can order material in concert with another hsm, the 'minimum purchase' may not be an obstacle.

If the outfit has a not-so-big minimum charge, and you only need one certain item, take enough other material to meet the minimum. One local outfit that sells non-ferrous alloys has a $20 minimum order. I wanted some 1.5" dia. brass. For $20 I got what I wanted, plus more than $20 worth of useful material from the scrap box.

In such a situation, be discriminating in what you take, or you'll end up with a bunch of stuff you'll never use. Therefore, have a mental list of future projects, and think about them while you're pawing around in the scrap box.

If you run up against a supplier who won't sell to you in the small quantities you need, ask him for the name of one of his customers who buys from him the type of material you want. If he'll tell you, call them, and/or go see them.

If you walk into a machine shop and say, "I'm an amateur machinist. Can I have a look in your scrap box?" your chances are slim. They probably visualize you as making toy electric motors out of nails and scraps of tin cans. Remember, these are busy people, trying to make a profit in a very competitive business. But they are also human. What to do?

Take along some one example of the sort of work you do. Take your best effort, not some minor item. Having told them why you are there, pull it out of the bag and say, "This is the kind of stuff I make." Chances are you'll have their immediate attention. I showed one machine shop owner a dividing head that had taken me about 4 months to make. His eyes lit up like stars, and he said, "Let me call the foreman!" From that shop I can get all the scrap I could ever desire, at no charge, and with pleasure.

If you arrange such a situation, don't tell your hsm friends - the last thing the shop owner is going to want is a bunch of clones showing up at his door with scrap box syndrome. Try to return the favour somehow: next time take along a big bag of donuts for the crew's coffee break. Or take along something you've made with the scrap you got from them. The day may come when they may turn your way a small job they can't afford to touch, or they may ask you if you know of a way to do some oddball job that has come in. If they do, regard it as a compliment. (Either that or they are really desperate for an idea.) Or maybe you have another interest - e.g. photography - where your skill could be useful to them.

Let me tell you a couple of little stories. They're not exactly about scrounging, but they're apt:

1. Max Jaffee, owner of a local tool store, once loaned me a precision level from his inventory so that I could get my then brand new lathe levelled up. When I said I'd have it back that afternoon, he told me, "I don't want to see you for a week."

When I returned the level, Max showed me the gear shift knob from his son-in-law's Porsche, and asked if I could fix it. The set screw had stripped in the factory-made pot metal mounting sleeve, leaving the knob loose on the stick shift lever.

I made a heavier sleeve in aluminum, with 2 larger screws in place of the original little one, and polished it up with Brasso at 2500 rpm - it looked like it had been chromed. I pressed it into the base of the knob and dropped it off a few days later. Max was delighted. He waved the rejuvenated gear shift knob and his ever present cigar about in his great fleshy paw, and he said, "Not every transaction involves money."

(And guess what my wife gave me the following Christmas? A beautiful Moore & Wright 8" precision level! Lo, I shall rise up and call her blessed, for it is there whenever I want to check the lathe, the mill, or the shaper with it.)

2. If you think you've overpaid a little in returning a favor like this, don't worry about it - the welcome mat will be out if you want something another time.

I helped a friend make some additions to a custom roof rack for his truck. It required some pipe bending and a fair amount of pipe threading. We went over to see my friend Bill Fenton, who I knew had a pipe vise and a first class pipe threading outfit. We were there 3 or 4 hours, Bill helping us all the while. We got the rack done, learned a few things about threading and bending pipe, had a few laughs, and generally enjoyed ourselves. Jack paid Bill more than he asked. Two or three days later he wanted to make a couple of minor additions to his roof rack. Do you think he'd have been able to go back if he'd grumbled about the amount Bill had asked for the use of his stuff?

STANDARDS OF WORKMANSHIP

I hesitate to write this, for fear of offending some, but here goes - if it gives some reader even one or two ideas which lift the quality of his work, 'twill have served its purpose.

Much of what we see in the world around us is not high class workmanship. Often the idea is to whip the job out as fast as possible, and to heck with finish, so long as it'll serve the purpose. Up to a point, that's fine, and entirely appropriate.

During WWII, my friend Bill Fenton - (We will meet Bill again elsewhere in this book. You will like him.) - was a machinist in the Royal Canadian Electrical Mechanical Engineers - R.C.E.M.E. (This was pronounced "Reamy", the C being silent for the sake of a catchy name.) When Bill got to Britain, he (along with the whole Canadian Army) came under the command of the British Army.

On arrival in England, the first thing Bill and his fellow "colonials" were told was, "We don't care if you think you're a machinist or not. We're going to train you to do things our way."

".... and I filed at a bench for 16 solid weeks," laughed Bill. Did he resent it? "No, I didn't. There were some who did, but I recognized it as a wonderful opportunity." You'd expect that though, Bill being a man of more than average common sense. He was being paid to do it, he was gaining skill he could use for the rest of his life, and he wasn't getting shot at, so why complain?

"We had one officer - the type we called a 9-day wonder. On civy street, he'd been a used car salesman in Hamilton, Ontario - and he didn't know his ass from 2 bits a week, (this is one of Bill's favorite means of dismissing incompetents of any stripe or hue). Everything we made had to be "drawfiled and polished" - even if it was a bar of black iron to be used for holding a spare tire under a truck frame."

Now that is the sort of foolishness I was speaking of a few paragraphs above - obviously all that's called for there is to put the holes in the right places, and champher the corners and edges of the cut ends so that the poor sot who has to change the tire doesn't rip his hands open on your work.

But where you do want "nice work", what to do?

Well, ok, this is what I'm talking about: No toolmarks left visible on exposed surfaces, within reason. Good fits, free of slop. Nice crisp corners and edges uniformly bevelled without a rounded-over look, which in itself bespeaks equally poor work. External threads given a "Higby end" (see elsewhere), or at the very least, the end nicely rounded. Internal threads counter drilled 1-1/2 to 2 threads deep at just over bolt O.D. so that when the bolt is tightened, if the thread is pulled up a little, it doesn't pull a burr above the mating surfaces to interfere with reassembly.

We had a fella (who we'll call "Wilbert") in the B.C. Society of Model Engineers who neither understood nor cared about any of the above. Everything Wilbert made was hazardous to handle because you'd cut yourself on the unfinished edges. We had another guy who didn't have a lot of skill, but he went the other way - things that should have been left with nice, crisp edges (not sharp edges, just crisp, mind you) looked as though they'd been made of wax and partly melted down. But you had to love him for his enthusiasm. Wilbert was a little less lovable because he had the ability to do better work - you could tell that by looking at what he did do - but he simply didn't care. Of course it wasn't up to me to say anything - Bill Fenton did that.

Knurling should look like knurling, not scarring. If left too sharp, it can be uncomfortable in some applications. To remedy this, pass a file over it lightly while still in the lathe. Champher the ends of knurled areas, after knurling, for best appearance. The L.S. Starrett Company seems to do it a little different: best I can tell, they leave a little ridge for knurling, knurl it, and leave it at that. This is not intended as a criticism - Starrett tools are nice stuff, and doubtless their way is faster, which is probably why they do it that way. But for myself, I still like a champher.

What else can I say? Take a critical look at your work and see where you can improve it.

The final result, when you make something for yourself in your own shop, can be far nicer than anything you'd normally be able to buy. People look at it and they are impressed, even if they don't look close enough to see why they like it. And even if they don't appreciate what they see, who cares? You know it's a first class job - and therein lies the satisfaction....or part of it, anyway.

CROSS FERTILIZATION
with people of other interests

One of the best things about the machinist's trade is its wide applicability. The home shop machinist may make tools, small working engines, museum class (or lesser) scale models of any kind of machinery that interests him - trucks, artillery, machine tools, marine engines, etc., guns, camera equipment or whatever else his hand may turn to. What he builds this year may not be what he's interested in building next year, but his knowledge, tools, and equipment can be used whatever the project may be.

I think that this aspect of the hobby can open a whole forest of other doors. There are fascinating people all around you with various areas of specialized interest and knowledge. Few will be machinists, but many will have interests which could be furthered by a machinist's skills.

Maybe you are interested in telescopes, but you know nothing about optics? See if you can unearth an amateur telescope maker in your town. How? Find out if there is a local telescope maker's club or astronomy club. How? Ask the local newspaper. Ask the librarian in the Science and Technology section of your public library. Inquire at a store that sells telescopes. Inquire at the local college or high school. Look in the Yellow Pages under "Associations" and "Clubs". Run an ad in your local newspaper. ("Machinist would like to meet amateur telescope maker for platonic relationship. Please reply Box xx".)

It's amazing what you can find in the way of interesting people around you if you once start trying to track down an idea along these lines. One thing leads to another - one contact to another - and pretty soon you meet somebody who lives nearby who needs a machinist pal and has know-how he'll share with you.

If you want to meet other home shop machinists, find out if there is a local model engineering club, or a group of "live steam" enthusiasts in your area. Or get some publicity in your local newspaper - have a picture and a little article done up about something you've made. Chances are you'll hear from some like-minded guy who's also interested in meeting other machinists, and all of a sudden, you can start a club, if there isn't one to join.

A SOURCE OF WELDING ROD FOR HIGH CLASS WELDS IN FINE WORK...

AND TO INTRODUCE YOU TO BROWNELLS, INC.

A superior welding rod material for very fine and finicky welding jobs is...sewing machine needles. Use small vise grips to hold the needle, and a small tip on your torch. Don't work too fast. Dip the parts in water from time to time to keep them from getting too hot as the job progresses. (Adapted, with permission, from a tip by Fred Linzy, (Porter, Oklahoma) in **Gunsmith Kinks, Vol. II**, p.437, a book available from Brownells, Inc. - see below.)

(Brownells also sells 3.5% nickel steel welding rod. They say it flows beautifully, producing a very smooth, non-porous weld.)

Brownells, Inc. is a gunsmith supply house. I have found them good to do business with, and they sell lots of neat stuff of interest to guys like us: files, abrasives, blueing supplies, books, and on and on.

They sell one item called a file brush, which every machinist should order two of. Purpose is for cleaning files, same as a file card, but the file brush works about six times better, and it has a file card on the back of it besides.

Not all machinists use file brushes. I was in a machine shop one time to inspect, for a customer, a large multi-stage deep-well pump which had been improperly stored, and in consequence, had warped. The pump was mounted in the lathe and we went all over it with a dial indicator. Some burrs interfered at one location and I asked the machinist for a file. The file handed to me was full of cuttings, so I asked for a file brush. He looked at me kinda funny for a second, his eyes widened, and he said, "File brush?" He took the file back, gave it four or five vigorous strokes on the left sleeve of his shop coveralls and handed it back. (He probaby sleeps in his underwear, too.)

Every home shop machinist should have a copy of Brownells catalog. It's $3.25 ($4.25 if outside the U.S.) and worth it - you'll find a lot of useful technical info in it, and besides, with the catalog you get a number of discount coupons on some neat books, not least of which will likely be "**Gunsmith Kinks**", Volumes I and II - both of which you should buy - and some others which may or may not be of interest to you. "**Kinks**" I and II are mentioned later in this book, but I will say here that they contain a mass of workshop know-how and ideas you couldn't possibly live long enough to find out on your own. Whether you are a gunsmith or simply a hsm, if you are anything like me you will find something useful in either of these book every time you pick one of them up.

(Gunsmiths etc: write for catalog on your letterhead and/or insert your business card and/or quote your FFL#.)

FILING IN THE LATHE....
AND ELSEWHERE

I often use a #2 cut 8" hand file for dressing up turned parts in the lathe. As a general rule, such filing is done for finish (i.e. appearance), not for size/roundness. If you want a job to be good for size and round, you turn it to size and leave it that way - no filing. Or so I was told. Others may think differently.

When filing in the lathe, a clean dry file, free of oil, will give a reasonably good finish.

A well chalked file is better. This trick is well known in some circles, but apparently not universally. The infilling of chalk in the file teeth helps prevent the file from "pinning" - picking up little bits of material from the work, which then scar the surface on the next stroke. The chalk also aids in keeping the file dry by absorbing any small amounts of oil that may be encountered. The best chalk for our purpose is "railroad chalk", which is sold in stationery stores. It is in sticks about 1" dia. x 4" long. It is good hard dense chalk, unlike the soft powdery stuff sold for home consumption as kids' blackboard chalk. Real school chalk is also good, but I think you will like the railroad chalk better.

For lathe filing, the best by far is same file, well brushed out with a file brush, and then smeared with or dipped in heavy brown cutting oil. Frequently pause and rub your index finger down the length of the file two or three times. This will work the cuttings, which are floating around in the oil on the file, out to one edge. Wipe 'em off, add some more oil (a toothbrush is a good applicator/cleaner), and go to it again. When done, wipe the job with a piece of toilet paper, and the result will like to frost your eyeballs.

As a general observation, not related to filing in the lathe, don't drag your files on the back stroke. This gives the teeth a hooked shape which contributes to pinning.

It goes without saying that you do not throw your files in a heap on the bench. Files are cutting tools, hard as blazes, and as such are readily nicked and damaged by such treatment.

The third and fourth paragraphs above may seem to contain conflicting advice. Should the file be dry or should it be oily? If it's not dripping oil, it should be dry - traces of oil are detrimental to the result desired, and contribute to pinning.

The idea of using a file soaked with oil to get a nice finish on turned work may be news to some, but I can assure you it works. I have a small file which stands in a piece of 1/2" copper pipe jammed in a hole in the plywood top of my (steel) lathe stand. The pipe is capped on the bottom end, and contains just enough Procut SC40 cutting oil that the file is submerged up to the handle.

Friend Bob Haralson spotted this arrangement in my shop and asked the purpose. He'd always been taught to keep the file dry for filing in the lathe. He's been in the trade since I was born, and his training was second to none, which just shows you can always learn something new in the machinist's trade.

I mentioned earlier two books called **Gunsmith Kinks**. Here's a tip from **Kinks II**, page 174: Brownells sells a product called Rust Preventive No.2. A chap by the name of Bob LeSuer discovered by accident that putting this stuff on the file (or the work) when drawfiling, helps keep the file clean and lets it cut much faster. Interesting.

Incidentally, the term drawfiling is far too carelessly used. It is a specific filing technique, and not all filing is drawfiling. In drawfiling, the file is held with both hands on the blade, palms down, and with the long axis of the file at right angles to the direction of the strokes. The file cuts on the push stroke. There should be no pressure on the file on the return stroke but it should remain in contact with the work. Drawfiling can produce a very nice finish.

When trying to file flat (a skill few people ever learn) one trick that helps greatly is to change the direction of your strokes frequently. This allows you to see where your file is cutting, as the new strokes will show up on top of the strokes going in previous directions. The next trick is to so control the file that it cuts where you want it to - and that is what separates the men from the boys. And the girls, too......see next paragraph.

I was in the local high school metalwork shop one morning a couple of years ago, waiting to speak to the shop instructor. I was surprised to see that half the kids in his class were girls. The one at the nearest bench was beavering away at a piece of aluminum with a 14" mill bastard like she was trying to saw her way out of a Mexican jail with a rattail file, both hands locked white knuckled around the handle. I watched this unusual performance in silent agony for a minute or so, and then asked her if I might show her something.

She handed me the file. I suggested to her that it might work better if she would hold the file thusly, and then demonstrated to her that if she changed the direction of her filing every few strokes, she could see where her file was cutting. When I handed the file back to her, she looked at me like I was from another planet, and went right back at it the same way as before. What is a poor man to do?

From a file manufacturer's brochure:

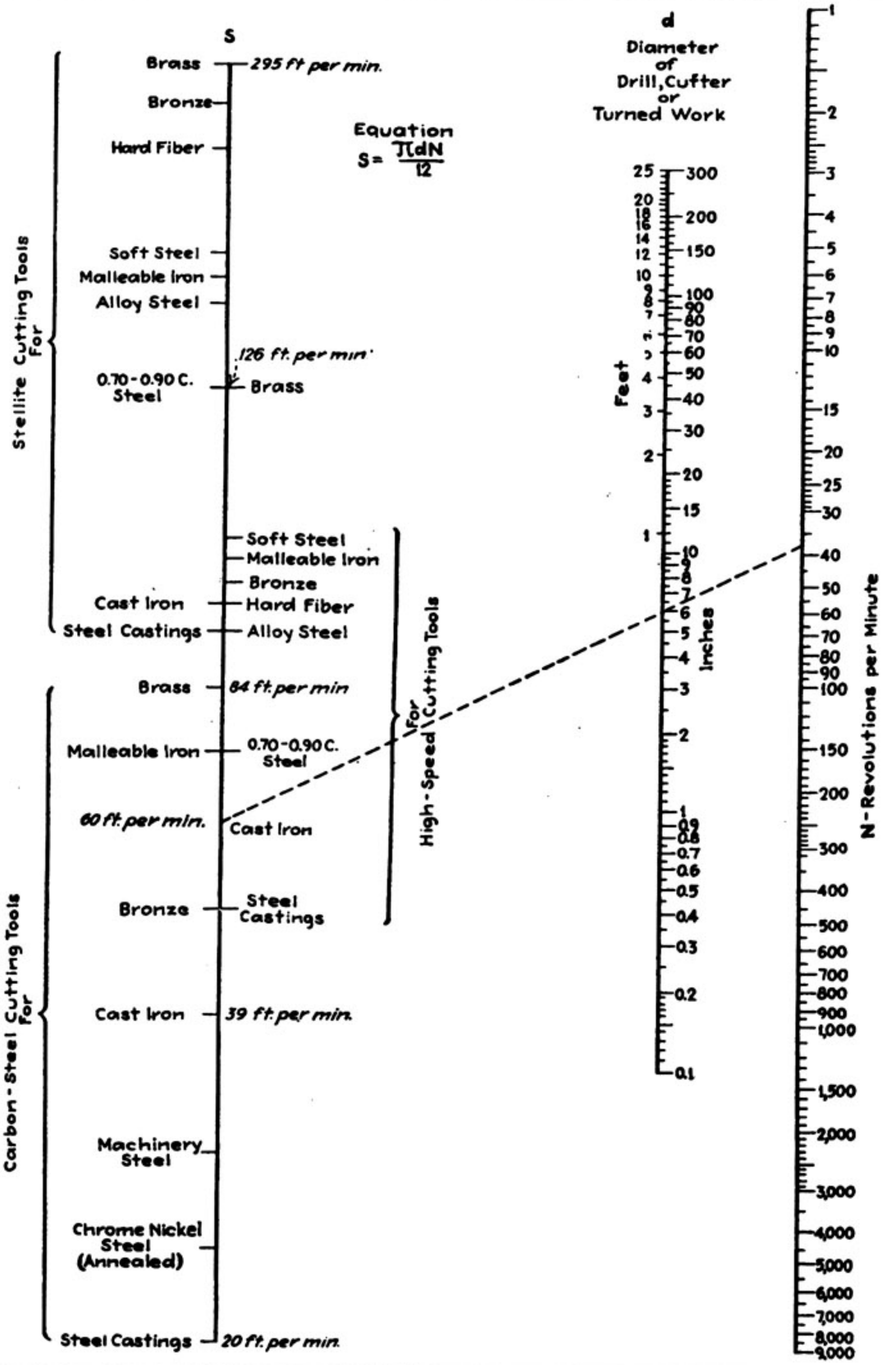
Remember: the maximum amount of work will be done with the minimum effort using the largest file available for that purpose.... Bastard cut files remove metal fast but leave relatively rough surfaces. Use second cut or smooth files where a nice surface finish is wanted...... On hard metal, fine files cut more freely.

A GRANITE SURFACE PLATE

If you're looking for a small surface plate, check out J&L's #EGP-09122D. This is a black granite Toolroom Grade B, flat within 0.000,2", priced at US$46 (May '97), However, before plunking down your money for any surface plate, you may want to see some notes I have in TMBR#3 on whether to go with black or pink granite, etc. My understanding is that pink is harder, hence wears better; black is stiffer, hence deflects less under load.

American Machinist

Cutting Speed Chart



DRILL, milling cutter, or work r.p.m. can be found quickly by means of this chart. It also affords a method for determining cutter or tool material and required changes in cutter material for varying speeds, and is read by placing a straightedge to satisfy two known factors in order to obtain the third. (The chart may of course be altered to suit individual conditions simply by reallocating the values on line "S". The values given are average—when taking heavy cuts decrease the r.p.m. found; for light cuts vice versa.)

Example—A high-speed cutter is to be used in a lathe or boring mill to machine a cast-iron pulley 6 in. in diameter. One point of intersection is "cast iron," lying within the "high-speed cutting tool" bracket; the second is 6 on the "d" scale. The "N" scale then reads 38. Computation by formula will give 38.2, showing an error of but 0.2 r.p.m.

Originated and computed by L. C. Simmonds

No. 30 — *REFERENCE-BOOK SHEET* — **Tools and Dies**

TWO NOT-SO-COMMON WAYS OF MEASURING HOLES

A HANDY TOOL FOR MEASURING BORES

Starrett sells a very handy set of Taper Gauges, #269A and 269B, for measuring the mouth of a hole. Picture yourself boring a hole that's got to come out at 0.875"Ø, and not half a thou over. You slip the appropriate leaf of the set of gauges into the bore and it slides in to show a reading of 0.863. It's not that it is a high class measuring tool, but that it is direct and fast - when you get up to 0.872" or like that you can get out your inside mikes etc. (And turn to the next section of this book.)

How many times couldn't I have used a set of these?

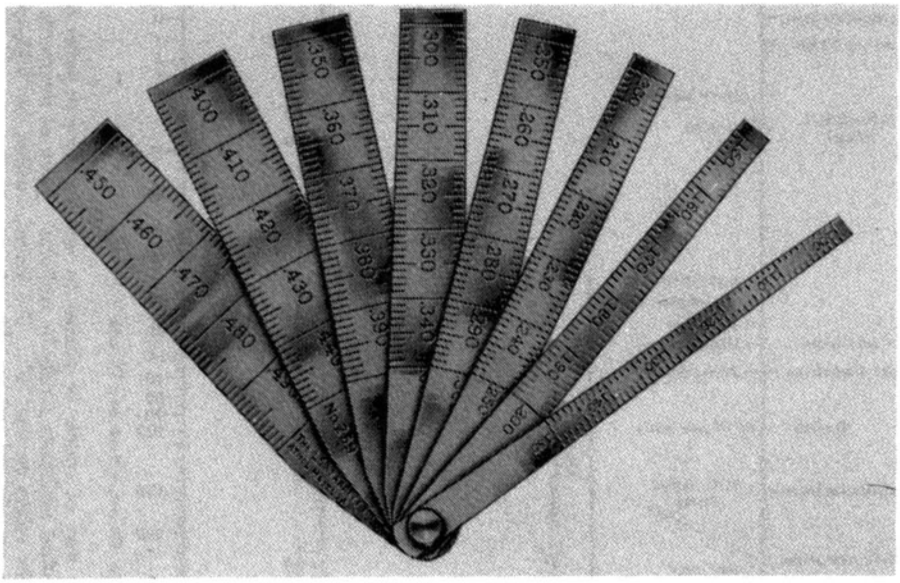


Photo courtesy of the L.S. Starrett Co.

They measure hole sizes from 0.010 to 0.500" by 0.001" (269A), and from 0.5 to 1" by 0.001" (269B) via, respectively, 8 and 10 tapered leaves of hardened tool steel, each leaf being about 2.5" long.

Other makers also offer such gauges. Unfortunately, none are low in cost. On the other hand they are so handy that if you have a lot of use for them, you will not mind the price.

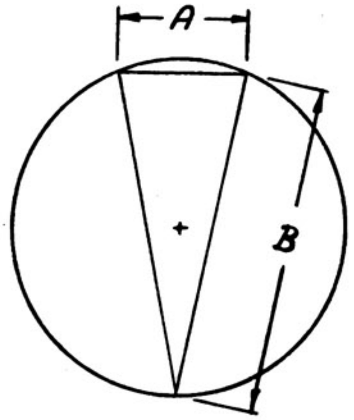
I considered the matter of making a tapered plug gauge, with the intent of showing how one could go about making a set of them that'd do the same job. It doesn't seem to be a practical proposition. You would need to turn the plugs to a specified taper within better than 30 seconds of arc, for them to be accurate. For the average hsm this would be difficult, to say the least. If the taper is made less steep than that required to give 0.001" per 1/32nd", the degree of accuracy of the taper becomes less critical, but the number of gauges proliferates rapidly. This then is one of those things best bought if needed.

A MEANS OF MEASURING LARGE BORES

A useful approach for measuring large bores is the use of a rod of a known length, slightly less than the bore diameter. The rod is placed across the bore mouth like a diameter line on a drawing. Being too short to span the bore, it can be rocked from side to side. The amount of this side-to-side movement will tell you - within very close limits - the bore size, using the formula below. This method can be used in holes as small as 3" Ø, and possibly somewhat smaller.

I understand this method was used in old time railway locomotive repair shops for gauging steam cylinder bores, journal bores, and in measuring I.D.'s for press fits.

The formula used is $C = A^2 \div 2B$ where:



A = number of 16ths of an inch of side-to-side motion of the rod or calipers.
B = length of the rod, or the dimension to which the calipers are set, in inches.
C = difference between hole size and dimension B, in thousandths of an inch.

Example: A hole bored in a casting is found to be a sloppy fit on a 4.000" plug gauge. Suitable tools to measure the hole diameter directly are not available. What to do?

The ends of a piece of 1/4" CRS are turned to tapered rounded points, and to a length such that it will rock back and forth in the hole by less than 1/2". (The side to side play should be less than one eighth of the hole diameter, for best results.)

The length of this rod, measured with a 3-4" mike, is found to be 3.998". The rod's side to side motion in the hole is then measured, and found to be 13/32", i.e. 6-1/2 sixteenths.

$C = A^2 \div 2B = (6.5)^2 \div 2(3.998) = 42.25 \div 7.996 = 5.2839$ thousandths

Therefore, the hole diameter is 3.998 + 0.0053" = 4.0033".

A little consideration of the amounts of error likely to be present in "A" and "B" shows that this is a pretty good way of measuring a bore. You will almost certainly be able to measure the length of the rod within 0.001" with a vernier or dial caliper. An error of 5 times this, i.e. plus or minus 0.005", which would be hard to overlook, will, in the above example, be found to result in an error of about 7 millionths of an inch - which obviously is far beyond the limits of precision we are interested in. If we cannot measure A within a 64th of an inch, i.e. 1/4 of 1/16", we are in the wrong business totally. An error of this much in the above example works out to less than 1/2 a thou.

See the **American Machinists' Handbook** for more details - I have a 1940 edition, wherein see page 721-724.

Added to the 15th Printing:
It has been suggested to me very recently that a more accurate formula for the above procedure would be

$$C = A^2 \div 2.048B$$

However, I have not had time to derive this result for myself. You may wish to investigate the matter on your own.

HOW TO PUT ON A MIGHTY FINE CUT

If you want to take another 0.0002" off the O.D. of a turned piece you're working on in the lathe, what to do, inasmuch as you cannot read your cross slide micrometer dial to such fine limits?

The basic dodge is simple and well known: slew the topslide around to an angle of 5°44'21" with the lathe axis: then 0.001" on the topslide feedscrew dial will give you 0.0001" in-feed of the tool tip.

But how quickly can you set your compound to 5°44'21"? If you're lucky, the promoters of this idea will give you the angle as 5.75°.

A British outfit will even sell you - if you should be so foolish as to bite - a steel mandrel, precision ground to the appropriate taper. The pitch is that you set it up between centers in your lathe, and "indicate" your topslide to zero-zero full travel beside it. Probably takes about 5-10 minutes - and remember, the contact point of your dial indicator would have to be exactly at center height for this to work properly. By this process you can set your topslide to give 0.000,1" infeed for 0.001" advance of the topslide. Supposedly.

What a crock!! Why not simply slew the topslide around to any convenient shallow angle in whole degrees, note the angle, and punch it into your pocket calculator? (See below.)

Every machinist should have a calculator with trig functions built in; such calculators can be bought very cheaply today. My calculator usually sits in the top of my toolbox, just off my right shoulder when I'm working at the lathe. Up on the wall behind the lathe is a simple diagram, and when I want to dish up a fine in-feed, or a fine axial feed, I slew the topslide, per diagram, take my measurements, punch the appropriate figures into the calculator, read the answer, pick up the cut and crank the specified feed into the topslide feedscrew. I'd be willing to bet that I'd be done the cut before you could get that fake-a-loo mandrel out and the rust wiped off it.

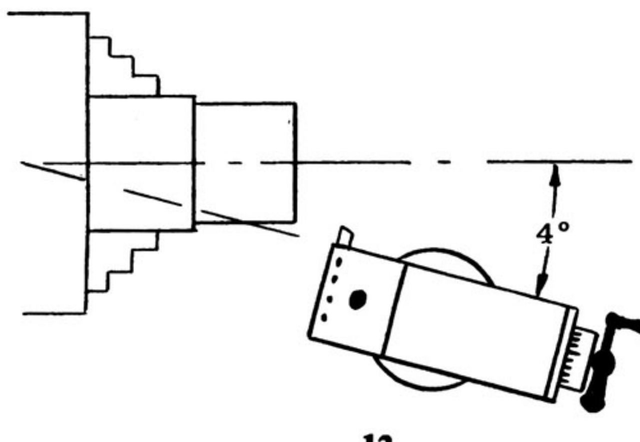
Xerox the diagram below if you like the method, and stick it up where you can see it when you want to - why clutter up your head trying to remember stuff like that?

For those who may not be fully conversant with this system, let's look at one example of each situation.

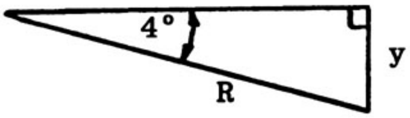
Example 1 - DIAMETER REDUCTION

A fine cut is to be taken off a turned piece. Piece is measured, and mike shows it is 0.5447"Ø. We want 0.5311"Ø, (Don't ask me why. We just do.) 0.5447" - 0.5311" = 0.0136". That, divided by 2, = 0.0068". Now what?

Slap the topslide around to some handy angle. Say it happens to stop at 4° off parallel, according to the degree scale engraved on its base. Now consider diagram A:



This resolves itself into a triangle like so:



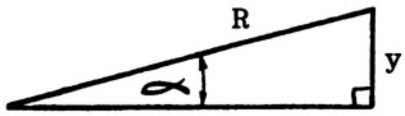
Now we want to feed the topslide in along "R" to give us a known in-feed "y".

But first, we take a very fine cut off the 0.5447"Ø, to get a new datum setting for our toolbit. Hmm... ok, it's just pulling swarf you can barely see. Take the cut, measure the part, and we find this time it's 0.5439"Ø. And of course you took up all your backlashes and started with your topslide feedscrew dial set on zero, didn't you?.

Ok, (faster this time): 0.5439" - 0.5311" = 0.0128/2 = 0.0064". (That, I assure you, would make a mathematician weep, but it's how we word the problem as we snap it out on the calculator.)

So: we need an in-feed of y = 0.0064", and angle A is = 4°.

I was always taught that decent trig triangles only appear thus:



It is an affliction to be so lacking in versatility, but I am, so let's redraw it, thus:

Our problem: What dimension "R" will give y = 0.0064" in such a triangle?

We know that: $R \sin A = y$

rearranging this : $R = y \div \sin A$

We know $A = 4^\circ$,

and we want $y = 0.0064$".

Therefore.. $R = 0.0064 \div \sin 4^\circ = 0.0064 \div 0.069{,}756$

$= 0.091{,}748$

So we feed in "0.091 and a bit" on the topslide, and take the final cut. We measure, and it's 0.5311" on the nose.

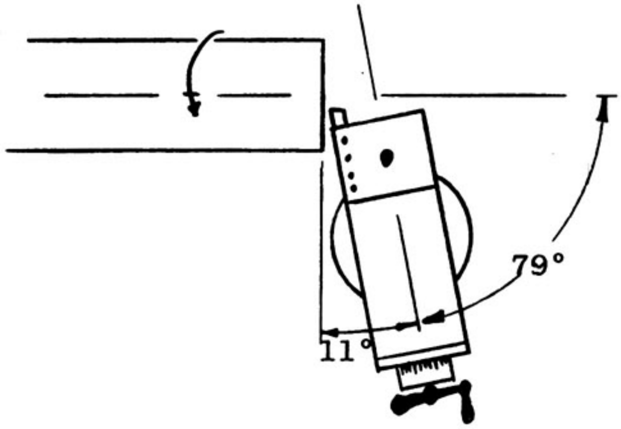
Well, shucks, it's a piece of cake.

Example 2 - Length reduction

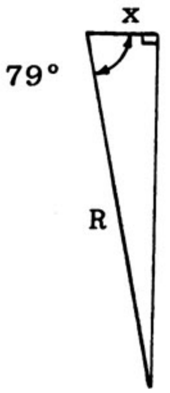
Now a trim-to-length job, (faster this time): we slap a piece of 1/2"Ø CRS in the lathe. Both ends faced, job out, measured for length: 4.509". Desired length is 4.500".

Rechuck, slew topslide to a shallow angle with the chuck face, and read the topslide protractor scale: turns out to be 79° off parallel with lathe axis, i.e. inclined 11° towards chuck face. Lock the carriage, pick up the face of the work with the end of the tool and do the math:

4.509" - 4.500" = 0.009"

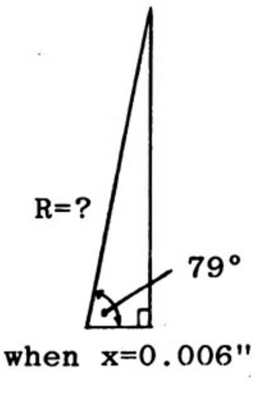


This resolves itself into a triangle like so:



and we want to know what R must be to give us X = 0.009".

First, we flip the triangle to make it decent.

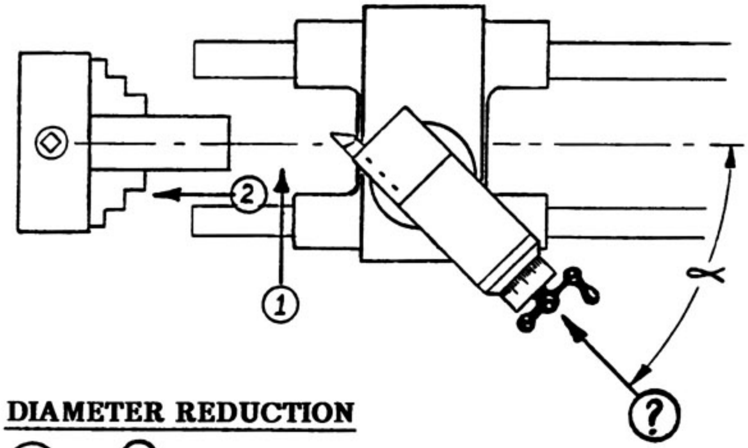


$$
\begin{aligned}
R \cos B &= X \\
R &= X \div \cos B = 0.009" \div \cos 79° \\
&= 0.009" \div 0.190809 \\
&= 0.047,168.
\end{aligned}
$$

So we feed in 0.047 on the topslide and .. uh, oh? We forgot to zero the topslide feedscrew dial. No sweat. What's the reading on it now? 26, you say? Ok, add 47: 26 + 47 = 73

So turn the dial to 73, take the cut, dechuck .....and measure ......Right on the money!

If you are boring a hole, slew the topslide a little past parallel, and get your fine out-feed the same way.



DIAMETER REDUCTION

$$(?) = \frac{(1)}{\sin \alpha}$$

e.g. want a cross slide infeed of 0.000,7"

say α = 4°

Then $(?) = \frac{0.000{,}7''}{\sin 4^\circ} = 0.010''$ on compound

LENGTH REDUCTION

$$(?) = \frac{(2)}{\cos \alpha}$$

e.g. want a carriage feed of 0.0113"

say α = 86°

Then $(?) = \frac{0.0113}{\cos 86^\circ} = 0.162''$ on compound

SOME NOTES ON REAMING

AVOIDING CHATTER

You can avoid chatter in a reamer by filling the flutes with Crisco (lard). You can also wrap it in waxed paper and get a similar result, so I read in Brownells' book, **Gunsmith Kinks II**, page 290.

HOW TO RUIN A REAMER

The fastest way to ruin a reamer is to turn it backwards in its hole. The reason will be obvious if you will but look soberly upon the business end: When turned in the correct direction, the cutting edge is backed up by the material behind it - that is to say, by the very steel of which the reamer is made. However, if you turn it backwards, the cutting edge is totally unsupported and will chip and otherwise go to pot in a hurry. Just imagine the effect on the end of a twist drill if you ran it backwards. Doing the same thing to a reamer is just a whole lot worse, 'cause it costs about three times as much. Same thing applies to milling cutters.

CHOICE OF REAMERS

For hand reaming in the lathe or milling machine, buy straight or helical fluted hand reamers. A hand reamer will have a square milled on the driving end, for use with a tap wrench. Chucking reamers, also known as machine reamers, do not have a square end, as they are intended to be chucked solidly, and driven by the grip of the chuck jaws - or other toolholder - on the round shank.

REAMER STARTING

It is a good idea, 'though not always necessary - depends on the class of work you are doing, for one thing - to true up a drilled hole by boring prior to reaming. The drilled hole may not be perfectly concentric with the lathe axis, but the bored hole will be. When starting a hand reamer, support it on the tailstock center to aid initial alignment.

DRILLS RESERVED STRICTLY FOR USE BEFORE REAMING

If you want to minimize the metal to be removed in reaming a drilled hole, buy yourself a set of drills for sizing holes to be reamed, keep each one boxed with its reamer, and use these particular drills for nothing else!

Reamer Size	Drill Size	
1/4"	letter D drill	= 0.2460"
5/16"	7.80 mm	= 0.3071"
3/8"	9.40 mm	= 0.3701"
7/16"	11.0 mm	= 0.4331"
1/2"	12.5 mm	= 0.4921"

REAMING A MORSE TAPER SOCKET

(I've never done this, but here's the way I was told to do it by friend Bob Haralson.)

Drill out most of the metal to be removed. Step bore the hole to within about 0.015" of the final profile. Do not try to bore the taper. (Yes, you can bore a taper correctly, but there is little purpose in trying to, if you are ultimately going to ream it. If a taper is to be bored to final form, the boring tool must be set exactly on center height.)

Anyway, step bore the hole, and then insert your Morse Taper Reamer, and let it find its own alignment in the hole. It'll want to go straight. If you interfere with its alignment with tailstock support, you'll likely do more harm than good.

Bear in mind, if turning a male taper, taking a very little bit more off the diameter makes a lot of difference in the axial location of the taper: if you have turned up a #2 MT shank and it fits the socket, and you decide to feed in 0.004" more and take a final cut, the shank will seat in the socket about 0.160" deeper than before.

> TIP: If you want a master gauge with which to test homemade #2MT shanks in the process of making same, buy a hardened and ground #2/#3 MT drill sleeve adaptor. It's a cheap way to acquire a high quality, portable "gauge".

CLEANING UP THE LATHE TAILSTOCK TAPER SOCKET

My friend Eric Marles bought and fixed up an ex-high school lathe made by the Standard Modern people. The tailstock socket was #2 MT, and it had a few pimples and warts in it - a common disease of school lathes.

Eric brought his tailstock barrel around to my place one day, we wiped it clean, slipped my #2 MT reamer in, and gave it a few careful turns. This minor bit of brain surgery did an almost miraculous job of smoothing up the taper socket.

SOME NOTES ON TAPPING

TAPPING ON-SIZE HOLES

Have you ever tapped a hole with a new tap and had it turn out to be a sloppy fit on a properly made screw, e.g. a Grade 8 socket cap screw?

Here's what one chap recommended as a cure: drill a tapping size hole in a piece of aluminum. Tap this hole with the offending tap. Back the tap out of the hole. Apply jewellers rouge to the tap (or the hole - I doubt it'd make much difference). Then run the tap back into and out of its own tapped hole several times. This is supposed to remove minute burrs left in the manufacturing process, and - said the chap - it is these that are causing the problem. Sounds like it'd be worth a try.

TAPPING OVER-SIZE ON DEMAND

For one reason or another it is sometimes necessary to slightly enlarge the thread cut by a tap. The standard way to make a tap cut oversize is to stuff a sliver of hardwood down one of the flutes, after the tap is part way into the hole, having already run the tap in and out once. This forces the tap off center in the hole, and as it is turned in, it'll enlarge the thread already cut. It might take a couple of extra passes, each time with a new and stouter sliver, but it does work - I've used this myself: we thought a certain hole was tapped 7/32-32, but it turned out to be #12-32. The difference in the two sizes is about 3 thou.

It does not work at all well if a sliver of soft wood is used, because the wood is too soft to be effective - I know because it happened to me on the above occasion. I ended up using a good hardwood toothpick. If you live in a part of the country where the woodpiles yield hardwood slivers, you won't have any problem, but if you don't, now you know what to do about it if you do.

ON NOT BREAKING VERY SMALL TAPS

Every time I am faced with using a tap smaller than any I've used yet, I quake in my boots that I'm going to break it. I have yet to break a tap - in any size - so perhaps this is not an entirely undesirable frame of mind.

On the other hand, maybe I'm overdue for a busted tap.....I hope not. At date of writing, my next project is a clock that is going to call for tapping some 2-56 and 0-80 holes, and I sure don't want to break a tap on that job.

There are a number of things that may be worth saying on the matter of not breaking small taps, so here goes....

First, never tap a hole without lubricant of some sort, except in brass, bronze, lead and babbitt - these are tapped dry.

> Cast iron can be tapped dry or with oil.
> Milk is used for copper.
> Varsol is pretty good for aluminum. (Varsol is paint thinner.)

Second, make sure you've got the right size tapping hole. Various charts give this info, including some at the back of this book.

Note: It takes twice the torque to drive a tap into a hole drilled to give a 100% thread than to tap a hole drilled to give a 75% thread. The 75% thread has about 95% of the strength of a 100% thread, so there is little to be gained from working on the tight side of the matter, except an increased risk of breaking the tap. Better, probably, to err on the easy side of 75% than on the tight side of it.

Gunsmiths are frequently called upon to tap small and often shallow holes in fiendishly tough and/or hard "ordnance steels". Many a tap has been broken, and many a nasty word muttered, in the course of such work. If the tap breaks, what's left of it is stuck in the customer's gun. Invariably, the customer wants his gun back (but never the tap) and probably quite soon. The problem then arises of getting the tap out before he calls for the gun. Various strategies and subterfuges have been developed to deal with the matter of broken taps. Some involve cultivating a reputation for being rather growly - this keeps the customers from being too pushy about when their guns will be done.

One technique used to circumvent the problem of getting the busted tap out is to grind a groove around the tap shank before using it, said groove being sized to leave the tap weaker there than down in the flutes. That way, if it busts, you're almost certain to have something stickin' up out of the hole to get hold of, whereby the tap can be backed out, and thereafter even more novel approaches tried in attempting to tap the hole. This idea is given, along with many others on not breaking taps, and on the removal of broken taps from holes, in **Gunsmith Kinks**, Vols I & II. See elsewhere herein for more details on these two books, which any machinist, whether or not he has any interest in guns, would do well to have on his bookshelf.

Third, start the tap square. My normal procedure (in the vertical mill) is to center drill and tap drill the hole, counter drill 1/64th over bolt size to about 1-1/2 threads deep, stick the taper tap in the (keyless) drill chuck, flip open the belt guard, and lower the quill til the tap enters the hole. With the tip of one finger on the top surface of the spindle pulley (which is about 6 or 7"Ø), I turn the spindle about 6 turns, stop, open the chuck, up quill, and remove the tap with a tap wrench. I may finish the tapping operation right there, with the job still in the milling vise, or later, over at the bench vise.

When tapping a hole in the lathe, the process is similar. Maybe one of the reasons I've yet to break a tap is that I'm pretty patient - I fail to see the need to drive a tap in under power in the normal run of the hsm's activities.

Now here's a tip that somebody showed me while visiting my shop in late 1985:

To help keep the tap square to the work when starting a tap into a drilled hole freehand (or when drilling the hole in the first place, for that matter) lay a small mirror - such as your wife probably has in her purse - beside the hole. **The mirror should be borderless**, and say about an eighth of an inch thick.

If the tap is square to the work, the tap and its reflection will appear to be a single straight item. If not square, the tap and its mirror image will bend at the edge of the mirror. Try it.

Now if only I could remember the name of the guy who showed this to me.... I'd like to give him the credit for a slick idea.

And did you hear about the watchmaker's apprentice who, on being shown a 1/4-20 tap, said "I didn't know they made 'em that big."

HOW TO GET TAP CUTTINGS (& OTHER THINGS) OUT OF A BLIND HOLE

I often use a magnetized allen key - it's slow, but it sometimes does the job. Another approach is to fill the drilled hole with soap from a bar of hand soap (or use wax), and/or put a bunch of it on the tap. As the tap goes into the hole, it forces the soap back out, and the soap takes the chips out with it. (In **TMBR#3**, you'll find out how to make a device to extrude soap or wax sticks of various diameters to use in this way.)

Another way to clean cuttings out of a blind hole is to wrap some toilet paper around a suitable sized twist drill, screw it into the hole, and then unscew it again. This will usually get out most of the chips - you may need to do it more than once per hole.

But sometimes the toilet paper gets twisted off and left in the hole. That's no sweat if the hole is say 3/8"ϕ or above. But if it's a 4-40 hole, what to do? I've tried burning the paper out with a red hot wire, but it isn't as effective as one might wish it to be, because the wire won't hold much heat. I got desperate one night and flattened the end of a straightened paper clip so it looked about like a little oar, then split the blade of the oar part way with a pair of tinsnips, and bent the two tips into a little forky thing. I filed the sides of this little wonder to suit, poked it into the hole, and twisted it about until it snagged some of the toilet paper. In due course I got it all out, in little bits, all the while keeping a civil tongue in my head. That little tool got saved for "next time".

At page 177 in **TMBR#3**, I note that if you can get your dentist to give/sell you a root canal broach, you will have about the ideal tool for salvaging toilet paper from such holes.

FIGURING THE MINOR DIAMETER HOLE REQUIRED FOR ANY SIZE OF THREAD

In tapping or screwcutting an internal thread, the bore size to start with for any given thread can be found via a formula I found on "Omnium Gatherum", an excellent machinist's wall chart available from Bay-Com (see Appendix).

$$\text{Bolt O.D.} - \frac{0.9742785}{\text{PITCH}} = \text{I.D. of nut}$$

However, there's no need to use all those decimals, so let's try an example, using a more practical statement of the formula:

Say we want a 3/4-28 thread: we'd need to bore the nut to

$$3/4 - \frac{0.975}{28} = 0.715\text{"Ø}, \quad \text{before screwcutting.}$$

Can we safely drop all those numbers way off to the right of the decimal? Yes:

$$3/4 - \frac{0.9742785}{28} = 0.715{,}204{,}339$$

and $$3/4 - \frac{0.975}{28} = 0.715{,}178{,}571"$$

That's a difference of 0.000,025,768" - or about 26 millionths of an inch. If you bore holes to that sort of tolerance, you operate in a different world than most of us, and probably shouldn't read this book, lest it taint you.

In practice, I would put a note on the drawing as follows: "Bore nut 0.715"Ø ± 0.005", and screwcut 28 tpi."

FINISHING OFF A MALE THREAD - THE HIGBY END

I don't know where I got the term "Higby End" - I don't even know if anybody else uses it, but I associate it with the proper way to finish off the end of a male thread. So if it's not a term in regular use, maybe this book will introduce a new term into the machinist's language!

Say you've just sawn off a 3" length of 3/8" N.C. ready rod. Chances are the sawn end would permit a nut to be run on only with some difficulty. Do you leave it that way? I hope not. A few licks with a 14" file will probably solve the problem, but how to finish it off right?

You can chuck it in the lathe, face the end, bevel it, and that's not bad. You can put a radius on the end, with a form tool held in the tailstock drill chuck (or in a multi-station tailstock turret or...) and that's ok too.

But to make a really proper job of it, take a pillar file or similar, and - with the job still in the chuck, and with the lathe off - break the sharp crest of the thread from where it originates at the end of the screw right around for one full turn or a little less. That way there is no sharp edge on which to cut yourself, and the nut goes on easy. That's what I call a Higby end.

Added to the 8th printing: Turns out the real "Higby end" is a type of thread used on screw couplings on firehose, so that the start of the thread can be both seen and felt.

DRILLING TO AN EXACT DEPTH

IN THE VERTICAL MILL

Bring drill down to touch work. Lock quill. Set quill stop. Unlock and raise quill. Raise table (via knee feedscrew) by desired depth of hole. Lock knee, switch on, and drill. If hole is to be spotted with a center drill, do above procedure after you are done with center drill, and either sight over work to see when drill tip is at surface of job (now drilled away), or use a 0.0015" feeler gauge in between work and drill tip.

IN THE LATHE

Put a parting tool in the toolpost. Bring tailstock up so drill is touching face of job. Move carriage to left until parting tool is near drill chuck. Engage half-nuts, take up backlash and, via topslide, bring parting tool into contact with end of drill chuck. Move carriage toward headstock by desired depth of hole, measuring by means of the graduated leadscrew handwheel you should have on your lathe - see item re same elsewhere herein. Drill into work until drill chuck again contacts parting tool.

HOW TO SHARPEN A CENTERPUNCH

Most books on machine shop practice tell you to sharpen a centerpunch as at Fig. 1 below. That's nuts. If you were sharpening a large fence post prior to driving it into the ground, would you do it that way? No, you'd make your cuts axially, **for a streamlined point**, right?

And is not a centerpunch much the same? Do you want your grinding marks to go around the point, or along it? Obviously the latter, so the point will shove aside the material being centerpunched. So do it as at Fig. 2. Bill Fenton taught me this.

Fig. 1

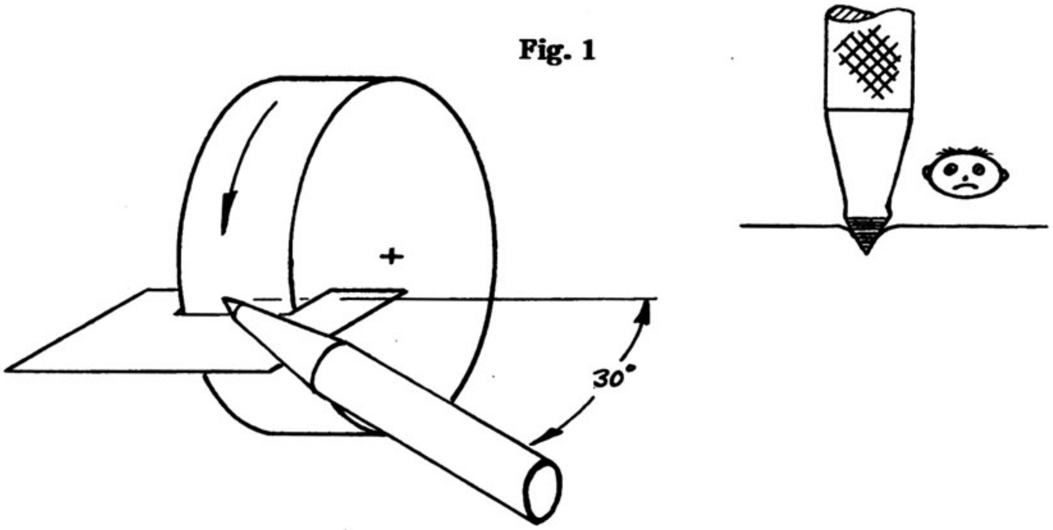
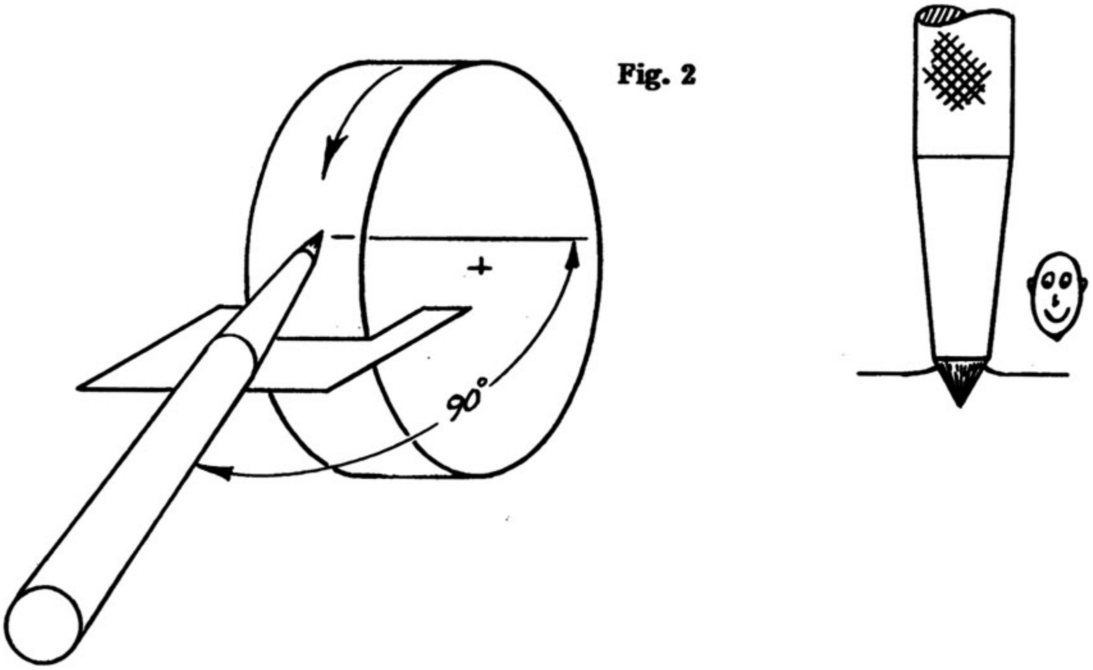


Fig. 2



A DEVICE FOR "INDICATING" CENTERPUNCH MARKS TO RUN TRUE IN THE LATHE

If you want to drill, ream or bore a hole in a piece of metal in the lathe, and you have the hole center marked with a centerpunch mark, what do you do next? Chuck the job, or clamp it to the faceplate, and get the centerpunch mark running reasonably true by eye. Now you can set up the scriber of a surface gauge pointing at about the center of rotation of the work, and you can eyeball the centerpunch mark to run quite close to true, if your eyes are good. But if you want it to run dead true, you need a "wobbler." This handy and well known gadget can take a number of forms.

Mine is a 7" length of 5/16"Ø CRS center drilled at one end and with a gramophone needle Loctited into the other end - see Fig. 1.

The center drilled end goes on the tailstock center, or if the tailstock drill chuck is in place, on a flanged center (see below) which can be quickly grabbed in the drill chuck, thus saving swapping the chuck for a tailstock center briefly, and then swapping back again. The gramophone needle goes into the centerpunch mark. A dial indicator plunger is then positioned to ride the wobbler up near the work. With this set-up you can get a centerpunch mark to run true.

Another form of wobbler is a 10" length of 1/8" drill rod, plain at one end, and having a hardened point at the other. Grab the plain end in the tailstock chuck, and apply the point to the centerpunch mark to be indicated true.

I have seen drawings of wobblers with a spring-loaded telescoping feature, and I can understand the thinking behind the idea, but in practice I think this is an unnecessary elaboration.

The flanged center mentioned above was made up to replace one which was simply a 1" length of 3/8"Ø CRS turned to a point at one end - see Fig. 2. This critter would go weaseling backward into the tailstock drill chuck whenever I opened the latter and made a grab for it with my oily fingers. Finally, fed up with having to ferret it back out with a magnetized allen key, I made up a flanged center as at Fig 3. Life gets easier all the time!

Fig. 1

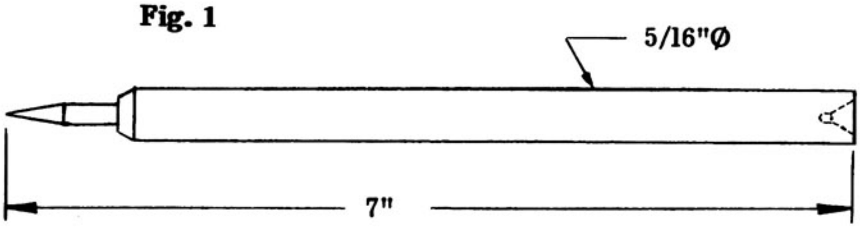
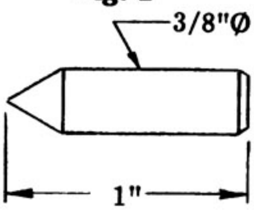


Fig. 2



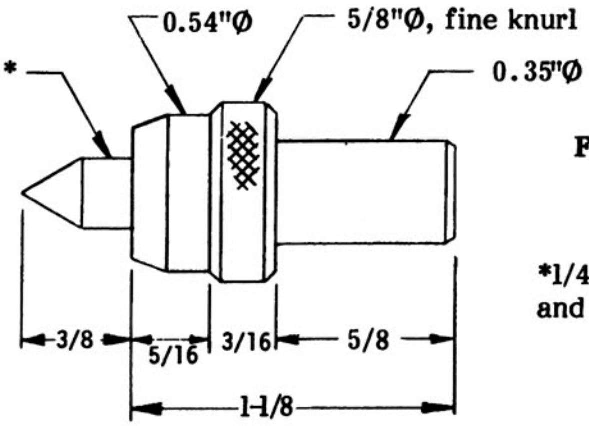


Fig. 3

*1/4"Ø drill rod, hardened and Loctited in place.

HOW TO GET MORE WORK DONE IN THE SHOP

TO FUSS OR NOT TO FUSS, THAT IS THE QUESTION

Where the clearances within a group of parts can be relaxed by 0.002", the time required for making mating parts can drop by a factor of 10. Thus, if you are making a table lamp, you can get the job done faster by not striving for close fits, which for the most part would be - well, a waste of time, see? - and the finished product will be 100% satisfactory. The same class of workmanship applied in the wrong instance, e.g. when making a boring head, a milling spindle, or some similar piece of high class toolmaking, will produce something completely useless.

Learn to differentiate where nice work is required, and where not, and you will accomplish more.

Or, as friend Eric Marles put it: "If you want accuracy, use a machine tool. If you just want stock removal, use a hacksaw."

PLAN THE JOB

Another way to save time is to plan the whole job, and then tackle it in a logical order. List the parts, and the operations to be done on each, then reorganize the list into a sequence wherein all the 4-jaw chuck work on several parts is done, then all the 3-jaw work, and so on - this minimizes chuck swapping, and saves time. The thinking runs thus: "I'll do this and this on part A, then I'll set it aside unfinished for now, and do some similar operations on C & D. When I get part D turned to size, I'd set up to screwcut the thread on the end of it, then I'll rechuck Part A and screwcut it too before I break down my screwcutting set-up..." and so on.

Obviously not everyone will want to work this way, but my experience is that time spent on such thinking will be more than recouped in the shop: the work goes faster, less time is lost swapping chucks, you are not wondering what to do next, and pretty soon - much sooner than otherwise - you'll find you have several parts all finished, and you'll think to yourself, "Hey, I'm really highballin' tonight!" - and you will be, too.

COLD ROLLED STEEL - WHAT IT IS, AND HOW TO STRESS RELIEVE IT

At various points in this book you will find reference to the use of "CRS" which is to be understood to mean "Cold Rolled Steel", (this is somewhat of a misnomer - see below), or more specifically, cold rolled low carbon steel. A typical low carbon steel will have a carbon content in the 0.15 to 0.23% range. A steel designated as C1018 or C1020 would be an example. This is the American Iron and Steel Institute (AISI) designation for a plain or basic open hearth carbon steel having <u>about</u> 0.18% to <u>about</u> 0.20% carbon content. You may run across a designation like SAE 1018 - it's the same stuff. (SAE means Society of Automotive Engineers.)

Cold rolled steel (CRS) is nice stuff to use, for various reasons. There are a number of reasons for this, aside from the fact that it machines, welds, brazes and casehardens readily. The following is quoted, with permission, from a steel supplier's catalog:

COLD DRAWING

The rolling of bars into rounds, squares, rectangles, and special shapes is a fairly well standardized procedure. The product of a rolling mill, if supplied to a manufacturer in this form, would require considerable machining and grinding operations to get the bar into a suitable form. It was early discovered that if a hot rolled bar were pulled through a die of smaller diameter, several advantages resulted that were beneficial to the manufacturer. The results attainable by cold drawing may be summarized as follows:

a) Bars of various cross section may be elongated and reduced in section to an extent not always attainable by other means.

b) The surface of the bar becomes uniformly smoother and more highly polished than a hot rolled bar.

c) A closer dimensional tolerance can be attained.

d) The mechanical properties of the metal are changed. Hardness, stiffness, tensile strength, and elastic limit will be increased, while ductility will be decreased.

Okay, now we know what we're talking about - it's low carbon steel that's been rolled or drawn to desired dimensions and cross section: usually round, hex, square, or flat. It is well suited for items not requiring the higher strength of high carbon and alloy steels. It machines readily (although it is not necessarily a "free cutting steel" - that is another animal again), has good case - hardening properties, and is excellent where cold bending and forming operations are required.

I said above that "Cold Rolled Steel" is somewhat of a misnomer. A better term is "cold finished steel". The sheet forms are about the only ones that are actually **rolled.** Square, hex, round and flat sections are made by being lubricated and **drawn through dies**, after the black mill scale has been removed, probably by pickling.

As you might well deduce, the surface layer of CRS is stressed by the drawing operation.

If you chuck a piece of 3/8"Ø CRS and machine it down to 5/16"Ø, the stressed surface layer is removed all around the material, and the piece does not warp, because there is no unbalanced stress.

However, if you were to mill a flat 1/8" deep down one side of the same material, what would happen? It'd warp, because the stress has been removed on one side only. To avoid this warpage, stress relieving is necessary. I'll tell you how in just a minute, but let me tell you a little story first.

My friend Bob Haralson spent the major part of his working life building sawmill machinery here in the Pacific Northwest. At one place in Oregon they had a big planer, and on it, among other things, they made straight edges - say 12 footers - which a millwright would need in setting up sawmill machinery. These straight edges were machined all over, and were made from hot rolled steel, i.e. NOT from CRS.

Bob tells me every so often some mill owner would come in with a piece of nice flat CRS - say a piece 1/2" x 3", and 12 feet long - wanting a bevel planed on it because wouldn't that make a straight edge a whole lot cheaper than the ones that had to be machined all over? Of course they'd explain to him that this is not the done thing - that nice straight piece of CRS would not remain straight if machined as requested. Some would accept this, but every so often there'd be a stubborn one who wouldn't.

"Okay, we'll do it. But you stand right here and watch, and you pay in advance for the work."

Once the money had changed hands, the material would be set up on the planer, and the bevel machined. "But oh boy! When you unbolted it, that bar would just twist up like a snake!" said Bob, twisting his arms to illustrate his point. So the sawmill owner would depart, slightly poorer, but with a greater respect for the men who call themselves machinists.

STRESS RELIEVING CRS

In 1985 I prepared, for sale to home shop machinists, a set of drawings and instructions for building and using a small tool and cutter grinding jig called "**the TINKER**", after its inventor, N.W. Tinker, of Nottinghamshire, England. In making the TINKER, there is a part made from a 12" length of 1/2" x 1" CRS machined to about 1/2 x 5/8" for about 4" at one end. Without stress relieving before machining, warpage - maybe 1/16" or 1/8" or more - could be expected. What to do?

The following paragraph is what I wrote into the **TINKER** drawings, based on what I did myself, after conferring with "Ben", the foreman of a local heat treating plant. I don't know his last name, but he has freely shared his know-how with me on a number of occasions when I have asked him questions.

"Put the material in a piece of pipe about 1.5" I.D. x 15" to protect it from the direct action of the (gas fired) heat treating furnace flame. No need to cap the pipe - just stick it in loose. Put in furnace, run up to about 1100°F and hold there for say an hour. Cool slowly. If the workpiece goes beyond a black heat, some scale will form - remove with a few hours soak in salt and vinegar, then proceed with layout and machining. If, like me, you do not have a heat treating furnace at home, your local high school can probably help, or you can even do the job in a wood fire in your back yard - in which case I'd be inclined to use a slightly larger diameter pipe, provide caps at both ends (not real tight) and fill the area around the workpiece with dry sand. The sand should minimize or prevent scaling. Charcoal will give the same or better protection from scaling, but may increase the carbon content at the surface - this will not matter if the job cools slowly. Don't overheat, or soak at temperature for too long. Leave in the fire til fire dies out completely."

WHAT IS MILD STEEL?

In spite of the fact that you will find it used a few times in this book, the term "mild steel" is another misnomer. The letters "MS" stand not for mild steel but for "merchant stock" (also merchant bar). It is often - but incorrectly - referred to as "soft" or "mild" steel. It is easily welded, machined and formed. It is used for general production and repair work, machine parts, welding jobs, bracing, etc. It is not particularly recommended for forging, heat treating, or complex machining operations. In other words, it lacks the technical sophistications the steel maker can bring to bear when higher quality steel is required.

In producing steel of the quality known as "merchant stock", only a minimum discard is made from each ingot, but bars of this quality should be free from visible piping. Seams and other surface irregularities may be present but are not objectionable for the purposes for which this quality and type of steel would typically be used.

A DRILL SHARPENING JIG FOR DRILLS FROM 1/8" to #60.

Freehand twist drill grinding is a knack every machinist should acquire. The best way, I think, is to get some old machinist to show you how it's done....it's not something that's easily explained on paper....I know, because I have tried.

Drills above 1/8" are not too difficult to grind freehand, but below that, things get tougher. The Drill Sharpening Jig described here, in conjuction with a bench oilstone, will sharpen any twist drill in the range from 1/8"Ø down to #60. The type of point produced is not a conventional conical point. Rather, it is a faceted point, which, while not quite as strong as a conical point, will be found to have excellent free cutting qualities.

The basic idea for this Jig was described in *Model Engineer* Magazine, October 25, 1934, p.397, by "Inchometer". At the time, several readers suggested certain changes to the design as originally shown. Years later, other writers described the same device all over again.

Several years ago I made a number of these Jigs, and put together a kit consisting of the necessary materials plus a booklet of instructions and drawings. I sold hundreds of these kits to machinists and gunsmiths. I had more than a few feedback letters reporting how pleased they were with it.

Here, I present a slightly improved version.

It is not a difficult item to make - if you can make a toolmaker's clamp, you can make this Jig - and you will find it thereafter a very useful addition to your toolbox.

NOTE RE DRAWINGS

The drawings of the Jig Body and Spindle Nut are partially section drawings, and not all views are shown.

CONSTRUCTION NOTES

(To some, most of the advice which follows will be unneeded, but it is intended to give the **least** experienced maker sufficient instructions to ensure success.)

NOTE: All operations are carried out in the lathe with a 4-jaw chuck in place, unless otherwise noted.

JIG BODY (Part 2) (Drawings 1, 2, & 3)

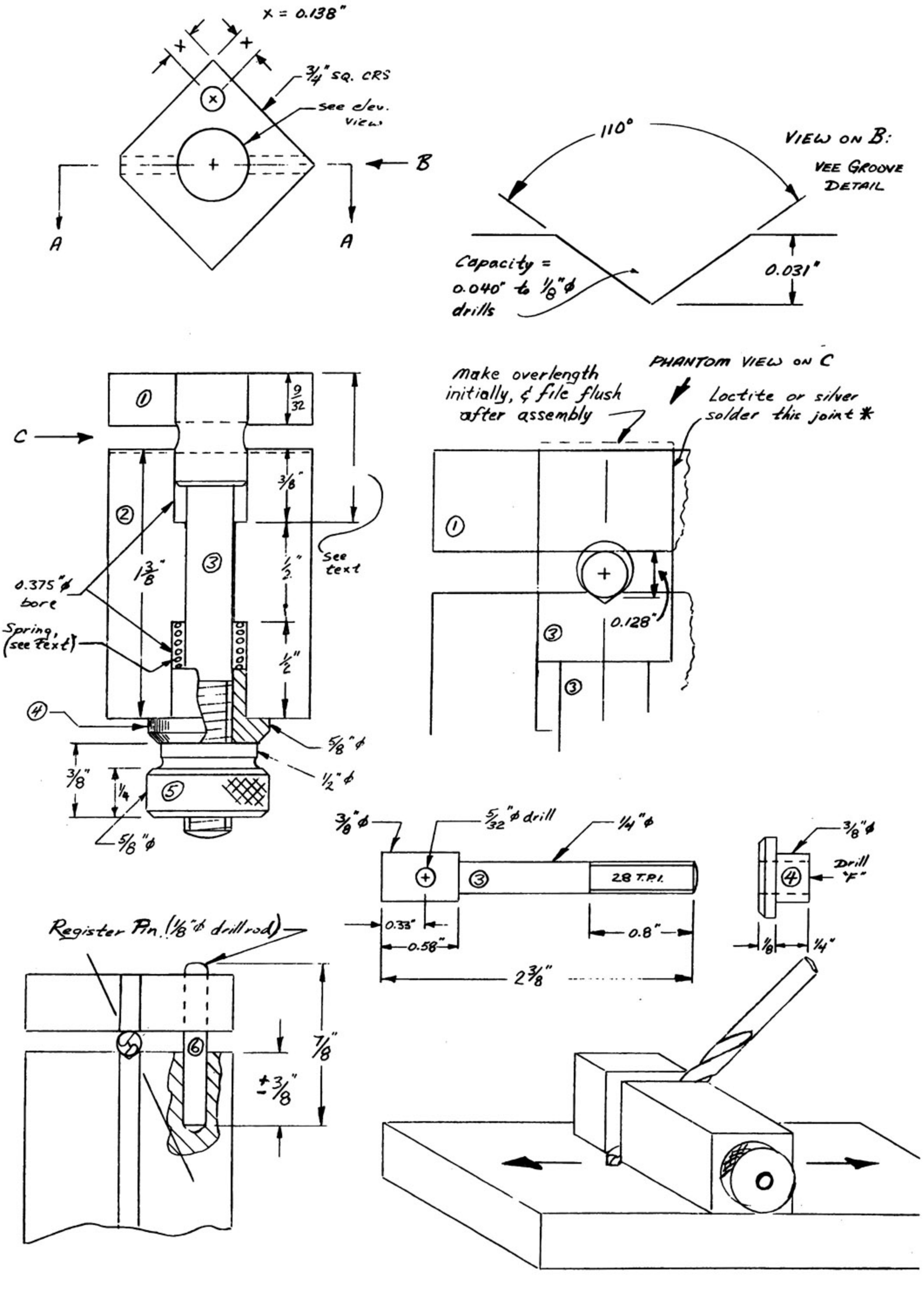
1. Roughly center a piece of 3/4" CRS about 1-7/8" long, and face both ends.

2. Dechuck, measure overall length, rechuck and face to an overall length of 1-9/16" **plus the width of your parting tool.** (See Step 10 below.)

3. Drill the Register Pin hole in the top, or "clamp" end, about 3/4" deep. (Actual depth should be about 3/8" **plus** 9/32" **plus the width of your parting tool.**) Start the hole with a small center drill, and progress through 2 or 3 smaller drills before finishing up with a 1/8" drill.

Do not do this operation in the drill press. If you do not have a vertical mill, do it in the lathe's 4-jaw chuck as follows:

Centerpunch the location of the Register Pin hole per drawing. (Note that the Register Pin hole is omitted completely from the General Arrangement view (middle left), for clarity of other matters shown there, but is shown in the scrap detail below the G.A. drawing.) Chuck the Jig Body, and with the aid of a wobbler (which see elsewhere herein), indicate this centerpunch mark to run true, then drill the hole.


x = 0.138"
3/4" SQ. CRS
see elev. view
B
A
A
110°
VIEW ON B:
VEE GROOVE DETAIL
Capacity = 0.040" to 1/8"ϕ drills
0.031"
PHANTOM VIEW ON C
Make overlength initially, & file flush after assembly
Loctite or silver solder this joint *
C
9/32
3/8"
1/2"
1/2"
1 3/8"
See text
0.375"ϕ bore
Spring, (see text)
5/8"ϕ
1/2"ϕ
3/8"
1/4
5/8"ϕ
0.128"
3/8"ϕ
5/32"ϕ drill
1/4"ϕ
28 T.P.I.
0.33"
0.58"
0.8"
2 3/8"
3/8"ϕ
Drill "F"
1/8
1/4"
Register Pin (1/8"ϕ drill rod)
7/8"
±3/8"

4. Rechuck with "nut end" outwards and carefully center the Jig Body preparatory to drilling it full length for the Spindle. Center by touching the work with a toolbit, noting cross slide feedscrew dial reading, rotating chuck 180 deg. and returning toolbit to again touch the work. Note the difference in the cross slide micrometer dial readings and adjust the work in the chuck accordingly. Repeat for both pairs of jaws until the work is centered within a couple of thou or better.

5. Start the hole with a center drill. Follow with a sharp 3/16" drill, drilling only about half way through the block (i.e. about 1" deep).

6. With the workpiece undisturbed in the chuck, counterbore the "nut end" 3/8"Ø x 1/2" deep for the compression spring shown in the G.A. drawing. Make this counterbore by first entering a 23/64" drill almost to depth, and then following with a 3/8" slot drill to depth. Lacking a slot drill, bore the hole with a small boring tool. Bevel the outer corners of the Jig Body slightly at this set-up. (Bevels not shown in drawings: see photos.)

7. Rechuck work with "top end" outward; center up perfectly again. Do not depend on the two undisturbed chuck jaws for repeat centering!

8. Center drill, and follow with the 3/16" drill as before, drilling through to meet the previous hole.

9. Put a 1/4" drill, then a letter F (0.257") drill through full length, and counterbore 3/8" dia. as for nut end, but to appropriate depth for this end.

10. Bevel the corners lightly as in 5. above.

11. Part off the Clamp Block portion (2) from the Jig Body. (Alternatively, the Clamp Block could be hacksawed off, and the sawn faces cleaned up in the lathe - but chucking the Clamp Block squarely would be tricky.)

(Adherence to the above procedure will ensure, in the finished Jig, perfect alignment of the holes in the Clamp Block and the Jig Body.)

12. If need be, take a facing cut across the end of the piece still undisturbed in the chuck, and then deepen the 3/8"Ø counterbore to a depth of 3/8" if it is not already that deep. Dechuck.

THE SPINDLE (Part 3)

1. Chuck and roughly center a piece of 3/8"Ø CRS with about 1/2" extending from the chuck. Face the exposed end. Rechuck with about 2" exposed, and indicate true. Center drill for tailstock support.

2. Turn down to 1/4"Ø for 1-5/8" with tailstock support, and screwcut 28 tpi per drawing. Check that the Jig Body will go over the 1/4"Ø Spindle - if not, pass a file over it til all is right, then dechuck.

3. Cross drill the Spindle per drawings, starting with a small center drill and preceding the final 5/32" drill with one slightly smaller.

4. Loctite (or silver solder) Part 3 into Part 1 per note re same on the drawings.

THE SPINDLE NUT (Part 5)

Straightforward. Turn, knurl, drill & tap 1/4-28, per drawing.

THE FLANGED BUSHING (Part 4)

Straightforward.

THE SPRING

The recommended material for making the Spring for the Drill Sharpening Jig is 0.029"Ø music wire. This was the size of wire supplied in the kits we sold, and the instructions which follow are based on use of that material. However, if you don't happen to have 0.029" wire on hand - and why should you? - any other near size can be used.

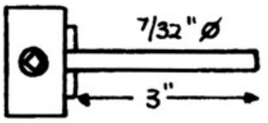
The diagrams and notes below show the procedure I worked out for making a suitable Spring. If you do use 0.029" wire, and follow them exactly, you will get a good spring the first try. No heat treatment of the finished Spring is necessary, because the amount of compression it undergoes is small. (See info on spring making elsewhere in this book.)

Here's the procedure....

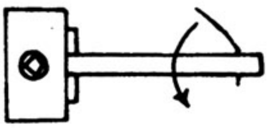
1. Using your 3-jaw chuck, turn down the end of any piece of rod to 7/32" for about 3". Dechuck.

2. Cross drill or hacksaw a slot in the end, as shown, to take the music wire. I will assume a hole, for the purpose of these instructions.

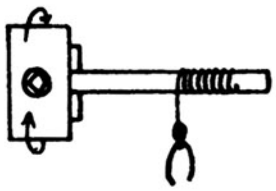
3. Replace rod in chuck.



4. Insert a 7" length of 0.029" music wire into the hole in the rod. Form a sharp bend in the wire where it emerges from the hole.



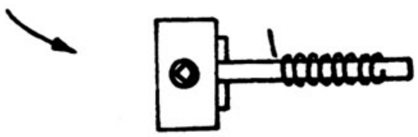
5. With left hand, turn chuck clockwise as viewed from tailstock. Keep coils tightly spaced as they form. Keep a strong tension on the wire with pliers in right hand.

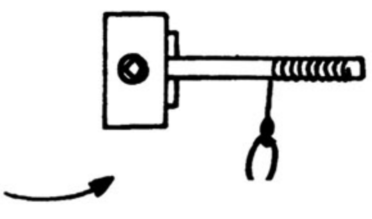


ADDED TO THE 18th PRINTING, SEPTEMBER 2006:

> NOTE: I now have available some **much better info on spring winding**. Flip to page 206 herein, and read about it in the info about my **Tire Pump Plans.** GBL

6. Let go of wire. Spring will unwind a little. Spread coils to the left about 1.5", then release.





7. Pull coils tight again with pliers, while holding chuck stationary.

8. Repeat steps 6. and 7. until spring, at rest, is about 5/16"Ø.

9. Remove spring from mandrel and snip off ends to leave about 5 coils, which should give a spring about 1/2" long.

Note: Brownells sells an excellent pair of cutters for stuff like music wire. See PIANO WIRE NIPPERS in their catalog. Handy to have around the shop.

MACHINING THE V-GROOVE IN THE TOP END OF THE JIG BODY

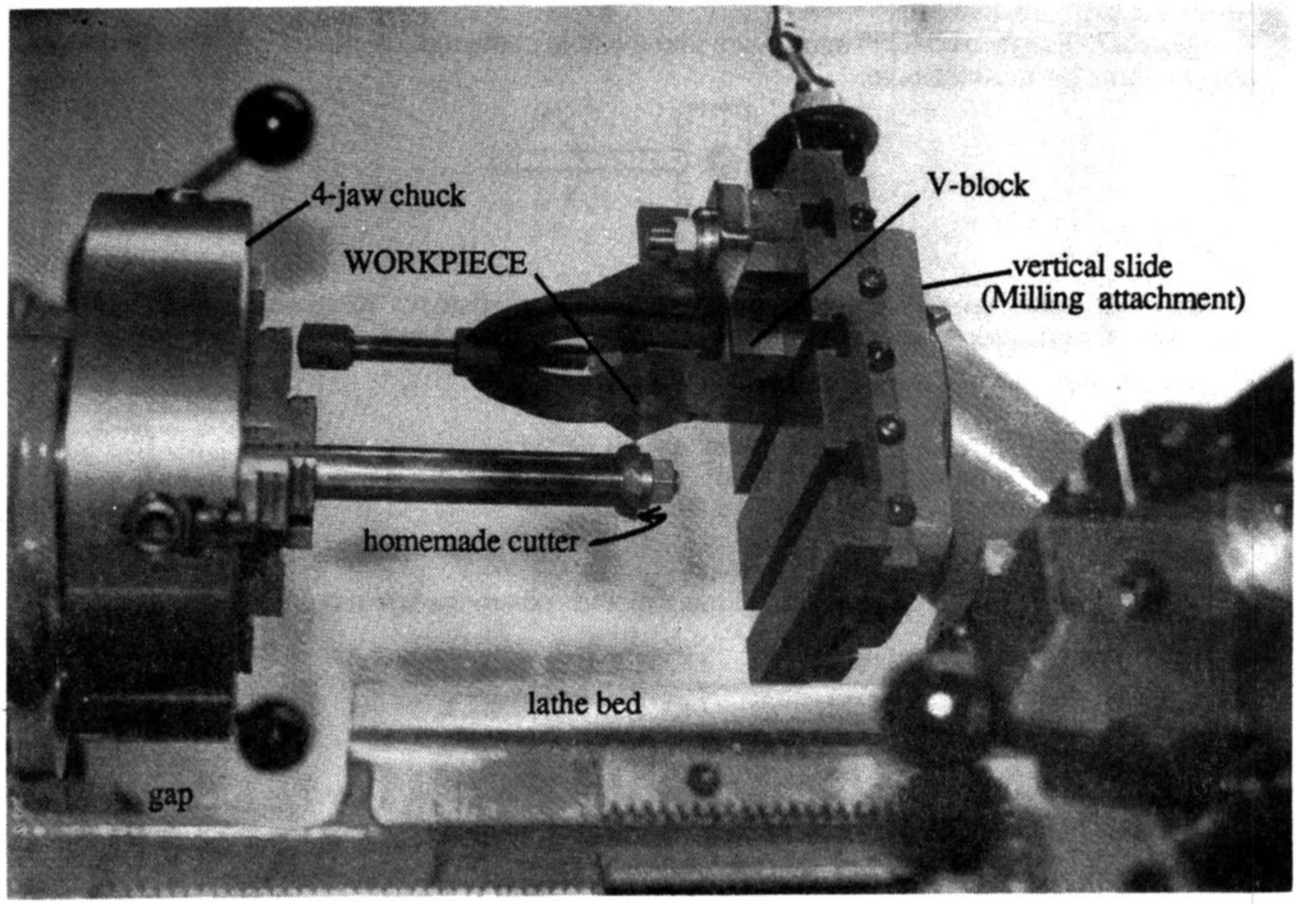
The V-groove will take all drills within the 1/8" to #60 range if made to the dimensions shown in the VEE GROOVE DETAIL, upper right hand corner of drawing. These dimensions were derived from a large scale drawing, and will work, but are not the only groove specs which will do the job.

The V-groove can be machined in several ways. I've done a couple in the lathe, and others in the vertical mill.

If a milling machine (or a shaper) is available, the job is easy. A special cutter can be made up, or a stock cutter - eg. a 90° double angle milling cutter, if you have one - can be used, modifying the depth of the cut accordingly. Hold the job in a V- block clamped in the machine vise, to assure that the axis of the V-groove falls where it is supposed to - see next paragraph for more on this.

Lacking a mill, the job can be done in the lathe using the vertical slide. A suitable cutter can be made up and employed in conjunction with the V-block set up as shown in one of the photos. To ensure symmetry of the groove, if you are using a cutter of the type shown, mill one side, rotate the Jig Body 180° in the V-block, reclamp it, and mill the other side of the groove. The result should be a perfectly centered groove.

Whatever means is adopted, take pains to do this job accurately, for the accuracy of the jig depends upon the care with which the set-up is made.



MAKING AND FITTING THE REGISTER PIN (Drawing 6)

Round and bevel the ends per drawing, and Loctite it into its hole in the Jig Body.

FINAL ASSEMBLY

Loctite the Spindle into the hole in the Clamp Block, drop the Spindle into the Jig Body. Put a 1/8" drill in the Spindle cross hole and turn the Spindle in the Clamp Block until the drill lines up and seats in the V-groove in the Jig Body. Give this assembly about an hour or so for the Loctite to set. If you are in a hurry, apply a little heat from a propane torch, and the Loctite will set in a few minutes.

File off any portion of the Spindle which protrudes beyond the top surface of the Clamp Block.

Place the completed Jig in the bench vise with the V-groove vertical (i.e. two corners of the Jig Body gripped by the vise jaws). File a small flat along the exposed corner of the Jig Body - this flat is shown on the left side of the upper left detail on the page of drawings and may appear - am not sure at time of writing this - in one of the photos.

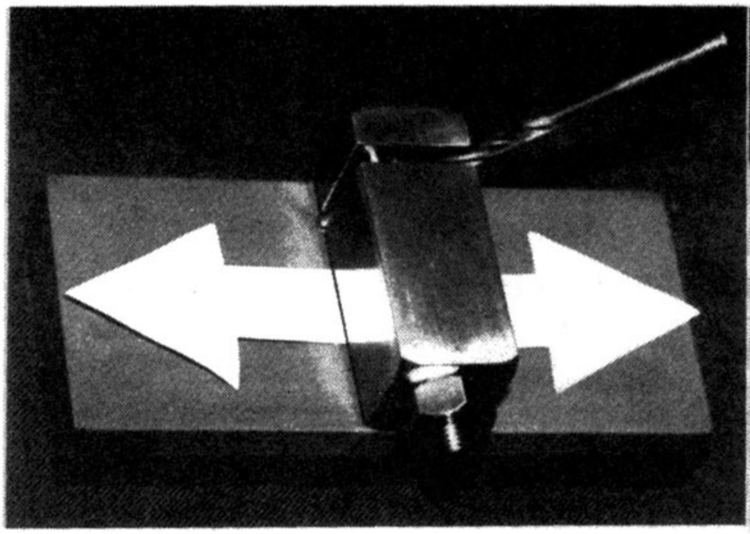
As the Jig is used, two sides will be marred by the oilstone. With much use, the Jig Body will lose its squareness to a slight degree, but it will take a long while before this will significantly affect the cutting qualities of drills sharpened with the Jig. When that day comes, make a new one. Or, make it and caseharden it....

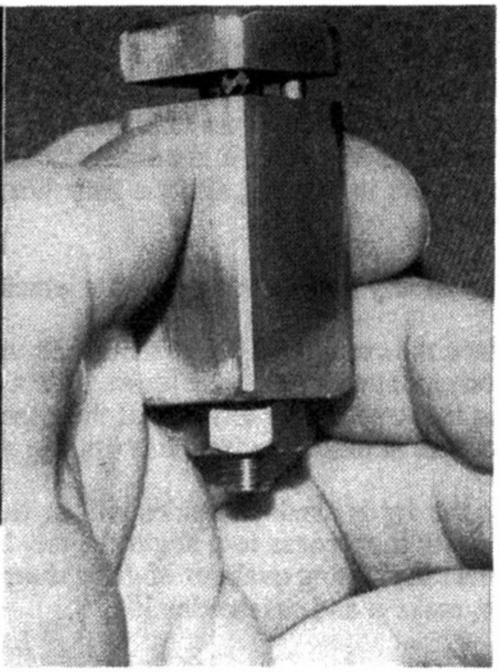
USING THE JIG

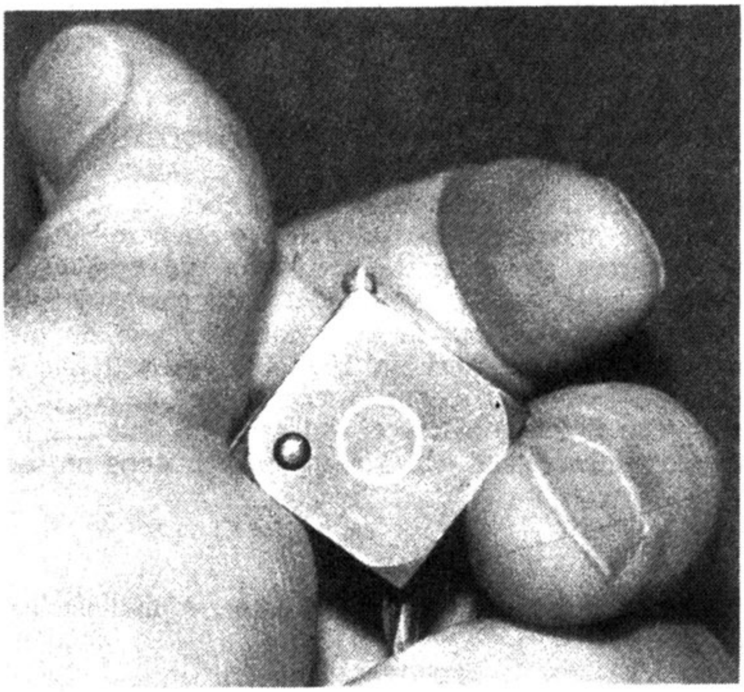
The use of the Jig is explained in the illustration at the lower right hand corner of the page of drawings, and in the following paragraph:

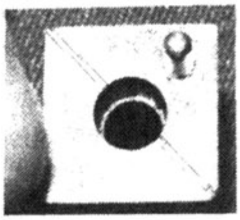
> When a drill to be sharpened has been set in the Jig correctly as shown in the drawing at the lower left corner of the page of drawings, proceed as follows: Apply the Jig to a small bench oilstone having a good, flat surface. (A medium hard Arkansas stone is recommended.) Move the Jig back and forth in the direction indicated by the double ended arrow. Keep the full length of the trailing edge of the Jig body touching the stone - the only other point of contact will then be the drill point. When one side of the drill point is ground, flip the Jig over and grind the other half of the drill point. Check the symmetry of the point carefully, using a magnifying glass if need be. If the point is not symmetrical, the drill will not produce an on-size hole.

You'll find more good info on spring making in TMBR#2, "Hey Tim.....", and TMBR#3.









Upper left - A drill being sharpened in an early prototype Jig made by the author.

Upper right - Correct drill position. Note also the flat filed full length of nearest corner of Jig.

Lower left - The tip of the drill should stick out beyond the Jig Body just a little.

Lower right - View onto top end of Jig Body showing V-groove and Register Pin.

A SMALL DEPTH GAUGE

At a very early stage in my workshop activities I made a simple depth gauge. The stock was a block of steel 3/8" x 1/2" x 1". The rod was a 3" length of 1/8" drill rod. I used this little tool often, but it had two flaws in it that always bugged me.

These flaws concerned the locking screw. At the time, I didn't have a knurling tool. Consequently, I couldn't knurl the screw head, which I'd made too small in any case. Thus it was difficult to finger tighten sufficiently to properly lock the rod at a desired setting. Also, when I drilled and tapped the locking screw hole in the stock, I somehow got it in there slightly crooked, and although it really didn't matter, it never looked very nice. So much for Depth Gauge, Mk I.

Eventually, I decided I must make a new depth gauge, nicer than my first effort. The result was so satisfactory that I will not likely make another, but as I believe often happens in such cases, Mk II immediately revealed how Mk III could be made nicer.

The drawings given here show Mk III.

THE STOCK (A)

This part is turned to profile, the gripping shoulder knurled, and the piece parted off without drilling the 1/8" hole for the Depth Rod.

> (As to whether to do this turning with the contact face or the knurled end toward the tailstock, both approaches have merit. I don't recall which way I did it, but I think I would be inclined to the former approach. Please yourself.)

If need be, reverse in the 3-jaw chuck and clean up the parted face, chucking carefully via the 1.25"Ø rim for this operation.

Next, hacksaw off the surplus material on one side, and mill the sawn face back to finished dimension. Repeat for the second face. Now, without disturbing the work in the milling machine vise (assuming you are doing the job in a vertical mill), drill and ream the 5/16"Ø hole to take the Clamping Bolt (B).

CLAMPING NUT (C)

Turn, knurl and tap. A 1/4-40 thread is specified. 1/4-28 will do, but the finer thread is preferred if you have it. Drill #1 is correct tap drill size for 1/4-40 thread. (I mention this because I had somewhat of a hunt for the info.)

CLAMPING BOLT(B)

Make to the dimensions shown. Screwcut the 1/4-40 thread to fit (C). Finish and polish the end of the thread nicely before parting off, leaving a service flange about 3/8"Ø x 1/16" thick. This flange is called a "service flange" because it will be machined away later. (See also alternate method two paragraphs down.)

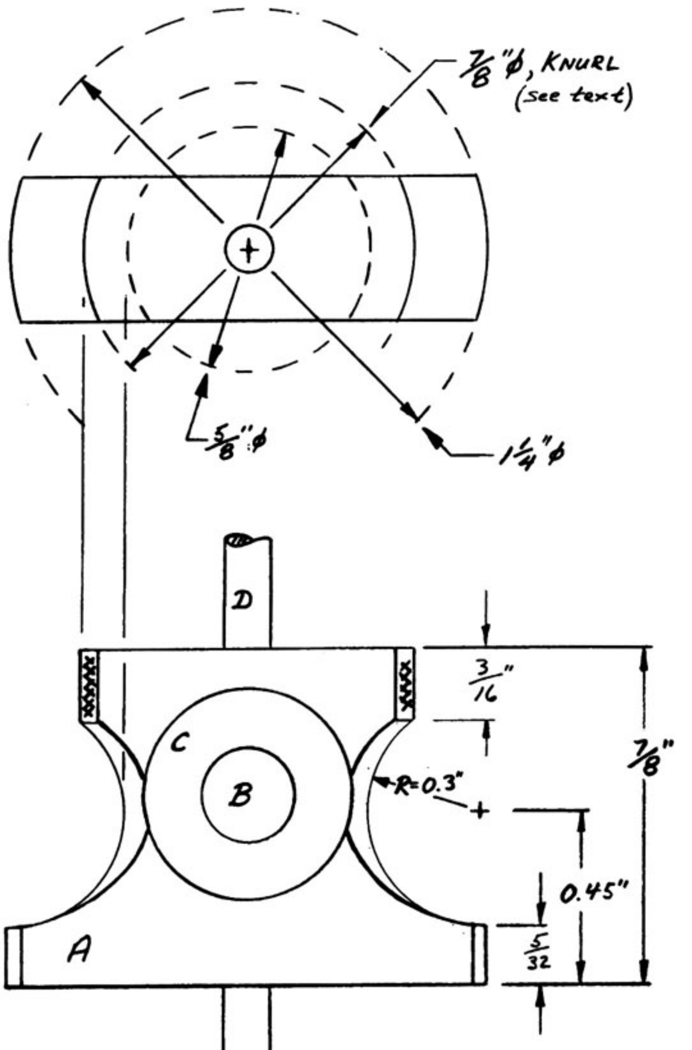
Assemble Parts (B) and (C) in (A) and put the assembly in the milling vise with the working face of (A) flat down on a parallel, and use a pusher piece about 3/8" long with a 9/16"Ø hole bored in it to fit over (C). Drill and ream 1/8" for the Depth Rod (D). Unship from vise and turn away the service flange on (B).

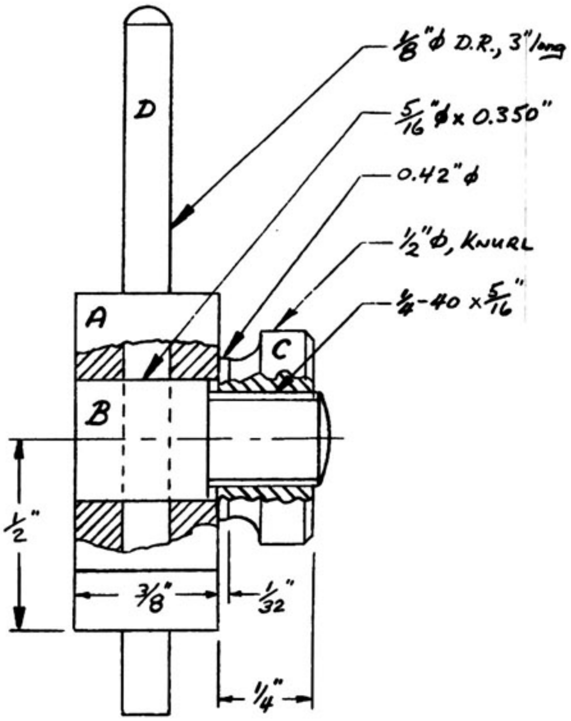
Alternatively, omit flange altogether, Loctite (B) into (A) for drilling/reaming, and free it thereafter with the aid of moderate heat from a propane torch. Apply the heat directly to the screwed end of (B). The Loctite bond will let go at about 400/500°F.

If you used Loctite and a torch as above, a half hour soak in salt and vinegar will remove the brown oxide from (C). Remove the scorched Loctite from (A) & (B) using steel wool.

I blued (B) by heating it to a dull red and dipping it into thick brown cutting oil. A couple of such treatments gave it a beautiful blue/black finish. (See section on steel blueing elsewhere herein.)

For the Depth Rod, I used the same piece of 1/8" drill rod that'd been in my first depth gauge. A 3/16"Ø x 4" rod would be an appropriate alternative.





A SMALL TAP WRENCH

This little tap wrench is slightly smaller than Starrett's #174. It will take taps up to #12 machine screw size, as well as drills, reamers and other small tools.

At the time I made the prototype, I did not own, nor had I ever handled, a #174. I measured the photo in the Starrett catalog with my 6" dial caliper, noted the dimensions given in the catalog description, and from that "analysis" drew up a smaller version.

About a week after I got it made, I was drilling and tapping the tang of a Norwegian-made Remington Rolling Block rifle for a tang sight I'd made for it. (That rifle's receiver wall was date-stamped 1878, if I recall correctly. When we started work on it, we found the Norwegian hunting licence of a previous owner under the butt plate!!) For one reason or another the set-up on the vertical mill left no room to turn my regular tap wrench. Out came this little sucker, and we got on with the job.

You can make this little tap wrench in an hour or two. If you want to, you could file one side of the wrench hole out to 90 deg. Mine is made as drawing, and works fine.

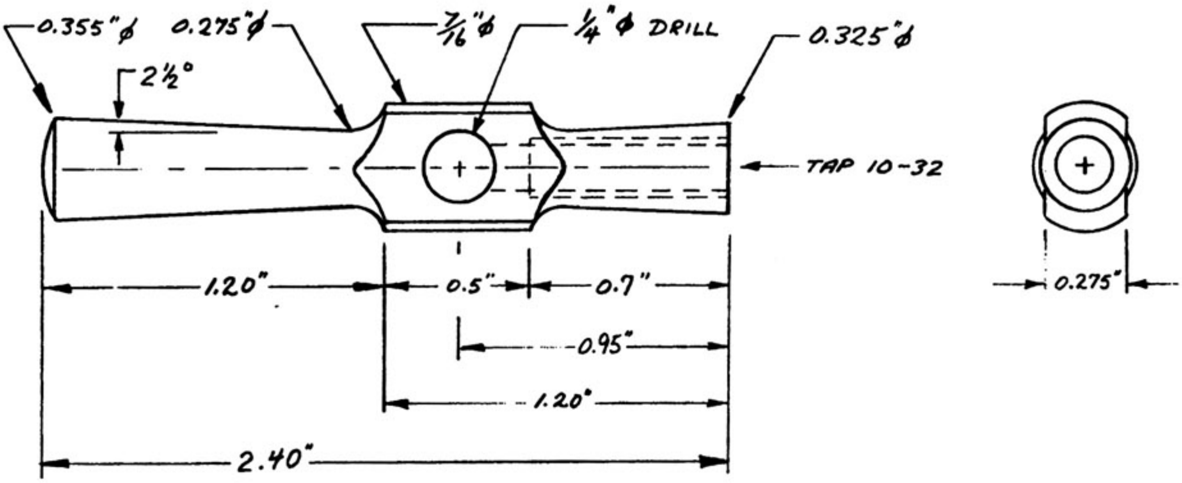
THE BODY

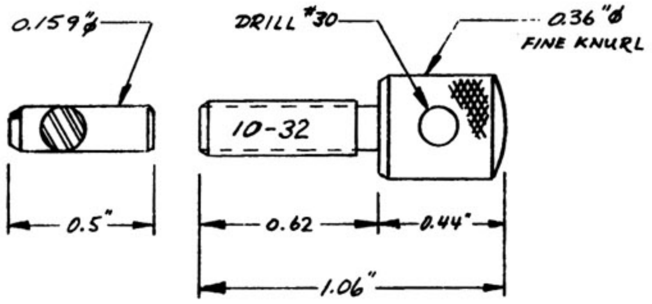
Make from 1/2"Ø CRS. Casehardening is not necessary, but would give it longer life, as would making it from 1/2" drill rod. If you've got a piece of 1/2"Ø material anywhere from 6" long on up, here's how to make it with minimum material waste.

1. Coat with marking out blue for about 3-1/2".
2. Chuck with about 2" protruding from jaws of 3-jaw chuck.
3. Face end.
4. Center drill, drill #21 and tap 10-32 for Screw.
5. Set oddleg calipers to 45/64" (= 0.7"), and make a mark on the O.D.
6. Turn taper and radius at the root of same.
7. Turn O.D. to 7/16"Ø for 1/2".
8. Move material further out in chuck.
9. Turn next radius and flaring taper for solid side of Wrench. DO NOT PART OFF!!!
10. Dechuck. Slip parent bar into a 1/2" cutter block, (see same elsewhere herein), mill flats on 7/16"Ø portion, and drill a 1/4"Ø hole in center of flat.
11. Saw off, and chuck in the 4-jaw using protective slips of scrap aluminum sheet on central 7/16" x 1/4" portion.
12. Indicate true, and radius and polish the end with a file.

THE SCREW

The Screw is straightforward. The separate Pusher is not a necessity. Starrett's screw/pusher is one piece, and heat treated. Mine is in two pieces, not hardened, and unfortunately, not champhered as shown. Consequently, after about 3 years use it has mushroomed slightly and cannot now be withdrawn from the Wrench: some day I may make another such wrench. When I do, the Screw will be made from 3/16"Ø drill rod, with a hardened tip, and will have a CRS sleeve knurled and Loctited on - drill rod is a little tough to knurl.





Left: a small Depth Gauge
Middle: Starrett's #174 tapwrench
Right: Lautard's smaller Tapwrench.

A SWIVELLING BASE FIXTURE FOR A WILTON #20N VISE

A small vise is a useful adjunct to the regular bench vise. I have two Wilton vises, a 2" and a 3-1/2". I like the Wilton design: it is very strong, the vise screw is protected from dirt, and the maximum capacity of the bigger one can be quite useful at times, e.g. when you want to swage a hex socket in a special shop-made screw.

For years I had my little Wilton bolted to a block of wood about 2" x 3" x 6". This block could be gripped in the jaws of the bigger vise at various orientations to suit whatever I was doing at the time.

On page 28 of the July 6/84 issue of *Model Engineer* magazine, Charles O'Halloran described his idea for a swivel fixture for a small vise. This was one of those things that struck me as being "right" the moment I turned up the page on which it appeared. I made one almost immediately, adapted to the flat, circular base of the little Wilton vise. I asked Mr. O'Halloran's permission to use my version in this book, and he graciously consented.

If you have a small vise around the shop, I highly recommend this swivelling base fixture. It is quick to make, and you will like it.

NOTES TO DRAWINGS

Drill and tap Part (A) to suit your vise. The Wilton #20N's mounting holes are spaced 2.25" apart. For best results - i.e. reasonably close concentricity between the vise's mounting flange and Plate A, for good appearance - mark off through the vise base itself. I used 1/4-28 hex cap screws and washers to bolt the vise to the fixture.

Stick (A) & (B) together with Loctite 609. See notes re Loctite elsewhere in this book.

The bore in Part (C) will close down slightly, so make it 2 or 3 thou oversize initially, i.e. an easy fit on the 1"Ø portion of (B).

Aside from the foregoing notes, the only point which bears mention is the matter of how to set up the **Clamp Piece** to cross drill it. If it is made from square cold rolled steel, (say 1-3/8 or 1-5/8" sq.) the set-up in the 4-jaw chuck is routine: mark out and centerpunch the location of the cross hole, and set it to run true with the aid of a wobbler, (which see elsewhere). For a round piece, do this:

1. Blue one end and down one side, full length.

2. Place in a V-block on a surface plate, scribe a line down the outside of the cylinder in the blued area.

3. Remove from V-block. Use a center square to scribe a diameter line across the blued end continuous with the line down the side.

4. Put the job back in the V-block, and position it so that the scribed diameter line is horizontal. Scribe 2 chords parallel to the diameter line, one above it, one below, and spaced so that the distance between the chords is just slightly more than the width of the jaws on your 4-jaw chuck. These lines are for eyeballing purposes, and need not be at equal distances either side of the diameter line.

5. Using oddleg calipers, locate center of line scribed down the length of the cylinder in 3. above, and centerpunch same.

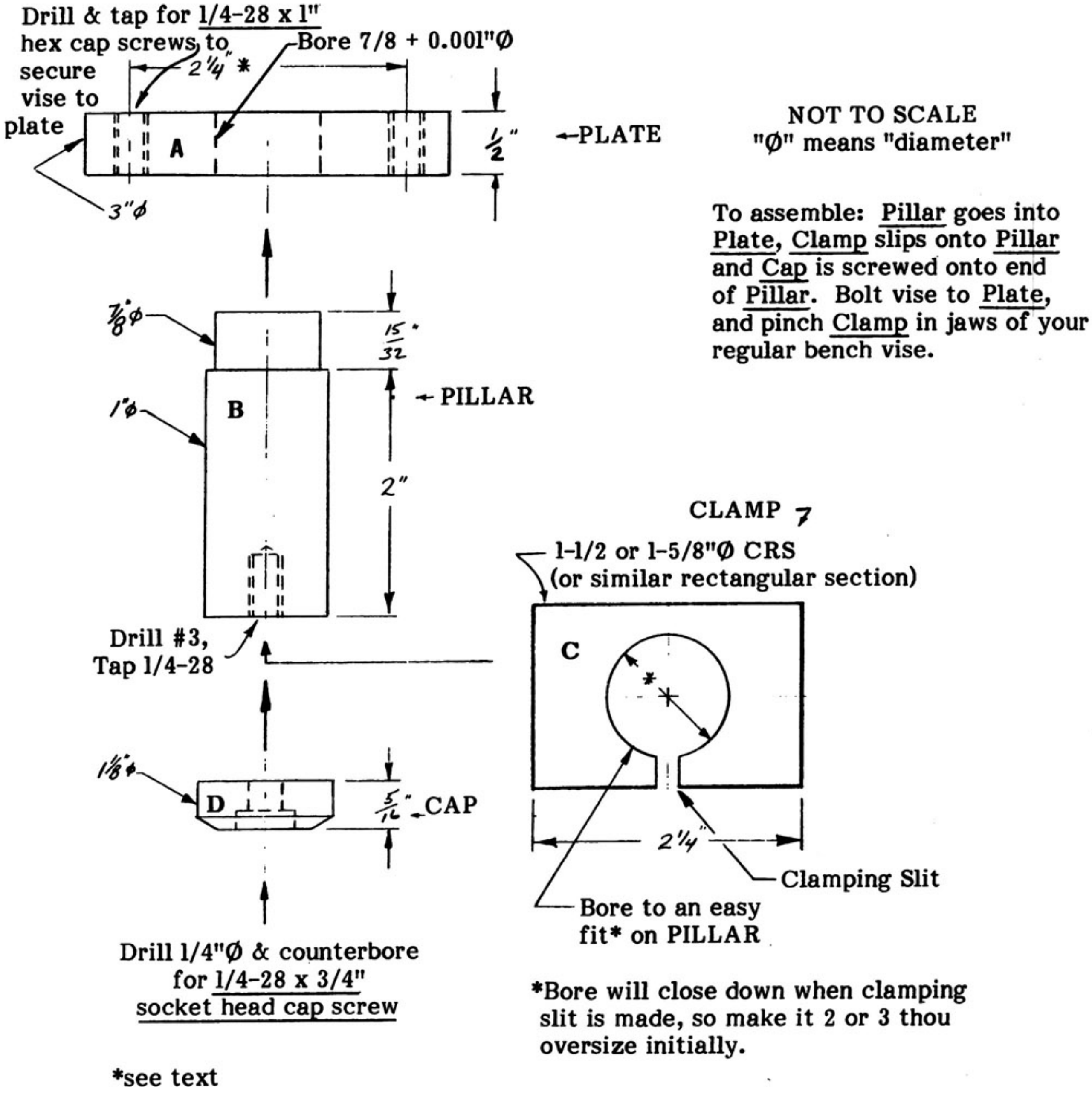
6. Taking a bird's eye view of the work and the outer end of one jaw of your 4-jaw chuck, eyeball the scribed chords parallel to the sides of the jaw and set up in the usual way, using wobbler and indicator. That gets the centerpunch mark facing the tailstock as close as need be.

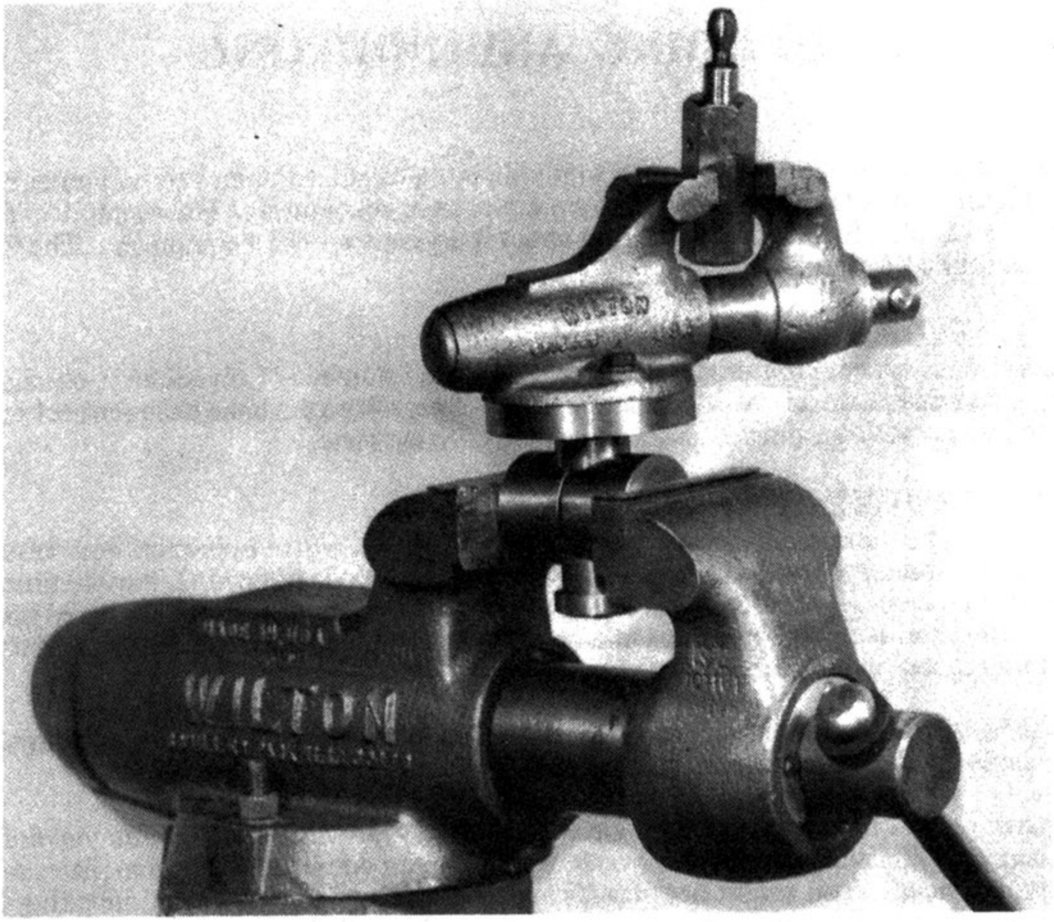
7. Center drill, drill, and bore to size.

Remember, the cross hole does **not** have to be **perfectly** located. If its axis were to be 1/16th" either side of the diameter line, it wouldn't matter. Without taking undue pains, you should be able to get it at least 10 times closer than that, i.e. within about 0.006".

ASSEMBLY

Stick Plate and Pillar together with Loctite #609.





OTHER WAYS OF WORKHOLDING

ANGLE PLATES

Don't overlook the humble angle plate as a work holding fixture on the vertical milling machine. Sometimes a one-off machining job - and that obviously takes in most of the hsm's work - can be readily set up on an angle plate. This can be a real time saver if the milling machine vise has been removed for some reason: it may be quicker to do the job with an angle plate than to re-install the vise, dial it in, and then immediately have to remove it again - and I have seen instances when this would have been the case had not the angle plate been used. If nothing else, the angle plate was quicker and easier to install and remove than the machine vise. Sometimes, in spite of careful planning of the work sequence, it is impossible to avoid such things.

I have a 4" length of 4" x 4" x 1" thick 'cast iron section', machined inside and out, which I find quite handy at times. 'Cast iron section' (as it is called in the trade) is a standard product of the jig & fixture makers' supply business. It comes ready machined, to close tolerances, in flat, L-section, T-section, box-section, etc. It can be bought from local distributors of various die makers' supply outfits - see ads in *American Machinist*, and/or look in the yellow pages under "Die Makers' Equipment and Supplies". Carr Lane is one maker, Producto Diemakers Supplies is another name, and you will see numerous others.

A T-SLOTTED WORKHOLDING PLATE

Friend Geoff Symons, a Calgary tool and die maker and model engineer, sent me photos of a device he has found useful over the years. It is a plate about 5" x 7", with two T-slots lengthwise, and three crosswise. This, with a set of 4 clamps of the type shown for the Finger Plate (see page 88 herein), would make a mighty versatile workholding device for the vertical mill, and on the drill press, too.

DIVIDING AND INDEXING

The machinist is sometimes called upon to divide out a circular job into some number of equal spaces. Graduating a feedscrew dial is an example, as is gear cutting. How to do it? The basic arithmetic is simple. Exactly how one goes about it depends on one's equipment. The following is basic, and may be useful.

DIRECT INDEXING

Essentially, this is a copying process, wherein a desired number of divisions is obtained using something else that is already divided appropriately - a gear from the lathe changewheel set, or like that. The gear serves as a simple, cheap and handy division plate.

SIMPLE INDEXING

Simple indexing is commonly carried out by introducing a worm reduction gear between the workholding spindle and the division plate. The reduction ratio is often 40:1, thus 40 times around the division plate will give one full turn of the work. The division plate is usually fixed (immobile) and the worm shaft is turned by means of a crank arm carrying a detent pin or tooth which can be dropped into spaces in the division plate.

While 40:1 is a common dividing head ratio, 60:1 and 90:1 are also used, and anything else that suits the builder can be used. Some ratios are of course more practical than others.

Say you have a 40:1 dividing head, and you want to cut a gear with 36 teeth. Can you do it? That depends on your division plate, but say you have a full set of commercial division plates to go with your dividing head. You might **not** have, if you build some sort of geared indexing head for yourself, using lathe change gears as division plates, but let's look at a 40:1 head and a set of plates.

The basic formula for simple indexing is

$$R/N = T$$

Where: R = the number of teeth in the worm wheel
N = the desired number of divisions
T = the required number of turns (and part turns, if any) of the worm shaft, to produce the desired N.

For a 40:1 head and 36 divisions, if we apply the above formula, we have the following:

$$T = R/N = 40/36 = 1.1111$$

That proves to be too brutal an approach. Let's be a little more subtle:

$$T = R/N = 40/36 = 20/18 = 10/9 = 1+1/9.$$

This tells us that an index plate having a row of holes containing the factor 9 should be put on the dividing head, and the index crank pin set to engage that row of holes. For each of the 36 divisions, we will make a full turn plus 1/9th of a turn. We could use the 27-hole row, and for each division, make one turn plus 1/9 of 27 = 3 **spaces** (not holes).

Simple indexing, which is what we've just been talking about, will cover a great variety of dividing work. There are published tables for such work in **Machinery's Handbook, The American Machinists' Handbook,** and similar sources. No sense in duplicating those tables here. If you don't own one of these useful books, try to pick one up second hand or go see it at your public library. Don't worry if it's 40 years old - the old ones are just as good for most of our purposes - my **American Machinists' Handbook** is a 1940 edition, and I am entirely happy with it.

COMPOUND INDEXING

Compound indexing is like simple indexing except that the division plate is made to revolve also, by known amounts, during the indexing operation, rather than being a fixed reference.

DIFFERENTIAL INDEXING

Differential indexing involves the interposition of a compound train of gears between the division plate and the worm shaft.

Differential and compound indexing are fully covered in both **Machinery's Handbook** and in **The American Machinists' Handbook.**

There is an excellent book entitled **Dividing and Graduating**, details of which are given at the end of this chapter. Even if you do not build the differential indexing head for which complete working drawings are given in the book, you will learn a great deal from a careful reading of it.

INDEXING ON A GEARED ROTARY TABLE

If you have a horizontal/vertical geared rotary table, you can do a lot of dividing work on it.

> (Incidentally, if you are contemplating the purchase of a geared rotary table (R/T), do not go the cheaper route and buy a "horizontal only" type. I made this mistake, thinking it'd do all I wanted. It was a 6" diameter unit made by the Yamato Koki Co. of Japan, under the "News" trademark, and a really fine piece of equipment. But came the day I needed to do something with the R/T standing vertical. Eventually I talked the store owner into taking my horizontal R/T back in trade on a H/V of the same make and size. The trade cost me $75 extra. If I'd bought the H/V in the first place - as my wife had encouraged me to do - I'd have been money ahead over what I finally ended up paying.)

I (now) have a 90:1 H/V rotary table. One complete turn of the handwheel gives me 1/90 of 360° = 4°, and the handwheel dial, which is about 3.4" dia., is graduated directly in minutes of arc. 240 divisions, about 0.044" apart. Readable? Nice? You better believe it! Now if I want to put say 100 divisions onto a feedscrew dial, the process is very simple:

360/100 = 3.6 degrees per space.

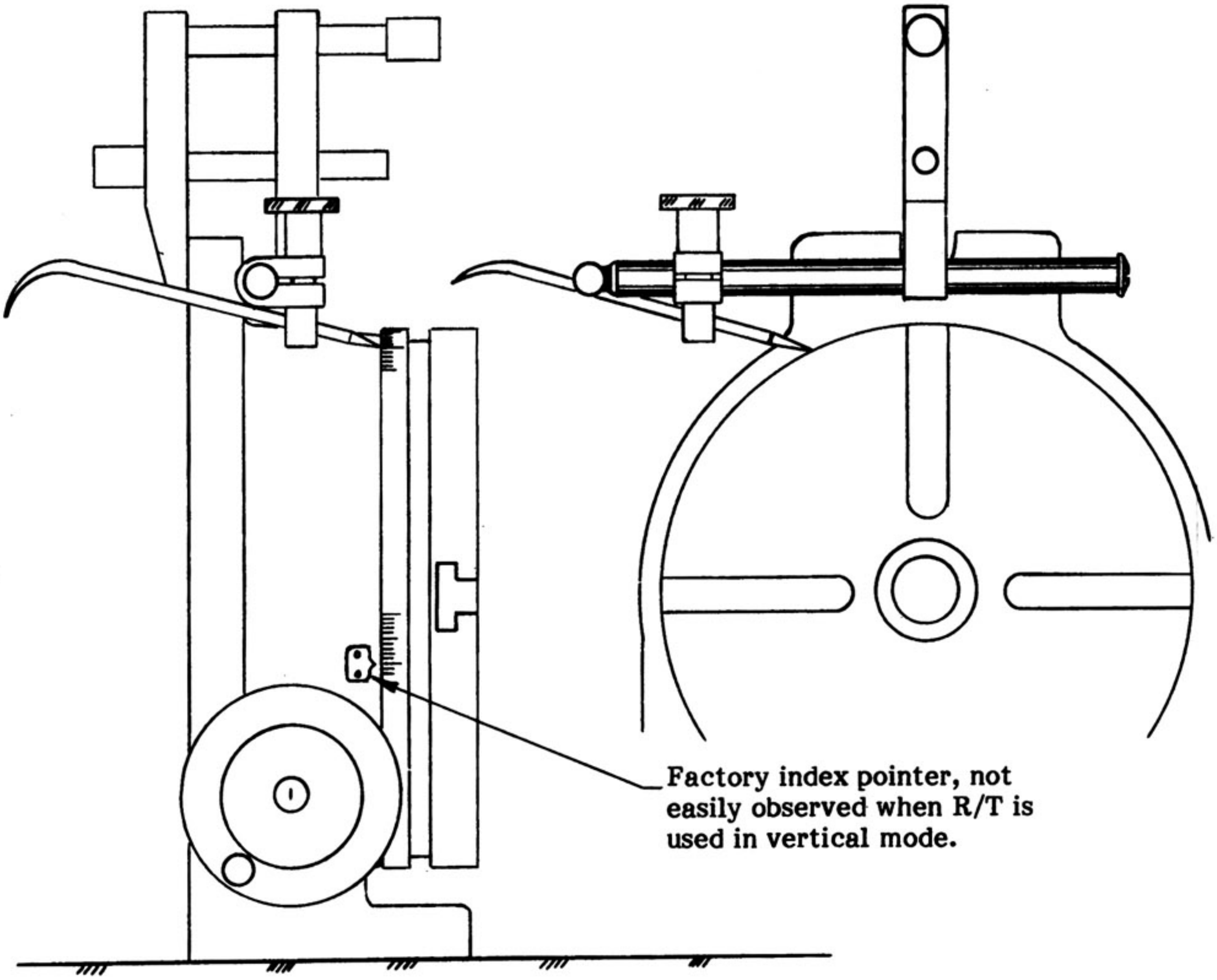
3.6° = 3°36'

I make up a table of settings for the R/T handwheel, starting at zero, and adding 3.6° to itself, over and over, til I reach 360°. Each new setting is expressed in degrees and minutes. I set up the job on the R/T, rotate the handwheel dial to each successive reading in the table, and at each setting, I engrave a graduation. 'Twerks nice. (See excerpt from **Strike While the Iron is Hot** elsewhere in this book, for more details.)

EXTRA INDEX POINTER FOR A H/V ROTARY TABLE

When using a horizontal/vertical rotary table in the vertical position, observation of the degree scale index pointer usually requires constant crouching and bending.

Pull the spindle and scriber unit from a toolmakers surface gauge. Clamp the spindle to the R/T's uppermost horizontal bolting lug, and use the scriber point as a witness mark.



Safer: make a single-ended blunt pointed scriber. Better than snagging your arm on the hooked end of the standard surface gauge scriber.

THE 15/16 HOLE VERNIER

There is another means of dividing which has some interesting features. If you make a vernier consisting of two plates, one carrying 15 holes on a pitch circle of some convenient diameter, and the other carrying 16 holes on the same P.C.D., you have a simple device capable of producing any of the following number of divisions: 1, 2, 3, 4, 5, 6, 8, 10, 12, 15, 16, 20, 24, 30, 40, 48, 60, 80, 120, and 240.

Thus the 15/16 hole vernier will give spacings as small as 1.5° apart: 360/240 = 1.5°

A most interesting article appeared in *American Machinist* Magazine for January 22, 1931, page 168, wherein a device is shown which incorporates a simple and foolproof built-in calculator which shows the next pair of holes to line up to carry out the indexing of any number the device is capable of indexing.

I can see possibilities for the 15/16 hole vernier in the hsm's shop, but I do not think there would be much point in presenting full details of the *American Machinist* device in this book - few of us would be able, or likely to want, to make an indexing head just like it - for one thing it would be a little large, and in the form shown it would not be practical to scale it down. If you want to build a gadget incorporating a 15/16 vernier, you might want to have a look at the *American Machinist* article.....If your local library does not have a collection of back issues of *American Machinist,* your librarian can get a copy of the article for you from some other library at a nominal cost.

DIVISION PLATES FROM BANDSAW BLADES

While working on the text of this book, I had a letter from a chap who wanted some advice on how to do some dividing in the absence of any of the above means. I wrote such a good letter in reply that I decided to edit it and tuck it in here right alongside the other info I was writing about dividing and indexing. So here it is...

There is no need to be put off of engraving dials and the like if you do not have a dividing head. The actual cutting of the graduations can be done with a suitably ground toolbit clamped in the lathe toolpost. This side of the job is as easy as falling off a log, and much more satisfying. One type of cutter suitable for this work is covered in the excerpt from **Strike While the Iron is Hot,** and so I will say no more about it here. As for the dividing out of the job, fear not, but only read on.

You can do all the dividing work on your lathe using an appropriate train of gears set up on the banjo arm, assuming you do not have a quick change gear box on your lathe. If you have a QCGB, life is not so easy because all the gears are inside the box, not out in a nice pile where you can paw through them to assemble a train that suits your purpose. Full info on setting up gear trains for dividing is given in the book **Dividing and Graduating**, referenced at the end of this section.

An alternate, and practical method that may appeal to you is to make a division plate from a band - saw blade wrapped around a plywood disc of suitable size. This may strike you as being "mickey mouse". Not so. It is the brainchild of Allen ("Mac") Mackintosh, of Cornwall, England. Mac is a retired Scottish tool & die maker, and into telescope making. He makes division plates thus for cutting telescope drive gears and other such things.

He reported this method first in *Model Engineer* Magazine for March 2, 1973, page 245, in an article entitled **A Jury Rig for Indexing.** Mac has mentioned it to me more than once in private correspondence, and was pleased at the prospect of its further dissemination through the pages of this book.

The bigger the diameter of such a makeshift division plate, the more accurate the work will be: for low number dividing it would be impractical to try to make the division plate with just the number of teeth corresponding to the number of divisions wanted. Better all around is to make the plate with some multiple of the desired number, preferably with as many other useful factors in it as possible, for future uses.

Let's look at an example: Say you needed a stop collar graduated into 6 divisions at one end, and 8 at the other end. Say you use a blade with teeth pitched at 10 per inch. Now the number 240 is one which contains both 8 and 6 as two of its multiples, and quite a few others besides. 240 teeth would require a piece of saw blade about 24" long. This can be wrapped around a disc about 7.6"Ø. For 6 divisions, you'd cut a graduation mark at every 40th tooth, having first counted off that number of teeth on the division plate and marked every 40th tooth.....and double checked your counts.

So how perfect will be the work produced with such a division plate? How uniformly are the teeth in a bandsaw blade spaced? Pretty close, I think. Good enough for your purposes? How to make one? Read some more...

The disc can be most easily made if mounted on a pivot of some sort and then sanded to size on a disc sander. Make it to a diameter to just nicely take a length of used bandsaw blade with a number of teeth corresponding to the number of divisions you require. Rim the disc with the blade and fasten it in place, using, for example, two small wood screws in holes drilled through the blade about 1/4" from the ends.

(NOTE: It is likely you will need to anneal the ends of the blade before they can be drilled.)

The resultant toothy creature can be mounted on an expanding stub mandrel in the outboard end of your lathe headstock spindle, a simple detent arranged, and you can go to it.

> NOTE: For accurate dividing, the OD of a bandsaw blade division plate plugged into the outboard end of the lathe spindle must run concentric with the spindle. If making a bandsaw blade division plate, check that it does, or build some means of compensation into the stub mandrel if necessary. Not all lathe spindle holes run true at the outboard end. Some lathe manufacturers do not seek perfection here, which is generally quite ok, because few users will be found casting such crafty glances at this end of the spindle.
>
> It is likely that a *slight* eccentricity at the rim will have minimal effect on the accuracy of dividing, and the effect a given eccentricity will have will decrease as the disk OD goes up. The main points are to have the end teeth of the blade segment well matched, and the ends of the blade a good butt fit when wrapped around the rim of the disk. Mac says he doesn't mount his disk on a pivot for sanding, just lays out the circle a little oversize in order to leave mat'l for sanding, bores the center hole - 1"ϕ in his case - and then shaves it down (freehand) on the disc sander. He finds that keeping to the compass line by eye gives him a circle quite good enough for the intended purpose. Nevertheless, "the better the better," in such things - aim to make it the best you can do, and it should work out fine.
>
> One further comment from Mac's latest letter: "One of the big advantages of this method of dividing is that it is very tolerant of small errors in construction of the parts. ... Also, if you are using a conventional dividing head, and have a difficult number of divisions to make, it's all too easy to make an error. ... (but) it is not so with the bandsaw blade method: all you have to do is listen to the click-click of the detent in the teeth."

You can thus cheaply make division plates to suit virtually any dividing requirement. As Mac says, such plates cost nothing in money, and little in time.

If you want to make more sophisticated conventional division plates, get the book **Dividing and Graduating**, by George Thomas. (See page 85 for a dividing head made to drwgs in that book.) This soft cover, 160-page book gives full info on setting up gear trains to divide through the lathe headstock spindle, plus many other related matters. The book features the use of a Myford lathe, but the principles are the same for any lathe. Try Power Model Supply Co., or contact TEE in England (see Appendix for addresses).

Added to the 16th printing: Power Model Supply is out of business.

DUAL SET SCREWS FOR V-BELT PULLEYS

The main drive pulley on my lathe motor is keyed to the motor shaft and is locked with a set screw which is lined up over the key. From time to time this set screw works loose. The following cure was told to me by friend Geoff Symons, a Calgary tool and die maker.

Drill and tap for a second set screw 90° around the pulley from the first one. When the pulley is reinstalled and both set screws are tightened up, the problem is solved permanently. I haven't had time to do it yet, but if Geoff says it'll work, I believe it.

NOTE TO READER: You may wonder why the item below was included in this book. There are in fact a couple of reasons. First, it is a painless and easy way to pass on to you a number of pieces of technical information on the heat treating of drill rod cutters, the use of salt and vinegar as an oxide remover, how to make and use an engraving cutter for dial engraving jobs, and a built-in alignment feature of my own devising which I think you will like – I have since come to call it a "John Kelly centerline." Second, it is the first chapter of a fiction story I wrote for one group of people only – us machinists. I think you would enjoy reading the rest of the story – many others have, and some of their comments appear at the end of this excerpt. If you would like to read the whole story, see page 51.

AN EXCERPT FROM THE FICTION BOOK

STRIKE WHILE THE IRON IS HOT

BY

GUY LAUTARD

CHAPTER 1

SEPTEMBER 7, 1982

John Kelly put down his file and wiped chalk dust from the partially finished engraving cutter with a piece of cloth. Previously he'd cross drilled the shank of the cutter with a #52 drill about half an inch from what was to be the working end, and now he slipped a ten inch length of 1/16 inch drill rod into this hole to check the alignment of the point he was filing.......a few more strokes on the left hand side would even it up.

Mentally he patted himself on the back for the idea of the cross hole. When he went to use the completed engraving cutter, he would put the 1/16 inch drill rod through the hole, line it up over the center of the job to be graduated, and have the cutter neatly 'square' to the work in seconds - a small refinement perhaps, but handy.

He turned the cutter slighly in the vise, and commenced filing again. After a few strokes he stopped, picked up the magnifying glass and studied the angles critically. He reoriented the cutter again, and with a heavier file began to bevel its bottom face. He worked more quickly now, for this face did not matter greatly, bringing the bevel out till it reached the very tip of the cutting edge. Then, with a half round file he blended the filed areas into a clean, symmetrical and pleasing union with the untouched portion of the 1/4 inch drill rod. He worked out the last of the file marks with a piece of fine emery paper backed up by a file, and when satisfied, removed the cutter from the vise.

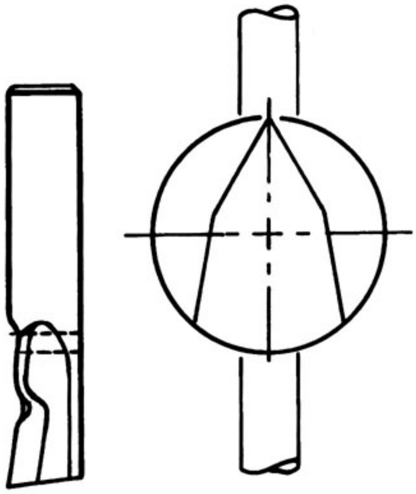
He was a perfectionist in such things, and although this was not a cutter he would use often, it would probably serve him for graduation-marking jobs of every description for the rest of his life, so he might as well make a decent job of it while he was at it.

He took a propane fuel cylinder from a shelf beside the bench, screwed a burner head onto it, and set it on the bench. He left the shop and returned with a soap dish and a small can full of water. He scraped the cutter across the soap cake, and with his fingers smeared the soap all over the working end of the cutter. After setting a large horseshoe magnet on the bench beside his "quenching tank", he lit the torch.

Holding the cutter gently with a pair of pliers, he heated it slowly, watching the soap foam up, swell, and dry into a blackened skin. Then he turned up the torch, and watched as the cutter began to glow dull red. He picked up the magnet, and touched it to the glowing end of the cutter without moving the latter from the flame - when the steel would no longer attract the magnet, it would be ready to quench. He recalled how surprised Janet had been when, nine years ago, he'd shown her this phenomenon.

"A little hotter," he thought, holding the magnet close, but outside the flame. In a few seconds he touched it again to the cutter, which for all the attraction it now exhibited for the magnet, might have been a piece of wood. He shifted the cutter slightly in the flame, laying the magnet down as he did so. Then with a movement as sudden and quick as a striking rattlesnake, he plunged the glowing cutter into the small quench tank. There was a brief hissing, and he shook the cutter slightly under water as it cooled. When he withdrew it, the hardened area was a pale, even grey color.

With a few strokes of the file-backed emery paper, he polished up a small area on one side of the working end of the cutter before returning it to the flame. This time he watched the steel intently, and as the first faint show of colors began to run on the shank, he withdrew it from the heat. Straw yellow was the color he wanted, and at the instant this color reached the working end of the cutter, he quenched it again.



"Done!" he grunted with satisfaction, removing the lid from a bottle containing a solution of salt and vinegar, and dropping the cutter in. He replaced the lid, paused for a moment to run a hand through a head of close-cropped, prematurely grey hair, and then began putting away the tools he'd been using. He looked at his watch: 2:30 p.m. Now what? Lunch, then a quick trip downtown to pick up his hardtoed boots which were in for new heels.

* * *

Coming home, he caught the West Vancouver bus, and took the last empty seat, beside a woman who was busy looking out the window. He set the heavy brown paper bag containing his work boots on the floor between his feet. From a flat, zippered briefcase, he took a pile of Xeroxed pages nearly half an inch thick. Removing the spring steel clip from the upper left hand corner of the pile, he riffled the pages till he brought to the top the one he was looking for. Re-clipping the pile, he began to read.

After a few minutes reading, he took a pen from his pocket and made a note in the margin of the page. As he did so, he became aware that the woman was "reading over his shoulder". Well, let her, he thought. It wouldn't do her any harm, though on the other hand, she wouldn't make head nor tail of it either.

"Excuse me, but isn't that a *Model Engineer* article you're reading?"

John Kelly looked at her, surprised. She was several years younger than himself, blonde, and stunningly pretty. "Yes, it is. It's about making a dividing head. Are you familiar with *Model Engineer*?"

"Yes. My dad used to take it and *Live Steam* regularly. He said they were the two best magazines in the world!" She smiled. "He said he got all kinds of ideas out of them for his work - he was a tool and die maker. Are you in the trade, or is it just a hobby with you?"

"I build models on commission, and I do some prototype and specialty work for various outfits. When I'm not busy doing that, I make tools for my shop - stuff like this," he said, indicating the papers in his lap.

"That's nice - it must be great to have your own business and do what you enjoy doing."

"It is, if you like working by yourself. For me, it's the best arrangement there is," John agreed. "And you, what do you do?"

"I'm a draftsman. Or I'm supposed to be. I just got here from Toronto yesterday, to start a new job today, and when I showed up for work this morning, I found the outfit that'd hired me had gone broke. So I'm not sure what I'm going to do next..."

John Kelly pushed his upper lip up with his lower lip - the universal expression which means, 'That's too bad.' "And they never bothered to phone you to tell you not to come?"

"I guess they had bigger things on their minds - like their own problems," said the girl.

"Have you been looking for work today?"

She nodded. "I went to see Manpower [Canada Manpower, the Canadian Federal Government employment agency], to see if they knew of any openings, but they just gave me a bunch of forms to fill out, said they'd call me if anything came up, and to keep in touch."

"Well, that's a start." He thought for a moment. "Not a good time to be looking for a job, these days. Have you got access to a private phone?"

"Yes. I'm staying with friends, and I can use their phone. Why?"

"If I were in your shoes, I'd look in the 'Yellow Pages' under every classification of business that even *might* employ draftsmen, and I'd phone every outfit I found listed.

Tell 'em you're a draftsman with so many years' experience with such and such a company and you're looking for work. If they're looking for somebody, tell them you'll come in and see them the next day. Be polite. Be persistent. Don't get discouraged. Don't give up. If somebody's rude to you, or whatever, just hang up and forget it, and phone the next one."

"But who'd hire you over the phone?"

"Nobody. But if they don't want to hire *anybody*, why waste your time knocking on their door when you can dispose of them in one minute by phone? And if they *are* looking for somebody, they'll be receptive to talking to you. You'll cover far more ground in a day that way than any other. And it shows you've got some initiative."

The girl nodded. "You're right. I'll give it a try, tomorrow morning. Have you ever done that yourself?"

"Twice. Got a job both times, too. Once as a night shift janitor, after high school, and once as a warehouse hand. Just a summer job, both times. That was a good many years ago, but I'd do the same thing today if I were looking for a job."

They were across Lion's Gate Bridge now, and well into West Vancouver. She looked out the window somewhat distractedly.

"Whereabouts do you get off?"

"At 14th. It's my first time on the buses, and I'm not familiar with everything. I don't want to miss my stop."

John nodded. "14th is just coming up - better ring the bell..." She did so.

"Well, I can't do much more than wish you good luck, but I'll do that. I hope you find a job you like, and soon."

"Thanks. And thanks for the advice. I'll try it."

He stood up to let her out of the seat. "Take care of yourself," he said kindly.

"Thanks. You too. Nice talking to you." Her smile crinkled the corners of her eyes, and then she was gone.

As the bus pulled away from the stop, she glanced up at the window beside which she'd been sitting. He'd moved over to sit next to the window, but he did not look up, for he had already turned his attention back to the papers in his lap.

He sat staring at the page for a minute or two, seeing not the printed words, but the girl's sparkling brown eyes and sunny smile. "Nuts!" he told himself abruptly, stuffing the papers back into his briefcase. At his stop several blocks further along, he got off and commenced the 3/4 mile climb up the hill to his house.

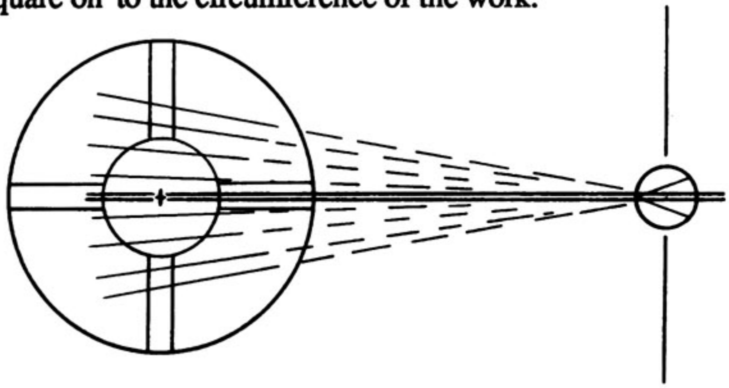
"...Probably more interested in her own good looks and having a good time than anything else...," he thought. Only Janet had been unlike that, and she was ...

He fixed himself an early supper, and then returned to his basement workshop, where he fished the engraving cutter from the salt and vinegar bottle. Due to the several hours of soaking in this acid solution, he was able to rub off, with his thumb, nearly all the discoloration due to the earlier heat treatment of the cutter. This done, he examined the cutting edge under a 10X hand lens before carefully stoning it to final form. With a few more strokes he removed some small burrs raised by the pliers on the shank of the tool, and laid it on the bench.

From under the workbench he took a plywood box. Opening it, he lifted out a six inch rotary table, which he proceeded to set up on the table of his vertical milling machine. When all was in order, he dropped a #2 Morse taper shank arbor into the center hole in the rotary table, fitted a previously prepared bushing over the end of the arbor, and carefully fitted a workpiece onto the bushing. Washers, spacers and a 5/16 x 24 socket head cap screw followed, the latter clamping the workpiece from turning with respect to the rotary table.

The 'workpiece' was the table for a smaller rotary table he'd been working on in his spare time for several weeks. It followed almost exactly the "Small Rotary Table" design which had appeared in late 1976 in *Model Engineer*. Tonight he would graduate the rim of the table 0-360 degrees, this being the final job requiring to be done to complete the project.

When the set-up was complete, he fitted the newly-made engraving cutter into a collet in the machine's spindle nose, and with the aid of his piece of 1/16" drill rod, quickly lined it up. He could not suppress a small smile of satisfaction at the ease with which the cross-drilled hole allowed him to set up the cutter 'square on' to the circumference of the work.



He began to cut the graduations, working methodically. Cut a graduation. Turn the graduated handwheel of the 6 inch rotary table 90 degrees, thus turning the work one degree through the 90:1 worm reduction gear. Down quill (cut another graduation). Up quill. Turn the handwheel. Down quill... Up... Turn... Down... Up...

It took four trips around the job to complete the engraving, once for all the graduations, then a second and third time to lengthen the 5 and 10 degree marks, and a final trip around to both lengthen and deepen the 90 degree marks, which fell in the center of the T-slots.

By the time he was done, he was tired, but now was not the time to stop. All those little curls cut by the engraving tool must come off, and the burrs thrown up by its action must be removed. Then a good cleaning up of all the parts, and he could assemble the little rotary table, and it'd be done!

He'd just glanced at his watch - it was 9:15 - when the phone rang upstairs. He caught it on the third ring.

"Hello. Kelly here." From the background noise, he knew that it was long distance.

"Hello there, young fella. How's things in the Big City?"

A grin of pleasure split John's face from ear to ear. "Just fine, Bob! How are you? And how's Doris?"

"Well, I don't want to scare you, John, but in fact we're not in the best of shape..."

"What's happened?"

"Well, we had a bit of an accident. We got hit by another vehicle on the highway west of Smithers and wrote off my pickup truck. That don't matter, of course, but Doris got pretty thoroughly banged around, and broke her leg, and I bust my arm. Doris'll be in the hospital another week or so. Other than that, we're okay, but it's going to take us a while to get back to normal."

"Is there anything I can do to help? Could you use a hand for a while?"

"That's mostly what I phoned about, John. Are you busy?"

"No. I just finished up a couple of jobs last week, and I've got nothing new in sight right now. I was going to start making myself a dividing head, but there's no rush on that."

"Well, if you'd like to come up, I could sure use you. I've got more work than I can keep up with, and I can't do much with a busted arm."

"You mean run that big lathe of yours, and that big old Garvin milling machine? Hey, my Myford is the biggest lathe I've ever run..."

"Makes no difference, boy. Principals are all the same, as you know as well as I do. With the kind of work you do, the stuff I'm being asked to do will be like falling off a log. Besides, I'll be able to supervise. My tongue ain't in a cast, as you can tell."

John laughed.

"How about it? I can pay you pretty well, and I'd sure like to have you here. I can't get anybody around here that I can depend on. I hired one fella who said he was a machinist, but he hardly knew where the center of the work was, even when it was turning!"

John laughed again. A visit with Bob and Doris would be like a trip home for him. "Sure, I'll come. I'll be on my way in a day or two. I'll have to pack a bunch of stuff if I'm going to stay a few weeks."

"Well, that's the best news I've heard all day. We'll probably see you Saturday, eh?"

"Should do... Say, how's the moose hunting situation up there this year?"

"That's the other thing I meant to mention, John. Bring along your rifle, and maybe we can drop us a moose while you're here. There's lots of them around this year."

"Fine - will do - you get one tied up, and I'll do the rest."

"Okay, John, I'll let you go. We'll sure look forward to seeing you when you get here."

"Okay. See you in three or four days."

John hung up the phone. He thought about the prospect of a stay with the Davidsons and working with Bob for a few weeks.

..."Yahoo!" he roared at the top of his lungs, leaping off the floor and kicking his heels together.

This exuberant manoeuver brought him into the middle of the living room. His eyes went to a portrait on the wall above the fireplace. He stood looking at it for a minute, his back to the large picture windows with their view out over English Bay and the lights of Vancouver, a city of a million people.

She had been unlike anyone else he had ever met...

Now what? Start thinking about what to take. What else? Phone Ailene. Next Wednesday was her birthday. Well, he'd be in Smithers then, so he'd best take her out to supper before he left, preferably tomorrow evening. What else? Clean up the house. Eat the refrigerator bare. Turn off the newspaper. Redirect the mail. And fifty other things ... But tomorrow was soon enough to start tackling them. Tonight he'd finish the little rotary table. He wanted it done before he left for Smithers. Hey! He might even take it with him to show Bob - Bob would appreciate it.

(end of Chapter 1)

The foregoing is the first chapter of a book I wrote and published in 1983, entitled **Strike While The Iron Is Hot.** We've had a lot of good feedback about it - here are a couple of readers' comments about it:

> ".... a real treat to read - I couldn't put it down, and kept hoping it wouldn't end. I haven't read anything like it since I was a boy. .... it should be required reading for every apprentice machinist and every boy taking a machine shop course - I think they would enjoy it as much as I did ... Meantime, am eagerly awaiting your next book! ...The drawings and photos .... really added a lot and helped to make the book unique." IMS, Thunder Bay, Ontario.

> "I enjoyed your book, "Strike While the Iron is Hot". I also gave away a couple more as Xmas gifts. My two buddies liked it too...." WB, Marietta, GA

Added to the 14th printing: The first printing of **Strike While the Iron Is Hot** has been sold out for several years now. I am currently (June 2000) working on a new book which will consist of the best of **"Hey Tim, I Gotta Tell Ya"** (which is also currently out of print), with some revisions, along with several chunks of additional technical material, together with all of **Strike While the Iron is Hot**, and **The Rebirth of Morgan Ranch**, a 10-chapter fiction story written jointly by Marsh Collins and myself.

These stories are not great literature (neither is "The Secret of the Old Master," nor "Trustee from the Toolroom,") but a lot of guys have written or phoned to say they really like them. They aren't full of sex and violence. Rather, they are spiced up with practical machine shop and other do-it-yourself ideas, plus a little local historic and geographic detail.

BERNZOMATIC TORCHES AND HOME MADE PROPANE TORCHES

In the excerpt from my fiction book, **Strike While the Iron is Hot**, (see previous section) a propane torch is used to heat treat a small cutter.

There is more than one kind of burner head for Bernzomatic torches. The "Jet" torch is preferable to the older style for our purposes.

What's the difference? The Jet torch - the ones I use have a 5/8"Ø flame head - puts out a lot more heat than the older type of head. The latter has a smaller pipe coming up from the valve, then a screwed-on sleeve with two wrench flats and six little radially drilled holes about 0.080" visible just at the base of the final section. The "Jet" type can be identified by the green metal band just back of the flame head, or, in case the makers have changed them in recent years, by what it says on the package.

One Jet torch is handy. Two is better, because one is sometimes not man enough to heat up a job. A cutter made from 1/2" drill rod is just a little too much for one Jet torch, but with two, there is no problem bringing it up to the non-magnetic condition.

I remove the burner head from the fuel cylinder as soon as I am finished a job. No leakage, that way. My cousin Garth Richter who seems to have every welder's ticket there is, and who knows my every welding sorrow, tells me there is no leakage if the burner is left on the cylinder, so long as it is screwed on tight, and the valve shut off. I prefer my own way, and it takes me all of 15 seconds to install when I want to use the torch.

Did you know: -that the Bernzomatic outfit has been around since 1876? -that although

Bernzomatic torches produced more recently are not, older ones are guaranteed for life? If you need to call them, the number is 1-800-654-9011.

They make a soldering bit which slips onto the end of a Jet torch burner head, and locks in place with a set screw. I have one of these. I also have a piece of 5/8"Ø solid copper, from which I'm going to make up a heavier soldering tip, along the same lines, but with more "meat" in it. Why? 'Cause I want to, although, to be truthful, I have never even used the factory-made one I have.

SHOP MADE PROPANE BURNERS

Want lotsa heat? Don't have an oxyacetylene outfit? See August 1977 *Live Steam* for details on how to make torches of larger size, for use with 20 lb. propane tanks. Where a lot of heat is needed, e.g. for brazing up a model steam locomotive boiler, the writer of the article says he feels no need of an oxyacetylene outfit. The larger of his two propane burners has a 1.5"Ø flame tube and will throw a 30" flame on 65 lbs. of gas pressure. I bet he goes through a lot of propane......but then he's not renting oxyacetylene tanks, so maybe he can well afford the propane.

HOW TO MAKE YOUR OWN REAMERS

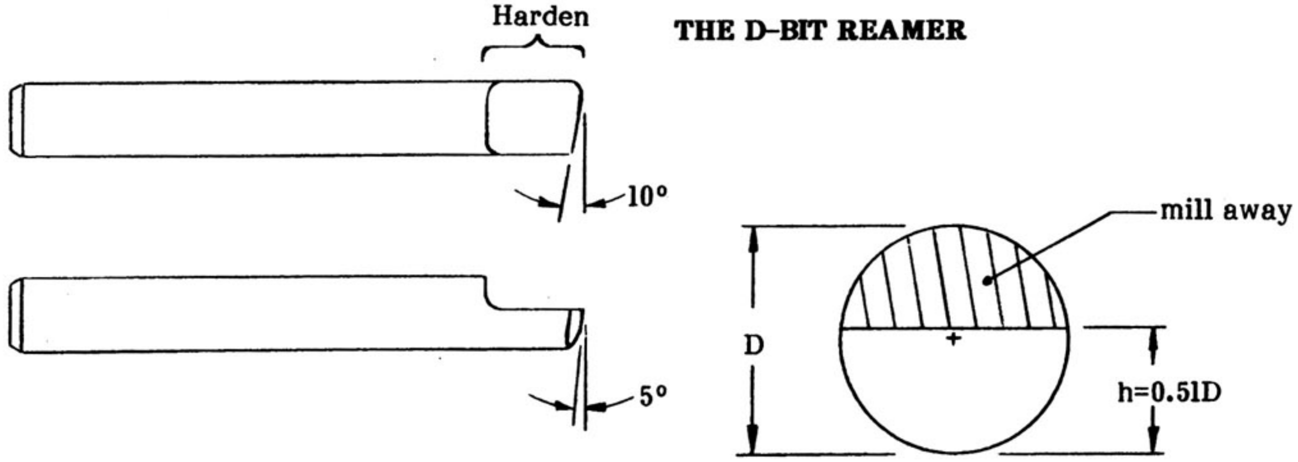
There are two types of reamers which can be easily made when the need arises. The best material in most cases would be stock size drill rod, although if a special size is required, the material can be turned down to suit.

D-BIT REAMERS

Machine the end of the reamer blank to a D section as shown in the accompanying drawing. Then hand file the required relief angles one at a time into the tip of the reamer, gauging the angles by eye or with a protractor. Keep the file well loaded with chalk to prevent pinning.

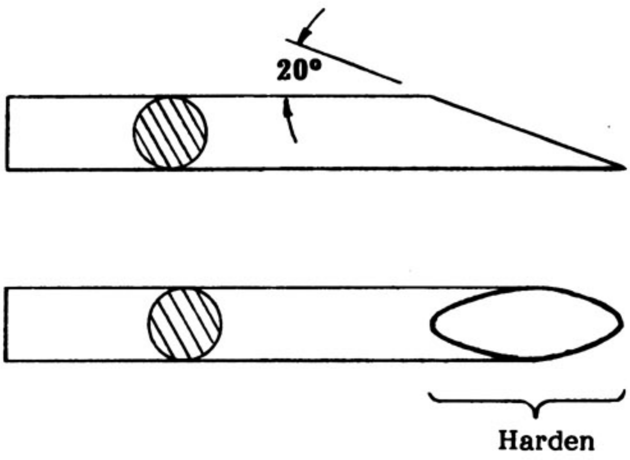
To enable the D-bit reamer to start readily in a hole less than its own diameter, radius the leading corner as shown. Check the edges with the aid of a magnifying glass in strong light. Carefully stone the business end of the reamer to remove any burrs prior to heat treating.

THE D-BIT REAMER



TOOLMAKERS REAMERS

These are simply made by filing or machining an oblique flat on the end of the reamer blank at about 20 deg. as shown below. Make your last strokes with the file down the long axis of the flat. Leave the filed surface with the best possible finish: use a sharp, fine cut file, well chalked, followed by careful stoning to remove all burrs before heat treatment.



THE TOOLMAKER'S REAMER

(One of these in 3/16" or 1/4" size makes an unbeatable manicure tool.)

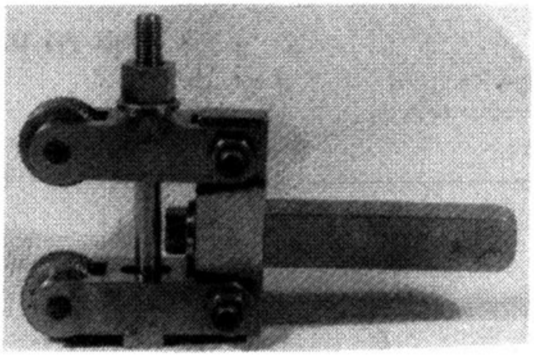
WARPAGE DUE TO HEAT TREATMENT

One thing to watch out for in making your own reamers is that the material does not warp in the course of heat treating. The best way to quench a long part such a this is to plunge it straight down into the quench tank, and then give it two or three up and down movements in the water as it cools. If the tool shank warps, and is subsequently used in a deep hole, the reamer may seize in the hole, and this can, at the least, give you a heart attack. It may ruin the reamer and/or the job. I have had all these things happen to me, and I can't tell you a foolproof way to avoid the trouble other than as above. One other thing to do is to reduce, by a few thou, the diameter of the tool shank back of the head, but I have to say I do not like this idea at all.

A D-bit reamer should be run rather slowly, with plenty of cutting oil and frequent withdrawals to clear the tool and the hole of cuttings. If used in brass, no pilot hole is required with a D-bit. When used in steel, a pilot hole must be drilled not much under the reamer size: reamers are basically sizing and finishing tools, intended for the removal of only a few thousandths of material. However, a 1/4" D-bit reamer with a radiused tip as shown above will open out a 7/32" hole in mild steel without difficulty. When using a non-radiused D-bit, it is necessary to use a small boring tool to bore the mouth of the hole to the desired size for about one diameter into the work before applying the reamer.

To enable the reamer's on-the-job activities to be observed, set it in the tailstock chuck so that the flat on the reamer is inclined towards you at about 45°.

HOW TO MAKE A
FLOATING ARM KNURLING TOOL



INTRODUCTION

The knurling tool described here is intended for use on a lathe of approximately 3.5" center height (7" swing over bed) and equipped with an English type toolpost clamp, turret toolpost, or quick change toolpost. If the tool is to be used in an American type toolpost, the mounting shank may require modifications which will be obvious to the maker.

This is an excellent knurling tool, particularly for use on a small lathe, because its use does not impose heavy loads on the spindle bearings and feedscrew nuts.

It is also a good project for the relative beginner, after he's made some toolmakers clamps and like that. Thus it may not be entirely inappropriate that the instructions are based on the assumption that the only machine tool available is a lathe c/w milling attachment.

CREDITS, ORIGINS AND CONSEQUENCES

This knurling tool is developed from a design presented by "Duplex" in the December 14, 1950 issue of *Model Engineer*. About eight years ago I made one fairly close to the *M.E.* design, but changed it a little to reduce the amount of work required in making some of the parts.

Making that knurling tool provided the inspiriation for a small mail order business selling plans and materials for various small tools, it being one of them. With *M.E.*'s permission, I made new drawings and wrote up my own detailed instructions on how to make the knurling tool, and had this printed up as a little booklet. Those instructions reflected the equipment and experience I had at the time.

When I decided to include the knurling tool in this book, I looked at the prototype knurling tool, and re-thought how I'd make one now, given what I've learned since making mine. I worked up a new set of drawings, and to a degree, re-wrote my earlier instructions.

SOME GENERAL ADVICE:

Work carefully and do not provide any clearances in machining the rebates on the side of the Link, and when machining the Link and Knurl Wheel openings in the Arms. After machining, a well chalked fine cut file can be used to remove burrs and tool marks, and provide for the final fit at these joints. The joints should have almost zero clearance, for greater rigidity, which will give the best performance in use.

CAPACITY
The knurling tool I made has a maximum capacity of about 1.25" dia. A tool built to the dimensions given here should be able to knurl work slightly over 2" dia.

CONSTRUCTION NOTES
Face each part to specified overall length, mark out, then proceed as follows:

SHANK (1/2" sq. CRS): This is straightforward.

LINK (1/2" x 5/8" CRS):
1. Set the Link material in the 4-jaw chuck with the #1 and #3 jaws reversed, and with a wobbler, indicate the centerpunch mark for one of the Hinge holes to run true. Make sure the tip of the innermost chuck jaw will be clear of the 1/4"Ø hole to be drilled.

2. When the centerpunch mark is running true, start the hole with a center drill, drill through with one or more well-sharpened undersize drill(s), finish up with a letter D (0.246") drill followed by a 1/4" reamer. (Instructions for making your own reamers are given elsewhere herein.)

3. Repeat step 2. for the other hole.

4. Set the Link aside briefly, and drill the holes in the Arms next, (see below). This will save reversing #1 & #3 jaws an extra time. When you have done that, grab the Link again and drill the hole for the Shank Pin.

> Note: The location of the Shank Pin hole in the Link should be such that the center of the Link, when the knurling tool is in use, comes approximately at center height of the lathe on which the tool will be used.

5. The rebates on the side of the Link can be machined with either an end mill or slitting saw. If you do not have a vertical mill (I did not, when I made mine) a slitting saw in the lathe works very nicely. This work should be done when you are set up for machining the slots in the Arms. However, the method will be given here. (Similar techniques will also be used in the machining of the Arm slots)

Set up the vertical slide on the lathe so that the work will be between the operator and the lathe centerline. Mount a slitting saw on an arbor*, either between centers, or gripped in the chuck and given tailstock support for the outboard end. Mount the Link in the machine vise and "indicate" the Link into position perfectly at right angles to the lathe center line.

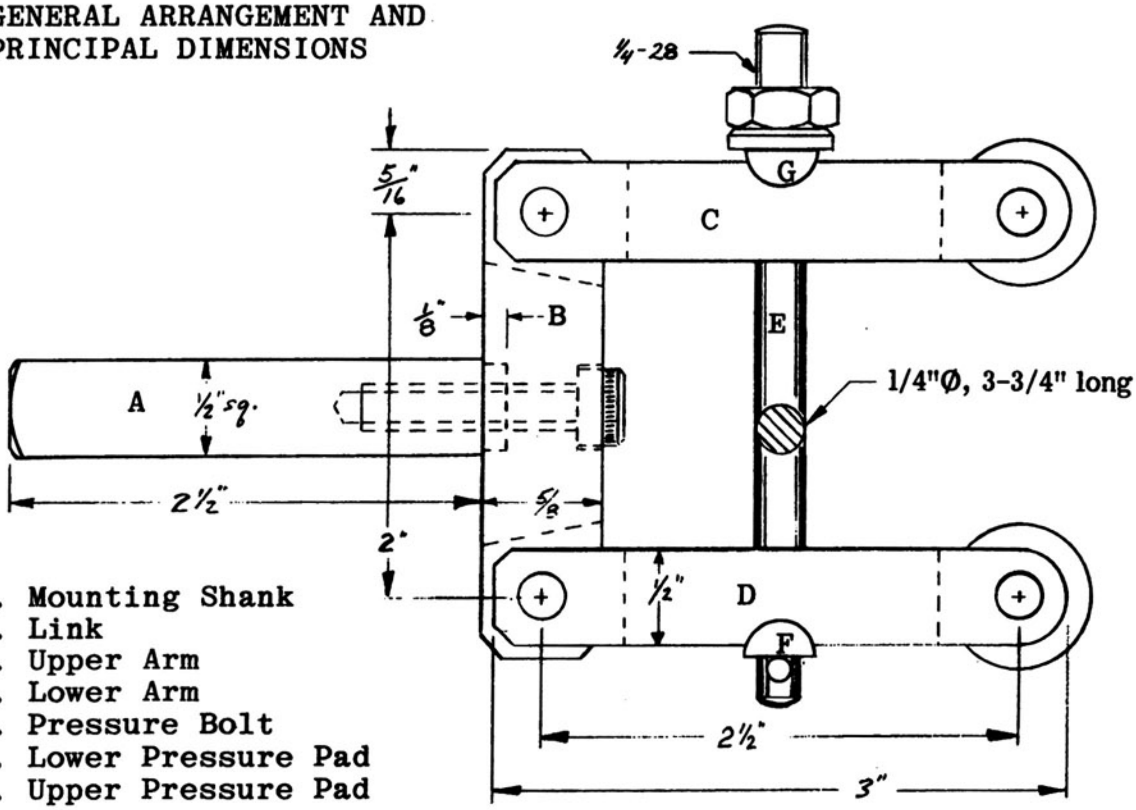
> * NOTE: Suggestions for a slitting saw arbor are given at the end of this project. Some comments on the cutting behavior of slitting saws will also be found there.

Bring the work up to touch one side of the slitting saw and use the leadscrew handwheel to advance the carriage 0.124", to leave extra metal on the Link for final fitting. (0.500" material thickness is assumed, but check your material - it may be undersized). Then feed the work upward to the slitting saw, advancing the carriage between cuts and making several passes to complete the cut.

When both rebates have been machined as above, take the work to the bench vise and hacksaw away the waste material. (Necessary only if the thickness of your slitting saw is less than 1/8".)

The 11° reliefs on the Link are marked out with protractor and scriber, and filed in with a safe edge pillar file, or milled, if you have a mill.

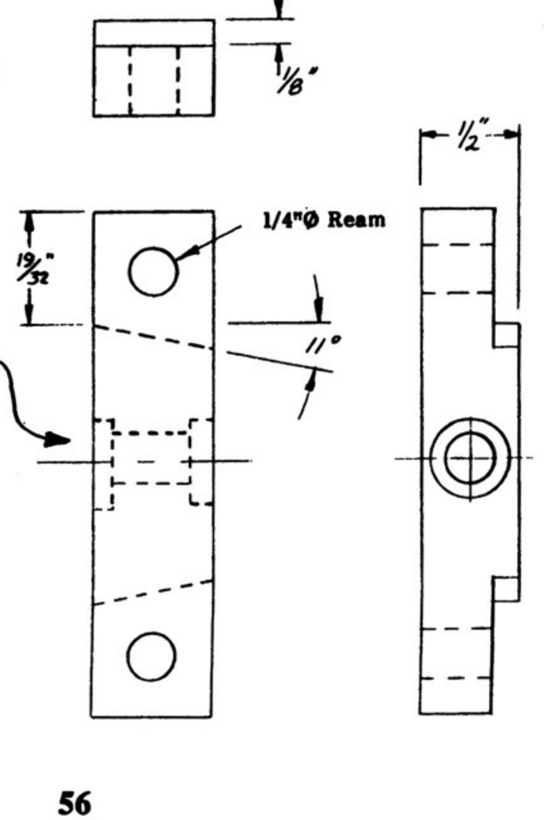
GENERAL ARRANGEMENT AND
PRINCIPAL DIMENSIONS



A. Mounting Shank
B. Link
C. Upper Arm
D. Lower Arm
E. Pressure Bolt
F. Lower Pressure Pad
G. Upper Pressure Pad

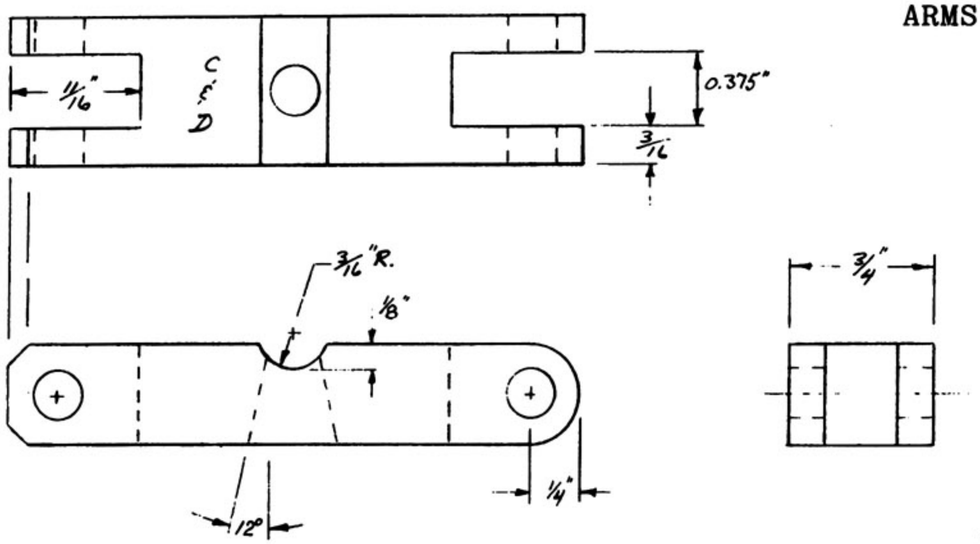
Note: several hsm's who've made this knurling tool have suggested the addition of a spring over "E" between "C" & "D", to help keep the two arms apart.

Further Details of
the LINK, Part B

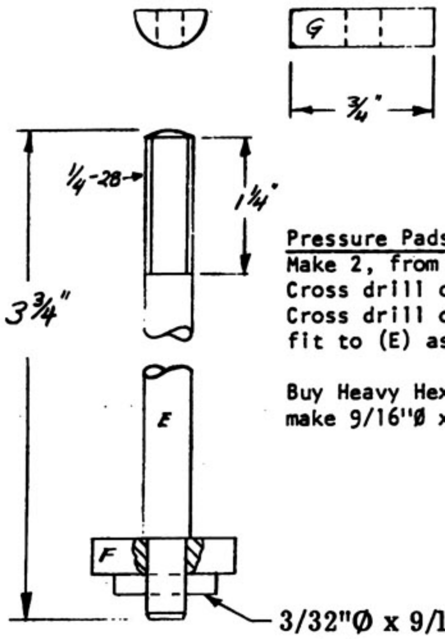


Machine a recess on backside of Part B to take the spigotted end of Part A (which should be about 0.485"Ø, 1/8" long). Drill through Part B at same setting with 17/64"Ø drill. Reverse B in the vise and counterbore 0.425"Ø x 1/8" deep for head of 1/4-20 x 1" socket cap screw.

ARMS - further details



PRESSURE BOLT & PRESSURE PADS

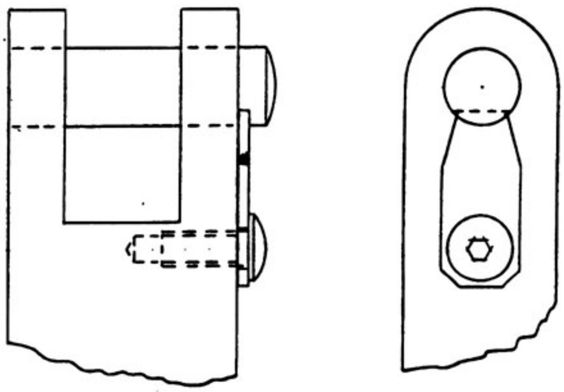


Pressure Pads (G)
Make 2, from 3/8"Ø CRS
Cross drill one @ 17/64"Ø
Cross drill other one @ 7/32 & fit to (E) as shown below.

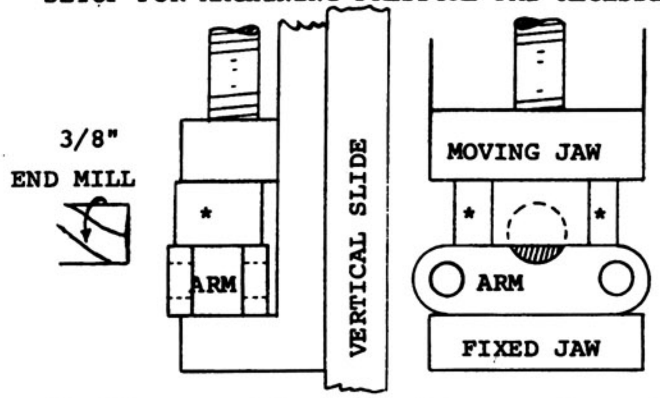
Buy Heavy Hex Nut
make 9/16"Ø x 1/16" washer

3/32"Ø x 9/16" pin, and silver solder entire joint.

Detail showing Pin & Retainer Plate for same screwed to side of Arm



SETUP FOR MACHINING PRESSURE PAD RECESSES



*Packing, used to gain clearance for cutter.

Pivot Pins (4 off)
Make from 1/4" drill rod. Harden & temper to middle straw (475°F). Retain in place with circlips or home-made wire rings in grooves. (2 per pin required) Alternate arrangement shown at right above is more to my liking. Only one per pin is needed.

* see page 61 for a note re another way to retain the Pivot Pins.

ARMS (1/2" x 3/4" CRS):

1. Face to length.

2. As for the Link, carefully set up each Arm in the 4-jaw chuck, and drill and ream each hole in turn.

3. The machining of the slots for the Link and the knurling wheels is done after drilling and reaming the pivot holes. The slots for the knurling wheels and the Link joint are machined with the slitting saw much as were the rebates on the Link. The 4 slots should be machined about 0.001" undersize to allow for cleaning up and close fitting to the Link and wheels with a fine cut pillar file after machining. This latter work takes patience, but is necessary.

4. The hole in the middle of each Arm can be drilled in the lathe or in the drill press. A high degree of precision is not required here as these are simply clearance holes through which the Pressure Bolt passes.

5. The angled reliefs of the Pressure Bolt holes are then machined, using a 1/4" slot drill in the lathe spindle, with the work held in the milling attachment.

> **Note:** If you lack a collet with which to hold the cutter in the lathe spindle nose, do not resort to your drill chuck and its Morse taper arbor. Mount the cutter in the 4-jaw, and indicate it to run true. Don't sneeze at this expedient. If you have the tooling, count yourself fortunate. If you don't, it'll come, in due course.

6. The Pressure Pad cut-outs are machined with a 3/8" slot drill, with the work held in the machine vise as shown.

I procrastinated over this job for some time before tackling it, and then found it was not a touchy operation after all. A good finish was desired in the Pressure Pad recesses. For me, the following worked beautifully: the last pass was made with only a few thou remaining to be removed, all chips were cleaned off the cutter beforehand, and the job was given a slug of Rapid Tap before the final cut. Result: perfect.

7. Radiussing the ends of the Arms is easily done with a file, if you lack fancier means, as follows: turn up a roller with a reamed 1/4" center hole, 1/2" O.D. x 3/8" wide. (Kinda like a knurl in need of a retread.) The roller need not be hardened.

Mount this roller in each slot in turn, using one of the Pivot Pins (see below). The roller then serves as a guide for filing the radii at the ends of the Arms. Be careful not to tilt the file or the finished result will not look well.

If you don't want to bother with filing radii, 45° champhers will do; these are shown at the other end of the Arms to illustrate the alternative. If you radius one end, you will of course have the basic decency to radius the other end in like manner.

The *M.E.* article recommended that the Arms and Link should be case hardened. (See note re casehardening elsewhere herein.) I doubt the need for this, unless the tool is intended for constant use.

PRESSURE BOLT (1/4"Ø CRS):

The Pressure Bolt is straightforward turning and threading. It might be found somewhat easier to cross drill the 3/32" hole before turning down the lower end of the Pressure Bolt to 3/16" dia.

PRESSURE PADS (3/8"Ø CRS):

Part off two 3/4" lengths of 3/8"Ø material. When you have the milling attachment set up, cross drill for the Pressure Bolt, and mill the flat while holding the workpiece with its long axis parallel with the machine vise screw.

Note that one Pressure Pad is drilled with a clearance hole (17/64") for the 1/4"Ø Pressure Bolt, while the other is drilled 3/16" to take the cross drilled 3/16"Ø end of the Pressure Bolt.

Make a pin from 3/32"Ø drill rod or turn one up from any little piece of scrap steel.

The 3 parts are assembled and silver soldered into a single unit.

This joint could also be made by riveting or by threading the mating parts and dispensing with the little cross pin. Personally, I think the cross pin and silver soldering is a good idea and it is the way I would go if making another knurling tool.

> **Where to buy silver solder?** Brownells Inc. sells it, as does Power Model Supply Co. See Appendix. You can also buy it from refrigeration supply houses - look in the Yellow Pages under "Refrig. Equip., Supplies & Parts, Whol. & Mfrs." You can get the flux from the same source.

To silver solder, thoroughly degrease both the parts **and the silver solder wire** with rubbing alcohol. Apply a suitable flux and assemble the parts. Silver soldering temp. is typically 1150/1400°F. In this temperature range the work will appear "dark red" to "dull cherry red". When the work has this appearance, apply the silver solder after dipping same in flux. If the joint is tight and well fluxed, the heat right, and the parts clean, the silver solder will melt and flow into the joint like gasoline.

Clean up the joint with hot water, soap and emery cloth. I don't think you'll pull it apart if you've done your work well.

NOTE

> **Do NOT carry out silver soldering operations in an unventilated area!** Most silver solders contain cadmium, which vapourizes at the working temperatures involved. Cadmium vapour is toxic. Open a window and a door and turn on a fan, or take the whole business outside.

NUT AND WASHER: Straightforward.

PIVOTS: (See notes on drawing.)

The Pivot Pins are made from 1/4" drill rod (or other size if required to suit the knurling wheels to be used). Heat treatment of the Pivot Pins is described below.

HARDENING THE PIVOT PINS

Read again how John Kelly hardened his engraving cutter, in the excerpt from **Strike While the Iron Is Hot** elsewhere herein.

To harden the Pins, proceed pretty much as he did. To hold the Pins for heating, bend a piece of wire into some sort of a looped gadget that'll hold them, (one at a time) reasonably securely.

After the Pins are hardened, temper them as follows:

Heat slowly, gently and uniformly until a middle straw color appears all over the work, at which point quench again. This tempering, (the purpose of which is to reduce brittleness) may be done with a torch directly, with care, but the four hardened Pins can be done all together and can be done more uniformly, by burying them in a dish of sand about 2-1/2" deep with only an end exposed, and heating the pan. If the heat is increased slowly, (as is possible on a kitchen stove), the sand and the pins will be heated uniformly throughout. The ends of the four pins should previously have been brightened up on some oil-free* emery paper. When the exposed, polished ends show the desired **middle straw color**, they are pulled from the sand one at a time and dropped back into the quenching tank.

> * TIP: When polishing a hardened piece of steel so that the tempering colors may be seen, do not use emery paper that has had oil on it, The oil will leave a film on the work and this film will modify the oxide formation which we are watching as an indication of the temperature reached.

The Pins will have a pleasing color upon withdrawal from the quench, and can be left in this condition, or soaked in salt and vinegar to remove the color.

No reader should be deterred from proceeding boldly with the heat treatment of the Pins, as there is no mystery about it, and no difficulty in carrying it out.

FITTING AND FINISHING DETAILS

The 45° bevels shown on B, C, & D can be done quickly with a hand file, uniformity being gauged by eye. The use of CRS for the parts minimizes finishing work.

Fit the Arm slots to the Link and Knurls individually by freehand filing - i.e. holding both work and file in the hands, not in the vise. Try the parts together for fit frequently.

If the Knurl Wheels do not slide onto the Pivot Pins easily, lightly polish the Pins with a fine abrasive stone or worn emery paper.

USING THE FINISHED KNURLING TOOL

To use the knurling tool, mount it in the toolholder at right angles to the lathe axis, and at a height such that the center of the Link is approximately at center height. Perfection here is unnecessary. Advance the cross slide until the knurls are centered on the vertical center line of the work to be knurled. Tighten the Pressure Bolt Nut to just bring the knurls into contact with the work. Only about 1/8" or less of the knurls, rather than their entire working face, should be in contact with the work when starting a knurl.

Tighten the Pressure Bolt with a wrench while turning the chuck by hand. The two knurls may not at first "track", or mesh, as the knurls penetrate the work surface on successive revolutions of the work. Increase the pressure on the knurls until a proper knurl begins to form - not necessarily to full depth, but such that the knurls are tracking properly.

Now open the knurling tool slightly. Douse the knurls and work liberally with oil and slowly traverse the lathe carriage, covering the area to be knurled, running the lathe at a low speed, say around 200 rpm. Be careful not to foul the chuck jaws.

If the knurls refuse to co-operate with each other, and will not begin to track, take a light cut off the work with a toolbit, to reduce the diameter slightly. Aim for a diameter that is some multiple of 1/64th or 1/32nd of an inch. See **Machinery's Handbook**, under "Knurling, diametral pitch knurls", for more details.

Knurling is a "cold forming" or "form rolling" operation, and is accompanied by the formation of a certain amount of metal dust or flakes. The generous application of oil to the work lubricates the knurls on their Pivot Pins, and carries away some of this dust, perhaps all of it if the lube is applied in a heavy enough flood, (not likely in the average hsm's shop).

I usually apply oil to the job with a toothbrush or an acid brush. If there's much of it to be done, I may knock up a crude drip tray of aluminum foil to collect the drops of oil coming off the work, and stick it to the cross slide with two small magnets. This contaminated oil should not be recycled onto the knurling tool, as it is loaded with the metal flakes we are trying to wash away from the operation.

If the knurls are seen to be becoming fouled with metal flakes, stop the lathe, withdraw the knurling tool from the work, and clean both knurls thoroughly with a toothbrush before continuing. Also, clean the work and, with a magnifying glass, examine the progress being made in the formation of the diamonds. In the first stages of the knurling operation these will be seen to have a crater in the top of each male diamond. The knurl is fully formed when this crater or hole is closed by further deformation of the metal under increased penetration of the knurls.

> TIP: Knurling should be accomplished with as few revolutions of the work as possible. Consequently, the operator should be reasonably bold in increasing the pressure on the knurls to bring about formation of a full knurl as quickly as possible.

If a full knurl feels too sharp for comfortable handling in use, take the points off the diamonds by making a light pass over the work with a fine file. After that, brush the file cuttings and metal flakes out of the knurled area with a brass bristled brush. I have also found that going over the knurled area again - after brushing out as above - with light pressure on the knurling wheels seems to give a burnishing action which improves the appearance of the knurl significantly.

(The brass bristled brush referred to above is a handy item to have around the workbench. Buy one at a local shoe repair shop.)

> NOTE: The knurling of stainless steels, particularly Type 303, is not recommended unless special high cobalt alloy knurls are used. One manufacturer of such knurls is Form Roll Die Corp., 217 Stafford St., Worcester, Mass. 01603.

LISTENING TO SLITTING SAWS

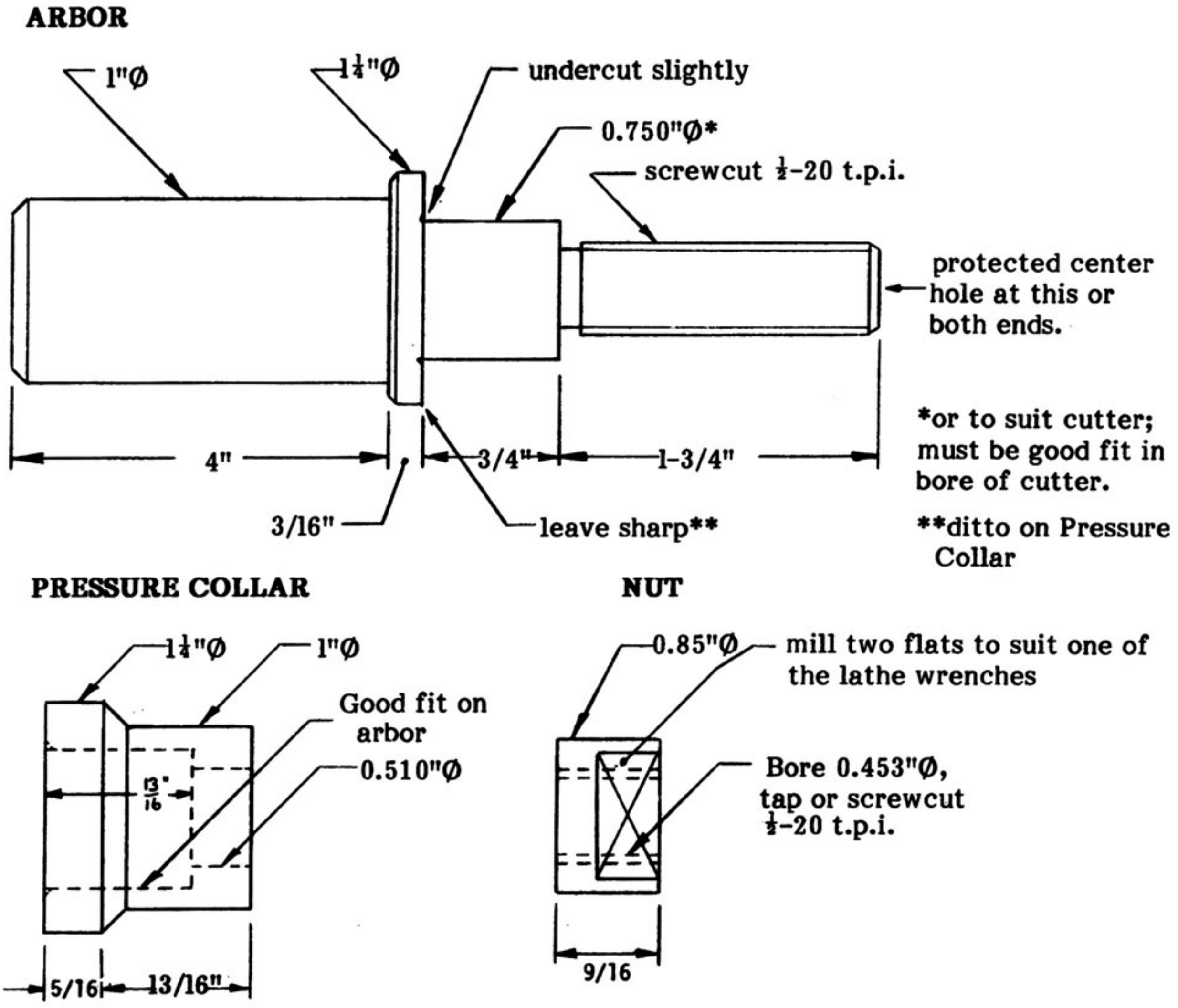
The first time I ran a slitting saw was on an arbor I had made in anticipation of its use in making my knurling tool. I set it up with the aid of my dial indicator so that the arbor was running within maybe half a thou or better, near as I could tell. In spite of all my painstaking efforts, that time and many times thereafter when using it in the lathe, and later on a commercial slitting saw arbor in my vertical milling machine, I was much disturbed by the "grunt and miss" nature of its cutting action.

What was the matter? Were my slitting saws oval? Were they running eccentric, in spite of all my pains? Finally I confessed everthing to my friend Bob Haralson, (70 years old, 75 years in the trade). He smiled that slow smile of his, and said - to my enormous relief - "Well, if you had it on a perfect arbor, in a jig borer, in a temperature controlled room, it might cut on all the teeth, but not for long. That's just the nature of the beast. Don't worry about it. Next time it'll be cutting on different teeth."

I keep a .45 caliber toothbrush close at hand when I am running a slitting saw in the vertical mill, and I very frequently shoot it at the rotating saw to clean chips from the teeth. If a fella were running a flood of coolant onto the job, this would not be necessary, but otherwise it seems not a bad thing to do.

Added to the 15th Printing: The Pivot Pins could also be retained by means of a small socket set screw in one leg of each fork in each Arm, said set screw to bear on a small flat on the Pivot Pin. My friend Tim Smith, of Toledo, OH gave me this idea. It makes for a very neat result. (See note at bottom right corner of page 57.)

IDEAS FOR A SLITTING SAW ARBOR



FRUIT ACIDS AND FINE TOOLS DON'T MIX

The acid from a peach, apple or similar fruit will invariably get on your hands when eating same. Therefore unless you wish to rust your finger prints forever into your micrometers, vernier protractor, squares, V-blocks, etc, wash your hands before handling such goodies, if you've been eating such goodies.

A TOOL FOR STRAIGHT KNURLING

or "Coining: How to Do It, and How to Save Some, too"

The straight knurling on the edge of a 10 cent piece is sometimes called 'coining'. A conventional diamond pattern knurling wheel can be used to form a straight knurl, but to do so a special holder would have to be made, and the sloped-over knurl then applied with considerable pressure to the work. Alternatively, a pair of straight knurls can be used in your conventional knurling tool.

Lusting for some straight knurling on something I was making a couple of years ago, and lacking a pair of straight knurls to put into my regular knurling tool, I found out a couple of interesting things:

FIRST: Quite nice and entirely functional diagonal coining can be produced with a single conventional (diagonal) knurling wheel - I just ripped the top arm off my floating arm type knurling tool, clamped it in the toolpost like a push type knurling tool, and proceeded to use it as such. The result was quite satisfactory, but required a lot of "push", which is not good for the lathe spindle bearings or the cross slide feedscrew nut.

SECOND: There is a type of knurl of which I had not previously known, wich actually **cuts** the knurl, rather than **cold forming** it. The brand name is **"QUICK"**. Unfortunately, these are expensive, the 1/8 to 10"Ø capacity unit teetering on the brink of US$265, complete with one knurling cutter.

That's a lot of coin for an occasional coining job. The matter lay dormant until about mid October '85. Then it occurred to me that the "QUICK" knurling cutters might be available separately. Turns out they are, and that they are quite reasonably priced: US$14 for the appropriate one.

I figured that if a guy put his mind to it, he should be able to make his own holder, so a visit was paid to a local supplier who carries the "QUICK" line. The factory-made holders were examined, and a cutter bought. It is marked "QUICK 30°R 0.8" - the 0.8 indicates the pitch, or fineness, of the knurl.

Preliminary drawings were made, which lead to an idea for a completely different form of holder, but one I liked better.

Working drawings were made, and are reproduced here. I have not yet made a prototype, so it has to be said that it is untried, but I will tell you how one would go about the job of making it.

SHANK (Part #1)
Make the Shank to suit your toolpost. I plan to use 1/2" sq. CRS. Face both ends and turn one end to 0.485"Ø for 0.495" back. 0.485" is an arbitrary size with no special or particular merit to it except that it will not require extreme accuracy in centering the 1/2" sq. CRS.

CLAMPING PLATE (Part #2)
Make from 1/2 x 1" CRS. Mill to overall dimensions, mark out, and bore in the 4-jaw chuck to fit the 0.485"Ø end of Item (1) above, then drill and tap for clamping screw, and split for clamping.

KNURLING WHEEL HEAD (Part #3)
Make from 1/2 x 1" CRS. Face to 3/4" long in the 4-jaw. Locate, drill and tap 10-32 for the socket head cap screw which holds the knurling cutter.

WASHER (Part #4)
Mine will be roughed out of a piece of 1"Ø hot rolled 4140, hardened, and set aside. Later, I'll

have it surface ground flat and parallel both sides. The exact thickness is not critical - plus or minus 0.005" is plenty tight.

WHEEL BUSHING (Part #5)

Same material and heat treatment as 4. above. Make with 5/16"Ø portion a very nice fit in the knurling cutter, and undercut the shoulder as noted. Get a good finish on the working surfaces. Make the 5/16"Ø portion overlength at first and face back very carefully to about 0.001" over knurling cutter thickness. Drill a tight clearance hole for the 10-32 screw, and part off over length, after cutting the bevel on the "big end". Reverse and chuck carefully by the 5/16"Ø portion, to face the top of the Bushing and counterbore it as drawing.

TO COMPLETE

Clamp Parts 2 & 3 together as shown in the drawing at bottom right hand corner of 2nd page of drwgs, and drill two 1/8" holes to take two pins made from CRS or drill rod. Sink these holes in about 7/8 to 1" deep, i.e. about 3/8 to 1/2" penetration into (3). Drive the pins into (3), flux the joint surfaces, put some flat strips of silver solder between the parts (flux the silver solder too), assemble (2) & (3), clamp up tight and heat up until the solder flows. Clean up, file the pins flush, and forget they are there - all they do is help keep alignment while soldering Parts (2) & (3) together.

Assemble (4) and (5) to the knurling head with the knurling cutter in place, with a little moly grease or like that for lubrication; fit to the Shank, tilt to 30° off vertical, and clamp up. Set up in the toolpost with cutter at lathe center height and try it. If the knurl produced is not parallel with the axis of the work, adjust the tilt and try it again.

Mark the final position with a scribed line, disassemble, and - if you want to - mill off surplus material as indicated by the three angled dotted lines on Part (2) and the two angled dotted lines on Part (3). Finish edges, etc. and reassemble.

This project will probably take you 2 or 3 evenings at most, and when done, will be the equal of the $250 commercial item. That's a fair bit of coin saved.

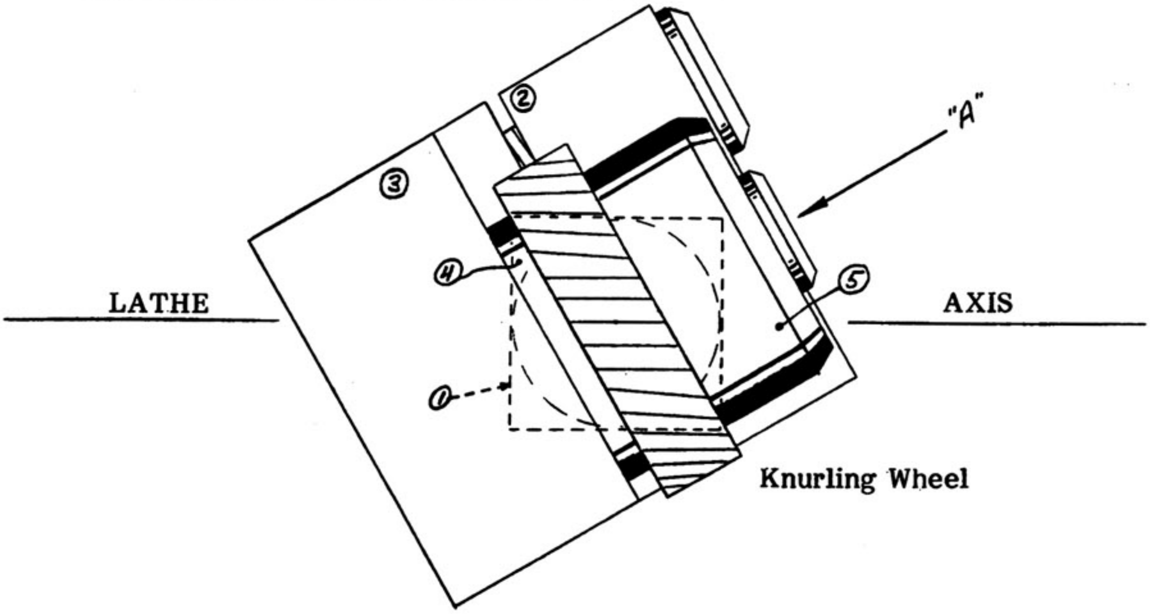
NOTE: "QUICK" is a registered trade name or trademark owned by the makers of knurling cutters and knurling tools carrying that name.

Two footnotes to the above

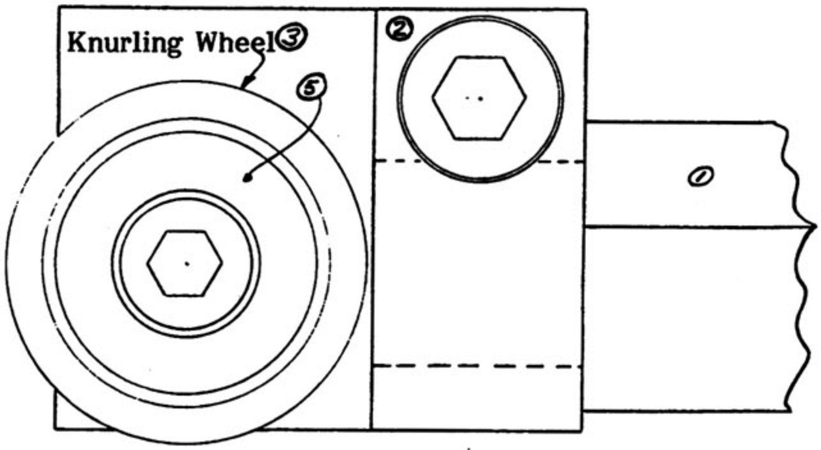
1. "QUICK" is a registered trade name owned by the makers of knurling cutters and knurling tools carrying that name.

2. "QUICK" knurling wheels are sold by SPI distributors. Look in the Yellow Pages under "machine shop suppliers," and call any outfit that sells precision measuring tools and cutting tools. If they are an SPI distributor, they can get you "Quick" knurls. If there's no SPI distributor near you, call SPI headquarters in Los Angeles (1-323-721-1818 or 1-800-626-5490) and ask for the name of your nearest SPI distributor.

"WORK'S EYE" VIEW OF LAUTARD-DESIGNED
HOLDER FOR "QUICK" KNURLING CUTTER



VIEW ON "A"

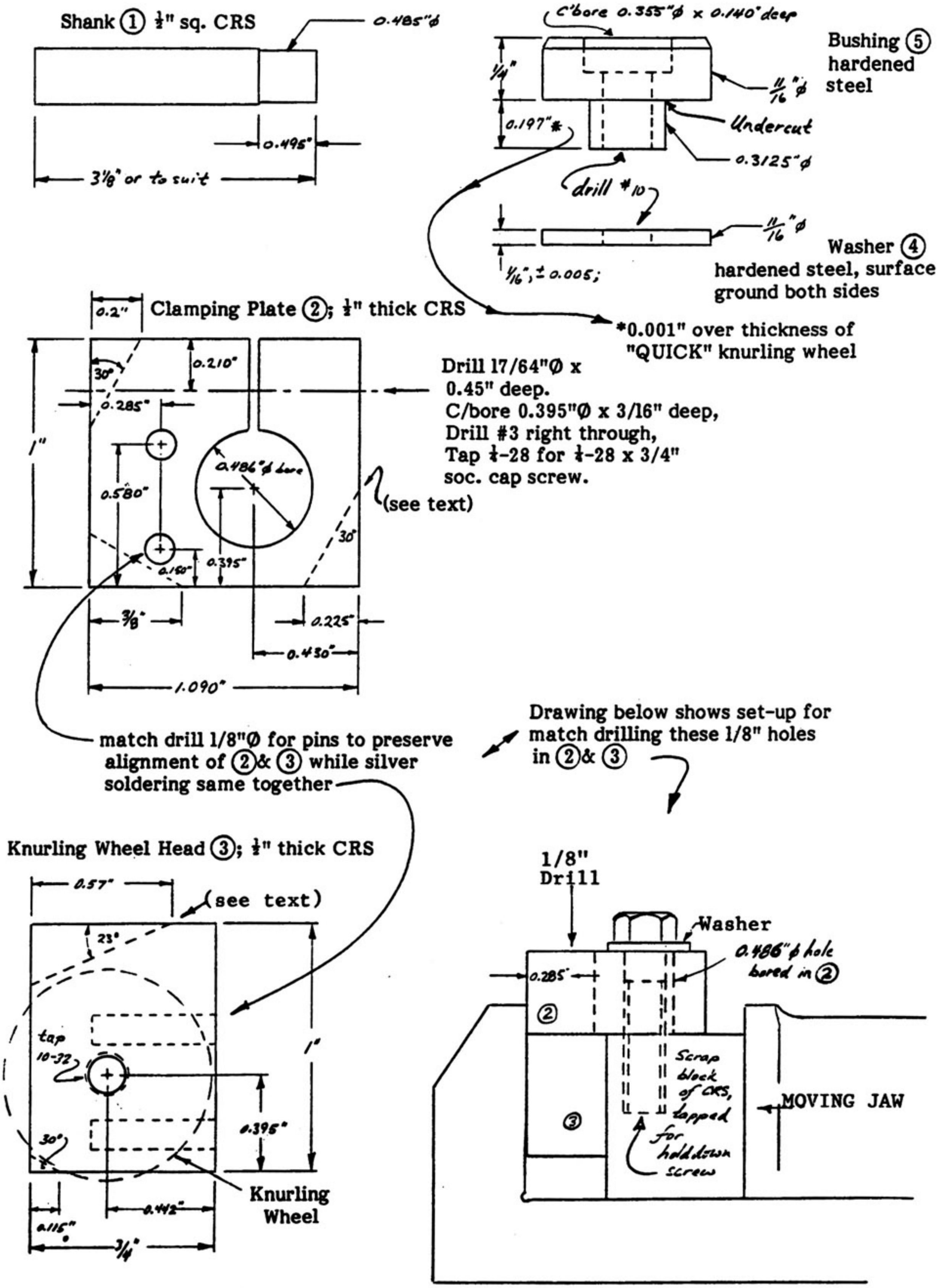


PARTS

1. Mounting Shank: ½" sq. CRS; end turned to 0.485"Ø for 0.495"
2. Clamp plate: ½" x 1" CRS; 1.090" long
   - bored 0.486"Ø* and split for clamping to ①
   - drilled, tapped and counterbored for clamping screw.

   *because it will probably close down slightly when split.
3. Wheel head: 1/2 x 3/4" CRS, tapped 10-32; fit two 1/8"Ø dowels to maintain alignment of ③ on ② while these two parts are silver soldered together.
4. Washer: hardened 4140; surface grind both sides.
5. Bushing: hardened 4140.

A TOOL FOR STRAIGHT KNURLING



SOME NOTES FOR MYFORD LATHE OWNERS

If you happen to be the owner of a Myford lathe, read this. If you don't own a Myford lathe, there may not be so much in this one for you, but you might get some ideas out of it anyway.

The Quick Change Gear Box (QCGB) - if you have one on your Myford lathe - should be serviced "periodically". The QCGB should be drained, flushed with diesel fuel or similar, and refilled with fresh 30 wt. motor oil about once a year. The factory manual didn't explain what sort of frequency they had in mind when they said "periodically", so I wrote and asked.

Whether the lathe has a QCGB or not, the lathe carriage apron should be removed and cleaned at about the same interval or more frequently. If you haven't done it yet, you will be amazed at the accumulated swarf and congealed oil you will find in there.

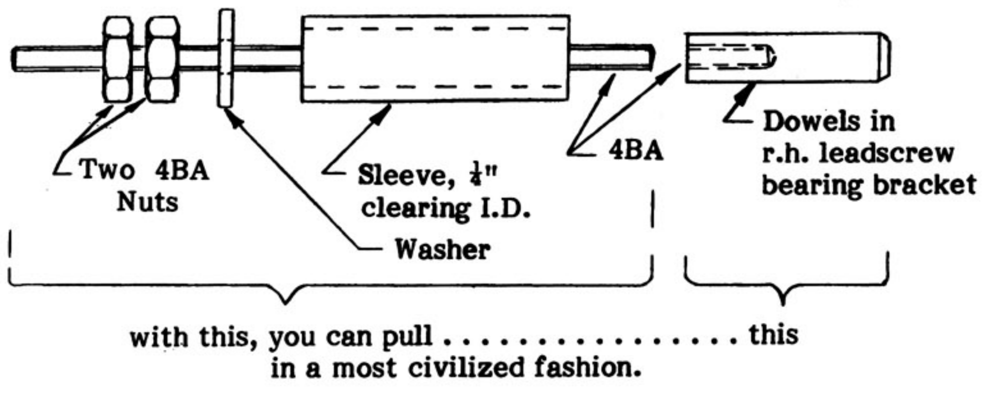
If you don't do it, some time when you least want it to happen, a chip from this mess will jump into the teeth of the miter gears (found at the inside end of the carriage handwheel shaft) and everything will be all jammed up. You will then have to clean things up when you least want to. This will not make you very happy. Don't say I didn't warn you.

The right hand end of the leadscrew is carried in a cast aluminum bracket dowelled and screwed to the bed casting. The leadscrew must be removed from the lathe before the lathe apron can be removed. Those two little dowels are the problem - how do you get them out?

I'll tell you: they are tapped 4-BA (confirmed by the factory Sept. 11/85).

Therefore take heed, and prepare thine household against the day of reckoning. If thou lackest a 4-BA die, order thyself one from a merchant of good repute, or take counsel with a friend who hath "BA" in his kit. See then that thou puttest this die unto the end of a little piece of rod, fair of form and of good mettle, yea, tested in the fiery furnace, and screw it 4-BA even unto a distance of about 3 diameters, and if thou can'st get thine hands upon a couple of 4-BA nuts, or a tap of that size, then screw the other end too, according to the drawings I have given thee. Better even than this, would be a piece of 4-BA threaded rod - may hap it will have been roll threaded, and therefore 10-20% stronger than if it be a cut thread. And on that very night, lay up all this treasure in a secure place, where rust doth not corrupt, nor thieves break in and steal, and where it will be found convenient to thine hand on a day that thou knowest must surely come. Yea, verily, on the day that thy dowels must be drawn, if thou heedest not this advice, thy difficulties shall be upon thine own head, thy grief will be exceeding great, and terrible to behold.

A DOWEL PULLER FOR MYFORD LATHE OWNERS



The 4-BA thread is 0.142"ϕ, 38.5 tpi, 47.5° thread angle (see page 203). The 4-BA thread rod would be available from a British supplier of model engineering goodies, or via a British model engineer pen pal.*

Further preparation if desired: buy yourself a couple of replacement dowels - 1/4"ϕ is the size - with a real (i.e. North American) thread in 'em. Once you've got them, and are sure they fit, garbage the factory dowels.

*** Added to the 11th printing:** We can supply top quality ground thread HSS 4-BA taps and dies. Contact us.

Added to the 13th printing: NOW AVAILABLE: If you are considering buying a used lathe or milling machine, you will likely want our new video, **"Examining a Lathe and Milling Machine - A Machine Tool Rebuilder Shows How"**. This video features Dennis Danich, a machinist, millwright, and machine tool rebuilder of some 30 years experience. This video could prevent you from throwing away thousands of carefully saved dollars on a machine that is beyond fixing. Dennis shows how to examine a lathe and mill for condition and accuracy, where to look for wear, what types of wear or damage are hard to fix, and what types are readily corrected. He also discusses proper cleaning and lubrication, so even if you already own a lathe and mill, you will benefit from the info presented in this part of the video.

In this video Dennis also presents an introduction to scraping and frosting of machine tool surfaces, demonstrates a reasonably-priced surface grinder well suited to the hsm's requirements, and warns against buying a used surface grinder from a commercial shop where it may finally have been reduced to service as an abrasive cut-off saw. You'll also learn how to re-lap worn oilstones, and see several useful items you can make for use in your own shop. Finally, you'll see Dennis's 6'Gray planer in use. This machine, although built about 1890, is in as-new condition. Finally, as a fun 12-minute "short", you'll have a close-up tour of a privately owned P40 Warhawk, and see it belch smoke and flames from the exhaust when it is started up!

A SIMPLE LATHE CARRIAGE INDEX

I once saw detailed working drawings for a gadget to be mounted to the apron of a Myford lathe carriage. The gadget incorporated a 2 or 3" section cut from a 6" steel rule. A movable pointer was to be clamped fetchingly to the edge of the lathe bed. These items together would serve as a carriage travel indicator, by 1/8" increments - quite handy, inasmuch as Myford lathes have an 8-tpi leadscrew, and many are equipped with a leadscrew handwheel graduated into 125 divisions, thus 1 div. = 0.001". The lathe becomes a metal cutting 0-20" micrometer.

What a crock! Why not simply lay a 6" rule on the rear shear of the lathe bed, and line up any convenient 1/8" division with the right rear edge of the carriage? Oil on the bed will hold the rule in place quite nicely. It can be adjusted without any fiddling about with clamps, screws, etc. Simply touch the rule and slide it to any desired new position. For situations where a carriage travel index would be useful - e.g. blind hole boring - the above method works fine, and requires only a couple of seconds to arrange.

HOLDING THIN WORK IN THE LATHE CHUCK

by H.J. Gustav Kopsch
AMERICAN MACHINIST Magazine
April 16, 1931, page 624

The article by Richard H. Kiddle, under the title given above, on page 183, Vol. 74, while describing a very clear idea, seems to invite the following friendly comment:

The blocks made to fit the jaws of a certain chuck cannot be used on another chuck having jaws of a different size, since the little wire loops (which Kiddle suggests) must fit snugly to be of any use. Most mechanics have, at one time or another, had to face thin disks or plates. The customary and quite satisfactory way is to put the piece in the chuck and tighten the jaws just enough to prevent it from falling out, and then true it by bringing the tailstock spindle, or better still, the drill pad, against it and then tighten the jaws firmly upon it. (See Fig.1.) If many disks are to be faced, a spacing disk, or a ring of the proper thickness but slightly smaller in diameter, is placed behind them. (See Fig. 2.) I know of no occasion where one of these two ways would not do.

I certainly would not advise the use of hard grease or heavy oil to stick any small blocks to the chuck jaws, since it might cause an error in the resulting thickness of the disks, and might cause them to run out of true. However, if small spacing blocks are resorted to, why not make them of steel, and harden, grind and magnetize them? Also, make them rectangular instead of square. They will be held to the jaws by magnetism, and by placing them in different positions, as indicated in Fig. 3, work of various thicknesses can be accommodated, leaving enough protruding for the facing operation.

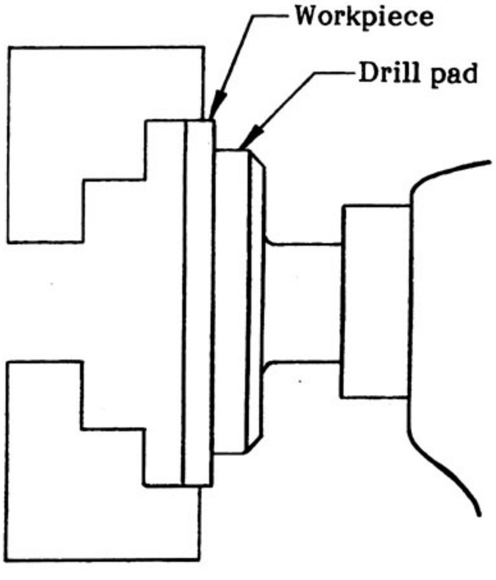


Fig. 1

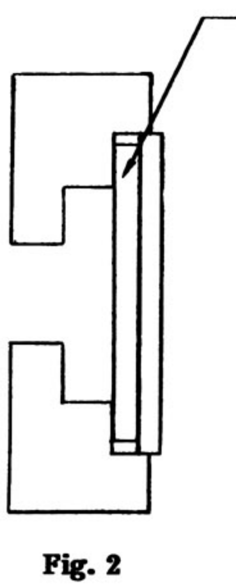


Fig. 2

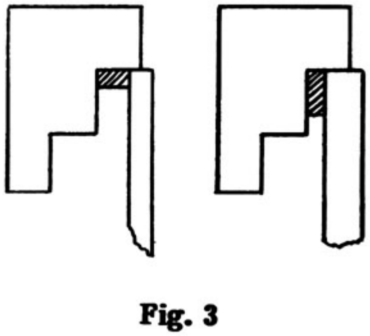


Fig. 3

There is a simple, fast and easy way to get a washer (or any similar workpiece) to run without wobble in a 3-jaw chuck. Say you want to bore out the hole in the center of a washer. Stick it to one side of a 6" rule by means of a small magnet placed on the opposite side of the rule. (Now you don't need three hands to hold the job while you try to chuck it!) With the rule plastered flat across the face of the jaws, tighten the jaws down on the washer. When the rule and magnet are subsequently withdrawn, the washer will be found to be sitting just the way you want it.

I reported this in *American Machinist*'s **Practical Ideas** column for July 1983, page 131.
GBL

PLEASE NOTE
There is some logic to the order of the contents of this book:

The next six sections are presented in sequence because each follows from the one before:

1. A graduated leadscrew handwheel for your lathe - useful when using.....

2. The Incremental Cut method of producing spherical profiles in your lathe without any attachments. Using this method, you can make....

3. A Grasping Groove Cutter, which you can use, along with.....

4. Design and fitting notes for locking cotters, to make......

5. A small scribing block (surface gauge) employing a locking cotter as at 4. above, and sporting grasping grooves made using the cutter from 3. above. This scribing block can be used with item 6. below, and the grasping groove cutter is again wanted in making.......

6. A fingerplate - a handy flat vise, useful as a surface plate accessory in conjunction with 5. above, in addition to its more obvious applications.

A GRADUATED HANDWHEEL FOR YOUR LATHE LEADSCREW

A graduated leadscrew handwheel is an extremely useful accessory for a lathe. If your lathe does not have one, you will find it well worth taking the time to make one. When you've used it a while, you'll know why.

For one thing, with the half-nuts engaged, the carriage can be advanced an exactly known amount via the leadscrew handwheel.

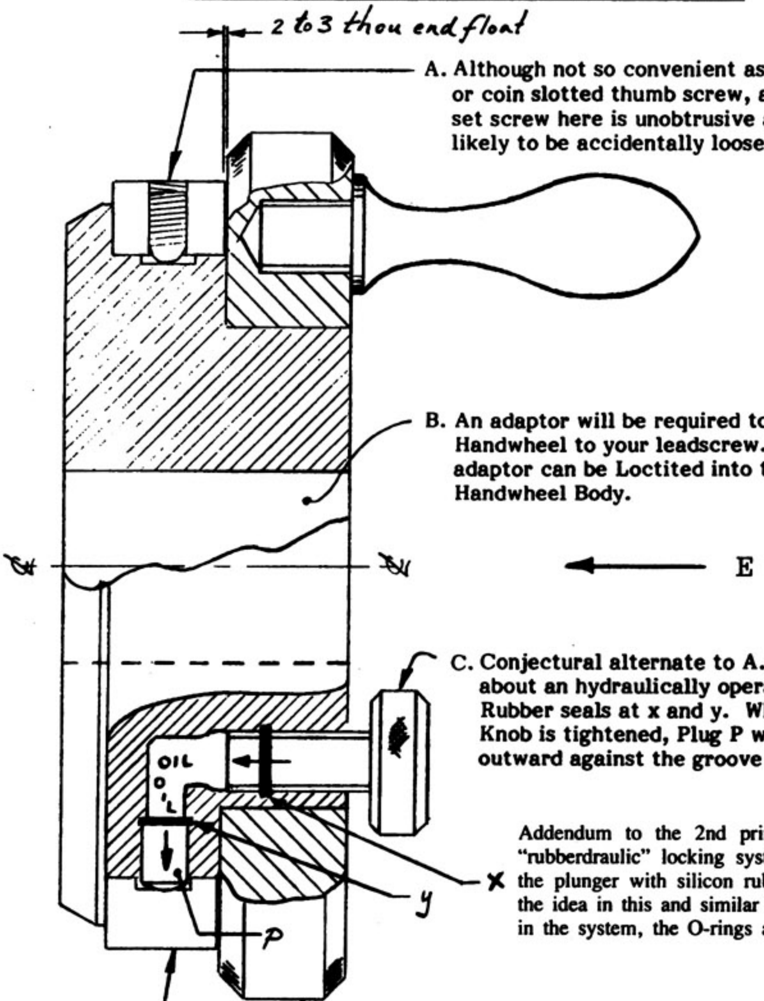
Drilling depth can be similarly controlled: bring up a parting tool to touch the nose of the drill chuck when the drill is just touching the work, then advance the carriage towards the headstock via L/S handwheel by the desired hole depth, then drill in til the drill chuck nose again contacts the parting tool.

And if you want to make ball handles via my incremental cut method - which see elsewhere herein - such a dial, with its larger diameter and more widely spaced graduations, will be found much handier to use than the small diameter compound feedscrew dial typical of most lathes.

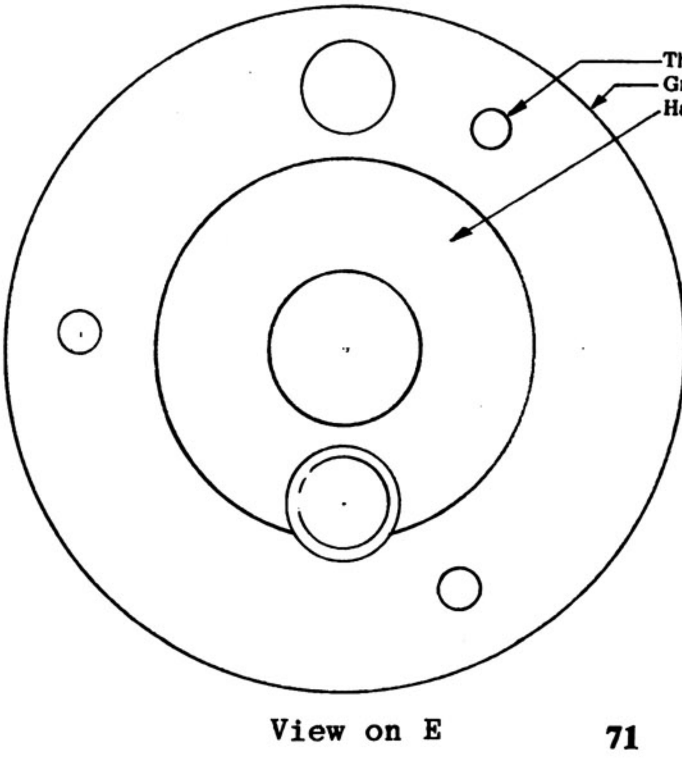
Given the variety of lathes owned by readers of this book, 'twould be pointless to try to give complete working drawings for such an accessory. Therefore, I will show only an annotated large scale General Arrangement drawing, plus a couple of scrap Details.

Make the graduated dial as large in diameter as practical, dimensioning it to suit your lathe, keeping sight of the need to be able to remove the tailstock without first removing the L/S handwheel. The larger the dial, the more widely spaced will be the graduations, the advantage of which is obvious: faster and easier reading/making of settings.

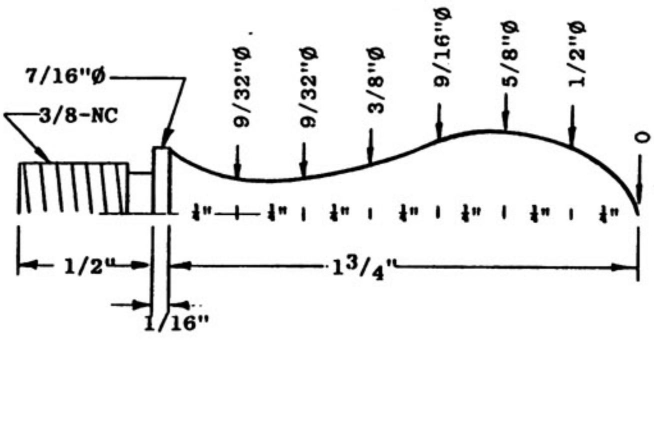
CONCEPTUAL DRAWINGS
FOR A
GRADUATED LEADSCREW HANDWHEEL



Addendum to the 2nd printing: Two readers suggest the use of a "rubberdraulic" locking system: fill the space between the screw and the plunger with silicon rubber instead of oil. Both say they've used the idea in this and similar applications with good results. With no oil in the system, the O-rings aren't needed either. Good Idea!



View on E



If the graduated dial is made as an adjustable Slip Ring running on the Handwheel Body, the whole thing will be an even greater asset. The Slip Ring should be a nice smooth running fit on the Handwheel Body - I would say 0.001" or so diametral clearance would be about right.

The Grasping Rim can be Loctited or screwed to the body of the Handwheel. Either way, this form of construction provides a simple means of making the Slip Ring captive on the Handwheel.

A socket set screw acting radially in the Slip Ring is the easiest and most obvious way to provide a locking adjustment. If you make yours this way, recess the mating O.D. of the Handwheel Body as shown to take the end of the set screw, so that the bearing surface will not be marred by the screw. Alternatively, give the screw a brass tip, or put a brass pad under it.

Another idea I like but have never experimented with is that of an hydraulically operated lock up for the Slip Ring. The success of this would depend on a good seal at each end of the oil chamber. This might be achieved with O-rings, pads cut from oil resistant rubber, or silicone rubber seals cast in a shop-made mold...if the idea appeals to you, you will have as many ideas as I might, and they'll probably work better - if I said any more I'd be talkin' through my hat.

A COMFORTABLE OPERATING HANDLE

One of the accompanying Details gives the profile of an operating handle of pleasant and comfortable shape. Turn screw end out. Thread as drawing, turn, file and polish to profile shown, as far as possible, before parting off. Screw into a suitably tapped chucked stub to finish off the outboard end.

If the dial is non-adjustable, i.e. made in one piece with the handwheel body, put the finger knob in line with the zero graduation.

A TAILSTOCK BARREL HANDWHEEL

Another small improvement not exactly related to the above topic is a tailstock barrel handwheel with radial rim spokes like a ship's wheel. I recall reading somewhere some comments by a fella who had so modified the handwheel on his lathe's tailstock. He said he found it much nicer and faster to use than the usual form with one axial finger knob in the rim. I like the idea, and one of these days I'm going to do it to my lathe.

BALL TURNING WITHOUT SPECIALIZED ATTACHMENTS ...AND HOW TO MAKE AN IMPROVED TYPE OF BALL HANDLE

The making of spherical shapes is sometimes required in the machinist's work. A ball handle is needed, or a ball end mill must be made. Ball turning attachments are well known, can be made or bought, and serve a practical purpose where much such work is to be done.

The following is a method of producing spherical profiles which:

(1) requires neither attachments nor special cutters to be made;

(2) produces near perfect forms (perfect enough for ball handles and 99% of the bull nose cutters we'll ever need);

(3) will produce a finished 3/8" ball end mill blank, ready for fluting, in less than six minutes, start to finish, including set-up time; and

(4) will produce any size ball you want.

The method is simplicity itself, and requires nothing except the most elementary mathematics, a parting blade or other suitable toolbit, a graduated leadscrew handwheel (nice but not an absolute necessity), plus some marking out blue and a file for finishing.

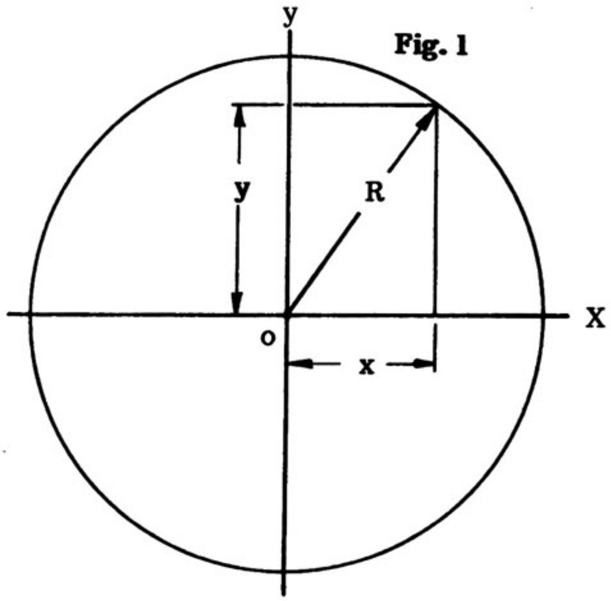
What follows is a complete description of the methods I have found effective. The technique has the advantages claimed for it above and thus is superior to other methods unless much work of this type is contemplated.

Furthermore, it can be used to produce profiles other than circular ones. I have used it to make small finger knobs for the sector fingers on a dividing head, a photo of which will be found in this chapter. These finger knobs are 1/4" max O.D., 13/32" high. There are two of them. I doubt if they vary, one from the other, by 3 or 4 thou in any particular, and they have a finish that'd frost your eyeballs. The point is, you can do nice work with this method. Interested? Read on.

Consider the graph of a circle as in Fig. 1. The equation which defines the points on a circle of radius R, and with center at O is:

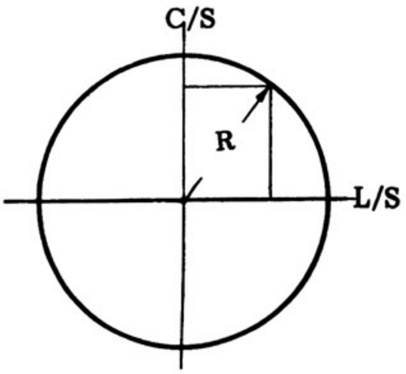
$x^2 + y^2 = R^2$ (good old Pythagoras)............Equation (1)

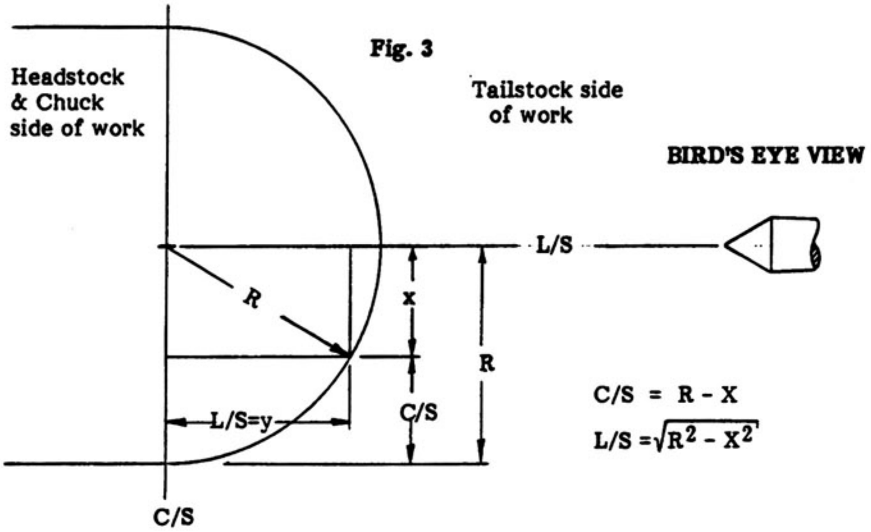
Fig. 1



For our purposes, let us re-draw and re-label Fig. 1 as in Fig. 2, and again as in Fig. 3, where we have something that looks suspiciously like a ball end mill blank ready to be fluted. Say that's what we want to make - a hemispherical profile on the end of a piece of (say) 3/8" drill rod.

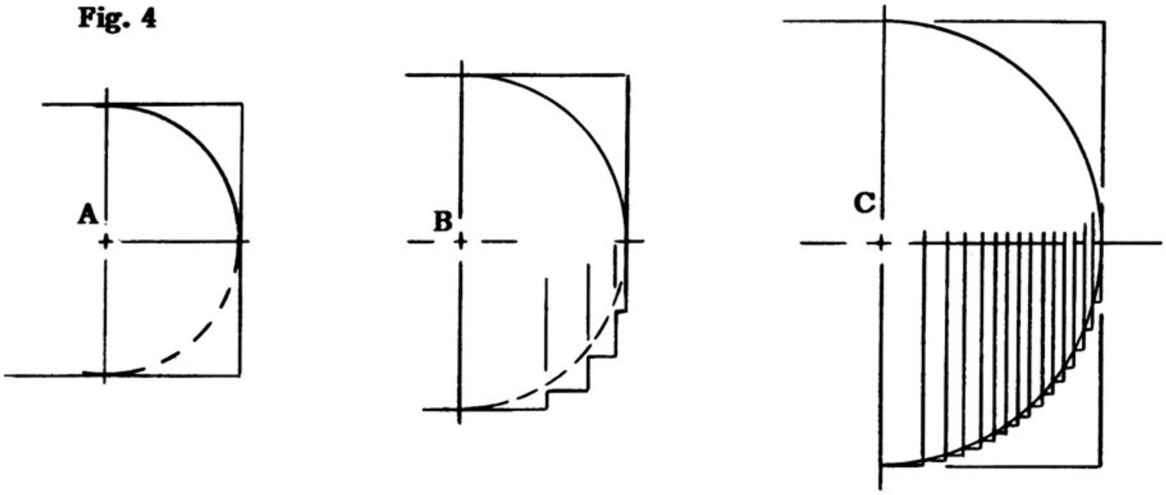
Fig. 2





Now, suppose we chuck a piece of 3/8" drill rod and apply a parting tool, or some other similarly ground tool, **in a series of small increments**, such that its cutting corner, at each cut, just reaches points which lie on the surface of the desired hemispherical profile. (Fig. 4.)

Fig. 4

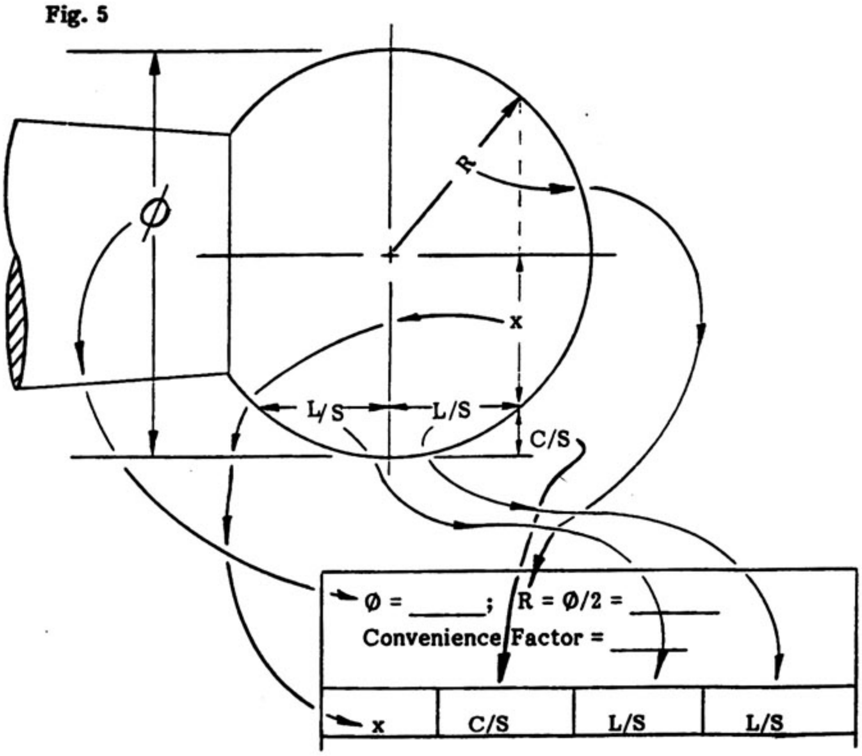


If we do this, we will rough out a close approximation of a ball end mill blank. We'll file it a whole lot smoother in a minute, but first let's think a bit more about the roughing out part of the job.

We can control the location of the cutting point of the tool very readily by means of our graduated leadscrew (L/S) handwheel and our cross slide (C/S) feedscrew micrometer collar. We can readily make up a table of the appropriate pairs of L/S and C/S settings, (see Fig. 5), using a rearranged form of Equation (1) above ($x^2 + y^2 = R^2$). A calculator is handy for calculating these settings, particularly if it is programmable.

For convenience in use at the lathe, such tables of C/S and L/S settings should be so designed as to have the cross slide readings come out in whole numbers: e.g. 31 thou, 82 thou, or whatever, instead of 31-1/2 thou, or 82-1/2 thou, etc. This is done by introducing a "**convenience factor**" into the calculations, which will produce C/S infeed figures which are in whole numbers of "thou's". How to make and use the "convenience factor" will be shown in an example at the end of this chapter.

Fig. 5



The C/S infeed figure dictates what the corresponding L/S figure will be. The L/S figures should be calculated to four decimal places. Then, in using the L/S settings so calculated, stay maybe 1/2 a thou outside the surface of the sphere.

For most cases, and for reasons which will become apparent shortly, the topslide should be set parallel to the lathe axis, although it need not be "indicated" into **perfect** alignment.

For making ball end mills and similar **hemi**spherical profiles, the parting tool should be ground either square across or so that the left side of the edge leads a little. If you are going to make about 90% of a full ball, say a ball on the end of a tapered shank, the parting tool should be ground straight across. It should of course be sharp, and set dead on center height.

> NOTE: Readers who have read Part I of my two part article, "Balls & Bull Noses", which began in the Sept/Oct. 1983 issue of *Home Shop Machinist,* will see that the method shown here is similar, **BUT IT IS NOT THE SAME!!!**
>
> Since writing that article, I have found that the method described below, i.e. working outward from the "equator" towards both "poles" of the ball, **WORKS MUCH BETTER.** In the article in *HSM*, I gave tables of C/S and L/S settings for various sizes of balls up to 1" diameter. However, those numbers are for working from the tailstock pole up to the equator and then from the equator toward the headstock pole and/or the ball/shank junction.
>
> **Do not** attempt to blindly apply the figures given in the tables which appeared in the *HSM* article while working as recommended below. **IT WON'T WORK!!**

I have found that the best way to use this method is - as mentioned above - to have the cuts proceed from the "equator" of the ball toward the "poles". (Fig. 4A) Some preliminary cuts - two or three, or more, depending on the size of the ball being turned - are taken to remove surplus material - see Fig. 4B - staying a few thou out from the settings in the table, before returning to the equator to start the 10 or 20 or more cuts required to produce the actual profile desired.

The foregoing paragraph contains an important point: If you work from the tailstock pole to the equator, there's always going to be material in the way of - i.e. to the left of - the cutter, necessitating that the C/S be wound back out beyond the max. O.D. of the ball at every move, before the L/S can be advanced to the next setting. This extra cranking makes the job take much longer. It took me a while to tumble to this point.

Let's run through the manipulations of the C/S and L/S handwheels, starting at any point on the curve. Say we have zero'd the C/S on the max O.D. of the hemisphere, taken the preliminary roughing cuts, and are now at some point in the series of cuts which will give us the desired profile. (Remember, we are making a ball end mill blank.) We have just made a cut, and the tool is still kissing the job.....what next?

1. Turn L/S to next setting in table. Carriage moves towards tailstock. Cutter ceases to kiss the job.

2. Advance C/S to next C/S setting in table. Metal is cut as this move is made.

3. Repeat Step 1. and then Step 2. over and over until you get to the "north pole" of the ball.

Then comes the next stroke of genius in Lautard's Incremental Cut system:

4. Move the carriage out of the way, and **coat the roughed out spherical profile with marking out blue.**

5. Take up a sharp, fine cut file and clean it. Then coat the file with chalk or dose it with thick cutting oil to prevent "pinning" and consequent ruination of the finely finished surface we are trying to produce. File the job down to the desired profile.

The purpose of the marking out blue is that it will tell us when we get down to the spherical profile, thus: the blue will be taken off by the file as it cuts away the ridges, and the areas of blue will reduce to lines (in the corner of each incremental cut taken by the parting tool) as we approach the desired surface. As the surface is reached, the last of the blue will disappear. Now is that clever, or is that clever?

6. Polish the profile with fine emery paper.

Tell me, why would anybody want to spend a week making a ball turning attachment?

Now let's look very briefly at the matter of fluting and relieving a ball nose cutter. Stick the cutter blank in a "cutter block" (which see, elsewhere), place the whole lot in the vertical milling machine vise, and mill in three flutes using a slot drill.

Next, blue the whole end of the cutter blank with marking-out blue. Use an oddleg caliper to lay out a land, say 0.020" wide, behind the cutting edge of each flute. File in sufficient clearances behind, and up to, each of these lines. After heat treating, <u>stone</u> the lands down till they <u>just</u> disappear, and then lightly stone the front face of each flute.

> TIP: When using a ball end mill to mill a radius or fillet in the root of an angle, first take out most of the waste metal in the radius with an ordinary endmill or slot drill. This way your ball end mill has only to make an easy clean-up cut. (Again, one of Bill Fenton's bits of genius.)

POINTS TO NOTE WHEN WORKING "SOUTH OF THE EQUATOR"

When doing the chuck side of a terminal ball for a ball handle:

1. Zero the L/S handwheel dial with backlash taken up in the correct direction.

2. Set the parting tool's right front corner on the ball's equator, by means of the topslide.

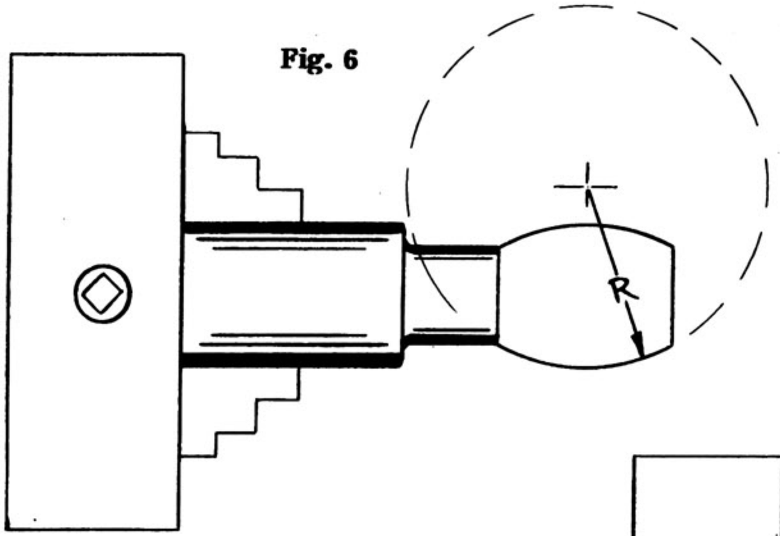
3. Proceed to rough out, and then cut, the chuck side of the ball until the point is reached where the ball and handle shank join. The numbers for this point should be worked out and noted on the drawing, and the appropriate numbers worked into the table of feedscrew dial settings. See sample table of settings, and notes to same, as noted in the paragraphs immediately below.

HOW TO CALCULATE THE NUMBERS

The concept behind the incremental cut method of producing spherical profiles is easy to grasp. The development of a table of cross slide and leadscrew dial settings to produce a ball of any given size is not something that lends itself to a brief explanation. (If you think otherwise, try writing one!) It will, however, become clear from a study of the last two facing pages of this chapter, where you will find a sample table giving settings for a 7/16"Ø ball, together with all necessary explanatory notes.

If you have a programmable calculator, you will quickly see how to automate the job of making up such a table. From making up tables of this sort, it is a small step to figuring out how to produce a spherical profile where the center lies outside the work, as at Fig. 6, or somewhere up in the lathe headstock, as at Fig. 7.

Fig. 6



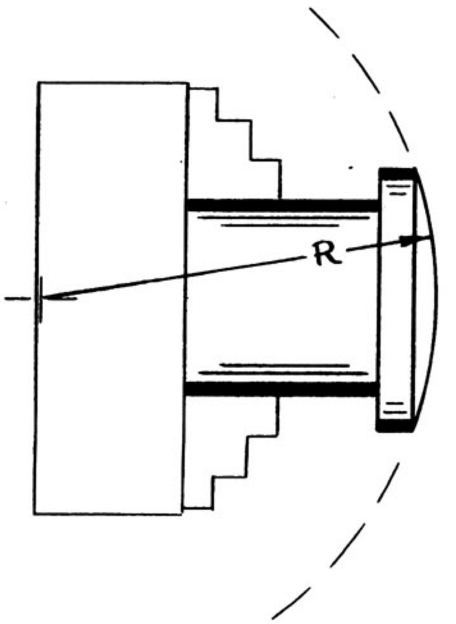


Fig. 7

Notes to the table of
CROSS SLIDE & LEAD SCREW HANDWHEEL SETTINGS
on the facing page

1. The C/S figure is = R - x. For example:

   0.21875 - 0.21575 = 0.003 (See 2nd line in table.)

2. The convenience factor is R - 0.xxx00; i.e. 0.21875 - 0.21800 = 0.000,75. To put that another way, "The convenience factor is the radius R to five decimal places minus the first three digets to the right of the decimal."

3. We need to use the convenience factor in the calculations, to get nice round C/S numbers, but we do not bother to write it down each time) For example:

   0.21875 - 0.21375 = 0.005 = C/S (See 3rd line in table.)

4. Notice how at this line we begin to simplify the way we write down the numbers, as we begin to see the pattern they follow.

5. The L/S_c figures are the leadscrew numbers for the chuck side of the ball. $L/S_c = \sqrt{(R^2 - x^2)}$ For example when x = 0.21375 (and here we do need to use all 5 decimal places):

   $L/S_c = \sqrt{(0.21875^2 - 0.21375^2)}$

   $= \sqrt{(0.047852 - 0.045689)}$

   $= \sqrt{0.002163} = 0.046503$, which is, say 0.0465

6. NOTE: The L/S will be turning **backwards** when we are doing the **tailstock** side of the ball. Therefore the numbers in the column headed L/S_t (the "t" stands for the **tailstock** side of the ball) are obtained by subtracting the numbers in the column headed L/S_c ("c" for **chuck** side of ball) from 0.125 (assuming an 8 t.p.i. leadscrew, where one full turn gives 0.125" movement).

7. Example re note 6. above: where x = 0.130, and C/S = 0.088, we find L/S_c is 0.0504, and then

   $L/S_t = 0.125 - 0.0504 = 0.0746$

8. Note how the L/S increments diminish almost to zero as we near the "polar regions" of the ball. Here, the table has been taken right through to x = 0, whereas in practice, we would probably not go beyond x = 0.040 or 0.030 - at which point we'd have an insignificant 1/16"Ø pip on the tailstock side of the ball. Also, after you've done a couple of balls, you will learn to increase the increment from one value of x to the next as you near the end of the series of numbers.

9. At this point the L/S has made one full turn and is on its next revolution. Actual total distance from "equator" would be this number plus 0.125 (or 0.250, 0.375, etc., depending on ball size), again assuming an 8 t.p.i. leadscrew.

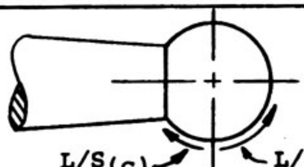
10. If you are doing the big ball of a double ball handle, about here the handle ball will be ready to fall off. See note 8. above.

A TYPICAL TABLE OF
C/S & L/S SETTINGS
(This table is for a 7/16"Ø ball.)

Numbered notes on the page at left correspond to numbered arrows below

Ø = 7/16" = 0.4375"; R = Ø/2 = 0.21875

2 → Convenience factor = 0.000,75



1 → C/S

Note	X	C/S	L/S(c)	L/S(t)	Note
	0.21875	0	0	0	5
3	0.21575	0.003	0.0361	0.0890	
	0.21375	0.005	0.0465	0.0785	
	0.21075	0.008	0.0586	0.0664	6
	0.20775	0.011	0.0685	0.0565	
4	203	0.015	0.0796	0.0454	
	198	0.020	0.0914	0.0336	
	192	0.026	0.1034	0.0216	
	186	0.032	0.1139	0.0111	
	180	0.038	0.1232	0.0018	
9	172	0.046	0.1342 → 0.0092	0.1158	
	165	0.053	0.0178	0.1072	
	158	0.060	0.0255	0.0995	
	151	0.067	0.0326	0.0924	
	144	0.074	0.0390	0.0860	
	137	0.081	0.0449	0.0801	
	130	0.088	0.0504	0.0746	7
	120	0.098	0.0574	0.0676	
	110	0.108	0.0636	0.0614	
	100	0.118	0.0692	0.0558	
	085	0.133	0.0762	0.0488	
	070	0.148	0.0820	0.0430	
	055	0.163	0.0865	0.0385	
	040	0.178	0.0899	0.0351	
10	030	0.188	0.0916	0.0334	
	020	0.198	0.0928	0.0322	8
	010	0.208	0.0935	0.0315	
	002	0.216	0.0937	0.0313	
	0	0.218	0.0937	0.0313	

Added to the 8th printing: I've had several customers phone me because of difficulty in regard to the ball turning procedure detailed here. All asked the same question: *"Where does that second value for "C/S" (0.003) in the above table come from?"*

The answer is, *"It is an arbitrarily selected value."* You pick what seemeth good to thee as a reasonable first infeed for the cross slide, then calculate the value for the next column (L/S) based on the number you chose, and then pick another reasonable infeed value, and so on.

Also, see the note at the bottom of page 206.

AN IMPROVED TYPE OF BALL HANDLE

The incremental cut method of ball turning lends itself very nicely to the making of ball handles.

Ball handles (Fig. 8) are often a handy means of providing a "nut-complete-with-wrench" where a clamp bolt must be loosened and retightened frequently.

If you are making tools and such for your shop, sooner or later you will have a need for a ball handle. Properly proportioned double ball handles look nice, and serve their purpose well. (See footnote re proportions of ball handles at end of this chapter.)

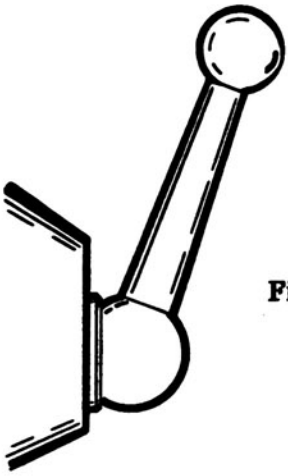
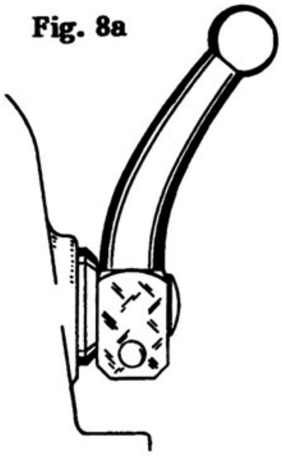
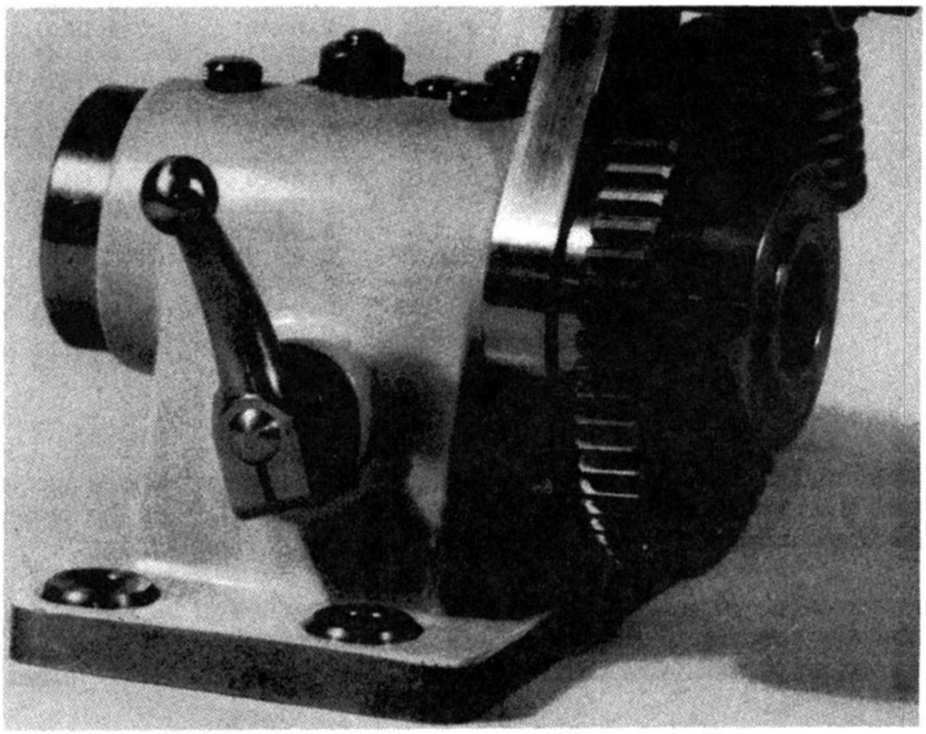


Fig. 8

I have, however, developed another form of ball handle which is even better in many instances. Verily, there is nothing new under the sun....doubtless the idea has been used before. I call it a clamp-on ball handle. I think you will like it.

Fig. 8a





DESIGNING AND MAKING CLAMP-ON BALL HANDLES

To make a clamp-on ball handle, we need first to "design" it to suit the application. At Fig. 9, dimensional ratios are given which will give some guidance in coming up with handles having nice proportions and good appearance.

We first decide the appropriate size of material from which to make the handle to suit the bolt size. Next we decide the center-to-center distance between the reamed hole and the terminal ball, according to such factors as the amount of leverage we want to apply, and how much operating room there is around the handle. We then work out the details of the tapered cylindrical shank - its length, diameter at each end, and the angle of shank taper. We must also work out the location and related dimensions for the clamping screw.

The dimensions worked out for the ball and shank need not be followed slavishly. The reason will become clearer below, but keep in mind that we are making a handle, not a part for a lady's wrist watch. I think the following is a practical approach:

1. Make a pretty accurate scale drawing, say 2 to 5 times full size, depending on the size of the handle.

2. Face both ends of a piece of square CRS of the appropriate size and slightly longer than the job calls for, to give room for a center hole for T/S support. (This hole will ultimately be completely removed before the ball is finished.)

3. Dechuck, and apply some marking out blue.

4. Use an oddleg caliper to mark out, from the "clamp" end, for "B" and "L" per your drawing.

5. Rechuck, centering the material closely by bringing the tip of a parting tool up to contact each pair of opposite faces in turn, and noting the C/S dial readings at each face. With just a little effort, centering of square or rectangular stock to within 1 or 2 thou is easy. Stick a center hole in the end for tailstock support, and rip the corners off to bring it down from square to round. Slap on some more blue, and, using a pair of dividers, mark in the location of the equator of the ball. This does not have to be within anything closer than say a 64th, although 'twould be easy to get it quite a bit closer than that.

6. Proceed with cutting and filing the ball and shank. The material carrying the center hole is cut away after as much of this work as possible has been done, and the extremity of the ball is then finished off. The shank taper is produced by making the initial cuts with the compound rest set at a steeper angle than your drawing calls for, and then finishing passes, with minor adjustments between, until the taper runs out at the desired location and diameter, or reasonably close to it. We are not making watch parts, but rather a handle, and perfection here is not required - excellence will do just fine.

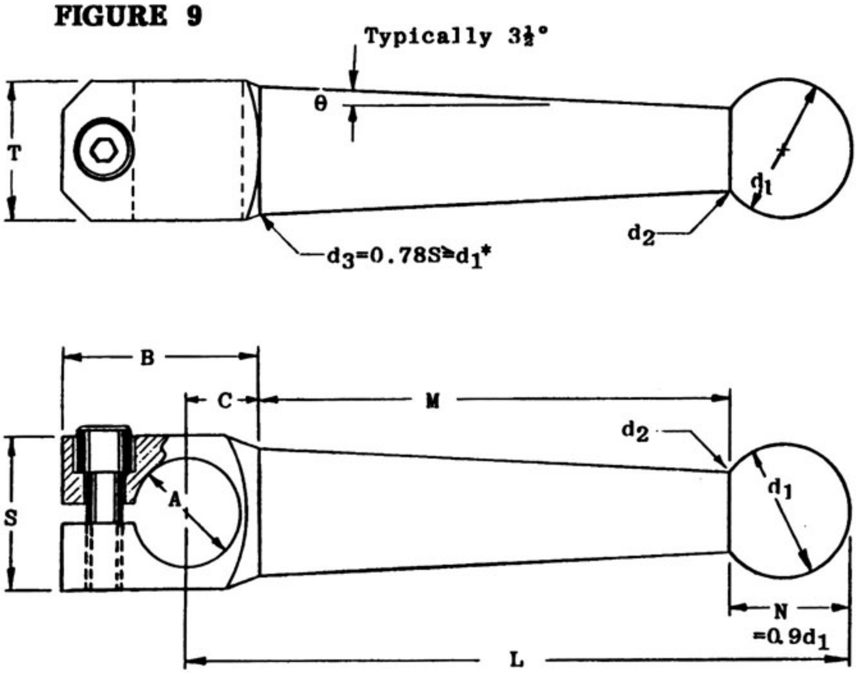
7. Dechuck, ream for the bolt or circular nut (Fig. 10) to which the handle is to be attached, flip and cross drill/counterbore for the socket head clamping screw, split for clamping, and the job is done.

ODDLEG ARTISTRY

Note that all the marking out for these operations can be done with an oddleg caliper. The clamping slot can be centered quite adequately by eyeballing the slitting saw into place between two lines oddlegged across the end of the block.

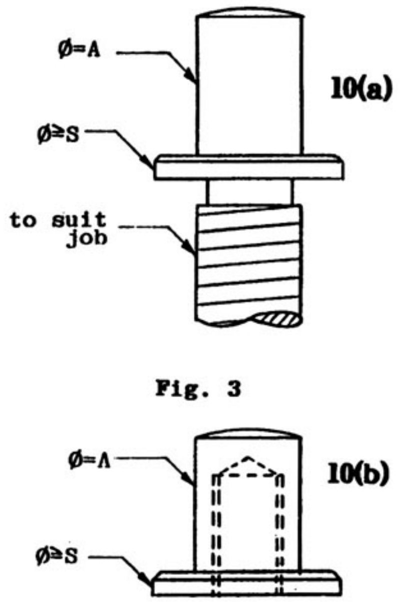
The nearly finished handle can be set up for this operation by eye in the milling machine vise. It will need to be set well over to one side of the vise and rather high in the jaws, for two reasons: first, so that the slitting saw can get a clear shot at it, and second so that the ball is not touched by the vise jaws. You may not have a parallel suitable for use in such a setup, but you don't need a

FIGURE 9



* ≥ means "greater than or equal to"

FIGURE 10



Suggested Proportions

Let **A** = **0.6S** to **0.8S**; <u>or</u> let **S** = 1.25**A** → 1.66**A**; **T** = $\mathbf{d_1}$ = 7/8**S**

B = (approx.) 1.35**S**, but dimensions will follow from clamp screw size and placement.

C = **0.4S** → **0.5S**; $\mathbf{d_2}$ = **0.6**$\mathbf{d_1}$; **N** = **0.9**$\mathbf{d_1}$; **L** = **3.3S** → **4S**

$\mathbf{d_3}$ ≥ (i.e. should equal or exceed) **0.68S**, but will be governed by the shank taper angle, thus:

$\mathbf{d_3}$ = $\mathbf{d_2}$ + (2M tan θ)

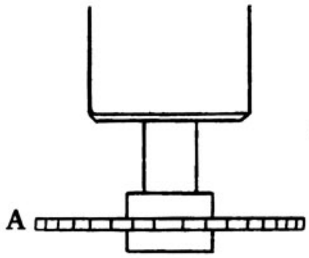
The steeper angle at the butt end of the tapered shank can be measured off the drawing, or done by eye when making the actual handle - just be sure it runs off the block before it intersects hole, **A**.

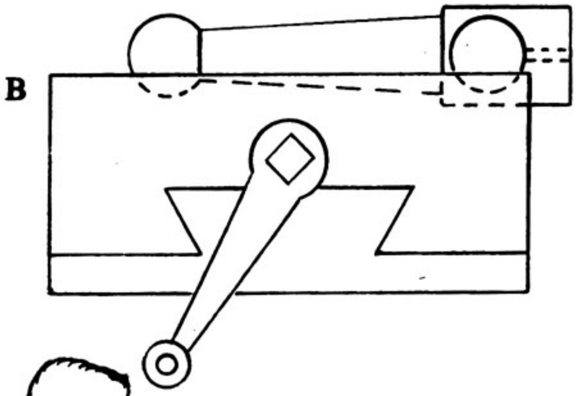
The handle length should be in keeping with the scale of the item on which it is used, the torque to be applied, and available clearances. Hence handle size cannot be related directly to screw thread size. Hole size "**A**" should be in keeping with overall dimensions of the handle, and therefore the screw to be torqued may want what might otherwise seem an "oversize" (cylindrical) head, in order to suit "**A**". Where bolt Ø = A, an integral washer or flange may be wanted on bolt as at Fig. 10(a). Where a circular nut is wanted, put the flange on the nut as at Fig. 10(b).

The proportions suggested above should be regarded as a good starting point. Make a drawing - if it looks good, do it.

Fig. 11

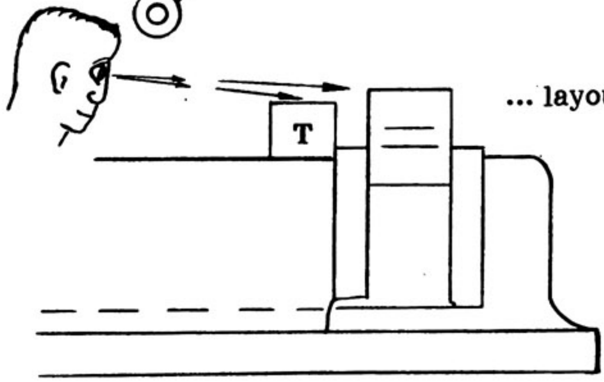
THE ODDLEG ARTIST AT WORK
or The Highballing Eyeballer





1. View from screw end of milling machine vise.

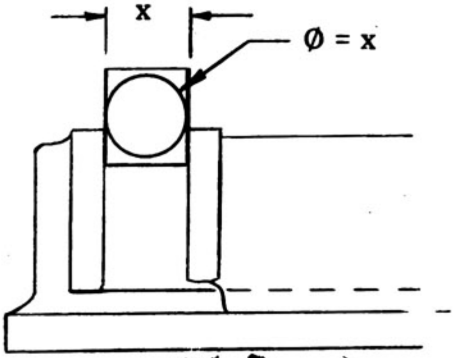
Work is set up by eye as shown in the drawing below, and then the slitting saw is eyeballed into position to center its cut in the space between the....



... layout lines oddlegged across the end of the block.

2. View on A

"T" is a toolbit or similar (not shown in **1.** above) placed on moving jaw and sighted over as an aid to eyeballing the job parallel with the milling machine table.



3. View on B

The ball is not touched by the vise jaws because its centerline is above the top of the jaws.

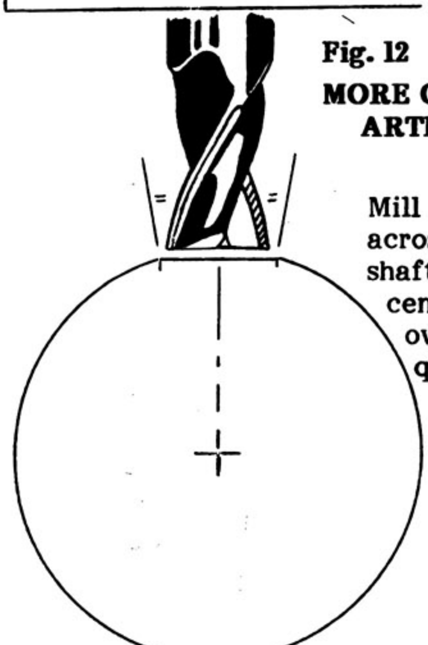
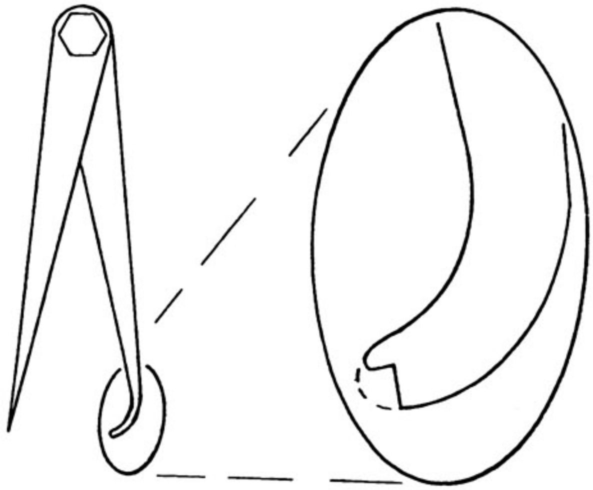


Fig. 12

MORE ODDLEG ARTISTRY

Mill a small flat across the top of a shaft, and you can center your cutter over this flat quite accurately enough for 95% of all the keyway milling jobs you'll ever do.

A useful modification to a pair of oddleg calipers is made by filing a small step in the hooked leg, as shown below. (This is not mentioned in the text.)



parallel - you can set it up as fast or faster without one: Put a lathe toolbit or something similar on top of the moving jaw, and sight over it at the block end of the handle, which should be just nipped in the vise. From here, you can eyeball and tap the handle into a condition so close to "dead level" that it will amaze you. (Fig. 11.) Tighten the vise and cut the clamping slot.

You may wonder why I have given so much space to this matter. I will tell you: this sort of info is not given in any book of machine shop practice that I have ever seen. Yet by these methods, which I call "oddleg artistry", you can work much faster.

It goes without saying that these methods should be reserved for jobs where the accuracy achieved is sufficient for the job at hand.

If you work long hours every day in your shop, all of a sudden these little tricks will start coming to you seemingly out of thin air - but that is not so - they come to you out of **experience.** But if you don't spend that much time in the shop, they probably won't. And as I said, you won't find them in other books. So I put them in here for the same reason that I wrote this whole book - to share my ideas and know-how with others of like interest.

I'll tell you a little story. Some years ago I was asked to do an appraisal of the equipment in a large machine shop. One item on the equipment list was a Czechoslovakian lathe with a 6' swing that would take 52 feet between centers, and another was a big old Cincinnati HyPro planer with a 26 foot stroke, if memory serves me right.

During the course of looking over the machine tools in the shop, I spotted a real live machinist setting up to mill a keyway into a shaft in a vertical mill. (At the time I was about four years into this hobby.) Naturally, I figured he would bring the cutter down beside the shaft, make contact - with the aid of a cigarette paper, maybe - and up quill, traverse over half the sum of the diameters of cutter and shaft, and then mill the keyway. But he didn't.

He took a light cut across the top of the shaft, centered his slot drill by eye over the flat thus produced, and proceeded to mill the keyway. Just like that.

The first cut was deep enough to give him a flat just a little wider than his cutter, and thus a visual reference within which to center his cutter. (See Fig. 12.) This method will get the cutter centered over the shaft with sufficient accuracy for 95% of all the keyway cutting work that goes through the average machine shop.

Here then was my first observation of an oddleg artist at work. Doubtless his favorite color, like mine, was machinist's blue.

I mentioned the use of a cigarette paper above. This well known dodge needs no introduction from me. However, friend Hayslip passed on the following, which is useful:

> TIP: If you don't have three hands, what do you do if you want the cigarette paper to stand in there nice and still beside the workpiece while you operate the table feeds to bring the workpiece in towards the rotating cutter until it cuts the cigarette paper? Very simple. Oil the paper, and stick it to the work. 'Twerks like a charm, too!

A FINAL NOTE - WHERE YOU WANT AN ANGLED HANDLE

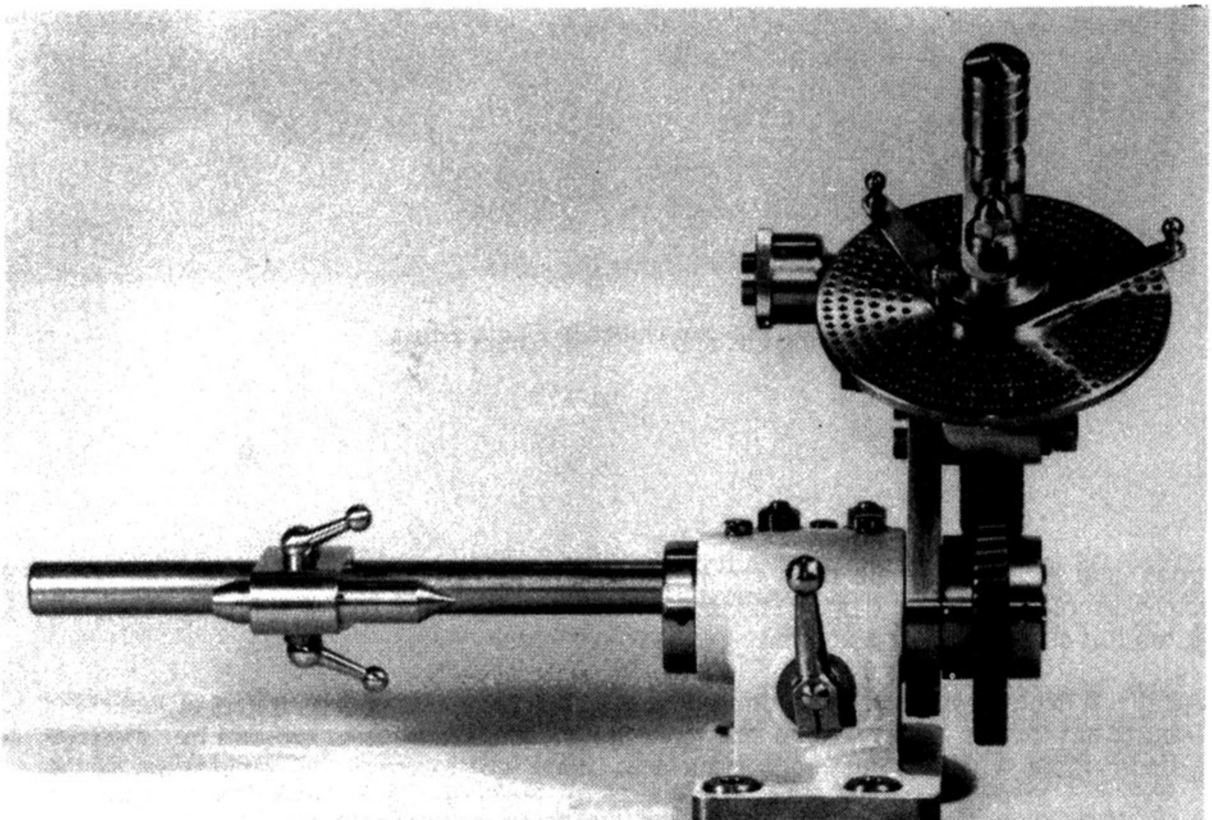
If you want the handle angled up from its bolt in much the same way as is the double ball handle in Fig. 8, the thing to do is to bend it, as at Fig. 8a. This should be done, after all other operations are complete, by heating the base of the shank red hot while holding the rectangular portion in the bench vise, and tapping the terminal ball with a wooden mallet. Make the bend parallel with the axis of the reamed hole in the base block - it will not look good if it nods off to one side.

After the heating and bending operation, the handle will require re-polishing. To minimize scaling, smear some soap on the area to be heated. Brownells' catalog lists a non-scale compound, and their book, **Gunsmith Kinks**, Vol. 1, gives a recipe for an anti-scaling compound that would serve much the same purpose - they recommend it for bending files without burning the steel. I think it would work well here.

No originality is claimed for the general idea of approaching, in increments, a desired surface contour with the sharp corner of a toolbit. It has doubtless been used by other crafty machinists who found themselves without - or too lazy to make - a radius turning attachment. As stated at the outset, it can be applied to the production of not only spherical, but other profiles.

Footnote re double ball handles:

Machinery's Handbook shows dimensions for "two-ball clamping levers" at page 1140 in the 20th Edition. (Look under "Handles, machine" in the index, if you have another edition.) This source however starts with levers 4.5 inches long. If you want some guidance on proportions for smaller ball handles, see Part II (Nov./Dec. 1983) of "Balls & Bull Noses", the *Home Shop Machinist* article I referred to near the beginning of the chapter. Although the **methods** shown here are better, the proportions given in that serial are still valid.



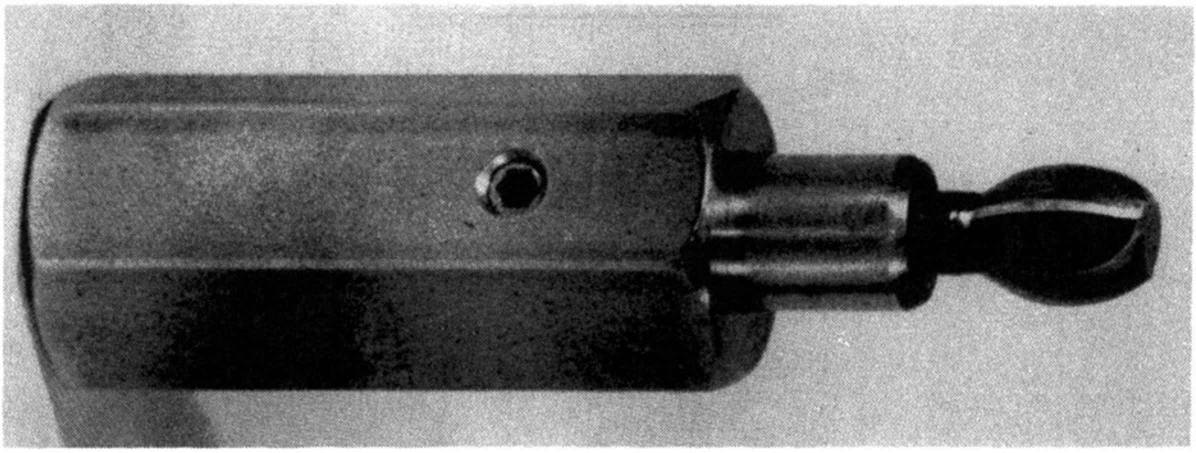
A differential indexing head made by the author in 1982 according to drawings in the book Dividing & Graduating. See page 41, in the 3rd paragraph under the heading "COMPOUND INDEXING"; see also page 44 for sources of this excellent book.

A GRASPING GROOVE CUTTER

A practical application of the preceeding section on the Incremental Cut method of generating spherical profiles is the making of a grasping groove cutter. The cutter here described will cut, in Meehanite grey cast iron, the best lookin' grasping grooves you'll ever want to see.

Make from 1/2" drill rod. Be sure you have left no sharp corners when you are done machining the blank. Sharp corners, if present, act as areas of stress concentration, and the cutter will be more likely to crack or break at such points.

Stick the blank in a Cutter Block - which see, elsewhere - and mill three flutes. Blue the end, and mark a land behind each cutting edge about 20 thou wide. File in the relief behind this land. Blue again, and very carefully file the primary relief, so the cutter will cut.



Grasping Groove Cutter in Cutter Block

Harden, and temper to a pale straw color. Stone the cutting edges. Soak in salt and vinegar to remove discoloration from heat treatment. Stamp cutter specs on end or side, if you want to. In use, run this cutter at about 200 rpm.

> TIP: Whenever you stamp anything with steel marking stamps, (e.g. letters or numbers) burrs are thrown up above the surrounding surface. Dress this "swollen up" material down flush with the surrounding surface. This will improve the appearance of the stamped characters 100% and, in the case of markings on a cutter shank, it is also necessary to prevent damage to the collet in which the cutter will be held.

The following table of C/S and L/S settings will produce a profile of radius 0.442" as on the drawing, but it would be well for the reader to spend some time figuring out how the numbers were calculated, rather than using them blindly. If you once understand how these numbers were worked up, for a profile which typifies the situation shown at Fig. 6 in the preceeding section, you will be able to work up sets of numbers to produce any desired profile.

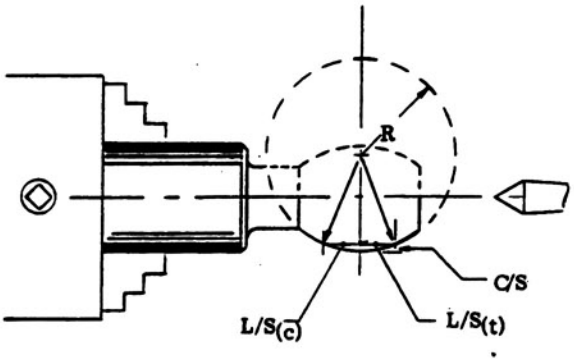
TABLE OF C/S & L/S SETTINGS FOR INCREMENTAL CUTTING OF THE GRASPING GROOVE CUTTER

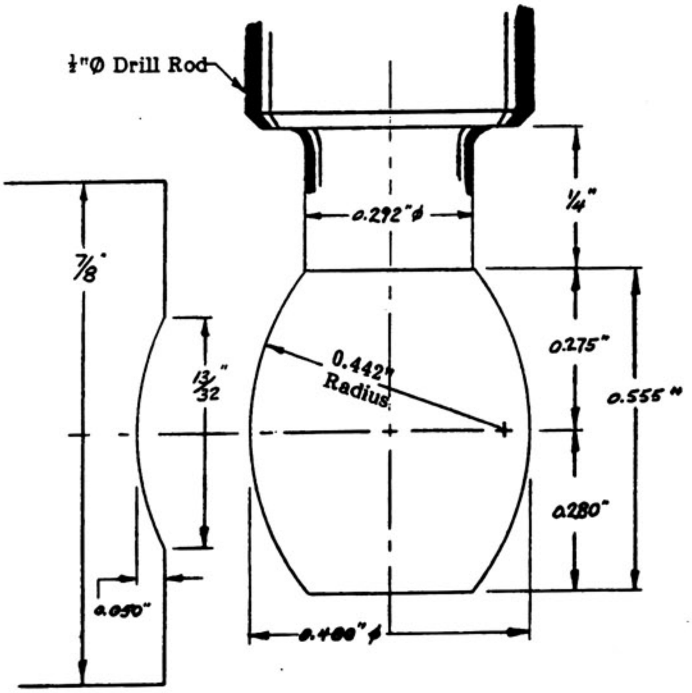
X_o	X_{corr}	C/S	L/S (c)	L/S (t)
0.442	0.240	0	0	0.1250
0.440	0.238	0.002	0.0420	0.0830
0.437	0.235	0.005	0.0663	0.0587
0.432	0.230	0.010	0.0935	0.0315
0.428	0.226	0.0140	0.1104	0.0146
0.425	0.223	0.017	0.1214	0.0036
0.422	0.200	0.0200	0.0065	0.1185
0.419	0.217	0.023	0.0157	0.1093
0.415	0.213	0.027	0.0271	0.0979
0.411	0.209	0.031	0.0376	0.0874
0.407	0.205	0.035	0.0474	0.0776
0.403	0.201	0.039	0.0565	0.0685
0.400	0.198	0.042	0.0631	0.0619
0.397	0.195	0.045	0.0693	0.0557
0.394	0.192	0.048	0.0753	0.0497
0.391	0.189	0.051	0.0811	0.0439
0.388	0.186	0.054	0.0867	0.0383
0.384	0.182	0.058	0.0939	0.0311
0.380	0.178	0.062	0.1008	0.0242
0.376	0.174	0.066	0.1074	0.0176
0.371	0.169	0.071	0.1153	0.0097
0.366	0.164	0.076	0.1228	0.0022
0.361	0.159	0.081	0.0050	0.1200
0.356	0.154	0.086	0.0120	0.1130
0.351	0.149	0.091	0.0186	0.1064
0.346	0.144	0.096	0.0250	0.1000
0.342	0.140	0.100	-	0.0950
0.340	0.138	0.102	-	0.0926

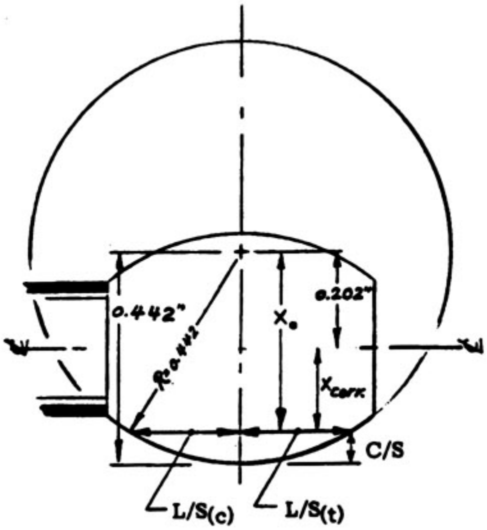
NOTE: 0.275" (L/S (c), rows 0.442 to 0.346)

NOTE: 0.280" (L/S (t), rows 0.442 to 0.342)

These two columns can be ignored when machining the cutter, but should be understood by the user.





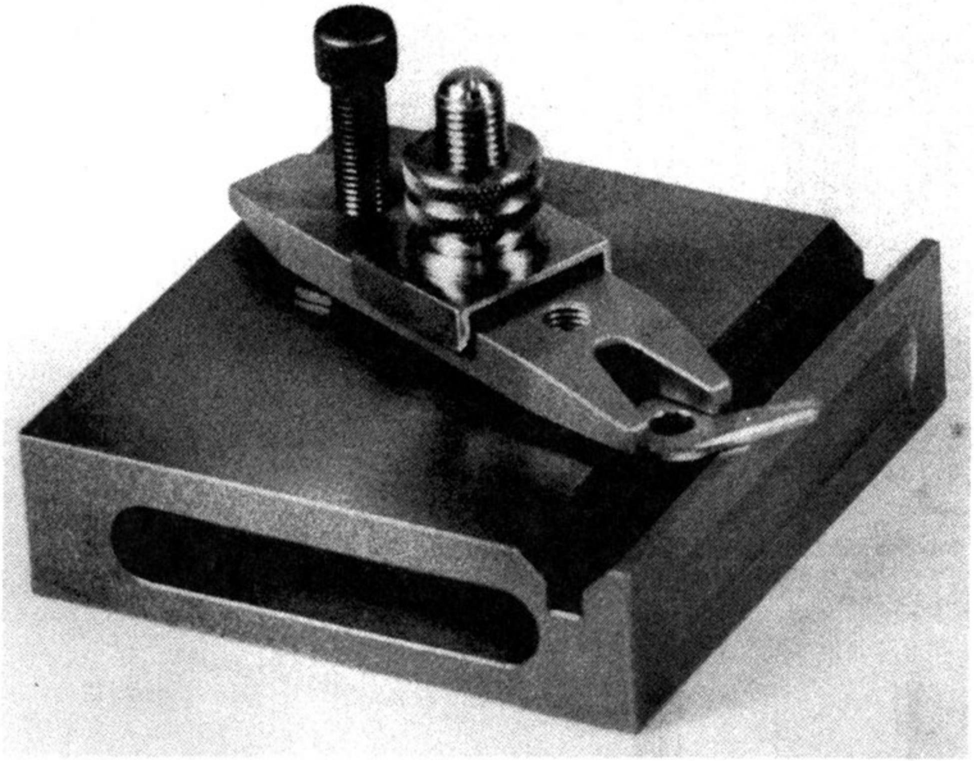


A FINGER PLATE

Every machinist, gunsmith, clockmaker, and
model engineer should have one.

This is my version of what used to be a common item in machinists' toolboxes. Each was made according to its owner's own ideas.

What is a finger plate? It is a flat vise, handy on the bench, the surface plate, the milling machine, and the drill press. It is heavy enough to help it sit still while you drill a hole in a job. (If the hole be of any but a small size, you know as well as I to clamp the job - or here, the fingerplate - against rotation.) Stood on edge, it will also serve as a rule stand, to hold a steel rule vertical for use in conjunction with a surface gauge and surface plate.



TIP: If the part being marked out is a small item, or of a shape that will not stand up on the surface plate on its own - and Part A of this project is an example - squeeze it against the on-edge Finger Plate while doing the marking out work.

The Finger Plate shown here has the following features:

1. It can be clamped down to a machine table by the side clamping slots, leaving the working surface clear.

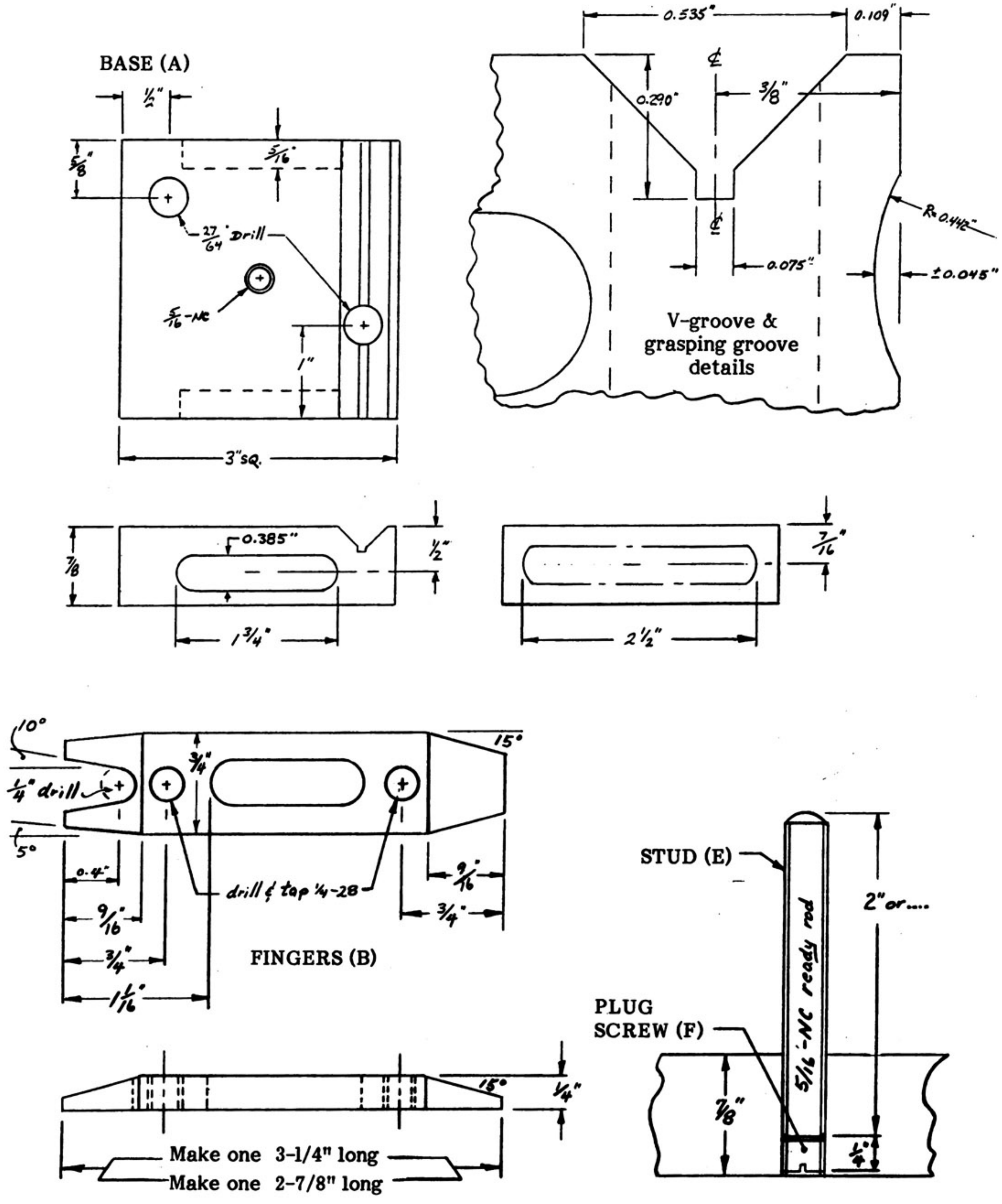
2. The through-drilled center hole permits it to be bolted to an angle plate from the back. (Additional tapped holes on the underside of the Base (A), and spaced to match the holes/slots in your own angle plate(s) might be useful.)

3. One Clamp Finger (A) is shorter than the length of the Base, so it will not overhang.

4. The other Finger is long enough to reach right out to the corners of the Base.

DETAILS OF A USEFUL MACHINIST'S AID:

THE FINGERPLATE



5. The Rocker, (C) backs up the Finger securely under the Nut (D) and Washer (C), even when the Finger is tilted fore and aft.

6. Studs of various lengths are freely interchangeable.

7. The heel screw (a socket cap screw) will work in either end of either Finger - the latter are double ended.

8. The V-groove permits round stock to be readily and securely clamped.

9. There is a clearance hole for through drilling of work clamped in the V-groove. An additional hole is shown elsewhere on the base - my own does not have this extra hole - yet.

BASE (Part A)

I would recommend the use of cast iron for the base, as it is more resistant to dings and bruises than mild steel, unless the latter be casehardened.

1. Machine all over square and true.
2. Drill and tap center hole.
3. Mill clamping grooves.
4. Drill clearance hole on V-groove centerline.
5. Make relief cut for V-groove with a slitting saw.
6. Clamp down and indicate true with travel of mill table.
7. Machine V-groove with a slot drill with its end re-ground to an accurate 90° point. (See info elsewhere herein re how to make or buy such a cutter.)
8. Mill grasping grooves.

FINGERS (Part B)

Straightforward. Make from 1/4" x 3/4" CRS. Slot width is 11/32".

ROCKER (Part C)

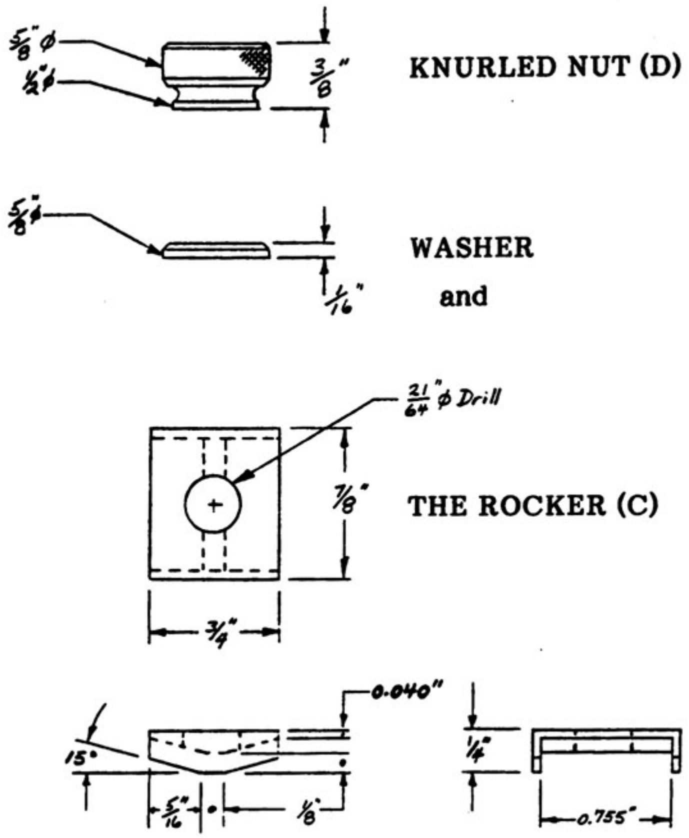
1. Make from 1/4" HR steel.
2. Hacksaw roughly to size.
3. Mill to size.
4. Blue and mark out.
5. Mill a trough 0.755" wide x 1/8" deep on underside.
6. Blue the trough with marking out blue, and mark inner limits of sloped cuts using an oddleg caliper.
7. Reposition in vise at a 15° angle, and mill sloped cut in underside in stages, raising the work toward the cutter and then passing it under the cutter, until the cut runs out just at the line scribed with the oddleg calipers.
8. At same set-up, bevel side panels. (A 3/8 or 1/2" end mill is good for all this work.)
9. Ditto for other end of Rocker.
10. Unship from vise, clean up all over with files and emery paper.
11. Later, perhaps when drilling and tapping the Fingers, put the Rocker upside down in the mill vise, and drill the 21/64" hole for the Stud.

KNURLED NUT (Part D) Straightforward. Brass would be nice. Mine is steel.

STUD (Part E) Ditto. Make from ready rod. Finish one end square across, and round the other, as shown on drawing.

PLUG SCREW (Part F) Ditto. Finish both ends square, and cut a screwdriver slot in one end.

FURTHER DETAILS OF THE FINGERPLATE



Added to the 8th printing:

NOTE: The Base of the Finger Plate doesn't have to be made of cast iron. You can make it out of mild steel if you wish, or even aluminum. These materials obviously won't be as resistant to knocks and dings as will cast iron. However, cast iron is not impossible to get:- here's something else from **TMBR#3**....

A Source of High Quality Cast Iron

Another tip **George Leverton** passed on to me was a source of very nice sand-free, blow-hole free continuous cast iron, in various cross sections, and of uniformly fine quality. He has used it for material from which to make bullet molds, and said that in spite of the small size of his business with the outfit, they fixed him up with a charge account arrangement right off the bat, and were just generally real nice people to deal with. The outfit? Midwest Metals, 2195 Lakeshore Drive, Woodstock, IL 60098-7467, Phone 1-800-526-0548

DESIGNING AND FITTING SPLIT COTTERS

Clamping a cylindrical part is a common requirement in the sorts of things a machinist makes and/or uses. The quill of a milling machine, the spindle of a dividing head, an adjustable center sliding in a reamed hole - all these require some means of locking them in a desired position.

One of the neatest clamping elements for such purposes is the **split cotter**, and its close relative, the **solid cotter**.

Such cotters may be fitted in blind or through holes. In making various tools and elsewhere, I have had occasion to fit a number of such cotters, and have developed some notions of my own about how to go about designing and producing them.

DESIGNING A SPLIT COTTER

I believe the best approach is to first make a drawing of what you want to make. As I have advocated elsewhere herein, a large scale drawing can tell you much that you need to know. If the job imposes constraints on the locked and locking elements, draw the outside stuff first, and then draw in the part to be locked, where it must go, and finally the split cotter, in that order. In other cases, it may be appropriate to draw the spindle and its cotter in their correct relationship, then draw the parts surrounding them.

The size of cotter appropriate to a given spindle diameter does not seem to follow any fixed relationship. I have seen designs which called for a 3/8"Ø cotter to lock a 3/8"Ø spindle, 11/32"Ø cotter to lock a 1/4" spindle, 3/8"Ø to lock 1/2"Ø and 5/8" spindles, 1/2"Ø to lock a 1-1/16"Ø spindle, and so on.

One consideration will be the necessity to have room for a screw of sufficient size to apply the needed clamping force without breaking. In practice, it does not take much torque on the screw to utterly immobilize the clamped part. Probably a 1/4"Ø cotter is a practical lower limit, and 10-32 is perhaps a practical smallest size screw, although doubtless a 4-40 socket cap screw would be appropriate for some applications - you will have to do your own engineering, either seat-of-the-pants, or via published technical information, e.g. Machinery's Handbook.

Take a look at Fig. 1 - the generalized split cotter. When the cotter halves are squeezed together (arrows) they effectively lock the shaft. This can be taken into practice as at Figs. 2-4 and these by no means exhaust the possibilities. Before we go into how to make such cotters, let's design one from scratch, on a 2X full size drawing. See Fig. 6(a) through (d).

Say the spindle is 1/2"Ø, and is to be clamped by a split cotter and a socket head cap screw. A 3/8"Ø cotter and a 10-32 screw would appear to be about right. At Fig. 6(a) we draw in the spindle and the screw, which must clear it by some amount. The screw and spindle center lines are next drawn in, as at 6(b), and then the cotter in profile, 6(c). Finally, at 6(d) we draw in the counterbore to take the screw head. Dimensions for socket head cap screws up to 1/2" are to be found in the back of this book, and more information along the same lines is to be found in Machinery's Handbook and like sources.

If you do not need an elaborate drawing for your own or other purposes, measure the dimensions "X" and "Y" at Fig. 6(c) and toddle off to the shop.

But hold it! How are you going to go about making and fitting the cotter parts?

MAKING A COTTER

Usually, the hole for the cotter is located and drilled, bored and/or reamed. Next, the cotter blank, which may take various forms, is stuffed into the hole, locked rigidly there, and the intersecting

SOME APPLICATIONS OF THE SPLIT COTTER

Fig. 1

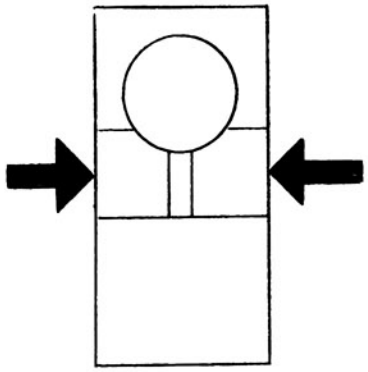
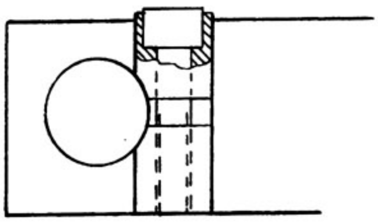


Fig. 2



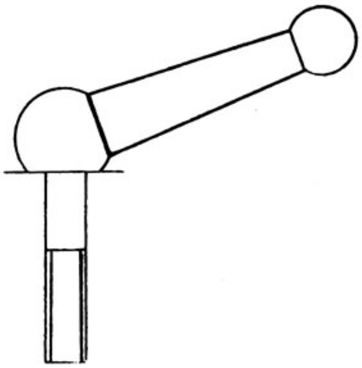


Fig. 3

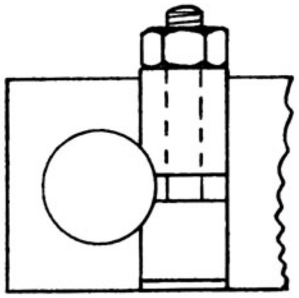


Fig. 4

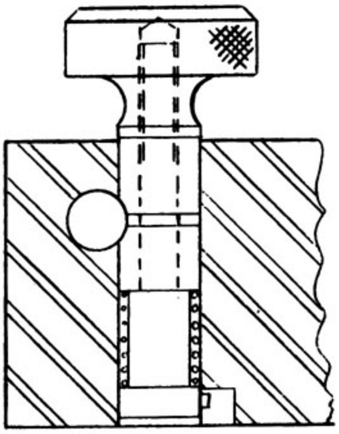
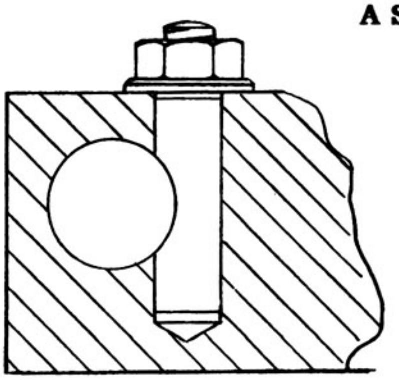


Fig. 5
A SOLID COTTER



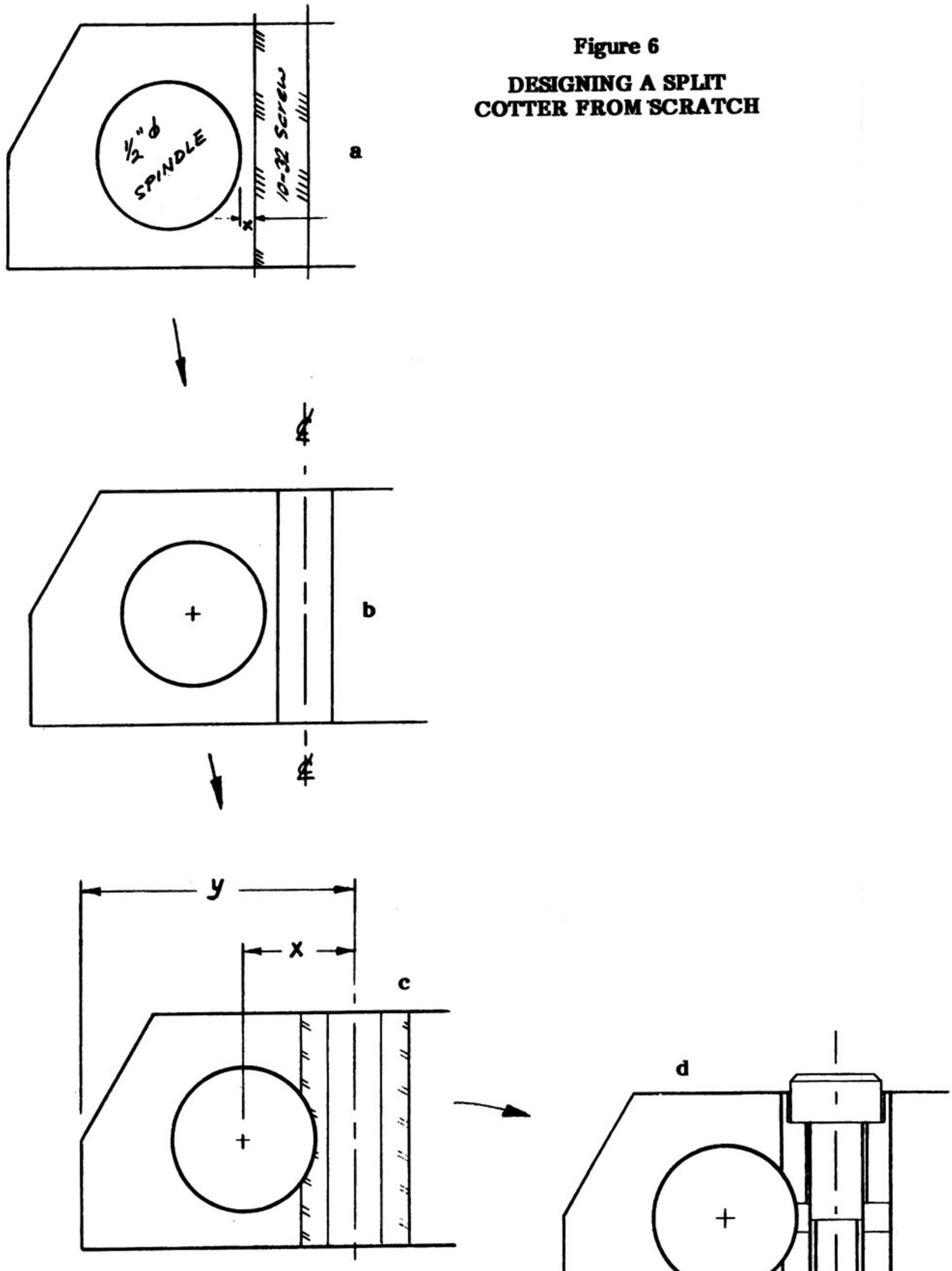
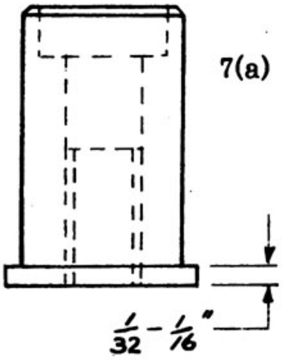


Figure 6

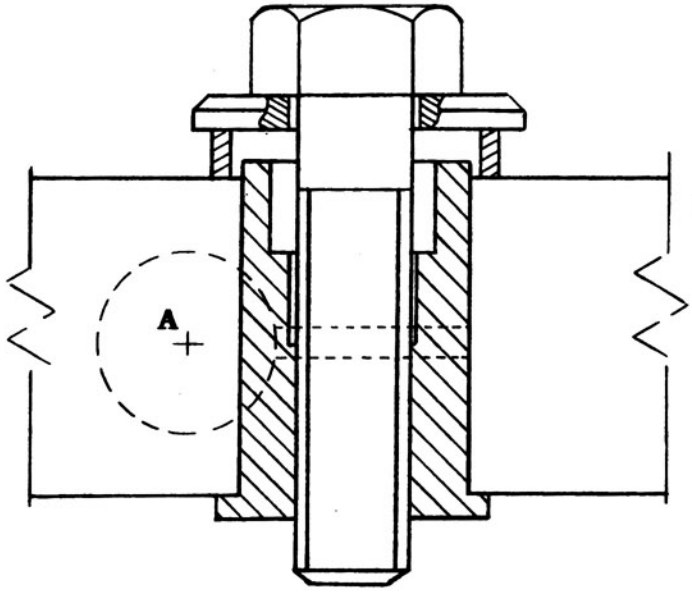
DESIGNING A SPLIT COTTER FROM SCRATCH

Figure 7
MACHINING & FITTING A SPLIT COTTER



7(a)

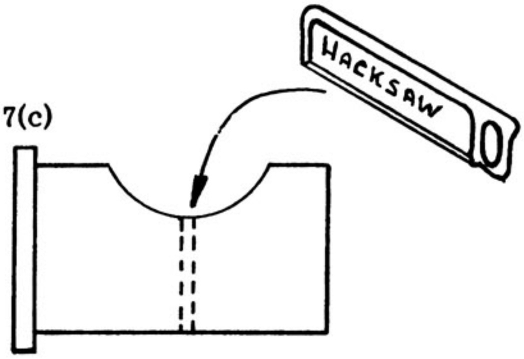
The cotter blank....



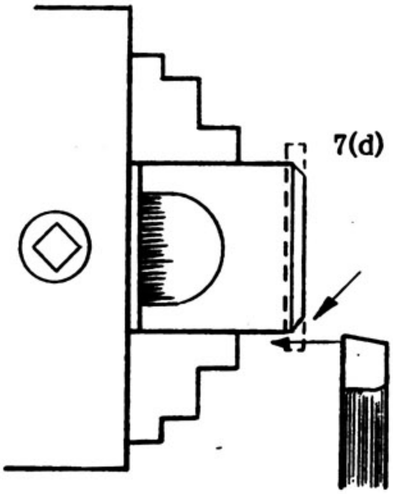
7(b)

.... is clamped in place for boring of Hole A....

7(c)

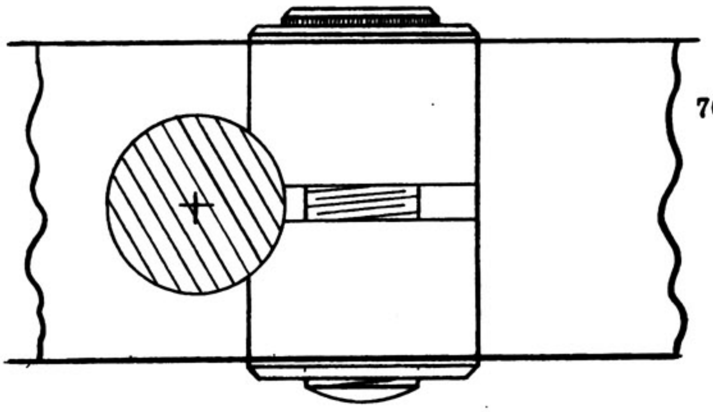


....sawn in two.....



7(d)

....the flange removed, and the ends faced, whereupon it is....



7(e)

....completed and installed.

hole for the spindle drilled and bored or reamed. Finally, the cotter blank is removed, split, cleaned up, and the parts assembled.

The commonest way to secure a split cotter blank in its hole for cross machining, is to make the cotter as a flanged blank, e.g. Fig. 7(a), which is secured in its hole as at Fig. 7(b). After machining out the spindle bore, the cotter blank will look as at Fig. 7(c). We put a hacksaw through the middle of the little notch, chuck each of the halves, and clean up the sawn face. In the case of the flanged half, we first chuck it the other way around to face away the flange, 7(d). Obviously, the space between the 2 halves of the cotter need be no more than that provided by the hacksaw cut, but it would be rather slovenly not to clean up the sawn face. It goes without saying that the various sharp corners are champhered ever so slightly, 7(e).

Note: If a cotter is fitted according to dimensions which yield a rather shallow cut-out in the cotter, the cotter may have too much wedging action, and too little clamping action. (The two are not the same.) This can be corrected by widening the split by facing off a little more from each of the two halves, when cleaning up the sawn faces. I mention this so that you will be able to keep an eye out for it in case you ever run into it in a cotter installation you may create.

SOLID COTTERS

Now, what about solid cotters, as at Fig. 5? In the Versatile Dividing Head (VDH) design, G.H.Thomas uses a pair of 3/8"Ø solid cotters with the exposed ends threaded 1/4-BSF (closest North American equivalent: 1/4-28), with a washer and a nut on top of each, to lock the 5/8"Ø Tailstock Overarm in place in the VDH main casting.

He puts a 1/4" tapped hole between the two 3/8" holes for the two cotters, stuffs the cotter blanks into their holes, puts a short piece of 1/4 x 1/2" CRS over the tops of the two, and screws a 1/4" bolt down through a hole in the 1/4 x 1/2" CRS clamping piece, to push the cotters rigidly down into their holes while the 5/8"Ø bore is produced. That done, out bolt, off clamp, out cotters, and on with the job. Later, face about 1/32nd off the bottom end of each cotter, then in cotters, in 5/8"Ø Tailstock Overarm, on washers, on nuts, two tweaks with a wrench, and the Overarm is locked solid.

However, it is not always possible to arrange for a means of pushing a solid cotter down into its blind hole for cross machining. Where it is not, I have found a simple way to secure such a cotter in place for machining, and have used it with complete success on several occasions. Simply Loctite the cotter blank in its hole. When the Loctite cures, bore out the hole for the spindle as if the cotter blank was clamped in place. That done, heat the job to break the Loctite's hold, clean off the charred Loctite, and put the part in salt and vinegar for half an hour or so to remove the discoloration due to heating.

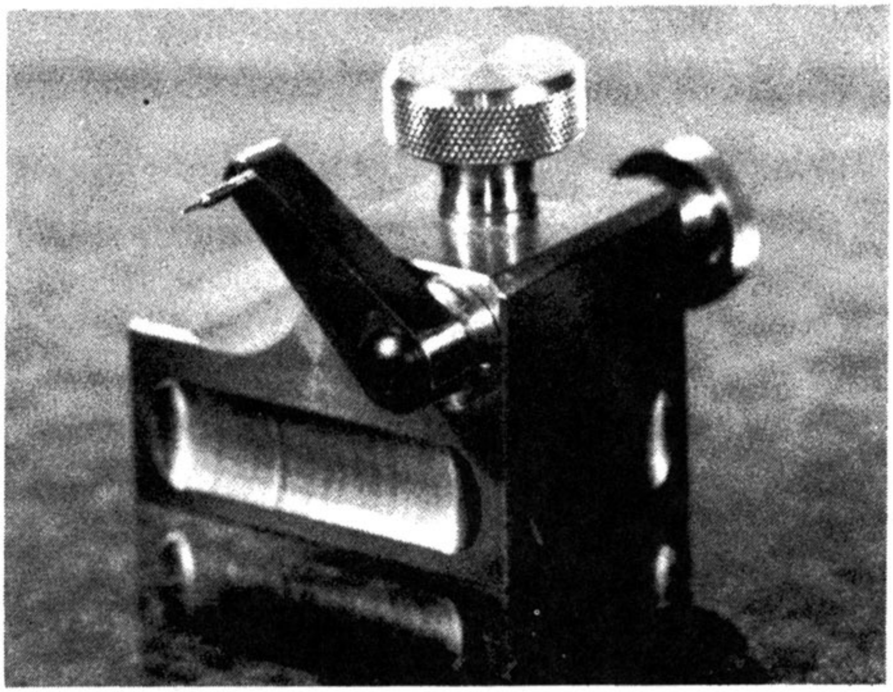
> NOTE: there are several types of Loctite made, for various specialized uses. The type most useful to the average machinist is probably Loctite #601. This designation has recently been changed to Loctite #609. The Loctite bond breaks up at about 400/500°F. Apply heat to the head of the screw or other inserted item, and let it flow down into the bonded area – no need to heat the whole assembly. **NOTE:** Don't breathe the fumes released when Loctite is heated – as I understand it, they're poisonous.

The fitting of another cotter, complete with preload spring, as at Fig. 4, will be described in the next section.

A SMALL SCRIBING BLOCK

Some years ago I bought an Eclipse #100 Surface Gauge, which is pretty much like Starrett's #56 Toolmakers Surface Gauge. The base is 2-1/8" x 1.75", the spindle 7/32"Ø x 4", and the scriber 3/32"Ø x 4". It has proven to be an extremely useful tool. Because of its small size it is handy around the lathe and the vertical mill, as well as on the surface plate. A couple of years ago I acquired an old Starrett #57 surface gauge, which is larger. I would not want to part with either, but the smaller one sees more use.

Even if you already have a conventional toolmaker's surface gauge and/or a "full size" one, you might still like to make the small surface gauge shown here.



George H. Thomas described his version in **M.E.** August '78, page 969, it being an improved version of one shown by "Duplex" in **M.E.** in 1948 and again in 1966. In his article, Mr. Thomas suggested a minor change from the way he made his own. I incorporated that change and some others when I made drawings for mine, shown here, with GHT's kind permission.

The main difference between mine and GHT's is that in mine the scriber arm can be reversed on its spindle, to get the scriber point "out of harm's way" when not in use - see photos. Also, GHT specified a larger radius for the cut away area back of the spindle and cotter holes. I put finger grooves on all four, instead of just two, sides. All these are minor differences, but I like mine better.

CHOICE OF MATERIALS

I made the scribing block Body from grey Meehanite cast iron. This material machines nicely and takes a nice finish. Cast iron is preferable to mild steel for jobs where a knock or bump could cause problems: cast iron is less likely to deform - you know how slight a knock it takes to cause a dent and/or a bump on the edge of a piece of CRS for example. If you make the scribing block from mild steel, and caseharden it, or from tool steel, and harden it, it'll be as ding-resistant or more so than cast iron. Nothing wrong with either of these materials - it just depends on what you can get your hands on. I happened to know a very obliging foundry owner.

The remainder of the parts can be mild steel, with brass for the cotter if you like. The spring is 0.029" dia. piano wire (or some size near that), and the scriber can be made from 3/32" drill rod, or an old gramophone needle can be used if you have some. That's what I used, because my wife gave me a whole bottle of them.

MAKING THE BODY AND THE COTTER

Face the material for the Body to size: 1-7/8" x 1-7/32" x 1-1/8". Ream the 3/8" hole for the cotter.

PREPARING THE COTTER BLANK

Before we can proceed further, we need to **make the blank for the cotter**. Do this as follows (make from 1/2" CRS or brass):

1. Turn down to 5/16"Ø for 1.125", and screwcut 24 tpi for 3/4" of this. Make the next 5/8" to be 0.375"Ø, and part off leaving a 1/2"Ø x 1/16" flange.

2. Put this piece in the hole in the main block, flange on top, and secure with a hex nut and washer on underside.

3. Clamp the Body in mill vise and drill/ream 1/4"Ø for Spindle. Unship from vise.

4. Chuck cotter piece by 3/8"Ø portion and turn the 1/2"Ø flange down to 0.370"Ø and face off about 1/32".

5. Grip carefully in bench vise by 5/16"Ø piece, and saw upper half of cotter off at center of cotter notch, and....

6. Saw lower cotter half free from 5/16"Ø portion.

7. Chuck each cotter half in turn and face the three sawn ends, facing away the 5/16"Ø stub exactly to the 5/16"-3/8"Ø shoulder.

8. Drill both cotter pieces clearing size for 10-32 screw. Use your 3-jaw if it centers well. If not, use a collet, or use the 4-jaw and indicate true.

This completes the cotter. **Work then proceeds on the Body again, as follows:**

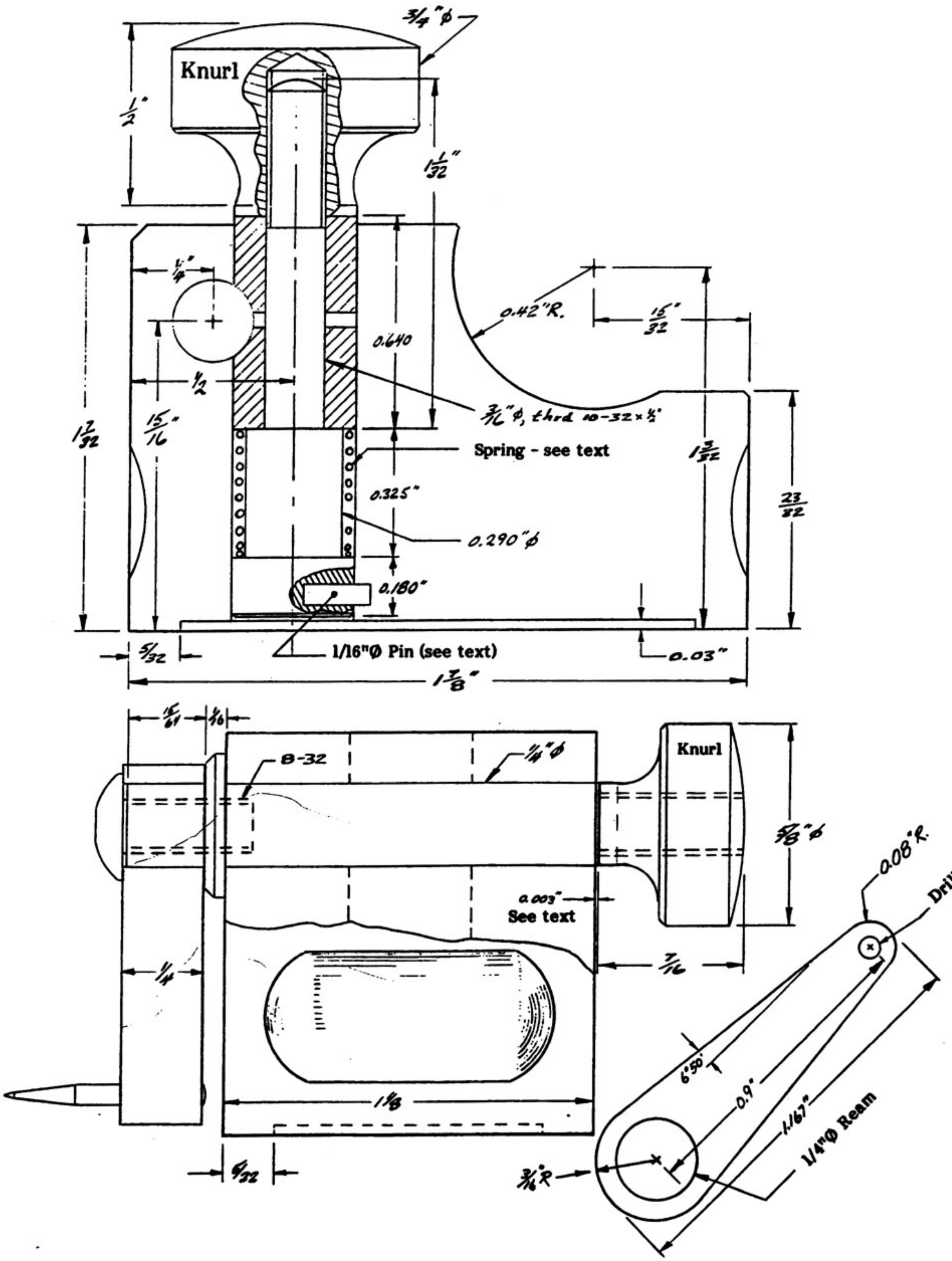
Set the main Body upside down in the mill vise, and mill out a recess in the working face about 1/32" deep and about 13/16" x 1-9/16" - this will leave a rim about 5/32" wide all around, for reduced friction (..."freer movement on the surface plate..." says GHT). If it tends to stick to the surface plate in use, file a little notch in the rim, not very big, but enough to provide an opening to the atmosphere.

The cotter bolt has a 1/16"Ø pin Loctited in a 1/16" hole in the head. Let about 1/16" protrude. (Make this pin from 1/16" drill rod if you have some - and if you don't, get some - it's a handy size to have around for various purposes.) Mill a pocket about 1/8" wide, 3/16" deep, 3/16" long in the underside of the Body, breaking into the 3/8"Ø reamed hole. This provides both a space and a stop for the pin in the head of the cotter bolt. See photo.

Set the Body upside down in the mill vise to mill the finger grooves. I think these grooves look better if not cut the full length of each face. Blue each face. Using your oddleg caliper, lightly scribe a guide for the ends of each cut, about 1/8" in from each side. Cut all 4 grooves to the same depth for good appearance. I take 'em in to about 45 thou deep.

To cut the 0.42" radius at the rear of the Body, start by scribing its outline, then hacksaw and mill

A SMALL SCRIBING BLOCK



away the bulk of the material with a 3/8"Ø end mill or slot drill, in a crude series of incremental cuts. Don't go over the line! Finish the job by setting the Body on its side in the mill vise, with a spacer about 1/2" thick between the head (where the cotter bolt's knurled nut will be) and the fixed jaw - this gives room for the cutter to do its thing without crashing into the hardened vise jaw plate. Use a boring head to clean up the roughed out cut.

Note that in the procedure described in the above paragraph, the center for the 0.42" radius is lost, so the location is picked up again by eyeballing the sweep of the cutter to close-as-possible agreement with the scribed line. A nice finish is more to be desired than perfect placement/dimension for the radiused surface.

After the radius is cut, set right side up in the vise, and take a cut over the flat at the back end of the Body, to clean up the sawn surface. Now you see why we don't make the curved face tangent to the flat - why make life difficult?

Bevel all edges carefully - not more than 1/64 to 1/32" at the most, to retain a nice crisp appearance - and lightly round all the corners so the tool feels nice to handle.

SCRIBER ARM SPINDLE

From the 7/16"Ø flange to the point where it shoulders down to 3/16"Ø for the knurled knob, the Spindle which carries the Scriber Arm should be about 3 thou longer than the 1.125" width of the Body. The 3/16"Ø portion can be threaded 10-32, as indicated on the drawing, or left plain. In either case the 0.003" extra prevents the knob and washer from clamping on the Body - which effect is NOT wanted. Screw and/or Loctite the knob on the end of the Spindle.

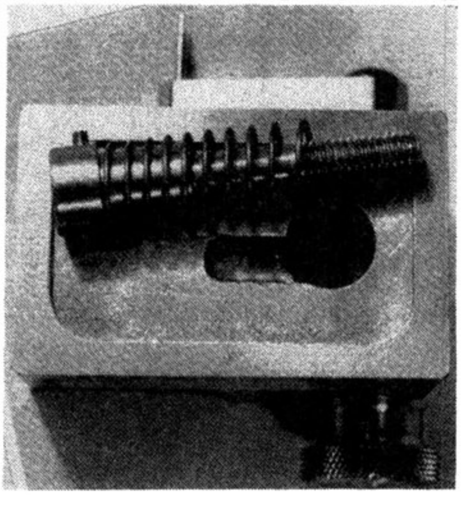
SCRIBER ARM AND SCRIBER

The Scriber Arm is straightforward - mill, ream, drill and file from 1/4" CRS or clean HR plate. The screw used to clamp the Scriber Arm to the Spindle is a hex socket button head cap screw (available from Power Model Supply Co., Travers Tool Co., or J&L Industrial Supply - see Appendix - if not locally). These screws are good looking, and superior in quality to an ordinary slotted screw. The use of a screw here permits the scriber arm to be removed and reversed, whereupon the fiendishly sharp scriber point can be tucked into the radius cut-out at the rear of the Body, for safer storage in one's toolbox. To have to reverse the arm to bring the scriber into play may be considered a nuisance. If you can't be bothered, well, just don't do it.

I Loctited a gramophone needle in place for my scriber. It is easily removed with heat and pliers, if needing to be "sharpened" (for which read "replaced"). If no gramophone needles are available, make from 3/32"Ø drill rod, about 5/8" overall length, harden and temper to a light straw color - 430/450°F. Finish by sharpening in the lathe with a fine India stone. What you want to end up with is a small and very sharp 60° included angle point, or some reasonable approximation thereof.

SPRING

My spring is 10 turns of 0.029" piano wire, free length 7/8". See info on spring making elsewhere herein.



Underside of the Small Scribing Block showing pocket milled in Body to take 1/16" drill rod Pin seen projecting from upper left of spring wrapped bolt.

CUTTER BLOCKS
AND SHOP-MADE CUTTERS

When a special cutter is required in the workshop, and either because on that day it can't be got, or it's an oddity you just can't buy, you have to turn to and make what you need.

I find the making of cutters interesting, and regard it as a challenge to "see just how good a cutter I can make this time". If you want to make good cutters, and do it conveniently, the "cutter blocks" illustrated herewith will be worth the little effort it takes to make them. A cutter block is simply a cheap, quick and dirty device for indexing a cutter blank around for milling in the flutes.

These blocks, in both square and hex forms, can also be used for other workholding jobs: milling heads on special bolts, putting a flat on a small shaft, or cross drilling a job with two holes exactly at right angles, etc.

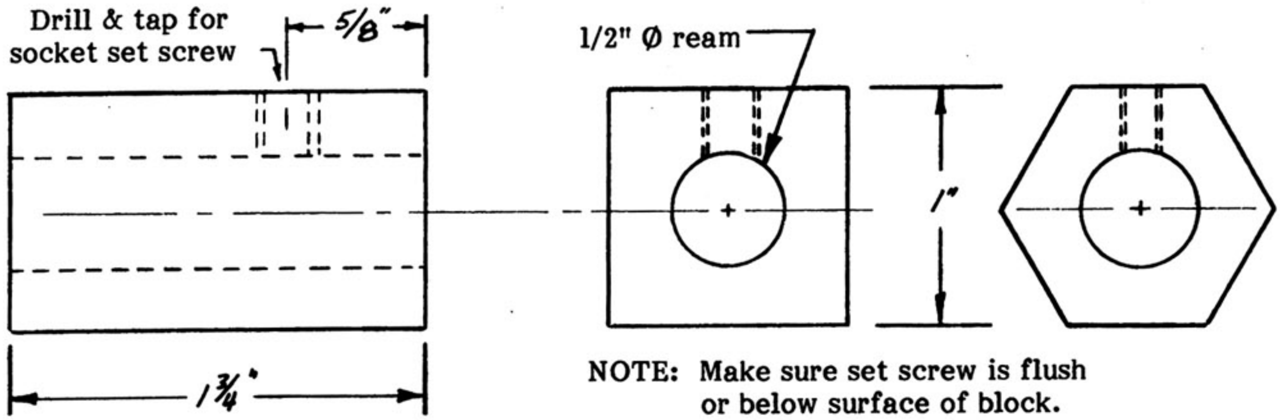
A cutter block can accommodate more than one size of cutter blank by means of reducing sleeves which adapt from say 1/2"Ø to 3/8"Ø, 3/8"Ø to 1/4"Ø, or as needed.

To the extent that you can do so, standardize on two or three diameters of cutter shank, say 1/2", 3/8", and 1/4". Get yourself a length of drill rod in those sizes, and use the first piece off each of them to make a D-bit reamer, (which see elsewhere herein).

Drill the block (and reducing sleeves, if any) near to size, then use this new reamer to ream the holes to size. D-bit reamers should be used at low speeds, and with plenty of cutting oil, withdrawing the reamer frequently to clear chips from the hole, because this type of reamer provides little space for accumulation of cuttings.

Face and bevel both ends of each cutter block, drill and tap for the set screws, and you're done.

> Note: It is sometimes desirable not to have perfectly spaced flutes, because a uniformly fluted cutter is more prone to chatter than is an irregularly fluted cutter. However, I find that making an irregularly fluted cutter takes more time and trouble than making a like cutter with uniformly spaced flutes using a cutter block.



MAKING YOUR OWN CUTTERS

The making of a cutter usually requires some sit-and-think time, and a sketch or two to help the process. If you will put some extra info - cross slide infeeds, individual and cumulative linear dimensions (leadscrew handwheel) and angles - on the sketch, you will recoup much of that thinking time when you start to make the cutter blank.

In some cases, something more than a rough sketch is required. Draw up the cutter blank in profile at say 4 or 7 or 10 times full size. On a separate piece of paper, draw a circle at the same scale, representing the O.D. of the end mill or slot drill you will use to mill out the flutes in the cutter blank.

A side view of your end mill may also be useful; if so, draw a rectangle - complete with centerline - at the appropriate scale.

Now overlay the circle (or rectangle) on your cutter blank drawing, and move it around until it is correctly positioned to produce the flutes you need. Using a compass point, transfer the center or centerline of the 'cutter' onto the cutter blank drawing beneath.

You can now measure, on the cutter blank drawing, the necessary distances between the milling machine spindle centerline and the side and end of the cutter blank. Because the drawing is so big, (at 10x full size, a 1/2" O.D. cutter will be 5" across) you can measure your drawing with the inside jaws of your dial caliper, and divide by 10 (or whatever the drawing scale is) to obtain your feedscrew dial settings with a degree of accuracy which will be more than adequate for the purpose.

This scaled up drawing technique can be used to determine angles, as well. And remember, all the trig and geometric relationships hold true whether the dimension is in hundreds of feet or thousandths of an inch.

A collet in the lathe spindle nose seems to me the nicest, quickest and most accurate means of chucking stock size drill rod when a cutter blank is to be turned up. Lacking a collet, chuck the material in the 4-jaw chuck, and indicate true before machining. If appropriate, drill a center hole for future use.

When the cutter blank has been turned to finished dimensions, part off at desired length, and reverse the cutter blank in the chuck (or collet), center up as before, face & bevel the end, and again drill a center hole for future use - e.g. sharpening.

If oversize material is machined down to bring both cutting area and the shank portion to size, I would recommend you put in a pair of center holes to start with, and then do the rest of the job between centers. It is thus readily removed for examination, and can be reversed end-for-end, and removed and returned to the lathe any number of times while you are working on it.

When the cutter blank is turned to spec, stick it into the appropriate cutter block, tighten the set screw, and then clamp the cutter block in your machine vise for flute milling.

After fluting, hand file the reliefs on the back side of the teeth, still holding the cutter blank in the cutter block, the latter being gripped in the bench vise or, often handier, in the smaller vise on its swivel base.

Examine all over with a magnifying glass, apply any necessary finishing touches with a fine cut needle file, and/or a whetstone. Finally, heat treat the finished cutter.

For details on heat treatment of shop-made cutters, see the excerpt from my fiction book, "Strike While the Iron is Hot", earlier in this book. If the steel's got enough carbon in it to harden, it'll harden for sure if you do what John Kelly did.

I'll bet you won't be able to suppress at least an inner smile, the first time you use a newly made cutter.

Other materials besides drill rod will serve for making cutters. Hot rolled tool steel is cheaper than drill rod, and would be a sensible choice if the whole cutter, including the shank, is to be machined. Drill rod has obvious advantages where it can be used, which is most of the time.

I have also used hot rolled 4140 for a couple of cutters and some other things I've made, partly because I lucked onto a lifetime supply in the form of 1" dia. bars from about 3" to 12" long, at a shop where it was being used for making large shackle bolts for leaf spring installations in heavy trucks. In the annealed state it turns like butter, taking a fine finish from a sharp tool, and it hardens satisfactorily, in spite of its relatively low carbon content. For a one-time-use cutter that does not have to cut a lot of metal, and that is not going to be "pushed", 4140 has a place in the average amateur machinist's home workshop. If you find some in your scrounging travels, don't leave until the tail end of your car is dragging.

If a special cutter is required for a particularly critical job, consider the possibility of making and heat treating it yourself, and then having it ground to spec on a tool and cutter grinder (T&CG), either at a professional shop that does this type of work as a business, or at a technical school, or...

NOTE:

See also page 124 herein for a description of the TINKER,
a Tool and Cutter Grinding Jig which you can build.

SOME INFO ON SILVER SOLDERING

CONTROLLING THE SPREAD OF SILVER SOLDER

To keep silver solder from flowing onto areas where you do not want it, and thus messing up a joint, smoke the parts with an acetylene flame (no oxygen). Then clean the soot from just those areas where the silver solder is to be.

Adapted, with permission, from a tip by gunsmith Dan Plamondon (Crescent City, CA) in **Gunsmith Kinks, Vol. II**, page 437.

GETTING SILVER SOLDER TO FLOW NICELY

Just had a call from a home shop machinist in N.Y. He passed on the following to me. It might be of interest to some reader:

If you want an excellent solder flux, try "Stay Silv" from Small Parts Inc. (see Appendix). This stuff apparently works in the conveniently wide temperature range of 700 to 1800 deg. F and makes silver solder flow very smoothly. One silver solder alloy it can be used with is "Safety Silv", catalog #SO-SC244, which is made by the same people who make this particular flux. According to my caller, Small Parts Inc. also sells an aluminum soldering kit.

GOOD SILVER SOLDERING TECHNIQUE

When silver soldering, always flux the silver solder as well as the parts to be joined.

This story was originally published in the October 5th, 1940 issue of the Saturday Evening Post. It was one of a series of stories woven by Lucian Cary around the character of J.M. Pyne - a character whose unmistakable resemblance to legendary barrel-maker Harry M. Pope makes these stories all the more appealling. I first encountered "The Secret of the Old Master" in the 1975 Gun Digest, and have read it, with much enjoyment, at least half a dozen times.

When I began writing this book, I knew I wanted to include in it "The Secret of the Old Master". My quest for the copyright holder led from the Gun Digest people back to the current publishers of the Saturday Evening Post, and from there to a firm of literary agents in New York. From there the trail led to the phone number of a house in Connecticut, the tenant of which gave me a phone number to call in New York. This was the end of the trail: the author's granddaughter, Eve Cary heard my request, went to some trouble to confirm that Lucian Cary's heirs did in fact own the rights to his work, and wrote me a very gracious letter granting the Cary family's permission to reprint "The Secret of the Old Master".

Lucian Cary passed away September 7, 1971 at the age of 85.

THE SECRET OF THE OLD MASTER

by

LUCIAN CARY

Joe Hill had two target rifles in cases of canvas and leather hanging from his shoulders as he walked down a factory-lined street in Jersey City of a hot Saturday afternoon in August.

He guessed, after half a mile, that he had come to the right corner. There was the little red-brick saloon across the street and here beside him was the outside stairway sheathed in corrugated iron.

He eased the rifles off his shoulders. They weighed fourteen or fifteen pounds apiece. He sat down on the curbstone and stood the guns upright between his knees. He wanted to rest. But mostly he wanted a minute or two in which to get up his courage. He had sat up all night and all morning in a day coach. He had slept at times, but he had awakened always to the same anxiety. Somehow he had to impress the old man, and by all accounts the old man was not easily impressed.

A hot breeze came down the street between the gray-brown walls of the factory buildings. The cobblestones shimmered in the heat. He knew how bad the mirage would be on a day like this. You would think you were looking at the target through running water. You wouldn't know where the bull really was.

He wiped his face with his handkerchief. He could feel the water running down his chest. He could see where the sweat had turned his blue work shirt a darker blue. He got up presently and hung the rifles on his shoulders and tried the door at the bottom of the stairway. The door was locked. He walked across the street into the saloon. The place was empty, except for the bartender.

"Where is J.M. Pyne's shop?" he asked.

"You mean the old man who fixes the guns?" The bartender pointed through the open door. "Up that stairway. Fourth floor."

"The street door is locked."

"When it's after hours you have to yell for him to come down and open the door for you."

Joe hesitated. It didn't seem right that he should yell to a man as famous as J.M. Pyne to come down three flights of stairs and let him in.

"They all yell for him when they come to see him," the bartender said.

Joe walked out into the middle of the street and looked up at the fourth storey. The window nearest the corner was open at the top.

"Hey, Pyne!" he called out.

There was no answer.

"Hey, Pyne!" he yelled as loud as he could.

The window he was watching went up and an old man with a white beard and a black engineer's cap peered out. He pointed to the stairway.

Joe waited at the door. He heard the old man's slow footsteps. The moment for which he had worked and waited and saved his money was coming.

The door opened and the old man stood there, in a sleeveless undershirt and pants, looking over his spectacles at Joe. The old man had brown eyes. His nose was finely molded. 'You'd know,' Joe thought, 'that he was somebody, even if you didn't know who he was.'

"Mr. Pyne," he said, "my name is Hill - Joe Hill."

"Come in," the old man said, and held the door wide.

Joe walked up the stairs while the old man climbed wearily after him. The air was hot and dead under the iron roof of the stairway and the rifles dragged at Joe's shoulders. But he was happy. He was going to see the place he had dreamed of.

The room he went into was fifty feet long and thirty feet wide, and so full of things that only a narrow gangway remained. He walked toward the bench that ran clear across the room under the bank of windows at the far end, guessing that the long narrow boxes standing on end contained rifles waiting for Pyne barrels, noting a drill press, no longer in use, and what looked like a lathe, but wasn't. He took another look over his shoulder as he passed the machine. It seemed too light and too simple. But it must be the machine from which, for fifty years, those barrels, so smooth inside, so even, so beautifully rifled, had come.

There was so little room in front of the bench that he paused to let the old man pass him. Except for a small clear space around the vise, the bench was piled three feet deep with open cigar boxes and cartons and letters and tools.

"Take off your coat," J.M. Pyne said. "It's warm."

Joe took off his coat and hunted for a place to put it. He laid it across a rack of barrel stock.

"Mr. Pyne," he said, "I've got one of your guns here."

He opened one of his cases and took out a .22 caliber rifle of the sort that is made for offhand shooting when there are no restrictions as to weight or trigger pull or sights. It had a long barrel as thick as a crowbar and a Ballard action with double-set triggers.

The old man opened the vise and dropped clamps of sole leather inside the iron jaws. Joe put the heavy barrel in the vise. The old man opened the gun and picked up a steel rod that stood against the bench, and a pledget of absorbent cotton.

He put two pledgets through the bore to get the oil out and held the gun up to the light and looked through it. He let the gun down and studied the open breech.

"Who cut it off?" he demanded.

"I did."

"What for?" The old man's eyes were no longer friendly as he looked at Joe.

"The chamber had been rubbed several thousandths out of round at twelve o'clock, so it wouldn't shoot any more."

"They will do that," the old man said. "They won't take the trouble to push a cleaning rod straight, so it doesn't rub."

The old man pushed the lever back and forth, studying the extractor, which was of the kind that travels parallel to the bore in a T-slot. Joe knew that extractor was a nice job. But the old man said nothing. He closed the action. The lever made a distinct snap as it passed dead center and the block came home, the way the lever of a falling-block rifle should.

"The action was in tough shape when I got it," Joe said. "I made new pins for the lever and the link."

The old man took the forearm off the gun and looked at the numbers stamped on the underside of the barrel. Then he got an old notebook out of a drawer under the bench and leafed through it.

"I made that barrel in 1923. I didn't put it on a Ballard action."

"The fellow wanted to keep the action it was on."

"What did you do about the firing pin?"

Joe picked up a screw driver and took the block out and handed it over.

The old man studied the face of the block with his magnifying glass.

"Where did you get the idea of that circular plate?"

"From one of your guns."

Joe knew his work was good. But he could guess what the old man was thinking. Maybe he was bored.

J.M. Pyne walked down to the other end of the bench and got cigarettes. He offered Joe a cigarette. Joe said he didn't smoke. The old man lit his cigarette deliberately.

"What's your trade?"

"I'm a toolmaker."

"How old are you?"

"Twenty-six."

The old man looked at him sharply. "They used to say it took twenty years to make a toolmaker out of a good mechanic."

"I'm still learning."

"So am I," J.M. Pyne said.

He took a cigarette paper and laid it across the breech of the barrel and raised the lever. He had to force it a little. But he closed the gun. He opened it again. The cigarette paper was torn away where the block had met the breech. The block was so closely fitted that it wouldn't quite accept the cigarette paper, yet it worked freely.

The old man picked up his micrometer and measured the thickness of the paper. It came to an even thousandth of a inch.

"Do you know how much your head space is?"

"Forty-three thousandths."

J.M. Pyne looked down at the gun. "I don't see anything the matter with it," he said. "How does it shoot?"

"Not as well as a Pyne barrel should. I've tried every kind of match ammunition in it. I haven't found anything that will average better than an inch and three eighths for fifty shots at a hundred yards."

The old man went down to the far corner of his shop and turned on a light and put up a card about five by eight inches in front of a small steel plate. He handed Joe a pair of field glasses.

"If you sit on that stool and rest your elbows on the lathe bed so you can hold the glasses steady, you can see."

He took the gun to the other corner of the room and put it in a machine rest. A little telescope was mounted beside the rest. Joe saw, watching everything J.M. Pyne did, that he had a clear line of fire past the rack of barrel stock, between the legs of the rifling machine, and under a step ladder.

J.M. Pyne began to shoot, firing five shots, and moving the rest a little and firing another five shots. Joe Hill saw that the first group was ragged; the second group closed up, as the gun warmed. But he did not know what to expect of a rifle at such a short distance.

J.M. Pyne paused after twenty-five shots and studied a fired case with his magnifying glass. He handed the case and the glass to Joe.

"Your pin is too big," he said. "It's hitting too far out over the rim."

He took the firing pin out of the breech block and fastened it in the vise.

"Take this stone and the glass," he said. "Reduce it a little at twelve o'clock, but don't make it any shorter."

Joe worked cautiously with the oil stone. When he paused for a moment the old man took the glass and looked at the rounded end of the pin and nodded to Joe to go on. Joe felt the sweat dripping down his body as he worked. It was hot in the shop. But he would have sweated anyway, doing a job like that with J.M. Pyne watching him.

"All right," the old man said at last. He put the firing pin back and tried a fired case in the gun. He turned the case about under his magnifying glass.

"That may help it," he said. "The area is reduced, so it's hitting deeper, and in the right place."

He put the gun back in the rest and fired five more groups of five shots each. Joe could see that they were closer than the previous groups. J.M. Pyne went down and got the card and brought it back. The groups were only a trifle bigger in diameter than a .22 caliber bullet.

"That gun is all right," J.M. Pyne said.

"Can you really tell - at fifty feet?"

"Yes. You should get some groups under an inch at a hundred yards. I'd guess it will average an inch and an eighth when everything is going right and there's no wind. It won't do it day in and day out, of course. It'll pick up a bit of lead or hard fouling now and then, like any twenty-two, that'll make it throw wide ones until it shoots out."

Joe knew the moment had come to say what he had come all the way from Indiana to say. How could he say it? Now that he was here he felt how out of line it would sound.

He thought of showing J.M. Pyne the other gun he'd brought along. But it was a Springfield bull gun to which he had fitted a factory-rifled blank. There was nothing about it that would interest the old man.

"I guess...I guess I've taken enough of your time."

J.M. Pyne smiled. "I'm old and I'm tired and I ache all over. My eyes are no good. I can't shoot any more. But I've always had time for anybody who was interested in rifles. What do you want to know?"

"Mr. Pyne --" Joe began, and for a moment the presumption of what he was going to ask overcame him. He knew he was a good workman. But who was he to propose himself as successor to the old master of them all?

"Mr. Pyne," he began again, "couldn't you use a helper?"

The old man shook his head. "I've had two or three helpers in the last thirty years. They got underfoot."

Joe Hill waited.

"Besides," J.M. Pyne said, and Joe could feel that he was softening the blow, "making fine shooting rifles isn't a paying business. I can't afford a helper."

"I wouldn't expect to be paid," Joe said. "I've saved some money."

He had $229 in his pocket. He knew that a man could live for four or five months on that if he wanted to.

The old man turned on him then. His eyes blazed as he spoke.

"Why do you want to work for me for nothing?"

Joe could not dodge the question. He had to tell the truth.

"I want to learn the secret of Pyne barrels."

The old man nodded grimly. "I thought so. You....and a lot of others.

"You're the most famous maker of rifle barrels that ever lived. What's wrong with wanting to learn what you know?"

"And setting up shop in competition with me."

"I wouldn't do that unless you said I could."

J.M. Pyne looked off into the dimming corner of the shop. When he spoke, he seemed to be talking to himself.

"I gave a fellow the run of my shop once. I told him all I knew. And he started out making rifles. I wouldn't have cared, if he'd done a good job. The more fine shooting rifles there are in this country the better. But he didn't make fine shooting rifles. He chambered guns without a pilot on the reamer, so the chamber wasn't concentric with the bore. He botched everything he touched. Time after time men came in here with guns he had made and I had to fix them."

Joe wondered why he'd felt he had to fix the guns his rival had spoiled. He thought he knew. It was part of the old man's passion for fine shooting guns.

"Mr. Pyne --"Joe began. But it really wasn't any use. You couldn't argue with an old master who didn't choose to give you his secret lest you abuse it.

"You come back tomorrow," the old man said. "Come back tomorrow and I'll show you how to fix the triggers on that offhand gun of yours so the front one won't kick. Leave your guns here tonight."

II

Joe went back to New York by the Hudson Tube and found his way to the Grand Central, where he'd checked his suitcase and his kit of tools. He carried the double load down 42nd Street to Eighth Avenue. He got a room in a small hotel for a dollar. The little room was hot, without a breath of air. He went out and walked back across 42nd Street until he came to Fifth Avenue.

He had never seen Fifth Avenue before. He felt he ought to be thrilled by it. He got on a Fifth Avenue bus and rode down to Washington Square and back. It was almost cool on top of the bus. And there was something about rolling down Fifth Avenue of a summer night, when the biggest city you'd ever known was Richmond, Indiana. But for Joe Hill the magic was in a cluttered, dusty room, four stories up, in a gray factory building on the other side of the Hudson River, where for so many years J.M. Pyne had done the work no one else in the world could match.

He awoke at dawn the next morning and remembered then that it was Sunday. J.M. Pyne must have forgotten that today would be Sunday, when he'd said to come. But perhaps he hadn't. Joe took his kit of tools. He might need it, and he didn't dare leave it where it might be stolen. He couldn't take a chance on a set of micrometer calipers and a micrometer depth gauge and the chambering reamers and gauges and counterbores and milling cutters he had made for himself through the spare time of several years.

He was sitting on the curbstone close to the locked door of the outside stairway when he saw the old man coming toward him.

"Good morning, Joe," he said. "I'm sorry to be late. I try to sleep on Sunday mornings. I seldom get here before half past eight...

"The trouble with those factory triggers," J.M. Pyne said, when he had taken off his Sunday clothes, "is they're on small pins. The least bit of wear and they wobble from side to side. They want to be on trunnions. And I put in a kind of recoil block, so the front trigger doesn't kick."

Joe Hill worked for hours, under the old man's direction, remaking the triggers of the offhand gun. Toward three in the afternoon J.M. Pyne remembered that they hadn't eaten. He got out a paper bag of sandwiches and two cans of beer, which he cooled a bit under the tap. They sat opposite each other, eating corned-beef sandwiches and drinking half-warm beer, and the old man grew expansive, and told stories of the days when he had made world records with a rifle. Joe Hill asked himself if it was really he, sitting there in friendly conversation, as if he were an equal, with J.M. Pyne.

They went back to work then. They worked until the light failed and J.M. Pyne turned on the powerful electric bulbs over his lathe and bench. Joe thought the job was done at nine o'clock that night. But the old man, trying the triggers, shook his head.

"They're too light," he said. "Maybe you could shoot them in weather like this. But they would never do in the Election Day match. You can't feel a light trigger when your finger is cold. We'll have to make a new spring."

It was nearly midnight when Joe finished the spring. He drew the temper in a gas flame while the old man watched the color. He put the spring in place. The old man tried the triggers.

He looked up at Joe Hill, smiling. "I could shoot those triggers myself. Let's go home."

Joe picked up his kit of tools.

"What do you want to carry that for?" the old man asked. "Why don't you leave it here?"

"I will," Joe said.

They paused in Exchange Place. The old man was taking a bus and Joe was taking the Hudson Tube.

Joe waited, hoping the old man was going to say he could hang around the shop as long as he wanted to. But J.M. Pyne was looking up at the sky, where the quarter moon gave some light behind the haze.

"Two more weeks of dog days."

Joe Hill was sitting on the curbstone again the next morning when the old man arrived. He hardly spoke. The old man got out a piece of barrel stock and set it up in the lathe. Joe didn't know what to do with himself, so he sat in a corner and watched J.M. Pyne turn the stock to size.

When he had done that he put the barrel in the drilling and rifling machine and got out a drill with a shank longer than the barrel.

"Come over here, Joe."

It was the first time he had spoken in three hours.

"This is my drill," he said. "It's better than any other I ever saw. It takes a smaller chip, so it doesn't choke itself."

Joe studied the odd shape of the cutting surfaces. He could see how well designed it was to drill a deep hole without choking itself. He watched with what care the old man set everything up before he started the machine and the drill began to bite into the rapidly revolving stock.

When everything was going to his satisfaction, the old man asked, "Can you file?"

"Some," Joe said. He knew the things old-timers could do with files. Few living toolmakers could do them.

J.M. Pyne picked up a malleable-iron casting with a curve to take each finger except the trigger finger.

"That's a blank for a Pyne lever. You ought to have one on your offhand gun."

There was a lot of stock to take off. Joe filed on that lever for two days and a half, trying all through the last day to make the contours perfect.

That was the pattern of the days that followed. Week after week he went to the shop every morning, seven days a week, and stayed until the old man left, which was sometimes at six o'clock and sometimes at midnight. He saw, several times over, the process by which the old man made a rifle barrel - drilling the blank, reaming it, rifling it, fitting it to the action, chambering it, polishing it with a lead lap cast in the muzzle and pushed out just enough so it could be coated with oil and emery and drawn back, and finally testing it in the machine rest.

But watch as he would, he could not guess the secret. He suspected that the old man put him to work on some simple job when he came to that part.

III

The money he had saved was almost gone by Christmas. He was lucky enough to sell his Springfield bull gun for a hundred dollars. He lived in a tenement where he got a room for four dollars a week. He did not smoke and he had no time for the movies. He got coffee and rolls for ten cents every morning. The big sandwich he ate for lunch cost fifteen cents and his dinner at a cafeteria was forty cents. He figured he could make a hundred dollars last ten weeks.

The old man came down the street one bitter morning in February, and Joe knew he was sick. His long overcoat hung almost to the ground as he bent against the wind and felt for a footing with his stick. It took him a long time to climb the stairs.

"I've got a heck of a cold," he said, when they reached the shop. "I think I'd better lie down for a while."

He spent that day and the next lying on an old couch in a corner. He had a cough that racked him, and when he got up and walked across the shop he staggered like a drunken man.

Joe offered to get a doctor.

"Nonsense," J.M. Pyne said. "I've been my own doctor for forty years."

Joe took his arm when they left that night, and went with him on the bus and saw him safely to his room.

But he didn't stay home. He came staggering down the street the next morning the same as ever.

"I had to come," he said. "I had a letter from Paul French yesterday, saying he'd be in today. His old barrel won't shoot. He wants a new one for the Metropolitan Championship."

The old man lay on the couch, coughing as if he were turning himself inside out, until there was a rap at the door.

"That's Paul," the old man said, and staggered to his feet.

Joe opened the door to a solidly built man of fifty with a rifle in a case over his shoulder.

"How are you, Johnny?" the solid man asked J.M. Pyne.

"I'm sick," the old man said. "But I'll be all right in a couple of days."

The solid man took his rifle out of its case. It was an exceptionally heavy gun on a Ballard action.

"The barrel's gone," he said.

"Why wouldn't it be?" J.M. Pyne said. "You've been shooting it ten years."

The solid man said he wanted the barrel in a hurry, the match was only two weeks away. J.M. Pyne said he would get the barrel out.

He went back to his couch again when the solid man had left. He lay there the rest of the day. He let Joe take him home again.

"I've got to get that barrel out," he said to Joe. "He's about the best all-round shot there is. He's got to have a new barrel."

Joe walked up and down the street the next morning in a snowstorm, waiting for the old man. He didn't come at nine o'clock. Joe kept on pacing back and forth, trying to keep warm, for another hour. Then he went back to Exchange Place and took a bus to the old man's house.

J.M. Pyne sat up in bed. "I couldn't make it this morning." A spell of coughing interrupted him. "My keys are in my pants there."

He wouldn't have a doctor. He insisted that all he needed was to rest until he got over the cold. Joe took the keys and went back to the shop. He measured the barrel of Paul French's rifle. It was thirty-two inches long and slightly bigger than a Number 4. He found a piece of barrel stock long enough and set it up in the lathe and began to turn it to size.

He knew a sixty-fourth of an inch more or less in outside diameter would make no difference that the man who shot the gun would ever know. But he did the job to a thousandth.

When he called on the old man that night he could see that he was feverish and a little out of his head. He thought he'd better not mention the piece of barrel stock he'd turned to size.

Joe went on with the barrel the next day. He set the barrel up and got everything ready. He checked and rechecked the setup. He wanted that hole to come out at the other end within a thousandth of dead center, the way it did when the old man drilled it.

It took all the nerve he had to start the machine. But he did it. He stood there anxiously, watching everything. If the drill struck a hard spot in the stock, it would probably break before he could stop it.

When the hole was drilled he took the barrel out and wiped it clean and looked through it at the light, watching the shadow line. It seemed to him that the hole was straight, and as smooth as a hole drilled by J.M. Pyne.

He got out the six-sided reamers that the old man used, and measured until he found the one that was right. He set the barrel up in the lathe and reamed it, watching it every minute, and putting on the oil with a brush the way J.M. Pyne did.

When the reaming was done, he upset a soft lead slug in the bore and pushed the slug through and measured it. The diameter was right.

That night the old man said he felt better. He said he would be around in the morning. Joe said nothing, feeling that if he urged him not to come, the old man would resent it.

Joe went back to the shop at daylight the next morning and hunted out the rifling head. He knew the cutter had to be stoned just so. Sharpening it was the toughest part of the job. It was hard enough to cut glass. And if the old man came in while he was working on that cutter, he'd be furious. What if he spoiled it?

The old man had said that nowadays he had to have bright sunlight, softened by the dirty window panes of his shop, to make a rifling cutter. It took days to make one, even when the sun shone. And in winter you might not get two hours of sun in a week.

Joe waited until after ten o'clock before he dared take the chance that J.M. Pyne might come in. He worked so cautiously that it took him all day to hone the cutter.

The old man was sure that night that he would be around in the morning. Joe caught himself hoping he wouldn't be.

Joe rifled the barrel the next day, running the rifling head back and forth by hand, the way the old man did, and making a chalk mark on the head of the machine for each pass, and indexing the head for the next cut. It took forty passes of the rifling head to cut one groove two and a half thousandths deep. There were eight grooves to cut, three hundred and twenty passes. He finished the job toward six o'clock and took the barrel out and wiped it clean inside.

He took a soft lead slug out of the drawer and upset it in the bore and pushed it through. He thought it felt pretty even - without any loose places where the slug jumped ahead, or any tight places either. But his hands were trembling so that he couldn't be sure it was as good as he hoped it was.

Then he held the barrel up to the light. He could see minute toolmarks, But then, of course, you always could - even when J.M. Pyne had rifled a barrel. The toolmarks came out when you polished with the lead lap.

Joe finished the barrel the next day and fitted it to the action. But he wasn't ready to test what he had done. The old Ballard action was loose. The lever didn't snap up. It took a whole day to get that right.

The old man looked a lot better that night. He would be there in the morning. Joe would have liked to stay away. But he couldn't. He had the key to the shop.

He got there at half past seven the next morning. He took the gun out of the vise and looked through it against the light. It looked good to him. But what did looks amount to? He had made it just the way the old man made his barrels - except that he didn't know the ultimate secret of a Pyne barrel. The old man had never said a word about that since the first time Joe had talked to him when he had said he didn't want a helper. Joe put the gun back in the vise. He guessed that was the best way to tell the old man what he had done - to let him see it.

J.M. Pyne knocked on the door at nine o'clock. Joe let him in. The old man walked down the narrow gangway and paused at the vise. He looked hard at the gun in the vise, and went on to the the corner where he hung his overcoat.

Joe sat down on the couch in the corner. The old man got into his working clothes and went back to the vise. He took the gun out of the vise and looked through it. He put it back and took a lead slug out of the drawer and pushed it through and caught it in his cap. He picked up his micrometer and measured the slug.

Without a word, he took the gun and put it in the machine rest. Joe got up and found the field glasses with which he had so often sat watching the old man shoot.

"Joe," J.M. Pyne said, "what did you do about those triggers you were going to fix on that 32-40?"

"Why," Joe said, "I haven't done anything."

He'd forgotten all about them.

"You'd better get to work," J.M. Pyne said.

Joe got out the triggers. The old man began to shoot from the machine rest. Joe's back was to the target as he worked. He guessed that was what J.M. Pyne intended.

The old man shot the gun all morning, firing five five-shot groups on a card and putting up a new card, while Joe worked on the triggers in an agony of curiosity. He guessed that the old man had fired four hundred shots when he took the gun out of the rest and put it in the vise and cleaned it.

The old man said nothing and Joe didn't dare say anything.

There was a rap on the door.

"That'll be Paul," J.M. Pyne said. "How are those triggers coming?"

"All right," Joe said.

"You'd better do something else for a while, so you'll be out of my way. You go back there and read some of the old copies of *Shooting and Fishing*. You can learn a lot from those old files of thirty or forty years ago."

Joe went back to the far corner where the pile of *Shooting and Fishing* lay, while the old man went to the door. He heard Paul French say, "Johnny, I just stopped by to see how you were coming with that barrel."

"It isn't done yet," J.M. Pyne said.

They moved down to the vise at the far end of the shop and Joe couldn't hear the rest of their talk. He could only sit there and open one old copy of *Shooting and Fishing* and look through it and take up another. When he couldn't stand it any longer, he sat up and looked over the boxes between him and the old man and Paul French.

J.M. Pyne had a sheaf of targets in his hand. He was always showing targets to customers. They might be targets he'd shot ten or twenty or thirty years ago. But as he watched, the old man laid the targets down. The gun was in the vise. And now the old man was hunting in the drawer under the bench. Joe saw that he had some small tool in his left hand. He was picking up a hammer with his other hand. And now he was holding the small tool on top of the barrel.

It couldn't be anything but the stamp that cut "J.M. Pyne" in small Roman capitals on a barrel.

Joe leaned forward, staring, and the old man struck with the hammer.

Paul French was turning to go. J.M. Pyne walked down the gangway with him. He paused at the door.

"It'll take a few days to brown that barrel."

"I know," French said. "I'll be in Saturday to get it."

The old man shut the door and walked wearily back to the vise. Joe got up and went down there. It was true. Cut in the polished steel was the mark of J.M. Pyne.

The old man got a cigarette and lit it with unnecessary deliberation. Then he picked up the sheaf of targets he had been showing Paul French. He leafed through them until he found the one he wanted. He took that one out, and laid the others down and picked up a .22 cartridge. He let the bullet gently into the round hole of the first group.

"You see," he said, "it sticks." He tried the others. The bullet stuck in all of them.

J.M. Pyne looked up at Joe.

"So," he said, "I put my name on it."

"But the secret.....I don't know the secret of a Pyne barrel."

The old man shook his head.

"There is no secret." He looked at Joe Hill over his spectacles and his eyes were friendly. "Except that you have to know what nice work is and you have to be willing to take the pains to do it. You knew that when you came here - else I wouldn't have bothered with you."

When I first published TMBR#1 in 1986, I was unaware that the foregoing story was only Part 1 of a 3-part serial. The next two installments were called "No Choice," and "Revenge in Moderation." In my opinion, the third installment is one of the pinnacles of Cary's writings.

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*see TMBR#1, page 104. "No Choice" and "Revenge in Moderation" are Parts 2 and 3 of a trilogy, of which "The Secret of the Old Master" was but Part 1. "Revenge..." is even better than "The Secret..."

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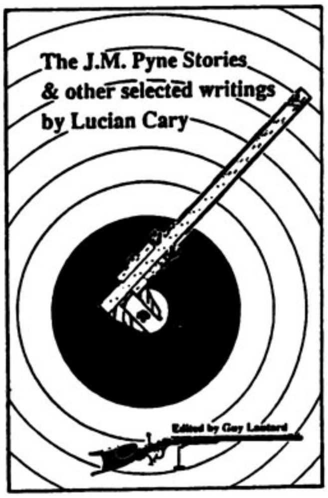

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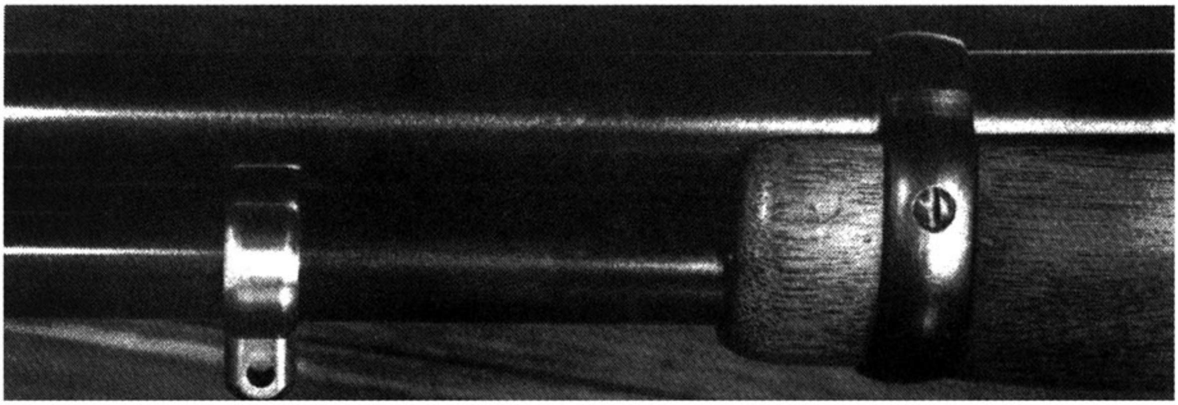
Tubular magazine rifles, be they Winchesters, Marlins, or whatever, retain a perennially and deservedly popular place in the hands of shooters and hunters. However, some of the sling swivel bases offered for installation on tubular magazine rifles are at best dubious propositions for looks and/or strength.

Therefore if you want a real nice one, you gotta make it yourself.



Herewith then complete drawings for a magazine tube sling swivel base - hereafter referred to simply as "the Base" - which is easy to make, and for which no apology need be made for appearance, or strength.

It must be made to fit your rifle. Using my own pre-'64 Winchester Model 94 as an example, **here's how, step by step:**

1. Use feeler gauges to measure the gap between magazine tube and barrel at the point where the Base will be located once installed. For my Model 94, this dimension is 0.051".

2. Measure the magazine tube diameter. For my M94: 0.650".

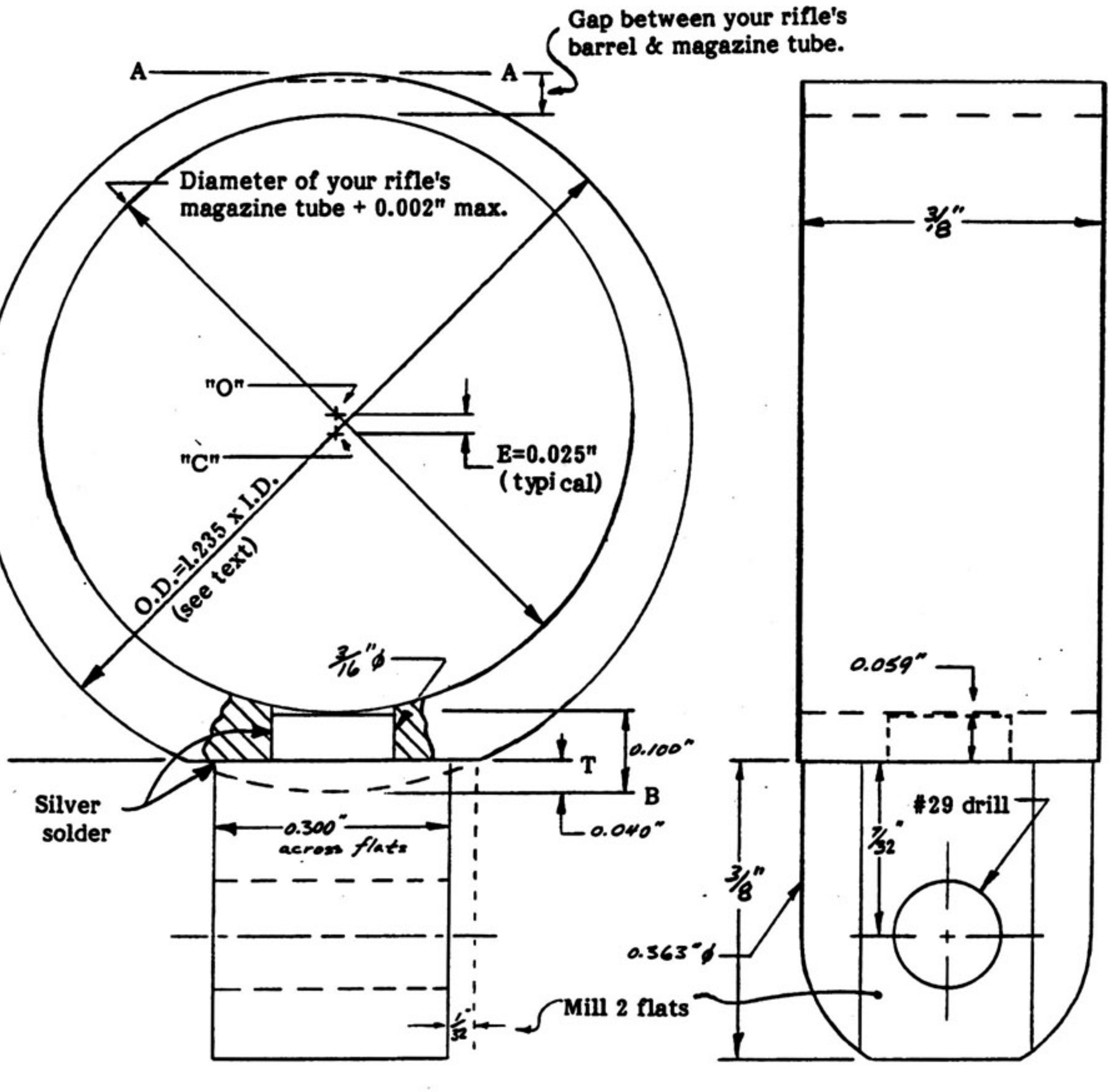
3. Using an accurate compass, draw a circle more or less centered on a piece of 8-1/2" x 11" or other convenient sized sheet of paper. This circle should be about 5" in diameter. This circle represents the magazine tube's O.D. and the Base's I.D.

4. Accurately measure the diameter of this circle, and divide same by the diameter of the magazine tube. The result will be a number probably somewhere between 7 and 8. Note this number down in one corner of the page, to 3 or 4 decimal places. This is the scale of your drawing, and will be referred to hereafter simply as "drawing scale".

5. Multiply the mag/barrel gap dimension 0.051" by the drawing scale, and draw in line A-A across the vertical centerline of the drawing, at that scale distance above the top of the circle.

6. We want the thickness of the Base band to be 0.100" at its thickest point. Therefore lay off line B at a scale distance of 0.100" below the bottom of the circle on your drawing.

A SLING SWIVEL BASE
for
TUBULAR MAGAZINE RIFLES



7. Bisect the distance between lines A and B to locate center "C".

8. Using this new center C, draw in a new circle, which passes through A and B. This circle represents the O.D. of the Base band.

9. Measure the diameter of this new circle, divide by drawing scale, and write in dimension D.

10. Measure the distance between the two centers O and C, divide by drawing scale and write in eccentricity E. It'll probably be a number on the order of 0.025".

11. Draw in a pair of vertical lines, one on each side of the vertical centerline, at a scale distance of 0.175" below the Base band which is taking shape on the paper. These represent the O.D. of the Stud which will take the actual sling swivel.

12. Draw in line T, and measure dimension F on the drawing. Divide by drawing scale, and write in dimension F, (for "Flat"). The area bounded by the dotted line will be milled away.

This completes the drawing. **Next step is to make the beast.**

BAND

Make up the mag tube band in mild steel, first boring the hole for the mag tube, aiming for -0.000, +0.001". (A handy thing to make first is a plug gauge of the same size as your mag tube.)

Once the hole is bored to size, offset the work in the 4-jaw chuck to give the desired eccentricity (say 0.025" - i.e. dimension E). (Note that the dial indicator needle will sweep out a total travel of twice the desired eccentricity, i.e. say 0.050".)

Before disturbing the dial indicator set-up, mark, with scriber marks in the bore, the top and bottom dead centers of the job in its new position. The wise machinist will make his life easier by arranging his eccentric set-up so that these points coincide with a pair of opposite chuck jaws.

Add a neat 30° bevel on both chuck and tailstock sides of the Band, and/or radius with a file to about the same profile as the rifle's barrel bands. Part off and deburr.

At one set-up, mill in the flat to dimension F at bottom dead center (i.e. the thick side) of the Band, and drill 3/16" for the 3/16"Ø locating spigot on the Stud.

SLING SWIVEL STUD

The Stud is shown at the bottom of both views of the Base. The Stud can be made, either end out, on the end of a piece of 1/2" square cold rolled steel bar, and both ways have advantages. By using square stock, the material itself will provide a built-in means of indexing the job 180° for milling the two flats on the sides of the Stud. Or make from 3/8"Ø CRS, and use a cutter block for the 180° indexing.

Silver solder the Stud and Band together, making sure the flats and cross hole in the stud are square fore, aft and across with respect to the Band. Flux the joint, flux the silver solder wire, get the heat right and then touch the wire to the joint. If the heat is right, the solder will quickly melt and flow into the joint like gasoline, leaving a neat fillet and effecting a very strong union.

INSTALLATION

Trial fit the now nearly finished Base on the rifle, and file a flat as shown by the dotted line just below line A-A, until a 0.005" feeler gauge can be pushed between barrel and Base when the Base is in its desired position on the rifle.

Loctite the finished Base onto the magazine tube, first degreasing the tube and Base with rubbing alcohol, and then applying 2 or 3 drops of Loctite 609 (formerly Loctite 601). Allow about an hour to cure. Thereafter it won't loosen or move about, but a little heat from a propane torch will remove it when necessary. I say "a little heat" but this is not exactly correct – it takes about 400 to 500°F to break the Loctite bond. To repeat what was said at page 96, be careful not to breathe the Loctite fumes, as they are poisonous.

GUN MAKING
(and some other tales from one who did)

The man who has a shop full of metal working equipment and knows how to use it, is, if he wants to do it, in an enviable position to take up gunmaking. I'm not talking about sporterizing military surplus rifles, or even about customizing commercial sporting rifles. I'm talking about making a gun from scratch - lock, stock and barrel, as the saying goes. And yes, if you want to make the barrel yourself, you can do that too. Buy a good commercial barrel, if you want just one, but drilling, reaming, and rifling a barrel, starting from the solid bar, is entirely feasible for the basement machinist, if he is seriously interested in doing so. The first step is to get a copy of my video on this topic. This video is described in the upper left hand area of the page facing page 1 of this book. See photo and description on our website at www.lautard.com - click on "videos."

Take a look in the 1981 **Gun Digest,** page 21. There's Editor John T. Amber holding a rifle of handsome lines. It is a rifle any machinist could make if he put his mind to it. It wouldn't have to be a muzzle loader. Something along those lines in .222 Remington would be a mighty interesting and pleasant little gun.

Un-dimensioned working drawings of two sizes of rifle actions are available from Saunders Gun and Machine Shop, Manchester, Iowa 52057, U.S.A., phone (319)-927-4026. Cost: about $10. All the parts are drawn full size, but no dimensions are given. I think a fella'd be smart to make a new set of detail drawings at about 3x full size, and work up all the dimensions from same. Saunders' design has one feature which makes it easier than average to make: the breach block, and therefore naturally the breach block hole in the receiver also, is round. This eliminates the need for broaching or filing out a rectangular opening in the receiver. Complete heat treating info accompanies the drawings.

Maybe gunmaking interests you, but you have doubts about your ability to do it. Let me tell you about a man I met. We'll call him Joe, though that isn't his real name.

Joe was a grinding room supervisor for one of the biggest lumber outfits in western Canada. He calls himself a "grinder man". Joe was not a trained machinist, although he was able to ask questions of such wizards when he needed help. He had no milling machine. He did have a wood lathe, for which he rigged a crude sort of compound rest. For the most part he worked with files, while the rough work he did with hacksaws and by grinding. He worked entirely without working drawings - a cutaway, sectional, or exploded view of some rifle mechanism was all he'd go by, and from that he'd make a full sized working rifle of that type.

"I'd look at some feature of a part I'd be working on," he told me, "and I'd say to myself, 'Well, it's going to take 5000 strokes with a file to make that. Lookin' at it won't remove any metal.' And I'd start filin'."

He showed me boxes of files, many of them ground down to special widths, and given safe edges at the same time, to do a particular job: a deep internal slot, or whatever. Just in case you're half asleep, may I suggest you go back and read that last sentence again? There's a valuable idea in it, whether you're into gun making or not.

And what did he make?

A Remington Rolling Block rifle in caliber 45-70. A Farquharson rifle. A .44 cal Remington Revolving Carbine. A .22 cal. single action pistol. A 9mm Luger, fully functional except that, lacking provision of a magazine well and magazine, it was not a repeater. A single barrel version of the Remington .41 rimfire O/U Derringer - and at least a dozen other weapons. These were not museum pieces, but they were, very much, weapons to be proud of having built. I would be pleased to own any one of them. The workmanship was excellent, and the lines, if not in all cases indistinguishable from their prototypes, were very very close to prototype.

He had bored, reamed and rifled his own barrels. "The first one took me 6 months. The last one I did took me one day, from start to finish! After that, barrel making didn't hold much interest for me."

So if you think you couldn't do it, go on back and read what I said about the equipment this fella had to work with. I have to say that when I look at my workshop, which is pretty well equipped, I think to myself, "Self, if he could do all he did, with just about nothing in the way of shop tools, what couldn't you do in here if you put your mind to it?!!"

Joe had some interesting stories to tell of men he'd known. He worked with a German who owned a set of 7 straight razors, one for each day of the week. Joe himself can sharpen a straight razor so you can't even feel it cut, but this chap could so sharpen his razors that he could touch it to a point about 3/4 of the way up a hair standing up on the back of your hand, and the tip of the hair would be cut off!

He met the man who had actually made the first Gillette safety razor blades. They had an interesting talk, and Joe stated his view that steel needs a "rest". He had found that a cutter sharpened and returned to service immediately would last so long before coming back for resharpening once more, but if sharpened and not returned to service for several weeks, it would, when finally put into service, last longer before requiring resharpening. He said the razor blade maker smiled and nodded and then said, "I like the way you talk, Joe - you and I think alike."

Joe told me another story: The outfit he worked for bought plywood lathe "knives" from Simonds, the American saw blade makers. The Japanese began lusting for a share of this business. What tolerance was wanted?

"Zero," says Joe, straight faced.

"That is impossible."

"Well, I could settle for 2 thou."

"That is difficult."

"But not impossible."

(After a slight pause:) "No. Not impossible."

The Japanese were not successful in the pursuit of Joe's employer's business, because although they were able to meet the requisite tolerances, their steel, excellent though it was, was too hard, and would chip on our British Columbia fir and hemlock knots.

Another time, a well known European (not German) firm put forth its best offering. The tolerance was plus or minus 12 thou. They figured Joe's expectations were totally unreasonable, and they said so. Joe's reply left no room for argument:

"I am not unreasonable. I get that routinely and without question from the Simonds people, in the U.S."

That was the end of the Europeans. Joe told this to a Simonds rep later and the reply was that if it was wanted, they could cut the tolerance to one thou.

On another occasion, Joe's people bought a Hanchett knife grinder. A man came up from the Big Rapids, Michigan factory to install it, and he spent a couple of days levelling it, and checking it with dial indicators. When he was done, Joe asked him, "How is it?"

"Zero, zero, zero from end to end - good old American know-how!"

"And you know," Joe said, in telling me this, "I think there's something in that." (So do I. GBL)

MAKING BULLET MOLDS

There are some guys in the shooting game who like to shoot cast lead bullets. Some do it because it's cheap bullets. Others like cast bullets because they are easy on a rifle barrel - 50,000 rounds of cast bullets would be as nothing, whereas you can expect an 'accuracy life' of 1000 to maybe 7000 rounds shooting jacketed bullets. Still others shoot cast bullets for the challenge of trying to make them shoot accurately. If there's one thing these boys all want, it's a good bullet mold, the last group being slightly more fanatical about it than the other two.

Well, if you are interested in making bullet molds, either for yourself, or to sell, here are a few points to ponder.

First of all, anybody interested in making good bullet molds is going to have to pay their dues, both in terms of making enough of them to learn how to make good ones, and - if they want to sell them - in terms of getting known. I can't help you with that.

But I have done some studying on the matter of bullet mold making, and may have some ideas for you, whether you want to make them for your own use or for sale.

The first thing everybody wants is a bullet mold with a well centered cavity. In other words, with exactly 1/2 of the cavity in each half of the mold block, and not the thickness of a cigarette paper either way from center.

The next thing everybody wants is a mold from which the bullets drop readily. That probably is as much a function of the design of the bullet - i.e. the nature of its profile - as much as anything else, although there are other considerations - see below.

A bullet mold is normally cut with a 'cherry' - a multifluted cutter having the profile of the bullet desired. One expensive aid to this process is a self-centering machine vise. Henry Beverage detailed simple methods which obviated the need for such equipment in an article which appeared in Rifle magazine March/April, 1972. Anyone contemplating making bullet molds should get this article from the local library, a gun enthusiast friend, or obtain the book, **The Art of Bullet Casting**, from Wolfe Publishing Co., publishers of ***Rifle*** Magazine - for address, see Appendix.

Nose poured bullets are to be preferred, from an accuracy standpoint. It has been conclusively proven that imperfections at the nose have less effect on accuracy than imperfections at the base of the bullet. However, base pour molds are easier to make, and I'd venture to say 99.9% of all bullet molds made in the last 100 years have been base pour. Harry Pope made nose pour molds. See below for where to see a reprint of his catalog, wherein he tells much that is still relevant and useful today.

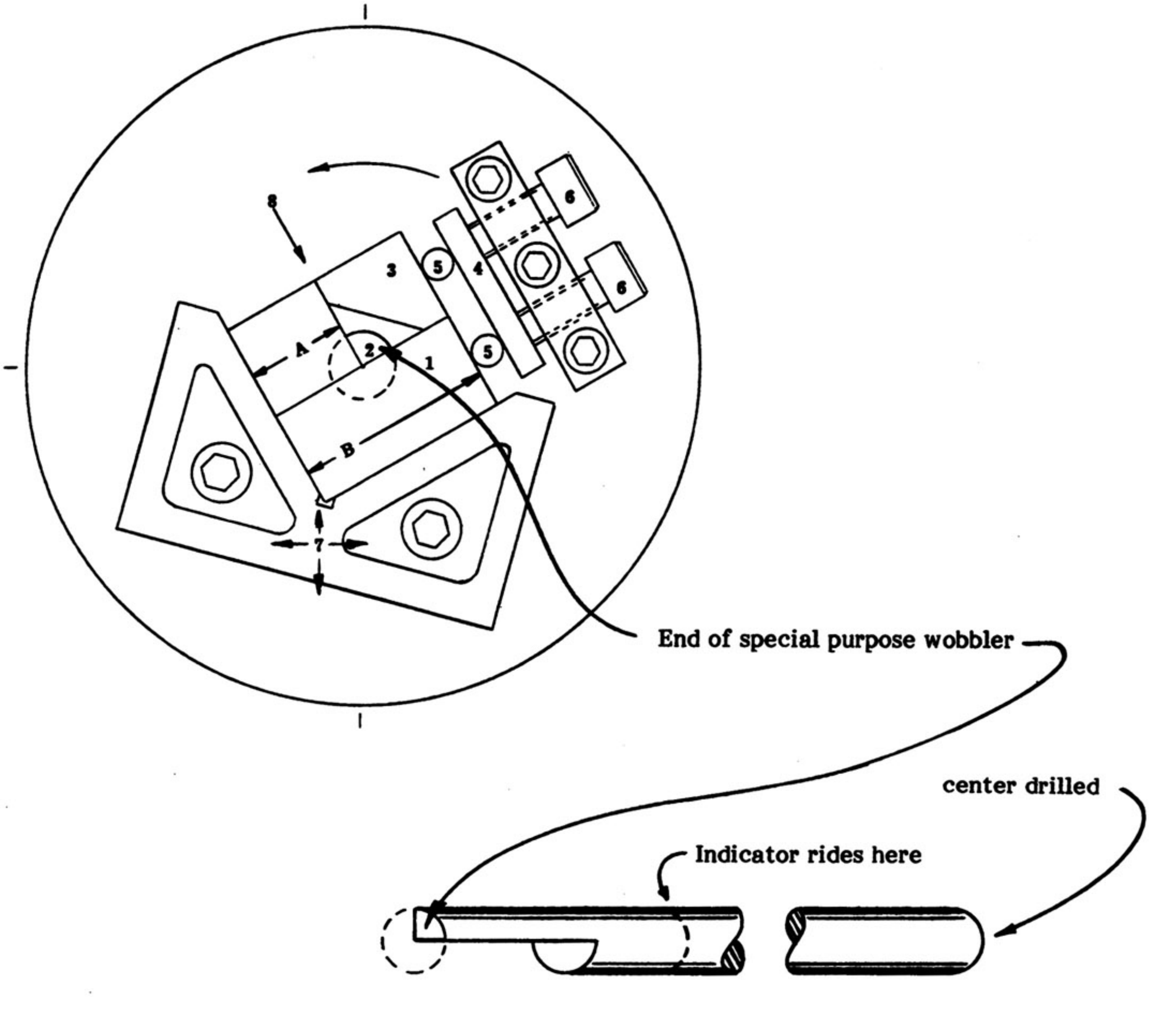
My approach, if I were planning to make a top flight bullet mold, would first be to resign myself to making several, to learn the ropes.

Second, I would bore the mold cavity, not cherry it. I would build, on a good faceplate, an adjustable V-block and clamp fixture to hold the mold block halves.

As a centering aid, I would make up a special wobbler. Its working end would be machined and then ground for about 1/2" at the working end exactly to the diameter; it would be rotated 90°, and again cut down to the diameter, so that when finished, the end view would show 1/4 of a full circle of metal remaining.

I would then make a block of steel which would be dimensioned to be one half of the other mold block half - see Item A in drawing.

SOME IDEAS FOR A
BULLET MOLD BORING FIXTURE
(VIEW IS FROM TAILSTOCK)



1. First mold block half.
2. Working end of special purpose wobbler.
3. Temporary corner piece, cut away as shown to clear 2., and used only during set up.
4. Bridge piece - 1/4" x 1/2" CRS.
5. Dual 1/4"Ø CRS rollers.
6. Dual 10-32 socket cap screws.
7. Shift V-block until indicator is zero/zero on wobbler.
8. Same clamping arrangement here as at right.

A is a setup piece - see text.
A = exactly 1/2**B**

This block and the wobbler would be used to indicate a mold block half into place on the faceplate fixture such that the face that would carry the cavity could be "indicated" exactly onto the lathe centerline. A spring or simple clamp would be needed to retain the wobbler in place in the V formed by the face of the mold block half and the above-mentioned block of steel.

Once I had got the first half of the pair of mold blocks where I wanted it, off would come the wobbler and the set-up block, and I'd slap the mating half of the mold face-to-face with it in the faceplate fixture. This would get me pretty well started towards the goal of having my bullet cavity centered in the mold blocks.

(Obviously, the two halves of the mold block must previously have been fitted with some means of providing permanent alignment in use - pins, cones, or whatever you think will work better than the means currently employed by other makers.)

I would then proceed to drill and bore the cavity to the 'minor diameter' of my desired bullet profile. I would finish the job with specially shaped boring tools. (If you want to make bored-to-profile .30 caliber molds, but the small size of the boring tools scares you, just consider making a .22 cal. mold this way, to help put the matter into perspective.)

Obviously this work must be done from the base end of the bullet cavity. I would, recognizing that a nose pour is preferable, test some of my prototypes as base pour molds first. If things looked promising, I'd convert them to nose pour by securing a plate to the base end of one block half, this plate being of a size to overlap the entire base end of the bullet cavity. I would then shorten the mold blocks until I could do my pouring from the nose end.

I'd use a thick sprue plate - 3/16" or more.

> TIP: I'd dispense with the use of a stick to whack the sprue plate to cut the sprue off after pouring each bullet, and would use instead my heavily gloved right hand. (Now right there is a tip for all bullet casters to note. When I showed this technique to one guy I know, who has cast more bullets than most of us will shoot in a lifetime, he adopted it on the spot and later told me he considered it the biggest single advance in casting methods he'd ever come across.)

Finally, I would, if possible, do my test shooting indoors, to eliminate wind effects, which are most noticeable at typical cast bullet velocities. Where? I don't know - in a school basement, in an industrial building owned by an employer or friend, or some otherwhere, maybe even - glorious fantasy! - in an underground tunnel dug under the street from my own basement.

As a preliminary to the above, I'd go to the public library and research the topic of cast lead bullet shooting - *American Rifleman* magazine, *Rifle/Handloader* Magazine, Lyman, RCBS, etc. all are sources with useful info for such a quest.

I'd find out about the latest thinking of the **Cast Bullet Association** membership, as soon as I found their address, which I soon would in the above-named sources.

I'd also investigate the possibility that a bullet, swaged after casting, might be more accurate, and if it seemed likely, I'd spend more time making some good swaging dies than trying to make perfect bullet molds - swaging dies should be a whole lot easier to make than perfect bullet molds.

> TIP: To quench a swage die - which is basically a cylinder with a hole down its long axis - hold the red hot die in a pair of hot tongs, and pour quenching oil through the swage hole.

I'd be particularly attentive to what one Carl Johnson had to say in his various writings (reprinted in the book mentioned below) in *Handloader* and *Rifle* magazines, some 10-15 years ago. Why? Because he was a machinist, and a meticulous experimenter along the lines here discussed.

Another thing I'd do is get, or build, a very accurate rifle in which to conduct my bullet testing. There is little point in trying to make top grade bullet molds if you lack an accurate rifle in which to test their bullets. Carl Johnson described a shortened .30/30 case, and rifles for it, back in *Handloader* #45, Sept/Oct 1973, page 30. This article is well worth reading, if all this interests you. (It did me, at one time, but then I got so wrapped up in the machine shop side of things I had no time for shooting!)

As mentioned above, the Wolfe Publishing Co., publisher of *Rifle* and *Handloader* Magazines, has come out with a book that is a collection of (most if not) all of the articles they've published since their inception, on the subject of cast bullets, shooting them, etc. Title: **The Art of Bullet Casting.** This book would be well worth having, if you are inclined to such activities. Price at date of writing (early 1986) is $12.95 in soft cover. 258 pages.

Read Harry Pope's catalog, reprinted in the 1975 **Gun Digest.** Read **The Bullet's Flight from Muzzle to Target** by F.W. Mann. (Also reprinted by Wolfe Publishing Co.)

Get, on interlibrary loan if need be, Ned Roberts' book **Breach Loading Single Shot Match Rifles.** It is excellent.

There are, or were, a couple of guys down in Madras, Oregon who sold a cast bullet lube that they figured was a cut above the well known Alox/Beeswax mixture developed by the NRA in the late 50's. Address: **M&N Bullet Lube,** 495 Jefferson Street, Madras, Oregon 97741.

Have fun, but don't get utterly carried away with this whole subject - there are more important things in life than making bullet molds.

Post Script: If you can find a copy of *Guns & Ammo* magazine for July 1977, page 74, in it you'll find an article I wrote on my experiments with cast bullets in a number of good .30 caliber rifles. Not all of my opinions are shared by others, but that's what makes life interesting.

Some info which may be useful if you ever get involved in DESIGNING AND/OR DECIPHERING VERNIERS

1. On a LINEAR scale (e.g. a 6" vernier caliper):

   a) Graduations on caliper beam = 0.05" each
   b) 50 divisions on vernier span 49 beam divisions = 49 x 0.05" = 2.450"
   c) Therefore 1 division on vernier = 1/50 of 2.450" = 2.450 ÷ 50 = 0.049"
   d) Thus the vernier will read to 0.050 - 0.049" = 0.001"

2. On a CIRCULAR scale (e.g. a vernier protractor):

   a) Graduations on protractor = 1° each
   b) 12 divisions on vernier span 11° on the protractor
   c) Therefore 1 division on the vernier = 1/12 of 11° = 0.917°.
   d) Thus the vernier reads to 1.000° - 0.917° = 0.083 = 1/12° = 5 minutes.

SOME THOUGHTS ON TOOL STORAGE

A couple of years back I bought an old machinist's toolbox and its contents. It was a Kennedy, 16" x 9" x 9", with 2 un-lined lift-out metal trays. The owner had had a stroke about 3 years previously and had not touched his equipment since. The tools in the box had therefore been unused and unchecked for three years.

He was a man who did not abuse his tools. Those loose in the box showed some minor surface rust, although even they were quite good, at that. Tools in their own wooden cases - e.g. a beautiful old Lufkin depth mike, and a 2" to 6" Starrett #224 mike, c/w all its interchangeable anvils and setting standards - were in better shape: cleaner, less rust, etc. Of course, the longer term history of the tools would have been similar; spring bow calipers, dividers and a combination square loose in the box when it came to me would also have lived out their lives that way, while the cased tools would have spent their working days in their cases.

Also in the toolbox was a 1938 Starrett Tool Catalog. Most of the tools would have been chosen from that catalog, and they served their first owner during his employment with the Boeing Aircraft Company of Canada Ltd. here in Vancouver during WWII. After the war he went to work for Terminal City Iron Works, a well known Vancouver foundry. His home was not three blocks from mine when I was in high school - how I wish I had known him then!

Everything got a good clean-up with Varsol, steel wool, and abrasive erasers, and I ended up with some very useful additions to my tool kit. I sold the old Kennedy box and the tools which were redundant, and got a new #520 Kennedy box, my Gerstner by this time being more than full. Having two tool boxes seemed an extravagance, but then I got to talking to a tool and die maker who confessed to six Kennedy's - four at work, two at home.

My conclusions regarding tool storage, from this little episode, and other observations, are as follows:

A wooden toolbox is probably preferable to a metal one, all else being equal. If you have a metal toolbox, the drawers should be felt lined. If the felt linings are of your own doing - i.e. laid in loose - soaking them in a rust inhibitor of some sort is also not a bad idea.

Protective cases for individual tools or groups of tools are definitely beneficial, and can be made in various ways.

If you have a wooden or metal box of suitable dimensions, it can be promoted for tool storage duty by the addition of several layers of corrugated cardboard, with pockets cut out to take the various tools. Use contact cement to glue the layers of cardboard together, so they don't wiggle out of position every time a tool is removed.

> TIP: While we're mentioning glue, here's something to note: Some glues cause rusting. Have you ever noticed the smell of vinegar (acetic acid) from some of those white wood glues? Acids will corrode ferrous metals. I don't know if these white glues contain acetic acid or not, but they can definitely cause steel to rust, even blued steel. What to do? If you use such glues when making a toolbox or tool case, after gluing, leave the box unused and exposed to the air until the glue has completely dried, and no trace of glue fumes remain...a couple of days anyway, maybe more. (Based on info from Jack Gutheridge, Dyer Indiana, in **Gunsmith Kinks, Vol II.**)

And while we're mentioning things that can cause rusting, here's something else that's pertinent:

> Some rigid plastic foams are made using steam. The moisture thus left in the foam can rust metal and ruin wood finishes. So watch that, if you run across some likely looking pieces of rigid foam and decide to carve out some tool pockets in it. Soft foams are made with

chemicals that serve as excellent oil and grease solvents. These chemicals can be trapped in closed-cell foam for long periods. They could degrease a tool stored in such foam, leaving it prone to rust. So watch that too. Again from **Kinks II**, (Bakers Gun Shop, Marshall, Texas.)

Some further thoughts: I have used a very dense form of particle board or "masonite" for making tool storage boxes. This material can be had in various thicknesses - 1/2" or 5/8 " is about right for making boxes.

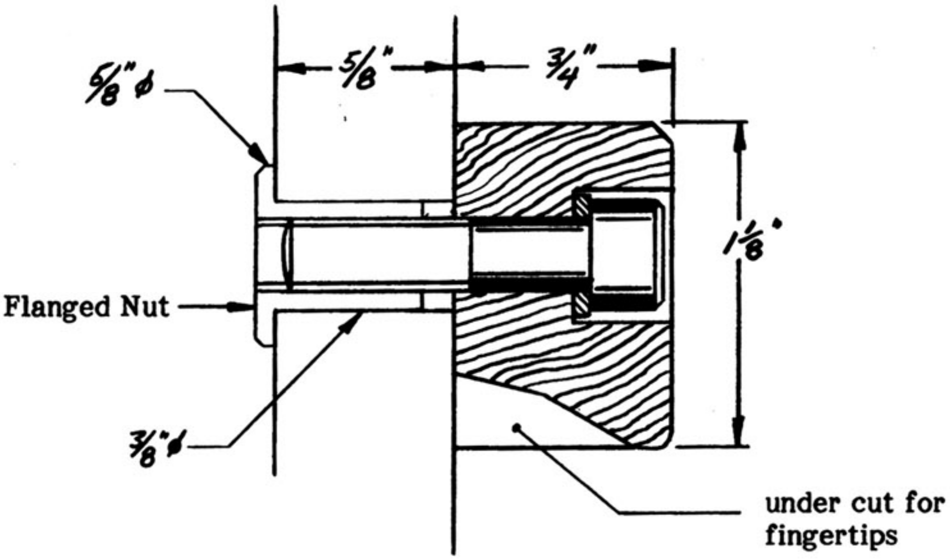
For accuracy, cut the parts on a table saw. Assemble as a sealed box, using glue and finishing nails, which should be sunk slightly below flush with a nail set. Mark centerlines for any fastening hardware before sawing the box open. Avoid driving nails in the vicinity of the 'split line'.

Put a black felt pen dot on one hinge, and a dot on its location on the box, (if you don't use a piano hinge), because the screw holes may not be identically placed on the hinges, and if not subsequently sorted out, the box lid may not register just right when the hinges go on for the last time. This seems a small point, but it is not something one would necessarily think of otherwise. Also, in fitting the hinges, do not run the screws in and out any more times than necessary - this stuff is not teak.

HANDLES FOR STORAGE BOXES

For storage boxes, side handles are best. Make from oak or other hardwood, about 3/4" x 1-1/8" x 5", two per box, one at each end. Make flanged nuts from 5/8"Ø CRS, as in the drawing below. Attach to box via these and 1/4" socket cap screws, using two screws per handle. Drill all 4 holes in handles: first the counterbore for the screw head, with a spade drill; then 5/16" or 9/32" for screw body - this drill will center itself in the hole left by the point of the spade bit. Clamp handle to box, and drill box using handle as a drilling jig. Remove handle, enlarge box holes to 3/8"Ø. Carve, rasp and sand the handles to a hand-pleasing shape. Insert flanged nuts, and install.

SECTION THROUGH HANDLE, SHOWING FLANGED NUT, SOCKET CAP SCREW & – NOT MENTIONED IN TEXT – WASHER UNDER HEAD OF SCREW



Cases for micrometers and the like can be made by milling pockets in this same hi-density particle board - and it mills quite nicely. I'd suggest you have a vacuum cleaner alive and screaming at your side during the milling process, to get the dust out of the way, so you can see what you're doing. I have read that some of the binding agents used in making this product are carcinogenic, and can be inhaled with the dust that arises from cutting it. Very brief exposure would probably not pose a risk, but why take any chances? All the more reason to use the vacuum cleaner, and to empty it afterwards.

For a pocketed-out case of this sort which will see day to day handling, glue a piece of Formica to the underside for greater durability. And for a lid...maybe some 1/8" hardwood plywood - and hinges? You could epoxy the hinges in place - sure as heck there's gonna be no room for screws in the lid. On the front, the usual little swinging hook or something similar.

Post Script: If you look in *Popular Science* Magazine, Nov. 1964, you will find an article on how to make such flat fitted cases, and how to finish the interior with "flock" - the fuzzy stuff. Basically, you paint the interior of the case and then blow the flock onto the still wet paint. Paint and flock should be the same color. The article gives good dope on hinges, etc.

A SIMPLE FORM OF SMALL STORAGE BOX

This brings me to another idea which would eliminate hinges and latches and protective feet all at one shot. I am at present in need of a box for an automatic boring and facing head and the few small tools that want to be kept with it. I plan to cut several pieces of this hi-density particle board, plus two pieces of good plywood for the lid and bottom, all exactly the same size. I'm going to stack them up, and drill 1/4" holes in the four corners. I will turn down the heads of four 1/4" hex head bolts to buttons about 5/16"Ø by 1/16" thick, bevel them, stick 'em in the holes, drop in the goodies, drop the lid on, and screw it down with four little knurled knobs. Simple.

THE ULTIMATE BOX LATCH

Dividing heads, rotary tables, automatic boring and facing heads, and other machine tool accessories which deserve better protection than afforded by a place on the shelf should be stored in protective boxes. Most such boxes are hinged and latched. If a 39 cent stamping satisfies you for your box latches, don't read the following. (If you don't like hinges, see paragraph immediately preceeding this section.)

I regard this as the ultimate latch for such storage boxes, as well as for shooters' accessory boxes, toolboxes and so on. I have used it with complete satisfaction on several storage boxes, and there is one floating around down in Pennsylvania that I made for someone who proved himself to be a rare gentleman and good friend....

Close up shot of the Ultimate Box Latch, shut.

When installed, and properly adjusted, these latches lock shut with the flick of a finger. I would be willing to bet that if you make one of these latches, you will be hooked - thereafter nothing less will do.

The basic idea was found in *Model Engineer* November 22, 1928, p.488, via a little drawing about the size of a couple of postage stamps. (I have elaborated it to fill three pages!) The last couple I've made have been per the drawings given here. This Mk IV version incorporates some improvements over the one shown in a plansheet previously published (with permission) and sold by myself. These improvements are:

1. The Mk IV latch protrudes only about 1/16" into the interior of the box. This could be reduced to zero if need be.

2. The suggested machining sequence permits the incorporation of a knurled rim, which although not essential, is aesthetically pleasing.

3. Finally, it is concentrically mounted, thus making its operating principal even less obvious to the uninitiated than previous versions.

Both this and my previous version of this box latch have an eccentric "lid pin", which allows some latitude in the spacing of the two mounting holes during installation - this was a feature not found in the *M.E.* version.

The boxes to which these latches were fitted are made from the hi-density particle board referred to in the previous chapter. The cutters required to make the installation holes were turned up from mild steel, and crude teeth filed in. The particle board goes directly to dust under such cutters, and as the speeds need not be high, an unhardened cutter serves without complaint.

Keep these cutters in a known place. When you make another box latch of this type, hew close to these drawings, and use the same cutters again.

The knurling on the latch rim is not essential. A straight knurl - i.e. axial lines only - would be nice, but lacking a straight toothed knurl, one diagonal knurling wheel can be pressed into service.

I simply dismantled my knurling tool, and put one arm, c/w knurling wheel, in the toolpost, screwed it to center height, and knurled away. 'Twerked quite ok, but I decided to get tooled up to do straight knurling, and to do it right. What I did is described elsewhere herein.

The accompanying drawings are fairly straightforward, but will require a little careful study to extract all the needed info. The General Arrangement drawing is an oversize section view, and shows the latch installed on a box. The box is closed but the latch has not been turned to a locked position. The smaller drawing at middle right is a rear view of the Latch Disc. These two drawings contain all necessary dimensions to make the box latch. At lower right is a typical installation.

If you decide to make one, you will do well to study the drawings closely, and then in making the few parts involved, work very close to the dimensions given.

PART NAMES

A = Latch Disk	B = Latch Pivot
C = Latch Bushing	D = Washer (shop made)
E = Lid Pin	F = Lid Bushing

Bushings C and F serve as washers for the two 10-32 screws, reinforce the box material, and provide a steel socket or sleeve to take the inner ends of B and E respectively, for strength, durability, reinforcement - call it what you like.

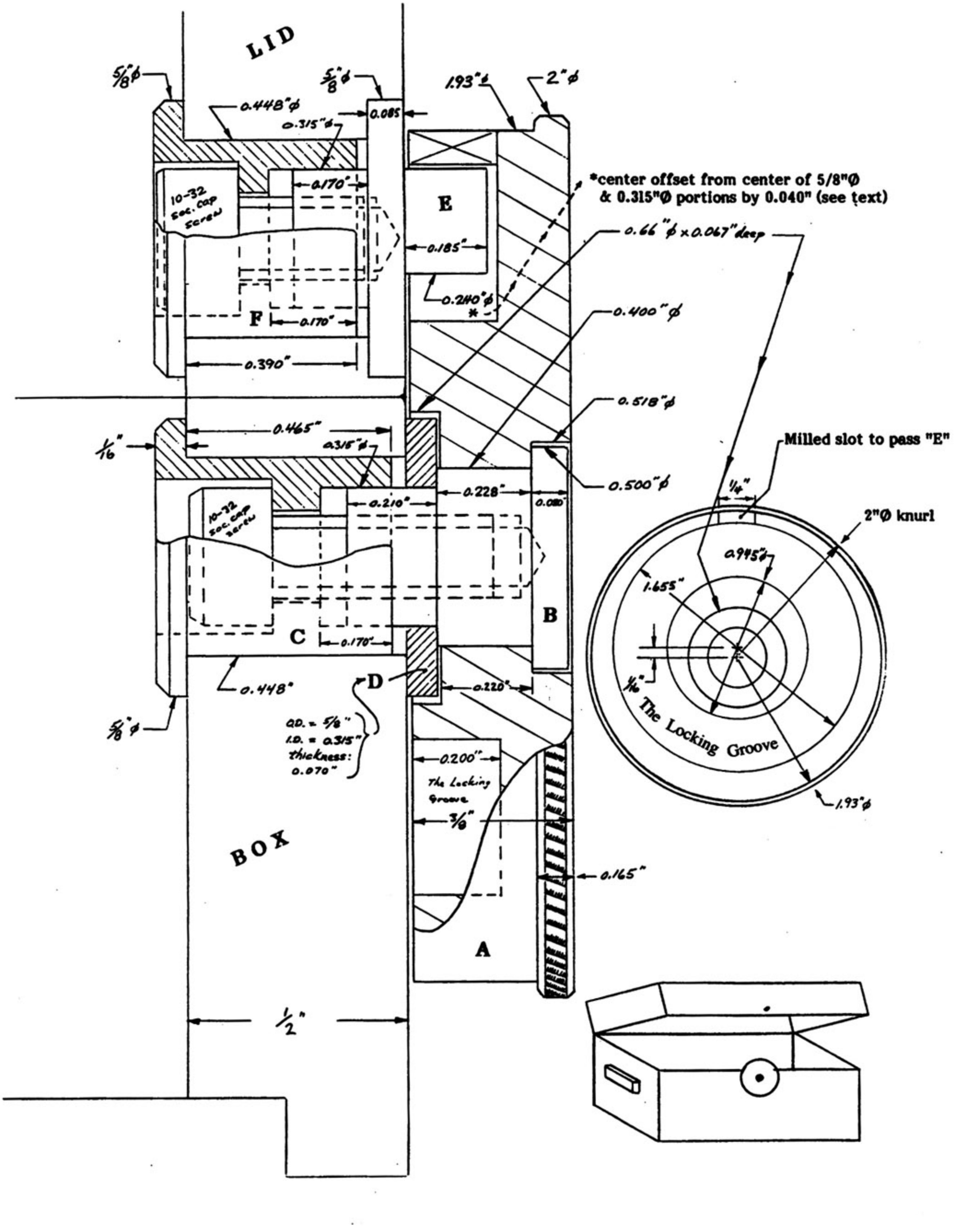
HOW TO MAKE IT

I will give first a very brief precis of the method of making, and then for the less experienced reader, more detailed instructions on how to go about the job. **NOTE: For installation, see notes at the end of the chapter.**

Make the latch disc by starting with the grooved face first facing the tailstock: turn the O.D., knurl, and face the exposed end. Machine yourself some relief back of where the knurl will be to give room for the knurling tool.

Reset in the 4-jaw chuck, and indicate the unknurled O.D. to run about 1/16" eccentric, per drawing. The groove is then machined. It will be found convenient to run the lathe in reverse for part of this machining, with the boring tool undisturbed in the toolpost but cranked in beyond the lathe centerline - this will become clear when considering the job in the chuck, if it is not immediately obvious on the first reading here.

With the groove done, part the Disc from the parent bar, switch over to your 3-jaw chuck, reverse


LID
5/8"ϕ
5/8"ϕ
0.448"ϕ
0.315"ϕ
0.085
1.93"ϕ
2"ϕ
*center offset from center of 5/8"Ø & 0.315"Ø portions by 0.040" (see text)
10-32 soc. cap screw
0.170"
E
0.185"
0.66"ϕ × 0.067" deep
0.240"ϕ *
F
0.170"
0.400"ϕ
0.390"
0.518"ϕ
0.465"
1/16"
0.315"ϕ
Milled slot to pass "E"
0.500"ϕ
0.228"
0.210"
0.080"
1/4"
2"Ø knurl
10-32 soc. cap screw
0.945"ϕ
1.655"
B
C
0.170"
1/16"
0.448"
D
0.220"
The Locking Groove
5/8"ϕ
O.D. = 5/8"
I.D. = 0.315"
thickness: 0.070"
0.200"
The Locking Groove
1.93"ϕ
3/8"
BOX
0.165"
A
1/2"

the Disc, and chuck by the unknurled portion of the O.D. At this setting clean up the exposed face of the disc to best possible finish, and drill, bore and recess the mounting hole.

(NOTE: See note re installation at end.)

DETAILED INSTRUCTIONS

Make **Bushings C & F** first, from 5/8"Ø CRS. Turn the 0.448"Ø portion, drill #5 full length, counterbore 0.315"Ø to specified depth, and part off. Reverse and chuck by 0.448"Ø portion to finish the flanges and to counterbore 0.357"Ø for screw head. The depths of these counterbores are not given, but can be discerned from the drawings - the one in C need not be as deep as drawn.

Make **Washer D** next. Just drill into the same piece of 5/8"Ø CRS at 5/16"Ø about 1/8" deep, bore out to 0.315"Ø, and part off, thickness as drawing. This Washer is better not bevelled at all, either side, although it may be difficult to resist applying at least a slight bevel to the "Disk" side of it.

The **Lid Pin E** is also turned from 5/8"Ø CRS. Turn 0.315"Øside to spec. Drill #21 about 1/4" deep, tap 10-32, reverse in 4-jaw chuck and indicate to run about 40 thou eccentric. (Dial indicator needle will sweep out a total reading of 80 thou when this is so.) Turn Lid Pin to 0.240"Ø, and machine the outer face of the 5/8"Ø flange back to 0.085" thickness, then shorten the 0.240"Ø portion to 0.185" length, as drawing. Give the outboard end of the Pin a slight bevel.

The **Latch Pivot B** is straightforward turning, drilling and tapping.

MAKING THE LATCH DISC (Part A)

Make from 2"Ø CRS, brass, or aluminum.

1. Chuck in 4-jaw and face the end clean.

2. Drill about 5/8" deep at the center (where else?) at some size under 5/16"Ø. Bore this hole out to a close fit on (B).

3. Machine the recess for (D).

4. Turn the O.D. down to 1.93"Ø, leaving a noticeable shoulder - this will prove handy in Step 9. below.

5. Cut yourself some relief behind the 3/8" overall thickness of the Latch, and knurl the 2" dia. rim. The method I used - see above - produced a slanted knurl on the narrow rim. It looks good. The trick to easing this operation lies in keeping the knurled rim narrow.

6. Shift the material in the 4-jaw chuck so that the 1.93"Ø portion is running about 1/16" (say 50 to 60 thou) eccentric. The indicator needle must sweep out twice the desired eccentricity.

7. Scribe a mark across the face of the job center to mark the axis of eccentricity.

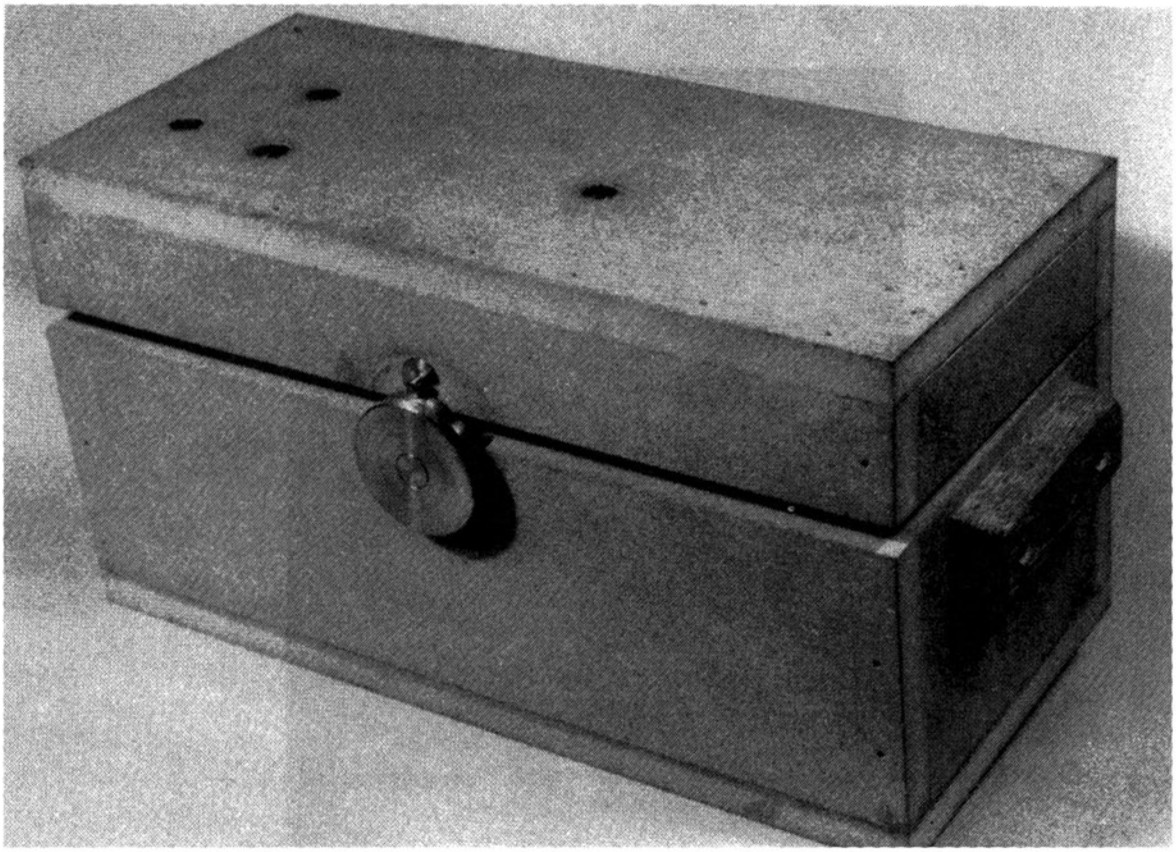
8. Turn the recess for the Lid Pin, running the lathe backward and forward to deal with both the 0.945"Ø and 1.655"Ø surfaces, with the same boring tool undisturbed in the toolpost. Aim for a good finish on the 1.655"Ø surface if nowhere else.

9. Part off, and reverse in the 3-jaw chuck, where the slight shoulder called for at 4. above will aid in quickly seating the job square in the chuck.

10. Clean up the parted off face to an exhibition finish, and recess as drawing for the head of (B).

11. Clamp the Disc down to the milling machine table, and machine out the 1/4" milled slot to pass 'E' as noted on the back view of disk, middle right of drawing. This cut-out also shows as a flat indicated by a pair of diagonals above the letter "E" in the G.A. drawing. Obviously, the slot is placed at the point of minimum rim thickness, which is found in 10 seconds, instead of 5 minutes, with the aid of the scribed line called for at Step 7. above.

INSTALLATION
The centers of the holes for the Latch and Lid Pin are located 0.360" back from the edges of the box and lid. **THIS IS NOT SHOWN ON THE DRAWINGS.**



A storage box equipped with handles and box latch as described in text.

DRAWINGS FOR A MACHINIST'S WOODEN TOOL CHEST

If you do some woodwork, or have a friend who does, the following drawing of a machinist's wooden tool chest may interest you.

It is reprinted from the December 1957 issue of *Industrial Arts* Magazine (now called *Industrial Education* Magazine) with permission of the publisher, Cummins Publishing Company, Inc., Troy, Michigan.

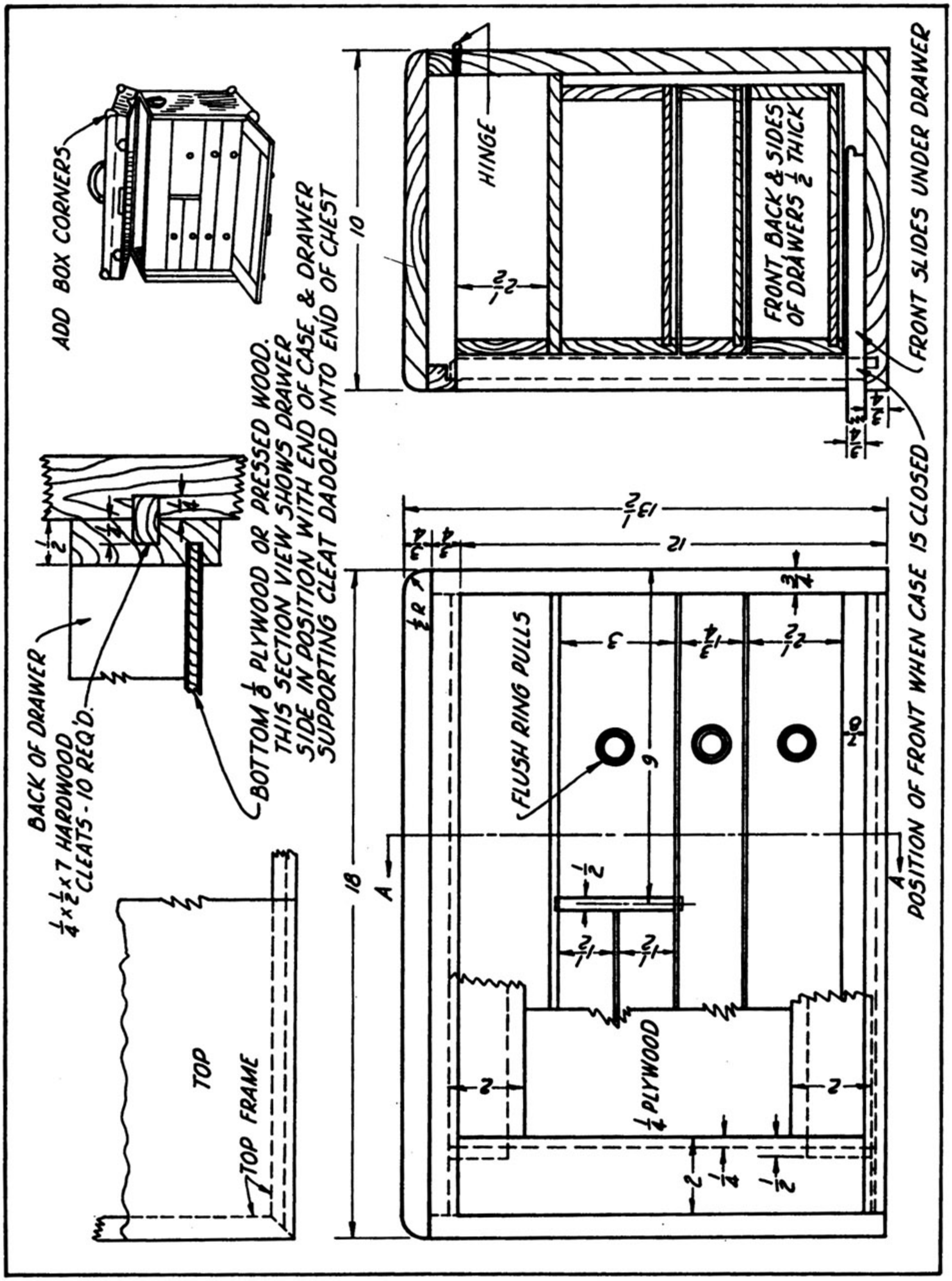
There was an excellent article on the same subject in the April 1983 issue of *Popular Mechanics* Magazine. Woodwork is not my thing at all, so I will say no more. If these are any good to you, I am glad.

If you are disinclined to try making a tool chest such as these - and to be truthful, it is a job for a skilled cabinetmaker - but would like to have a wooden machinist's tool chest, there are none finer than those made by H. Gerstner & Sons, Inc., Box 517, Dayton, Ohio 45402.

Photo courtesy of H. Gerstner & Sons Inc.

I heard about one machinist who had a big Gerstner chest, in solid walnut, on a matching base. He was understandably proud of this outfit, and woe betide anyone who touched it uninvited. One day somebody ground a right angled notch in the middle of a power hacksaw blade, and put a radius in the root of the notch so that it just fitted, and balanced on, the corner of the toolbox. When the owner of the toolbox came back from his lunch break, here was the saw blade looking for all the world as though it had been sawed into the edge of the box and then left there. The poor guy just about had a seizure.

I was talking to one of Gerstner's senior people one day while working on this book, and I asked him the reason for the mirror in the lid. As I suspected, there is a story behind that....



Reprinted with permission of Cummins Publishing Company, Inc. Troy, Michigan.

Back when the Gerstner firm was founded, in 1906, working conditions were not what they are today. The safety and first aid facilities would have been limited, and the washrooms better than nothing, but not much. The mirror was put in the lid of the Gerstner box so that if a machinist got a piece of swarf in his eye, he had some means immediately at hand with which to try and get it out.

SOME FREE MEDICAL ADVICE
If you should ever be so unfortunate as to get a steel chip in your eye, you will find that it brings absolutely everything else to an instant halt. Get it out immediately. If you can't get it out by yourself, get someone to help you. If you still can't get it out, get yourself to a doctor, or to the emergency ward of a hospital. This is not some thing to waste any time over: the salt in your tears will cause the steel to start to rust quite quickly, and it is imperative that it be removed ASAP.

One of the ways the medicos have of removing steel particles from the eye is by means of a small but very powerful electromagnet. They switch it on and bring it up near your eye, and if all goes well, it just pulls the particle right off the eye like that!

What if it isn't steel, but brass or some other non magnetic swarf? They have other things, like a fine wire loop on a handle.... None of this is fun to contemplate, but I can tell you from personal experience that if you get a piece of swarf in your eye, you will love whatever they use to remove it!

If you do not wear eye-glasses as a matter of course, **GET A PAIR OF SAFETY GLASSES, AND WEAR THEM!!!!** God gave you two eyes, and much as He loves you, He will not give you any replacements.

IMITATION IVORY

Suppose you want to make a nice handle for something, or some other decorative touch for something you've made, or been asked to fix, or whatever. Here's a way to do something unusual......

Get a nice looking, unbruised potato. Wash it in dilute sulfuric acid until the surface is clean. Then boil in the same solution in which it was washed, until it becomes perfectly dense and solid. After this, wash thoroughly in tepid water followed by cold water, until all traces of the acid are removed. Dry in a warm place. When quite dry it can be carved, and can be colored with dye.

I came across the foregoing in **The Girl's Own Annual** of 1895, one of several which had come down to my mother in her childhood from an aunt in Scotland.

My friend Eric Marles tells me that what the above does is to turn the spud into celluloid. You could fool me..., but it sounds like it could be true.

(I have not tried this one myself, so no promises that there'll be an elephant tusk under your pillow when you're done...)

THE MACHINIST'S WORKBENCH AND OTHER IDEAS

I'm not sure that anyone can tell anyone else how to build a workbench - it's pretty much an individual matter - but I've seen a few ideas you might be interested in.

The first questions are 'How big' and 'How high'. I cannot tell you much on either score, 'cause only you know your needs. But on the matter of height, note this: "The standard height of New Britain benches is 32" from top to floor", (p.201, **American Machinists' Handbook,** 7th Ed., 1940). I'm 5'11", my (inherited) workbench is 35" high. To my way of thinking, it is far too low. I had a visitor here just a few nights ago, and we got onto this subject. He said no work surface should be lower than the palms of your hands, parallel to the floor, arms straight down in front of you, standing erect. That's a minimum. I suspect the average height of people has increased somewhat in the past 40 years, such that New Britain benches, if still being made, are probably higher today than back then.

> Later: That's correct! I just unearthed some literature which I got in the last year or so from another outfit. They make their workbenches 34" high. Workbenches **are** made taller today, just like we are.

The standard way to determine the correct height of a vise is to measure from the floor to the point of the elbow. That's where the top of the vise jaws should fall: for me, that would be 47-1/2" off the floor. My vise being 6" deep, that'd indicate a bench top height of 41-1/2". As arranged until quite recently, my vise top was 46" high and sure enough, it felt too low.

Now, if you're still awake, and have eaten your mathematical wheaties, you'll have figured out there's 5" unaccounted for between my bench top and the bottom of the vise: Well, I'll tell you about that. My vise used to be mounted right down on the workbench. I'd last about 10 minutes filing. One day I cut up some pieces of 2x6, stacked them up, and drilled them to take some long bolts made from 3/8" ready rod. With this riser block under the vise I can file comfortably for an hour.

Several years ago, I bought myself a vise mouting device that makes your bench vise both height adjustable and "swivelable" in the horizontal plane. It is a wonderful gadget. If you want one, contact me by phone or e-mail (g311365@sprint.ca), or see my website at www.lautard.com.

COMFORTABLE WORKING HEIGHTS FOR MACHINE TOOLS
Time for a brief digression :

I have been told that a milling machine should be mounted so that the nose of the spindle is at "chest height". That's not very specific, so let's say about 6" below your chin.

How high to mount a lathe? Most lathes I've seen in basement workshops - and this is not a great number, but say a dozen or so - were mounted much lower than I would think appropriate, given the height of the owner. My own lathe - a 7" swing Myford - is 50" from floor to centers, and it could be just a little higher.

I had a chap visit me once who was **6'10"**. He could comfortably reach a faceplate hung on nails in the exposed floor joists of my shop ceiling, where I would need to stand up on a chair to get at it. Later I was in his shop, and was astonished to find his 9" South Bend lathe mounted at a height that would have been comfortable for me. I asked him about it, and he said it seemed okay to him. Out of unabashed curiosity, I measured the floor-to- centers distance of his set up, and found it was only an inch higher than my own! Now remember, this guy was six foot ten!

For working drawings of my lathe stand, which I consider to be a near perfect design, see "Two

Machine Tool Stands", *Home Shop Machinist* Magazine, Jan/Feb 1983; or see *Popular Mechanics* Magazine, May 1980, p.53. (There's a universal filing stand detailed at page 55 of the same issue of *Popular Mechanics.*)

SOME OTHER WORKBENCH IDEAS

One of my favorite writers from the 1930's in *Model Engineer* was Herbert Dyer. He was a master sheet metal worker by trade and no slouch as a machinist either. Aside from numerous worthwhile and varied articles in *M.E.*, he wrote a book entitled "How to Work Sheet Metal". This book is available in the U.S. from Power Model Supply Co.(see Appendix). I'd highly recommend it to any reader with even a modest interest in sheet metal work. In the first chapter he shows details of a well thought out workbench which incorporates, in the front edge, a large capacity sheet metal bending brake of simple design, as well as some other good ideas.

ASIDE RE OTHER BOOKS FROM THE PUBLISHERS OF *MODEL ENGINEER*

Over the years, the Model & Allied Publications (MAP) people have brought out many small books on various workshop topics. Most are based on articles previously published in M.E. Some of these books are excellent. For example, if you should have any interest in making your own castings, two books you should most certainly buy are **Foundry Work for the Amateur** and **The Backyard Foundry**, both by Terry Aspin. These are tops. Some of the others are, in my opinion, superficial to a greater or lesser degree.

For example, in the book **Milling in the Lathe,** (which is not an entirely bad book) there is a photograph and a small general arrangement drawing of a dividing attachment, and the text says, "An interesting light dividing attachment was described in *The Model Engineer* over twenty years ago by the author." The book thus tantalizes the reader with the possibility that somewhere there are complete working drawings for this item, but not only does it not then have those drawings within its covers - which would be nice, to say the least - it also does not give the date and page reference with which the reader might track them down for himself.

(Before I published **Lautard's Technical Index To *Model Engineer* 1920 to 1978**, which has made some 80,000 pages of *M.E.* an 'open book' to those who have access to a collection of same, tracking down such vague references was almost an impossibility.)

Two other MAP books that do deserve mention, for they are excellent, are: **Building the Universal Pillar Tool**, by George Thomas, and **Soldering & Brazing,** by A. Turpin. (Incidentally, Turpin was one of the designers of the Sten gun, a well known WW2 weapon. Turpin worked at Enfield Lock, the British equivalent of the US Government's Springfield Armory. The initials of the surnames of the two men who designed the Sten - Turpin being one of them - were combined with the first two letters of the word Enfield to make the word "Sten." ...Or so I was told by a fellow model engineer here who served his apprenticeship under Turpin at Enfield Lock.

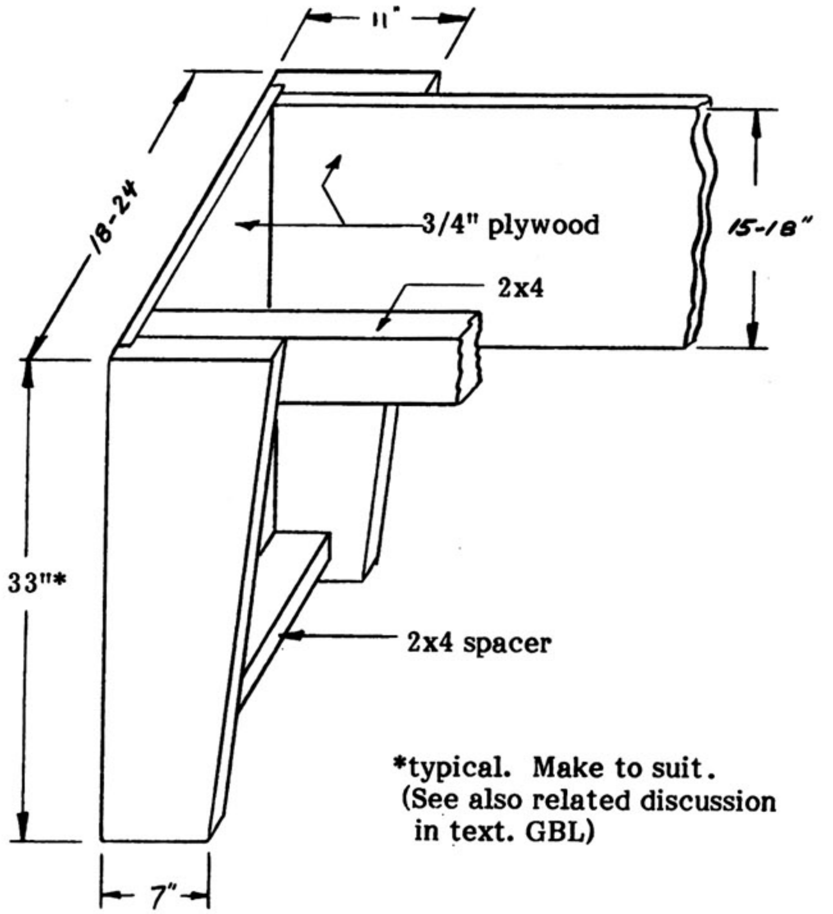
WORKBENCH LEGS

John Kopf

LIVE STEAM , September 1977

Jack McKenty had some tips on building workbench tops in Jan/Feb 1976 *Live Steam,* but no suggestions for legs. Those shown in the drawing are very sturdy. I have been using (benches with legs of this type) for several years, one to hold my lathe. They are inexpensive to make, needing only two 6' lengths of 2x12 for the legs, a 2x4 as long as the bench, a pair of short 2x4's for spacers (all of which can be cheap, construction-grade lumber) and some 3/4" plywood for the end panels (which act as braces), and the back piece.

The height, width and length will depend on the requirements of your shop, so the only dimension shown is the 33" leg length, which may be varied to suit the tools mounted, as well as your own height.



The hardest operation is cutting the ¾" x 1" rabbet in the legs for the end panels, but all work on these benches can be done with only an electric drill and a Skil-saw. (I think one could simply omit the rabbet.GBL)

Assemble with glue and screws. My benchtop is held down with 4 lag screws into the ends of the legs.

Added to the 16th printing: Since publishing this book in 1986, I've built 7 workbenches, and from so doing, I've learned a few things. In 1998 I made a 2-hour video titled **How to Make Simple, Solid, Utilitarian Workbenches**. If you are stymied by the prospect of having to build a good workbench, you might like this video. Among other good ideas, this video includes full info on a versatile router surfacing jig you can build for flattening an 8 foot long benchtop made by laminating 2x4's face to face. Not suitable for viewing by experienced woodworkers. ☺ **Price: US $28.**

RE-BABBITTING MACHINERY BEARINGS

If you need to pour new babbitt bearings for an older lathe or other piece of equipment, and want some guidance on how to go about it, get hold of an article by Bob Johnson in *Fine Woodworking* Magazine #38, (Jan/Feb 1983, Page 73); see also follow-up letters by others in *FW* #39 and #40.

ETCHING

A simple way to etch your initials on tools, etc. is to spread a little beeswax on the tool surface, scratch your initials onto the steel through the beeswax, and apply a drop or two of nitric acid. Let it sit for a couple of minutes, wash off, warm up the beeswax, wipe it off, and the job is done. (Once again, Bill Fenton.)

NOTE: as a means of applying an identifying mark, etching is not as "permanent" as stamping.

What if you want something a little more artistic than your scribed initials? There are relatively simple means whereby one can produce nameplates, etc. in steel, brass or other metals by etching.

Basically, the artwork (what you want the nameplate to say) is transferred to the metal surface, and either it or the background is etched away with a suitable etchant (acid). After etching, the item is cleaned, and possibly painted. The trick lies in protecting from the etchant those areas not to be etched.

Suppose you want to make a fancy etched nameplate for a toolbox, say with your name and a design of some sort on it. Maybe you're a machinist in the Navy, and you'd fancy having a couple of "fouled anchor" symbols, one at each end of the nameplate. (Okay, maybe you wouldn't, but I have a reason for using that as an example.)

How to go about it? You make up your "artwork", (see next two paragraphs), take it to a printer - most every town has somebody in the printing business - and have a "negative" (or a "positive", depending on whether you want etched lettering or etched background) made. Using this and some magic stuff in a spray can - see below - plus some acid, you can etch your design in the surface of the metal. All this in the privacy and comfort of your own basement.

For the lettering, buy some dry transfer lettering (Letraset, Geotype, or like that) from a drafting or art supply store. Such lettering comes in many typefaces and sizes - you're sure to find something you like. If you've never used dry transfer lettering before, the merchant can show you how - it's easy. Lay out your name on a piece of clean white paper, getting the spacing between letters just right for best appearance, and getting them all lined up nicely.

Draw your "fouled anchor" at some convenient size, possibly several times larger than you want it to be in the finished job. Ink the drawing with black ink to give a carefully filled-in black-on-white silhouette. If you drew it oversize - say 3" square - the printer can photo-reduce the image to say 3/4" sq. - just tell him what size you want it to end up at. Try to avoid needing more than about a 5:1 reduction. Give him your lettered out name, and ask him to stick a 3/4" fouled anchor symbol on it "here" and "here". Don't try to draw two anchors - the camera can take 2 shots of it in a second. (That's why the example of the <u>two</u> fouled anchors.)

Now, if you want the <u>design</u> etched, ask for a photo negative image: clear (see-through) words etc. on a black background. If you want the background etched, (in which case it would be a good idea to incorporate a border around your design), ask for a photo positive image: black words etc. on clear film.

Buy a spray can of auto-positive photo resist - it's used for making printed circuits. "Radio Shack" isn't the only place to buy such stuff, but it is one place.

Make your brass nameplate blank a little bit (1/64") oversize both ways. Spray it with the photo-resist. Position your finished artwork on the brass, and expose the whole assembly to ultra violet light (from a U/V lamp) for the appropriate time - (see directions on spray can). When done, set your artwork aside and wash the brass plate in water - the photo resist will wash off where **clear film** was, but will remain intact where **black** was.

Etch the plate with ferric chloride etching solution (Radio Shack or whatever) - this might take a couple of hours or so - see maker's directions. When done, wash and rub off the photo resist.

Now ain't that cute?! You can put paint on the whole thing, and then rub the face on a piece of fine wet-and-dry paper placed on a flat surface to bring up the unetched areas bright and clean. File and polish the edges, and rivet the finished nameplate to the toolbox, or stick it on with epoxy glue.

The printer's negative can be re-used if you want to make more than one identical nameplate. Store it in an envelope, away from the light and protected from bending and similar damage.

NOTE: Brownells sells a little kit for etching one's name, etc., on metal - "...anything you can type, write, or draw... ", as the catalog description says. Also pointed out in the catalog description is the fact that this method of marking does not meet the U.S. Govt. ATFD's "metal stamping" requirements.

Another idea: Stamped characters in steel can be filled with molten brazing rod flowed into the impressions, after which, file and polish back down to a nice smooth surface. The result? Brass inlaid lettering!

HOW TO HANDLE NEW COILS OF MUSIC WIRE

by H.L. Wheeler
American Machinist Magazine
May 14, 1931

It is quite common to see mechanics who have not had much experience in winding coil springs make a mess of a roll of music wire when attempting to wind springs in a lathe. Occasionally one will suffer a severe hurt to the hands, and another will waste a great deal of wire before coiling a spring successfully. The trouble arises out of mishandling the wire on the roll.

Some men will pull out enough wire from the roll to make one or two springs without first cutting the binding wires that hold the wire in tension. As additional wire is used, the binding wires soon become loose and slip around. Others may cut all the binding wires but one, allowing the roll to spread out like a fan. If the roll is put back into stock, the next man who wants to use it generally finds a badly tangled roll of wire to work with. Sometimes it is so badly tangled that it is next to impossible to do anything with it. Rather than waste time and patience...., the roll is put back into stock and a new roll is taken out to go through the same treatment. A lot of wire then becomes just so much scrap. I have seen plenty of men who should know better, handle rolls of music wire in these careless and extravagant ways. To avoid trouble in handling rolls of music wire there is a very simple procedure. It is essential to remember that a new roll of wire is under considerable tension, and it is this tension that causes most of the trouble and vexation. The first step then is to relieve the tension, which is a very simple matter.

After removing the paper wrapper, place the roll of wire on the floor and put a short piece of board over it. Place one foot firmly on the board to hold the roll down. With a wire cutter, proceed to cut the binding wires, and then release the pressure of the foot just enough to let the roll expand to the fullest extent. It will then be about twice the original diameter. Tie it in three or four places with soft iron wire or stout cord to hold it together. It will then be possible to reel off as much wire as needed for any job without further difficulty. Another method of doing the same thing is to place the roll between two short boards held in a bench vise, squeezing it between the boards when the binding wires are being cut.

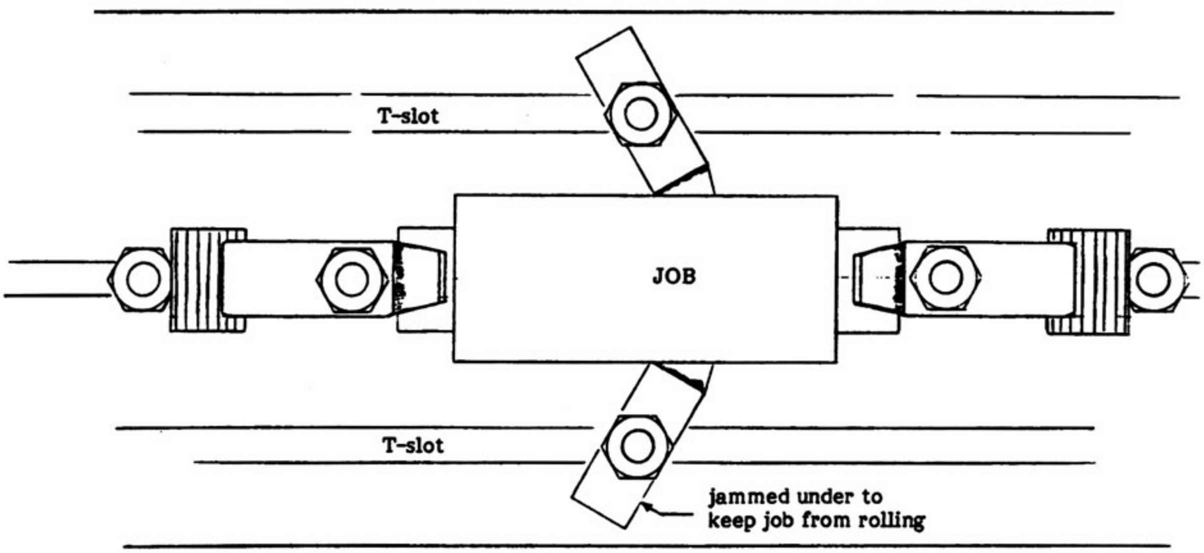
By using either of these methods, a lot of time and grief will be saved for both yourself and the other fellow, also there will be less chance of the roll of wire flying out of the window, or getting caught around your collar button.

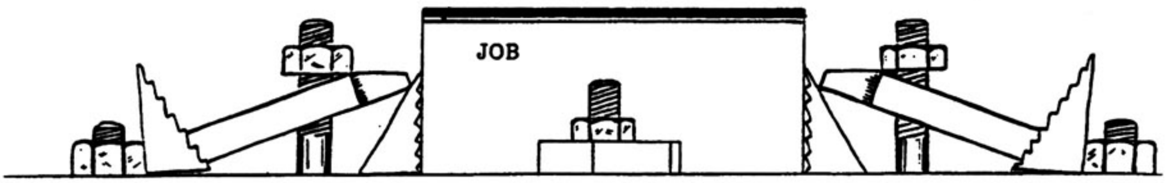
SOME IDEAS FROM TEXAS

Extracted from letters from
J.V. Hayslip, Texas City, Texas

FLYCUTTING THE FULL LENGTH OF A CYLINDER

Saw this set-up to flycut the full length of a cylinder to make it a square. Had occasion to use it, and it worked real good.



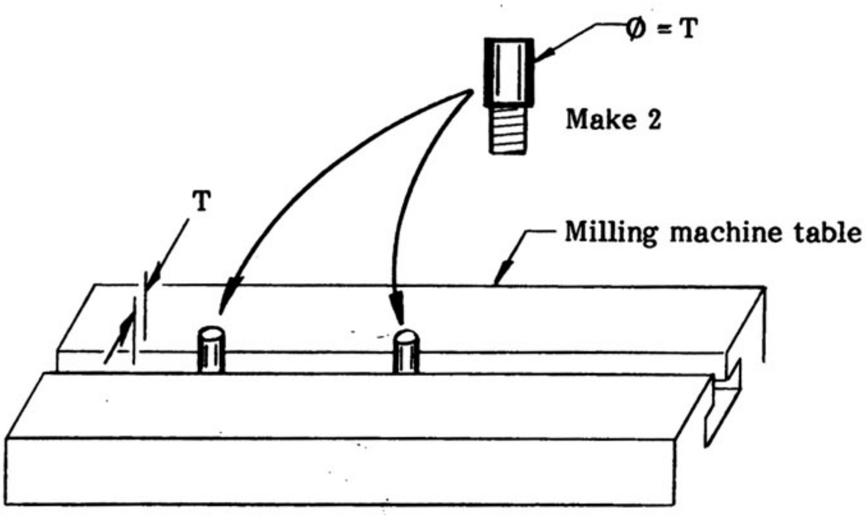


NOTE: Obviously, slips of cardboard or sheet aluminum should be placed under the step-blocks at the heel of each end clamp, if not elsewhere as well, to protect the surface of the milling machine table.

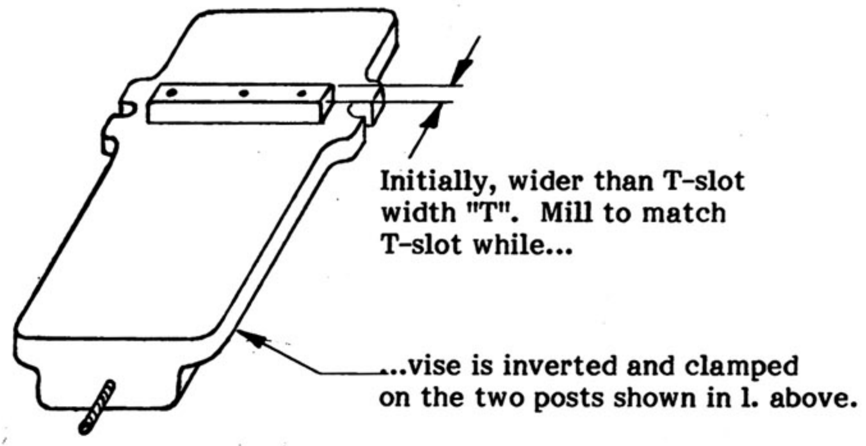
AUTOMATIC ALIGNMENT FOR YOUR MILLING MACHINE VISE

It's mighty nice to have things organized in such a way that your machine vise lines up correctly on the milling machine table whenever you've had it off and have to re-install it. To become a partic - ipant in this pleasant state of affairs, measure the width of your milling machine's center T-slot carefully, and turn up two cylinders exactly the same diameter as the width of the slot. Cut a very loose, sloppy male thread to suit your T-nuts. This thread is just to hold them generally upright when screwed into the T-nuts.

Turn machine vise upside down and clamp to the protruding portion of these two cylinders. The milling machine vise jaws are now aligned with your milling machine's T-slots.



Drill and tap two or three holes in line on the bottom of the vise. Using socket head cap screws, attach to the bottom of the milling vise a piece of CRS of some size slightly greater than the slot is wide. (**NOTE**: This piece of material should be stress relieved beforehand. See info on stress relieving CRS elsewhere in this book. GBL.)



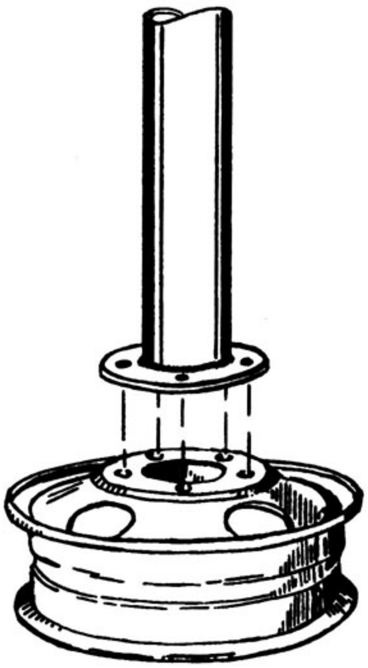
Machine the CRS to just nicely fit the T-slot, and to a thickness such that it leaves room for the T-nuts underneath (when the vise is installed in its normal position). Unclamp the vise from the two cylinders made and used at the first stage of the above procedure. Scrap these. Turn vise over and install it - it will now assume a "zero'ed" alignment with respect to the milling machine table whenever you install it.

Sometimes we do things differently up No'th from what they do in Texas: I would be inclined to make the Key to fit the T-slot beforehand, then invert vise and clamp to posts, drill and tap vise bottom, drill and counterbore matching holes in Key, attach Key to vise, and finally indicate Key zero-zero with axis of Table movement. Now tighten the screws, locking the Key in this alignment, and the same happy result will prevail as from Mr. Hayslip's method.

PEDESTALS FOR SMALL SHOP TOOLS

(I had asked Mr. Hayslip how he liked his bench vise mounted on a pedestal made from a length of steel pipe, at the bottom of which was a heavy truck wheel.) In answer he says:

"The vise on stand is superb as long as wheel is heavy enough. You could use a wheel (i.e. a rim) from your Oldsmobile - put some concrete in it to add the necessary weight - or do what I did for that one and get a truck rim that uses the split rim system, thus:



A truck wheel rim like this weighs 40-50 lbs and has a 6-7" hole in the center. Add a pillar with flanges top and bottom and you're in business.

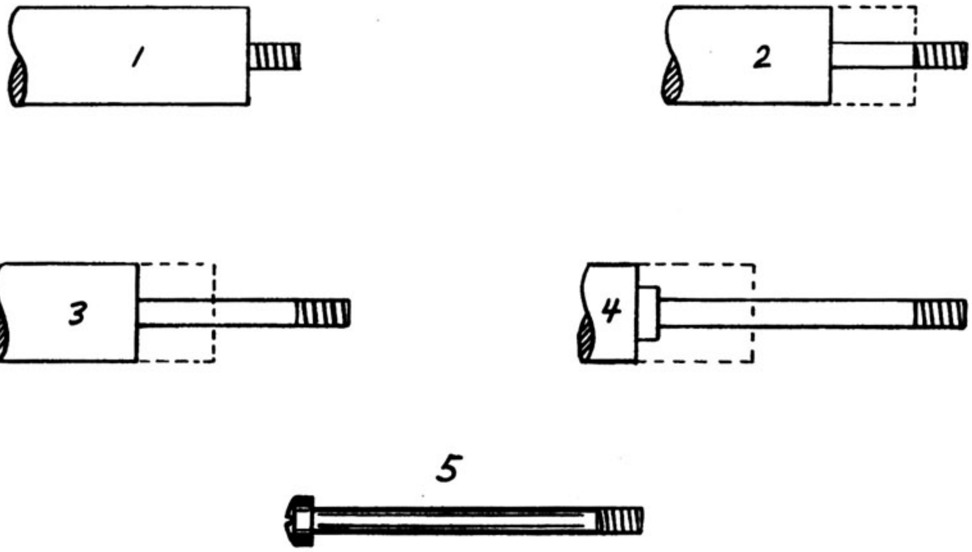
I've got the die filer, grinder, and Lisle twist drill sharpener on them and wouldn't be without them. Since it is wanted for a pedestal rather than for use on a vehicle, you can use a less-than-perfect one, so the price should be right."

Hayslip strikes again:

MAKING A LONG, SMALL DIAMETER SCREW

Problem: make a screw, 1.5" long, 0.105" dia., for the fore-end of Hayslip's O/U shotgun. Worse problem: Hayslip has no steady rest for his lathe.

Solution: turn the material down to 0.105" dia. far enough for the thread. Do the thread - start it by screwcutting if you want - and/or finish up with a die-nut.



Having screwed the short 0.105" portion, turn the material down to the desired diameter for the length of screw needed. The diameter of the rod on the left will give enough support so that no steady rest will be necessary. You may have to cool with air or water as you do it. But it works! (He's right. It does. I've used this idea more than once myself. GBL)

FOR THE CAMERA BUFF

I am tempted to incorporate a number of projects in here for the machinist who has, as another interest, photography. However, I think these might be of rather narrow appeal, so I will make some suggestions only.

1. Camera makers use the 1/4-20 thread for camera/tripod and like mountings. Knowing that will be useful, if you didn't know it already, which you probably did.

2. A gunstock-type camera support: I've never used one of these, but the idea appeals. Not hard to do, and seems 'twould be a practical item for off-tripod use of long telephoto lenses. The stock can be sawn from a piece of wood about 2" thick (solid or laminated), and brought to shape with rasps etc.

Alternatively, a partially finished stock for the purpose can be obtained from one or another of the companies which supply gunstocks, e.g. Reinhart Fajens, of Warsaw, Missouri. For a complete list of such outfits, consult the "Directory of the Arms Trade" in the back of a current or recent issue of **Gun Digest** (which see at your local gun store or public library).

The hardware can be basic, or elaborated to whatever degree you like.

For a couple of how-to articles on making a camera shoulder stock, see the references at the end of this section.

3. How about a handgrip for your camera? Such units are made by several camera makers as accessories. None are cheap. A machinist who wanted to could make one that would be nicer than anything he could buy. Look at the various factory-made offerings, take note of features you like,

then draw up one that incorporates them. Think in terms of 1/16" brass sheet carefully bent to shape, its edges filed to pleasing contours and polished smooth with abrasive paper, careful riveting or soldering, a hardwood handgrip carved to fit your hand, and so on.

4. Ever had anything to do with a PINHOLE CAMERA? A pinhole camera is simply a device for exposing a piece of film to light admitted through a very small hole, in fact literally a hole made by a pin. Often such cameras are crude affairs, cobbled together from cardboard and masking tape. Interestingly, they can be used to take some very nice pictures, with great depth of field and quite wide "viewing angle." Why not make a real nice one? Or make a pinhole adaptor to replace the lens on your 35mm camera? For details of such a project, see below.

I could add more, but I think the concept has been made clear - by applying your metal working know-how and shop equipment, you can make camera accessories fully the equal of anything you can buy, and in some cases, you can make stuff you can't buy.

For example, look up *Popular Mechanics,* May 1975, page 86. There you will find an article on how to make a 760mm telephoto lens for 35mm SLR-type cameras. I doubt the guy who wrote the article had a lathe, so given that you do, you could make it even easier, or better, or both, if such a project should interest you at all.

One final thought: don't overlook the possibility of buying some piece of camera gear - for example an older "view camera" that has seen better days - and refurbishing it to good as new or better. The basic item is there, with 95% of the work already done. If the thing has a metric thread in it and the screw to fit is missing, don't overlook the possibility of drilling the thread out completely, Loctiting in a bushing with a 'real' thread in it, and fitting a North American screw.

Obviously I am not suggesting the above with respect to major (or even minor) lens overhauls, but rather say fixing up a tripod, or some other mechanical item, where such an approach is realistic and practical to do.

REFERENCES FOR FURTHER READING

PIN HOLE CAMERAS

Mechanix Illustrated - May 1940, p.78.
Mechanix Illustrated - Oct. 1947, p.150
Popular Science - Oct. 1947, p.198
Science Model Making (a book) - p.81-88

TELESCOPE CAMERA

Mechanix Illustrated - January 1965, p.122
Mechanix Illustrated - April 1967, p.146

CAMERA GUNSTOCK

Mechanix Illustrated - March 1963, p.121
Science & Mechanics - Aug. 1947, p.137

NOTE: You can buy 4x5 and 8x10 wooden view camera kits from Bender Photographic, 19691 Beaver Valley Road, Leavenworth, WA 98826; phone 1-800-776-3199 for orders; inquiries: (509) 763-2626; or, if you're on the Internet, check out Benderphoto.com.

Why not build a HARMONOGRAPH?

If you would like to make something unusual, perhaps as a gift for your grandchildren or for your own family, a harmonograph is something that both children and adults will find fascinating.

What is a harmonograph? It is a pendulum-operated "drawing engine" which will draw graceful "harmonic" cycloidal designs. The two pendulums are gimballed on phonograph needles or similar, and the whole unit would have a footprint about 1' x 2', and would stand about 3' high. A sheet of paper is taped to a table fixed to the top of one of the pendulums. An arm driven by the other pendulum carries a pencil or pen which is placed in contact with the paper. When the two pendulums are set in motion, the machine silently draws a pattern.

The position of the weights on the pendulum rods can be varied, which changes their motion, and thus the nature of the pattern drawn. No two drawings are identical.

A harmonograph is not difficult to build and can be as nicely made as you want: a beautiful item to which your wife would be happy to give a permanent place of honor in the living room, or a not-so-fancy version kept in the recreation room. Either way, it will be a conversation piece and a source of entertainment for the family and guests alike. I would estimate the building time at about a week or two of evenings.

IF YOU WANT TO BUILD ONE
E.T. Westbury wrote an article on how to build a harmonograph in *Model Engineer* of September 8, 1960, page 300. Working drawings are available from Power Model Supply Co. Cost per October 1985 price list is $5, and the drawing number is G/4.

I had a letter in early January '94 from a customer in Texas commenting on the foregoing mention of harmonographs. He said it brought to mind some fun he'd had, back in the '60's, making one which he eventually refined to the point where it was so good it'd run for 10 minutes. Every drwg was different, naturally. He said some years later he saw an exhibit of harmonograph drwgs; they were for sale, some at up to $1,000.

A SET OF HEAVY BRASS NAPKIN RINGS

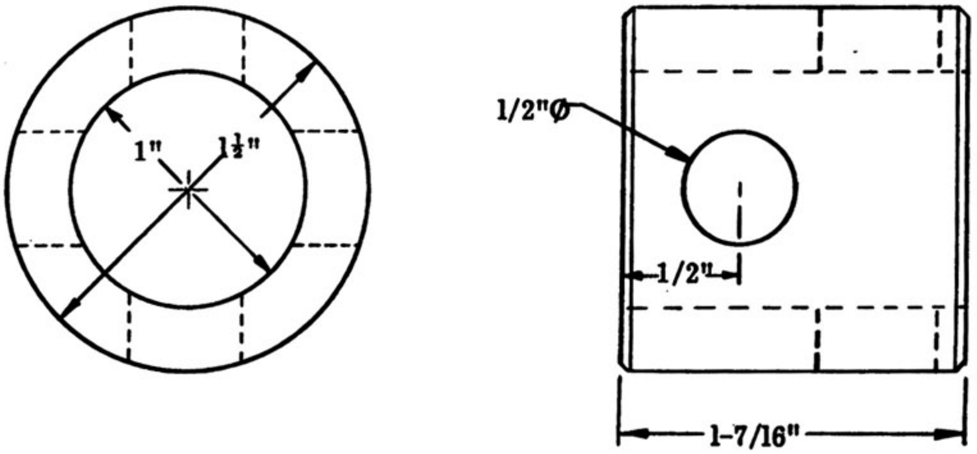
I made up a set of 8 napkin rings, per drawing below, and they elicit much favorable comment among guests whenever we use them. Mine are made far too precisely - here is a classic case of where loosening up the tolerances a few thou would shorten the job time significantly.

My wife says the hole should be bigger. I'd go to 1-1/16 or 1-3/32"Ø max - the heavy wall thickness is part of their appeal, and would be lost if the hole is made much bigger.

Note: If brass items are not lacquered, handling will leave fingerprints. In time, unlacquered brass will also tarnish. You can tell if an item has been lacquered as follows:

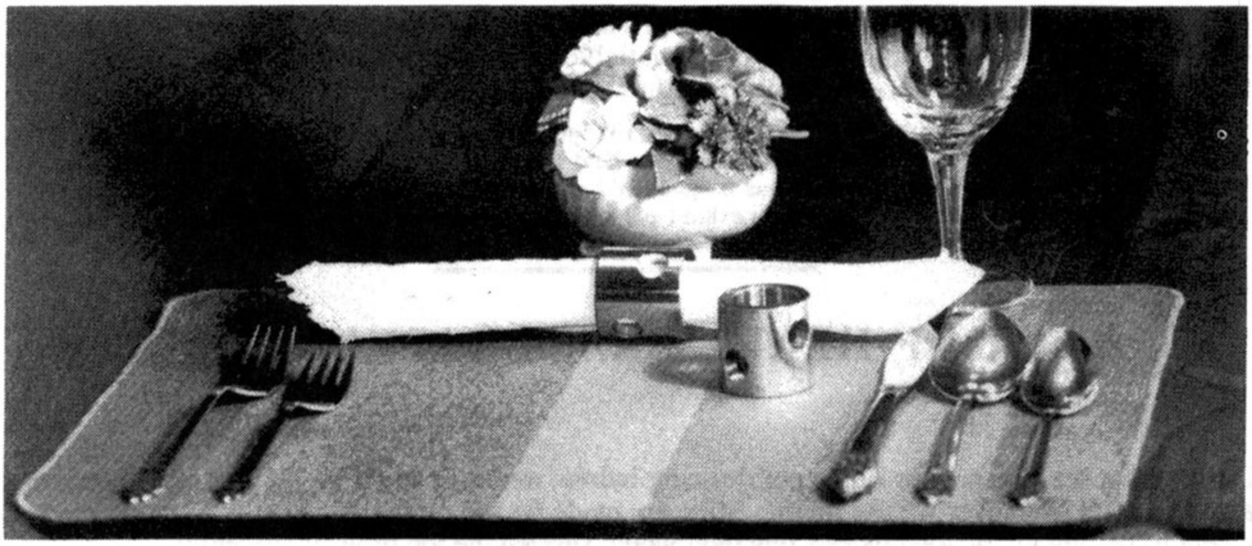
Touch it. If it has been lacquered, you will not leave a visible fingerprint. If the item is unlacquered, you will leave a smudge.

WORLD'S MOST EXPENSIVE NAPKIN RING



Margaret says that unlacquered napkin rings covered with fingerprints do not look nice. When she sets the table for guests, it looks like the Queen at least should be coming - when I do it, it is more like camping - so she probably knows what she is talking about. (And I am gonna have to lacquer those napkin rings.)

Lacquering can be done at home, or you can have it done for you by an outfit in your town that specializes in manufacture of brass beds, brass railings etc. Musical instrument repairmen can also do it - they re-lacquer trumpets, saxophones etc. Apparently, lacquering is best done in warm weather.



For those interested in building

MODEL INTERNAL COMBUSTION ENGINES

This subject could fill a book or two in its own right. I have in hand another project which in due course may result in just such a book, but in the meantime I will point you to a gold mine of info on this topic.

There was a writer by the name of Edgar T. Westbury, whose particular forte was designing, building and showing such as me and thee how to build what the Brits call model petrol engines. He was what we would call a Professional Engineer by training. But he was also a skilled machinist, and a keen and generous- spirited model engineer.

Westbury (ETW) applied his talents primarily to model engineering, and writing about it for the benefit of such as we. I understand that during WWII he was asked to design a very small petrol engined power unit for some military use which remained secret even after the war. I have been told he designed an electric generator using - for its silence both audibly and electrically - a steam engine as the power unit. This little steam generating unit was intended to be dropped to Allied agents in Europe for supplying power for their radio transmitters. Being steam powered, the engine would be virtually noise free, and one would assume, could probably be fuelled with bits of wood, or whatever else came to hand, rather than being dependent upon gas, which might be rather tough to get, if you were "in country" and not supposed to be. I have a notion that the "SIRIUS", the larger of Stuart Turner's two fully enclosed hi-speed vertical twin steam engines, is that engine. The name would tend to confirm that story... Now I would hasten to add that the foregoing is what I have picked up from conversations with other model engineers and from various items appearing in the letters column and in articles in *M.E.* over the years.

More than anyone else, Westbury made it possible for amateur machinists to build such engines. He said his initials stood for 'Engines That Work'. He did not produce designs for hopped-up, flat out, supercharged, pushed-to-the-limit engines. His engines were designed to be reliable, tractable, and workable, as well as buildable by the average home shop machinist. As Westbury pointed out, the hopped up engine is usually a source of great frustration for the man with little experience of model engines, being hard to start, hard to regulate, and hard on itself. Not to say you couldn't take an ETW design and hot it up if you wanted to, but his aim was to show the average home shop machinist how to build an engine that he could have assurance would work.

ETW's engines ran the gamut from 5 cc to 60 cc. There are 2-cycle and 4-cycle designs, air cooled and water cooled. Some are suitable for model aircraft, others better suited to 'marine' applications (e.g. 3' to 4' hydroplanes). Most were single cylinder types, but there are also vertical twins, horizontal twins, and 4-cylinder designs. He also showed complete working drawings and instructions for several carburetors and miniature magnetos suitable for use with these and similar engines.

These various engines and accessories were fully described in *Model Engineer* over the years from about 1930 to 1970. I am not sure when ETW died, but he was an active contributor up til nearly the end of his life. His passing left a gap which has not since been entirely filled.

At this point you are probably thinking : "Where am I going to be able to find back issues of *Model Engineer* Magazine?" If you can, great, but if not, don't feel bad, because....

Complete working drawings for most ETW engines are readily available! In some cases complete kits of castings etc.,(see below) as well as reprints of his how-to-build **instructions** are also available. And how do you plug into this gold mine? Very simple:

One source is Sulphur Springs Models Company, in Missouri; www.sssmodels.com, or phone 636-272-6632. Also, www.wokingprecisionmodels.co.uk/ sells castings etc. for some ETW engines. An internet search with words like *engine model castings* should reveal a number of other suppliers who carry this type of stuff.

There is also a little book called **Model Petrol Engines**, by E.T. Westbury, which I would highly recommend. It is available today as a reprint from an outfit in England called Traction Engine Enterprises, Ltd., (www.teepublishing.com/) and if the quality of the photos in this reprint is not what it might be, it will have to do – they weren't all that hot in the original edition either. To get a copy, contact Wise Owl Publications, or write direct to Traction Engine Enterprises. For addresses, see Appendix.

Then there are a couple of books by L.C. Mason, which are also good. These are: **Designing, Building and Running Model Four Cycle Petrol Engines, and Building Mastiff.** Same sources - Power Model Supply, etc.

Building Mastiff is a complete treatise on building a 4-cycle water cooled 'flat four' of 24 cc displacement. Mason dubbed this design 'Mastiff'. Power Model Supply Co.'s catalog does not list it, but I suspect they carry it. They do stock the 6 page set of detailed working drawings for this engine.

Another source of model engine stuff is Coles Power Models (see Appendix). They carry drawings, castings, etc. for several engines by Mr. (Elmer?) Wall (now deceased), who lived, I believe, in Chicago, and fathered half a dozen little engines during the 30's and 40's, and maybe later.

From such sources as given above, you can learn an enormous amount about building such models, how to balance them, how to make a simple lathe fixture on which to make the cams, appropriate materials to use for various parts, how to make and heat treat cast iron piston rings, etc. etc.

Let me describe some of ETW's most interesting designs:

Kittiwake is a 1-cylinder 15cc, air cooled o.h.v. 4-cycle engine of 1" bore, 1.125" stroke. It has inclined valves, enclosed pushrods, and forced lube. Drawings, castings, gears, and a reprint of the construction article are all available from Power Model Supply.

A good carb for Kittiwake is Westbury's "Atom Type R" carb, having a submerged jet and float feed. Again, full details are available from Power Model Supply.

Kittihawk is a scaled up Kittiwake: 1.25" bore, 1.43" stroke, for a displacement of 30cc. Drawings (but not castings, so far as I know), are available.

This brings up another interesting possibility - scaling up a design. The 15cc **Seal** (see below) has been scaled up and built in larger versions, with or without modification, as **Sealion** (30cc) and there was a **Seal Major** at 60cc, and **Seal Maximus**, at 120cc. Now, does that not open up further horizons for you?

Seal is a 15cc vertical 4-cylinder, 4-stroke, water cooled side valve engine, 5/8" bore, 11/16" stroke. It has splash lubrication, and is basically a model of a conventional automotive engine, "quite flexible.....recommended for the more advanced constructor" says the *M.E.* blurb.

One chap built a Seal, and then built a radio controlled Land Rover in which to install it. (I believe the Land Rover is not common in the U.S. It is the English equivalent of a Jeep.) This model was about 2 feet long, complete with functional steering, transmission, and differential; it sported tires from ashtrays. Full working drawings, etc. appear in *M.E.* of July 7, 1967, and in subsequent issues. Doubtless if you wrote to the Editor's office, they would be able to send you a photocopy of the series. Obviously such a model would be ideal for teaching your grandchildren to drive. If you don't have any grandchildren, you can always invent some, or say it's for the neighbor's kids.

Sealion is like Seal but has an overhead camshaft, 7/8" bore, 3/4" stroke, (30cc) and ends up 8-1/8" long, 6" high, and 3-3/8" wide. Castings, etc. are available from Power Model Supply.

So there's a whole field of activity for those who might find it of interest, and a preliminary map of the gold mine of info available.

. . . .

While working on this section of this book, I got some photos in the mail. They were from a guy called George G. Scott, (Box 272, Outlook, MT 59252.) These pix are of engines he has built and for which he sells castings and drawings. One is a handsome twin flywheeled Mogul side shaft unit. It has a 1.5" bore, 2" stroke, and those heavy rimmed, 6-spoked flywheels are 8" across. This is a good lookin' engine. Then there's another one, same horizontal layout, not so appealing to my way of thinking, but that's personal - 10" flywheels, 1.5" bore, 2.5" stroke. Finally, the real charmer of the bunch - a John Deere power unit, skid mounted, in factory colors (available from your friendly John Deere dealer) and complete with radiator, starter, etc. Bore and stroke = 1.7". I'd guess the O/A length would be 18 inches. Scaled down to half this size, it would be irresistable. If interested, write directly to George for further details, and enclose $1 to help with postage, xeroxing etc.

Added to the 8th printing: **George Scott passed away a couple of years ago. If you're interested in castings/drwgs for Mr. Scott's engines, send a note plus a SASE to Robert Washburn, Editor, *Strictly IC Magazine*, 24920 43rd Avenue S., Kent, WA 98032-4160. Mr. Washburn should be able to put you in touch with whoever now has the patterns and drwgs.**

ADDED TO THE 18th PRINTING, SEPTEMBER 2006:

A new magazine has recently come out called *Model Engine Builder Magazine*, put out by my friend Mike Rhemus. Check out their website at www.modelenginebuilder.com.

CLOCKMAKING

If you would like to leave your name on something of lasting value, make a clock. Most clocks will run for several hundred years with minimal repair. A mechanical clock capable of keeping time within an accuracy of 1 or 2 seconds a week can be made in a basement workshop with little more than a lathe and a drill press. Such clocks have a charm and prestige that no $5 quartz clock can match.

Your local public library can help you locate books and past published magazine articles on the subject, in such magazines as *British Horological Journal, Timecraft* (this one ceased publication some years ago), *Model Engineer*, *Home Shop Machinist*, and other similar magazines. Books and back issues of magazines not held by your local library can often be got through the Interlibrary Loan service.

We also offer a catalog of plans for various clock movements, and clockmakers' tools you can make. These are all from C.J. Thorne, a professional clockmaker in England. Also, we now offer a book called **Clockmaking for The Home Shop Machinist**, written by C.J. Thorne, and edited by yours truly me. This book takes you through the construction of a typical clock, describing, as they are encountered, the tricks and techniques clockmakers have learned in the past 6 or 700 years to make these little spring- and weight-driven gear boxes run for long periods at uniform rates, without seizing up, as they likely would if made with the sort of fits a machinist thinks in terms of. Specialized tools, virtually all of which can be made in your own workshop, are described as the need for them arises. This book is packed with information and clear explanations of the "how" and the "why" of a line of activity that promises endless variety, challenge and fascination.

Finally, W.R. (Bill) Smith, of Powell, TN offers a number of books, some on how to make specific clocks (e.g. his beautiful **Lyre** and **Grasshopper Skeleton** clocks), and some on shop techniques. His clocks are very handsome, and in at least 2 cases, his prototypes have won Gold Medals at national clock enthusiasts' meetings. For an up-to-date list of what he offers, send a SASE to: W.R. Smith, 7936 Camberley Drive, Powell, TN 37849; (423) 947-9671.

SHARPENING TUNGSTEN CARBIDE TOOLS

by Charles O. Lewis
Lucas Machine Tool Company
AMERICAN MACHINIST Magazine
April 30, 1931

In sharpening tungsten-carbide tools in the usual way they must be ground on a special wheel. The operation must be carefully done and takes considerable time. Then too, duplicate tools are required if the machine operator is not to lose time while his tools are being ground in the toolroom. With tools of high-speed steel, very little lost time is necessary as the steel is comparatively cheap and a good supply of sharp tools can always be kept on hand.

To overcome the objection of having the tools out of service for the time required to grind them, I use a 8"x2"x1" 60 grit Carborundum hand stone to sharpen them without taking them out of the machine. I find that a minute or two is all that is required to restore the cutting edge on a tool. It is surprising how rapidly such a stone will cut, and there is no danger of checking the tool as when it is ground on a wheel.

I have in my department Carboloy tools that have been in use for eighteen months and have never been ground. They have been kept in good condition by the use of a Carborundum stone as named above. This stone is of a size convenient to hold in the hand, and will last for a long time. If of 60 grit, it will not glaze over as will a fine stone. After the stone has been used for some time, it becomes grooved and uneven, but it can easily be made flat by rubbing it on a hand lap. For this purpose I use a cast iron plate about 12" square and about 1" thick. The top surface has a number of V-shaped grooves crossing each other at right angles. The grooves are about 1/16" deep and are spaced 1" apart. Loose Carborundum is sprinkled on the plate and the stone is rubbed upon it.

(See also elsewhere herein the item re a cobalt-free Chinese tool steel that outperforms HSS, and that is available in North America. GBL)

A HAND BEADING TOOL

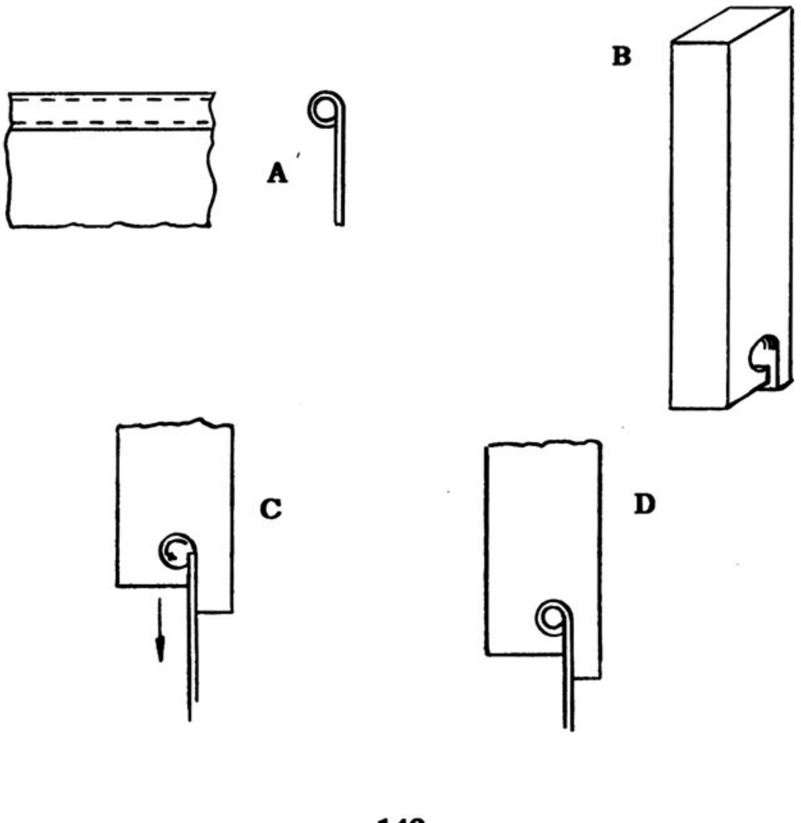
by Henry W. Boehly

AMERICAN MACHINIST Magazine

April 16, 1931, p. 624

Occasionally the edges of some sheet metal part will have to be beaded, as shown at A in the illustration. Such work often proves troublesome, especially when a neat job is wanted. At B is a tool with which such a job can be done very easily. It has a slot with enough clearance to permit the entrance of the work, as at C. A hole of the diameter of the bead is drilled tangent to the far edge of the slot. If the hole is lapped or otherwise polished, the metal will bead more easily.

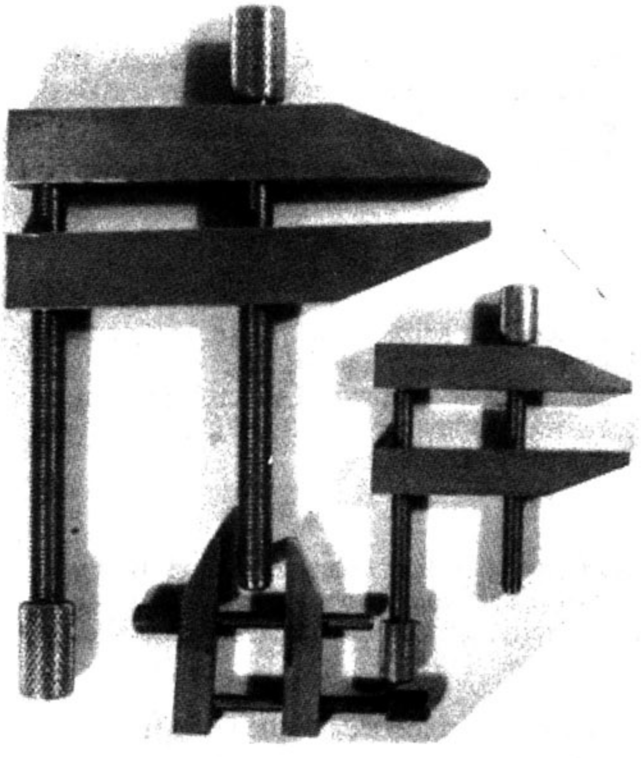
In operation, the tool is entered over the edge of the work, as at C, and when struck with a hammer the bead will be formed, as at D. Oiling the tool will help considerably. In forming a bead of large diameter, a pin should be slipped under the bead when it has been partially formed. The pin will prevent the edge of the metal from breaking down and will have the same effect as what is known in die parlance as "wiring".



TOOLMAKERS CLAMPS

(This is an edited version of an article I wrote for the Nov/Dec 1985 issue of *Home Shop Machinist* Magazine. The drwgs below are taken, with permission, directly from that article.)

Toolmakers clamps (hereafter referred to simply as clamps, because we aren't going to be talking about any other kind), are useful in many applications around the workshop, for sheet metal work, for clamping parts for marking out, drilling, riveting, soldering, machining, etc.



GENERAL ARRANGEMENT AND NOMENCLATURE
FOR TOOLMAKERS CLAMPS

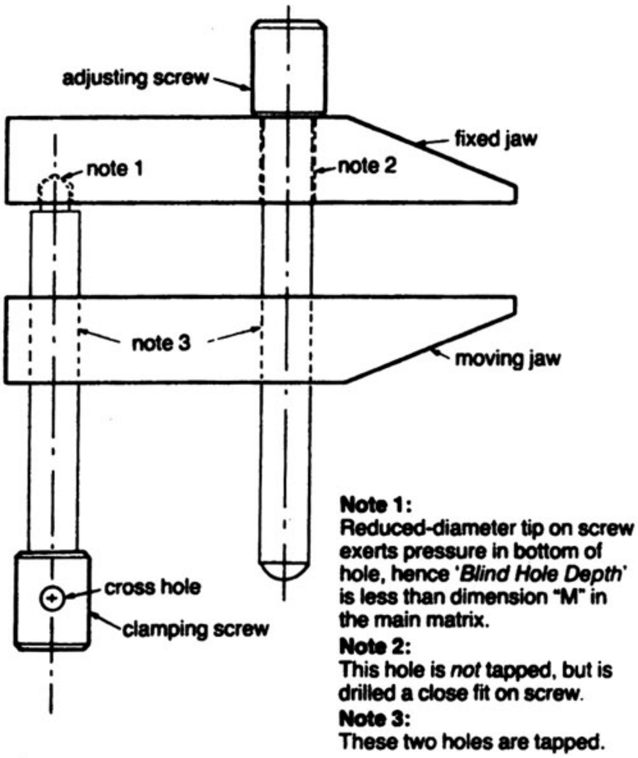


Figure 1

The accompanying dimension matrix and drawings cover six sizes of toolmakers clamps from 1-5/8" to 5" overall length (OAL). Measurements were taken from several commercial clamps of various makes, and a review was made of working drawings for various sizes of clamps found in numerous textbooks of machine shop practice, and other like sources. The various dimensions were then tabulated, standardized, and rationalized to form a convenient and logical progression through the normal range of sizes of such clamps. (Obviously, if the available material is of a slightly different section, e.g. 3/8" x 7/16" instead of 3/8" square, a clamp can be made to suit the material at hand - the matrix is not written in blood and stone.)

The suggested methods of construction are based on having made about 14 such clamps covering all but the 5" size.

The making of one or two clamps is not an entirely practical proposition, as the cost of a single clamp is not great even from a famous-name maker such as Starrett. However, if an extensive set of clamps in several sizes is wanted, the cost begins to add up, and if you make several clamps all of one size at one time, the time per clamp goes down significantly. The notes which follow may be helpful in this respect.

HOW MANY? HOW BIG?

The size of clamps you will want to make, and the number of each size, will be governed by the type of work for which you will use them. However, as a starting point, two of each of the smallest sizes will be found useful on small work and/or where space is limited, while four each of the 2-5/8" and 3-1/8" sizes, plus two 4" clamps, would round out a pretty comprehensive assemblage.

Decide at the outset how many clamps of each size you want, then make all the pieces for a given size at one go, to reduce the time per clamp.

Let's get down to specifics: (See Fig. 1 for nomenclature.)

MATERIALS

I would suggest: for the **Jaws** - cold rolled steel; for the **Screws** - "ready rod" (fine thread), with separate add-on **Knobs**, Loctited on. Note: For Toolmakers Clamps, unlike cabinet makers wooden parallel jaw clamps, both screws are right hand thread full length. Most Knobs will come from the scrap box, I suspect, but if you have it, use CRS for them too.

MAKING THE PARTS

JAWS

Cut pieces for jaws slightly over the specified OAL, face both ends of each piece, measure and machine to length. Apply marking out blue to all pieces. Mark out limit of taper on top of jaw (dimensions G & F in the main Matrix). A surface gauge, surface plate, and an angle plate make short work of this job. Machine the taper in the lathe, mill, or shaper. A little oddleg artistry is quite appropriate here and in a lot of other places throughout this project.

Do not rely on marking out and centerpunch marks for locating the four holes per clamp! Best way is to do the job on an assembly line basis in the vertical mill, if you have one, or hew as close to that approach as your equipment allows. Assuming the milling machine vise has been dialled in parallel to the table axis......

Locate the machine spindle centerline with respect to the left (or right) side of the vise's fixed jaw, and move the table in and left (or right) to locate for the Clamp Screw holes in the heel of the clamps. Stick a center drill in the spindle. Grab a clamp jaw in the vise on a parallel.

Drill the hole, tap it, unship and repeat, til half your jaw pieces have that hole done. Do the corresponding (blind hole) in the opposite jaw next, then shift the table and do the holes for the Adjusting Screw.

It goes fairly fast this way. Keep the chips cleaned out of the vise, butt each piece up against the same stop (I use a rule plastered flat against the side of the vise), and don't drill holes in your parallels! Also, lock up the table movements to preclude accidental shifting when you least want it. And keep an eye on which piece you're working on and what you want to do with it.

When the jaw pieces are all drilled and tapped as required, and the noses tapered, the heel of each jaw can be radiused or bevelled to suit. Here, a confession: my clamps all have square heels. (Confession is said to be good for the soul, but it doesn't seem to have done much good for the heels!) Maybe one of these days... In the meantime, they work just as good the way they are.

SCREWS

"Ready rod" can be used in making the Screws, plus separate knurled Knobs, drilled, tapped, and Loctited in place. This considerably reduces the amount of time and material needed to make a clamp. Details and information are given in Figure 3 and Matrix B.

KNURLED KNOBS

Knurling to full depth (i.e. to the point of producing sharp diamonds) is neither necessary nor desirable. In fact, it is a good idea to put a file to the knurled surface to make it a little easier on the thumb and forefinger when using the clamps. If you don't have a knurling tool, or don't want to bother knurling the Knobs, leave them plain. In any case, I would highly recommend you cross drill the Knob of the Clamping Screw for a Tommy bar. (Another confession would be too much of a good thing - don't look too closely at the photo accompanying these pearls of wisdom!) As far as I can see, a cross hole in the Adjusting Screw Knob serves no purpose - only the Clamping Screw needs a hole.

To assemble Knobs to Screws, when all the parts are ready, degrease with rubbing alcohol, apply a drop or two of Loctite 609 or equal in the Knob, run the Screw into the Knob, and back out again to suck the Loctite to the bottom of the hole, then screw fully home, wipe off excess Loctite and leave to set. Cross drill the Knob/Screw assembly after this has been done.

FINISHING TOUCHES

Remove toolmarks from the tapered nose of each jaw piece with a well-chalked file, then with a piece of abrasive cloth backed up with the same file. A quick rub with steel wool or worn emery paper will produce a nice dull finish on clean CRS. Sand blasting or glass bead blasting is quick and will give you a very nice looking finish. The jaws could be blued with one of the proprietary cold touch-up gun blues, if you like.

MATRIX A

Refer to Figure 2

Dimension (Letter)	CLAMP SIZE (=OAL) 1⅝	2⅛	2⅝	3⅛	4	5
A	5/16	3/8	7/16	1/2	5/8	3/4
B	5/16	3/8	7/16	1/2	5/8	3/4
C	11/16	15/16	1 3/16	1 3/8	1 15/16	2 1/4
D	11/16	15/16	1 3/16	1 1/2	1 3/4	2 1/4
E	1/4	1/4	1/4	1/4	5/16	1/2
F	1 1/8	1 7/16	1 3/4	2 3/16	2 3/4	3 1/4
G	1/2	11/16	7/8	15/16	1 1/4	1 3/4
α	25°	22°	22°	23°	22°	19°
Hole Sizes: in fixed jaw						
Through hole	#19	#11 or #10	1/4	1/4	5/16	7/16
Blind hole Ø	#36 (0.1065)	#29 (0.1360)	#19 (0.1660)	#15 (0.1800)	1/4	11/32
Blind hole depth	1/8	3/16	3/16	3/16	1/4	1/4
In moving jaw, drill both holes	#29	#21	#3	#3	Letter I (0.2720")	25/64
and tap them	8-32	10-32	1/4-28	1/4-28	5/16-24	7/16-20
Screws Thread	8-32	10-32	1/4-28	1/4-28	5/16-24	7/16-20
H	3/8	1/2	1/2	5/8	3/4	1
J	1/4	5/16	3/8	7/16	9/16	5/8
K	1 5/8	2 1/4	2 3/4	3 1/2	4	5
L	1 5/16	1 7/8	2 1/4	3	3 1/2	4 1/2
M	3/16	1/4	1/4	1/4	5/16	3/8
N	.100	.130	.160	.175	.240	.332
P	3/32	1/8	1/8	5/32	3/16	1/4

NOTE: All dimensions are in inches.

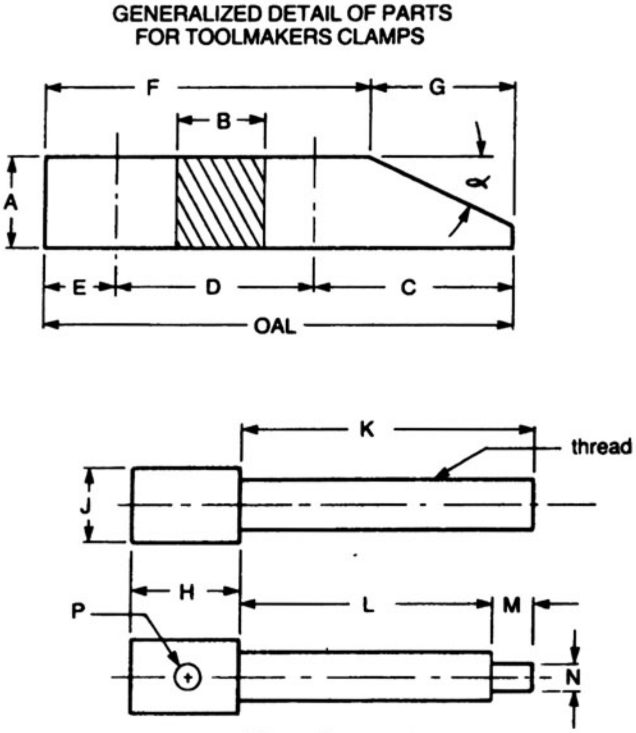


Figure 2

CASEHARDENING THE JAWS

Many factory-made clamps are casehardened and display the attractive mottling of reds, blues, browns, etc. associated with "color casehardening". Personally, I very much doubt the need for casehardening clamps for home workshop use. However, for those who disagree, there are commercial heat treaters who would no doubt do it for a nominal fee. You might, however, be wise to have them do just one clamp first, before you commit your whole output: a friend told me that during his apprenticeship he made a pair of toolmakers clamps, and casehardened the jaws. The first time he used one, the fixed jaw broke in half at the adjusting screw hole. The casehardening had gone too deep, and had left the thin section on either side of the hole hard right through and brittle. (This of course is a case of failure in "technique" rather than "application", and could perhaps have been corrected by annealing the area around the screw holes.)

The same chap also said he'd made one little wee clamp about an inch or so long, using socket head cap screws for the screws. He's had it in his toolbox ever since, and used it many a time where a larger clamp would not fit, but where a little nipper was just the thing.

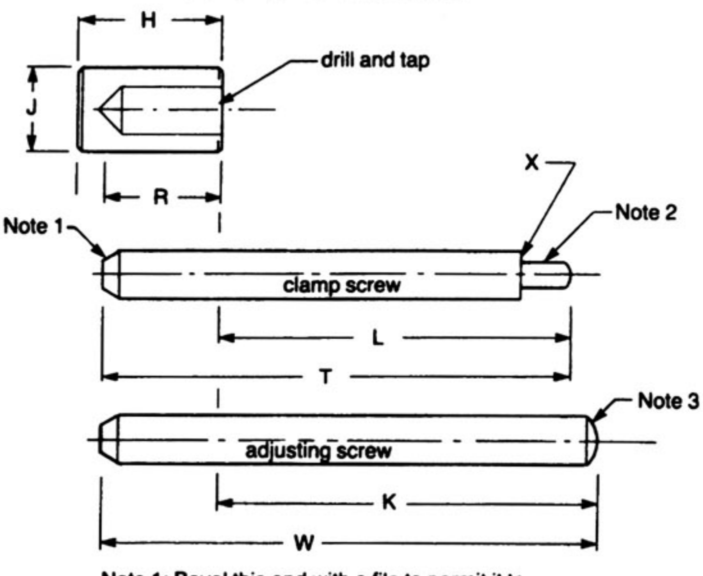
> Idea: Make a fully functional, miniature toolmaker's clamp as a lapel pin or tie tack. You might meet a fellow machinist that way, who'd otherwise never know you had a common interest.

MATRIX B

Refer to Figure 3

Dimension (Letter)	CLAMP SIZE (=OAL) 1 5/8	2 1/8	2 5/8	3 1/8	4	5
H	3/8	1/2	1/2	5/8	3/4	1
J	1/4	5/16	3/8	7/16	9/16	5/8
Drill and Tap	29 8-32	21 10-32	3 1/4-28	3 1/4-28	I(i) 5/16-24	25/64 7/16-20
to Depth R	1/4	3/8	3/8	1/2	5/8	3/4
T (Clamp Screw)	1 3/4	2 1/2	2 7/8	3 3/4	4 1/2	5 5/8
W (Adjusting Screw)	1 7/8	2 5/8	3 1/8	4	4 5/8	5 3/4
Knurling	Fine	Fine	Fine	Med	Med	Med

DETAILS RE: SCREWS AND SEPARATE KNOBS FOR TOOLMAKERS CLAMPS
refer to Matrix B for dimensions



Note 1: Bevel this end with a file to permit it to screw fully into tapped hole in the knurled knob.
Note 2: Turn down to dimensions "M" and "N" in main matrix above. Round tip as shown.
Note 3: Round with file, then blunt sharp edges of thread crests.

Figure 3

SOME NOTES ON MAKING THE OPTIONAL CLIPS

One feature commonly found on factory-made clamps is not shown in the main drawings and Matrix. This is the Clip, or Retaining Fork, on the Fixed Jaw (see Fig. 1 for nomenclature) which engages the head of the Adjusting Screw. While this Clip is convenient, particulary if the clamps are to be in constant use, I have found that clamps made without it work equally well in all other respects. The Clip requires additional work to make, and adds little in the way of utility. For those who want to incorporate this feature, an additional drawing and another Matrix is provided which should be helpful.

Usually the Clip on commercial clamps is a stamped metal part. Such is quite satisfactory in practice, but forming the bend might be a little tricky without a purpose-built bending jig, different sizes of which would be required for different sized Clips. If I were making Clips for a run of shop-made clamps, I would make them from CRS or nice flat hot rolled mild steel plate, thus:

1. Machine material to leading dimensions.
2. Mark out and centerpunch for hole A.
3. Put in a 4-jaw chuck and indicate centerpunch mark true, (or clamp in vise of vertical mill and pick up centerpunch mark with a centerfinder), then drill hole A.
4. Mill the step across the underside.
5. Drill the attaching hole on an assembly line basis as for the holes in the Jaws.
6. Cut the piece in half with a hacksaw, (thus producing two Clips, enough for two clamps).
7. Clean up that cut, and break all corners and edges with a file.

Attach the Clip to the Jaw with a screw.

SUBMATRIX "C" FOR OPTIONAL CLIP
Refer to Figure 4

Dimension (Letter)	CLAMP SIZE (=OAL) 1 5/8"	2 1/8"	2 5/8"	3 1/8"	4"	5"
ØA on knob	0.198	0.245	0.308	0.370	0.433	0.525
"A":drill in clip	13/64	1/4	5/16	3/8	7/16	17/32
B	1/16	1/16	1/16	3/32	1/8	1/8
C	1/16	1/16	1/16	1/16	1/8	1/8
B+C	1/8	1/8	1/8	5/32	1/4	1/4
D	0.270	0.33	0.42	0.47	0.62	0.70
E	1/4	5/16	3/8	7/16	9/16	5/8
F (approx)	0.80"	1.0"	1.2"	1.4"	1.8"	2.0"

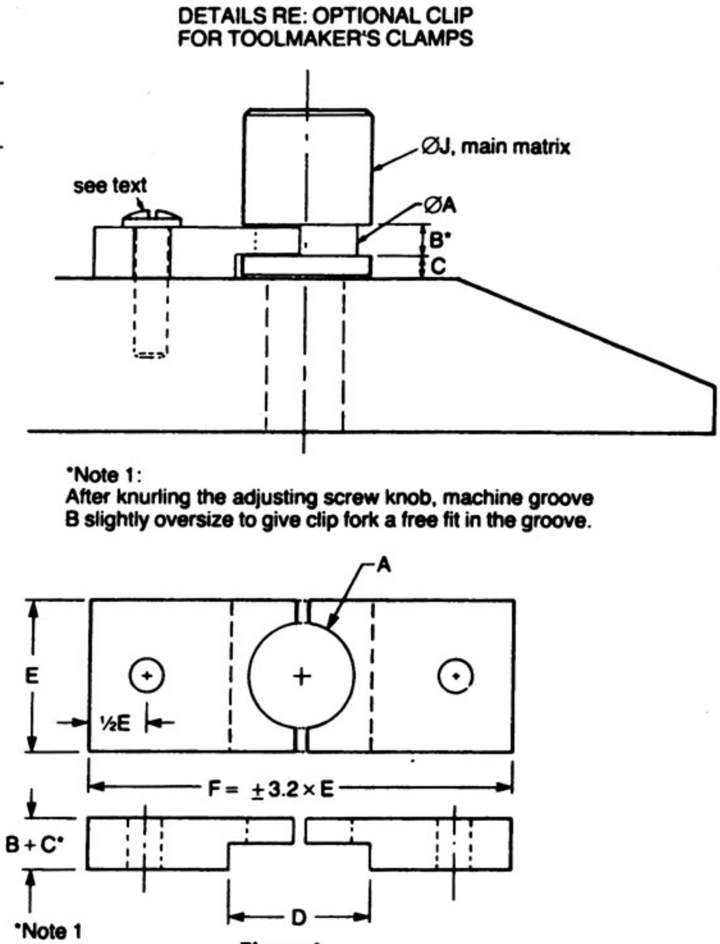


Figure 4

SPRING MAKING

(See also note at the bottom of page 31 herein.)

Springs are sometimes required to be made in the workshop. They are not difficult to make, whether they be coil springs, or flat springs.

Music wire and flat spring stock can be bought from Brownells, Inc. (See Appendix.) There is a book entitled **Handbook of Spring Design**, put out by the Spring Manufacturer's Institute, 2001 Midwest Road, #106, Oak Brook, IL 60521; phone: 708-495-8588. If you need a fair amount of technical info about springs, it would be worth the $10 cost for a copy.

In making coil springs, my experience has been that it is usual to have to make about 3 springs before one is produced which is right. I usually use a drill shank as my mandrel, and I catch the end of the wire between the drill and one jaw of the 3-jaw chuck. I turn the lathe on, grip the other end of the wire with a pair of pliers and put some tension on it before letting in the clutch. Spindle speed should be no more than 200 rpm.

On occasion I have let the wire pass through a wad of cloth very solidly gripped in a pair of pliers. Watch out for the end of the wire when you let go of it - it'll spin around like lightning! I usually stop the lathe and back the spindle up by hand to take the tension off the coils, before letting go of the wire, if the wire is more than say 0.025"Ø.

I've also just gripped the wire between thumb and forefinger, when using 0.006"Ø wire to make springs which had a free length of about 3/4", or less, that'd stretch out to about 3 1/2" and come back to original size. The bore of these springs would pass a 1/16" shaft. Those ones, made from music wire, required no tempering.

Others I've made, with 0.027" wire, which had a free length of maybe 20" and say 80 or 90 coils about 9/16" I.D., did require heat treatment - 3/4 hour in the kitchen oven at 375°F, after which they worked fine. Without the tempering operation, they would not regain their original free length after one full compression. With tempering, they did, repeatedly. This spring went into a movie prop, to wit, a collapsable spear I made for a movie being filmed here about three years ago. The little springs went into collapsable liver biopsy needles and collapsable syringes for the same movie.

Usually the mandrel on which a coil spring is wound will be 0.75 to 0.85 times the desired I.D. of the spring, but this is best found by experiment.

A German tool and die maker told me the following: To square up the final turn of wire in a coil spring, heat up a piece of steel red hot and then simply press the end of the spring against it. I've never had occasion to try it, but it should work.

There are various ways of heat treating flat and V-springs. Before heat treating such a spring, make sure your filing and polishing marks all go along the line of flexing, not across it. If there are cross marks, stress will be concentrated at those points, and the spring will likely break there, sooner or later.

Harden a flat spring as you would any piece of high carbon tool steel, then reduce its brittleness by heating it uniformly all over to about 550 to 570°F, indicated by a deep purple/dark blue color. There are various ways recommended for this, such as bashing a depression in the side of a quart size automotive oil can, said depression being big enough to hold the spring and enough used engine oil to completely cover it. Light the oil with your torch, and let it burn off. Then cover the spring with sand, lime, or ashes, and let it cool slowly. Apparently it does no harm to add a little wood alcohol to the oil, to encourage its burning. (The foregoing is a composite of some of the spring making info in **Gunsmith Kinks**, Volumes I & II.) Another way to gain good control over the supply of heat in the tempering process is to immerse the spring in a pan of sand, or fine brass cuttings, and apply heat to the underside of the pan. Polish and leave exposed a little bit of the spring, so you can see when the right color comes. Then remove the spring to cool slowly in ashes or lime.

Don't get the spring oily when polishing it bright again after hardening - the oil will distort the colors you are looking for and depending upon for an indication of the temperature.

TOOL STANDS

Blocks of wood with holes drilled in the top face are a handy way of keeping lathe and milling machine cutters organized and readily accessible. They look tidier if the rows of holes are kept neatly lined up while being drilled. For round shanked cutters, the holes want to be about a 64th over shank diameter.

For several years my largest twist drill was 1/2"Ø. When I wanted to make a block to take 1/2" shank tools, I'd drill the holes at 1/2", then run back into each one in turn with a suitable boring tool in my boring head, which was set to cut just a little over 1/2"Ø. 'Twerked fine, but it wasn't a fast way of doing things.

Then I bought a 13 mm flat spade bit, which ought to be 0.5118" or thereabouts, which should make just about a perfect size of hole for the purpose at hand. However, when tried, it made a too-tight hole. I guess the maker hadn't really put his heart into holding a close tolerance on his metric stuff. I took it back to the store, along with my 1" mike, and checked several other 13 mm bits, same type, same maker. They varied - I found one that miked 0.515". 'Twerks a whole lot better.

Moral: Not all flat spade drills that are marked the same, drill the same size hole. This can work to your advantage.

Come to think of it, the width of the spade drill isn't the only thing that matters, unless the point (which centers it) is truly centered with respect to the spade.

Bill Fenton Passes Away

Right after completing **TMBR#3** in 1993, we made a video which has proven very popular. It's called **A Video Visit with Guy Lautard & Bill Fenton**. Mostly it's just what the title implies, but you may learn a few things from it, too - others have. You'll get an up-close look at two quite different shops, their general equipment and layout, and a great variety of both bought and shop-made tools, models, ideas you can use, plus a few anecdotes and chuckles. 90 minutes of sometimes instructive entertainment from your favorite author. *See the very last page of this book for ordering instructions.*

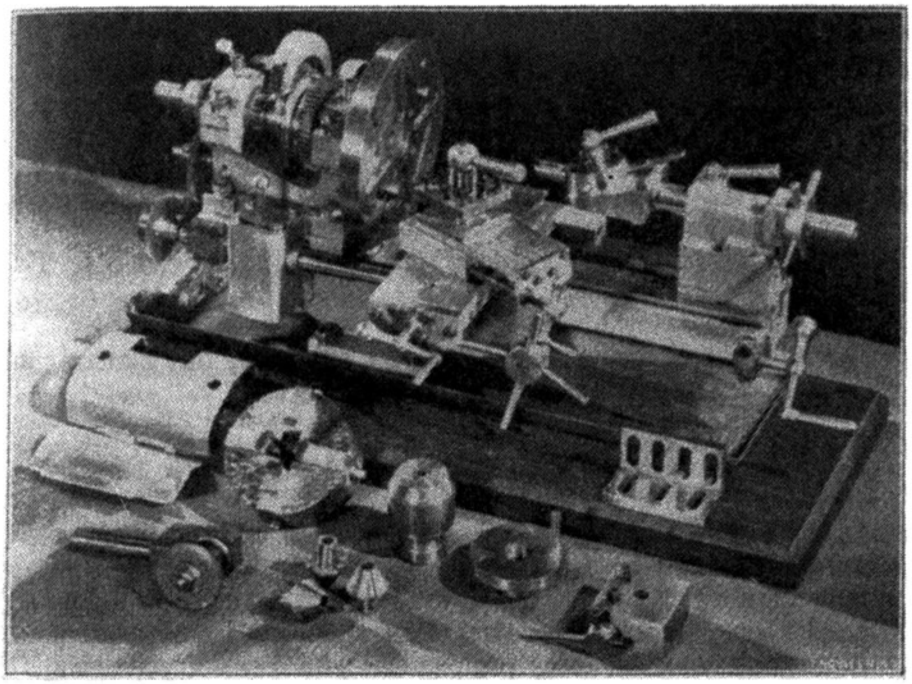
Note: A few months after we made the above video, Bill Fenton sold off his entire shop, then sold his house, and moved into a rest home, where he passed away rather suddenly in June of 1995.

Rest in peace, Old Friend.

A SMALL LATHE BUILT IN A JAPANESE PRISON CAMP

by R. Bradley, A.M.I.C.E.
ENGINEERING Magazine
January 7, 1949
(Reprinted with Permission)

The author, as an officer in the Royal Artillery, was a prisoner of war in Japanese hands from February 15, 1942 to the capitulation in August, 1945. During that time, he was engaged with some fellow prisoners on much useful engineering work, including the design and construction of artificial limbs, and in order to equip a workshop for these tasks he secretly made a small lathe, which is illustrated, with some accessories, in Figs. 1 and 2. Visitors to the Machine Tool and Engineering Exhibition at Olympia in August and September, 1948, may remember seeing this lathe, which was exhibited on the stand of ENGINEERING in the gallery. The overall length is 17", and the distance between centers is 6-7/8". The swing is 4" over the bed, 5-1/4" in the gap, and 1-5/16" over the saddle. The cross slide traverses for 2-3/4" and the topslide for 1-5/8". The topslide can be fixed to the cross slide in any of 3 positions, and it can be rotated through 360 degrees. The lathe, together with the accessories illustrated in Fig. 1, weighs 30 lbs.



After nearly a year of captivity, which had included service in two working parties in the town of Singapore, the author found himself back in the Changi Headquarters Camp on the northeast side of Singapore Island, where, with fellow prisoners, he had first been imprisoned. Much had happened in that year, but one short story must suffice to show how the prisoners had learned to seize opportunities and outwit their guards.

A few officers had systematically stolen tools from the Japanese, while out with working parties, and had smuggled them back into camp, but it was so inconvenient to have to hide them whenever a guard appeared in the hut that it was decided to establish a workshop. A Japanese N.C.O., who acted as an interpreter, was engaged in conversation after a roll-call parade, and persuaded to draw the Japanese characters representing "man", "dog", "tree", "house", etc; the word "workshop" was easily included and the character was carefully noted. It was copied onto a piece of wood, and the next changing of the guard awaited. After the last round of the guards, the sign "Workshop" was hung up in the officers' hut, and the tools neatly arranged so that the new guard found a small joiner's shop functioning and took it for granted.

After the return to Changi, the author was engaged in camp routine duties and managed to occupy his time lecturing small groups on engineering subjects, navigation and astronomy. Several large parties had been sent out into Thailand, and more were expected to have to go to work upon the Burma-Thailand railway scheme, but when the details arrived for the dispatch of more labour the author had the good fortune to be ordered to remain in the camp to instruct a Japanese General in astronomy. The General spoke English very well, and it was possible to turn the conversation to put in complaints or requests as instructed previously by the British Staff. This useful contact with a senior Japanese officer lasted for several months.

Meanwhile, a small repair workshop which had been equipped with a few tools found in the area when it became a prisoner of war camp, was moved into the camp hospital area, and the author was put in charge of it to make artificial limbs and surgical instruments. During an astronomy lesson the General was informed of these activities, and of the difficulties occasioned by the shortage of tools and materials, with the result that he visited the shop himself, and a week or two later sent in a few hacksaw blades, files, twist drills, a quantity of aluminum rivets, and some light-alloy sheeting removed from crashed aircraft. The workshop was equipped with a 3-1/2" backgeared screwcutting lathe with a 7" 4-jaw chuck, a small hand bench-drill; a portable forge; and a few vises and hand tools. Unfortunately, there were no change-wheels for the lathes. The workshop was staffed by 12 R.O.A.C. tradesmen.

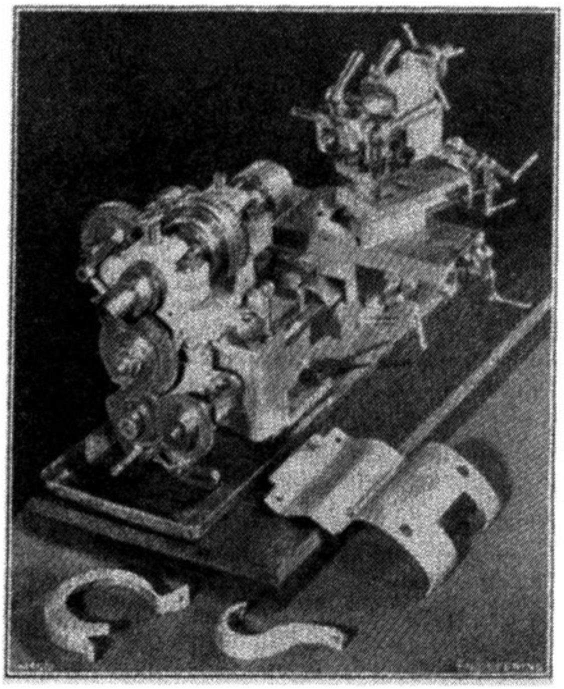
An endless stream of jobs poured into the workshop. They varied from repairs to cooking utensils to making sewing machine needles, from repairs to microscopes to making special splints, and at the same time experiments were being carried out with an artificial leg designed by the author. The patient was able to walk with the new limb, which had a link-motion instead of a hinge in the knee, and jigs and templates were prepared in order to facilitate production. Everyone learnt to improvise, and to salvage anything that could be of any conceivable use. Much useful scrap was handed in to the workshop. One officer brought along some gear wheels which were part of a set of change-wheels and were found to fit the 3-1/2" lathe, while another dug up and gave the author some artillery instruments (known as "transceivers") which had been part of the coast-defence guns; from them some precision gears and stainless-steel shafts were obtained.

Only six artificial limbs had been made, however, when orders were received to move the hospital, and several weeks elapsed before the workshop was established again, but it was recognised as part of the camp establishment and called the "Artificial Limb Factory". Both lathes were installed, and also a simple grinding spindle, and through the Japanese General a drill press was obtained from another workshop under his control. The workshop was extremely busy and the number of surgical instruments which had to be made increased week by week, in addition to heavier jobs such as turning 4"Ø rolls for rice-crushing machines, manufacturing parts for an ingenious machine which made nails out of barbed wire, and making components for many other labour-saving devices.

The author had given much thought to making the best use of the small precision gears, and he decided that a small and reasonably accurate screwcutting lathe, with a large range of accessories, would fill a growing need and would in any case allow much essential work to be continued if at any time the Japanese were to take away the larger machines. It was important, therefore, that the proposed machine should not be seen by the Japanese, that it should be small enough to hide and transport in a canvas pack, that it should be capable of fairly heavy work on large diameters, and that the essential parts should be made quickly while some machines were available.

A sturdy bed was the first requirement. Enquiries revealed that there was some 3" x 3" steel in stock in the Japanese workshops, and permission was obtained for a small piece to be brought into camp for the use of the Artificial Limb Factory. The author had a word with the officer in charge of the British personnel in the Japanese workshop, and he had the piece cut to the required length. The Japanese would have been suspicious if an exact length had been specified, and if a large piece had been requested, some weary prisoner would have had the task of carrying it.

The work was marked out from a dimensioned sketch, and the author drilled and chipped away with a cold chisel, all the surplus metal. The bed was then bolted to the saddle of the 6" lathe, and cleaned up with a fly cutter - an operation carried out on a Sunday when the workshop was allowed to be closed. Thus, in two weeks spare time the piece of steel was reduced in weight from about 33 lb. to 8 lb. The only available tool suitable for use as a surface plate was the ground face of a piece of heavy 6-ft. straightedge, and with its aid the top of the bed was scraped flat to receive the slides. These were made from a piece of good quality steel strip removed from an old R.A.M.C. stretcher, cut to length and then filed and scraped true before being put aside for a week or two while more drill and cold-chisel work was carried out on a piece of plate which was to form the lathe saddle.



The threads were turned off a phosphor-bronze screw to leave a piece of stock out of which the main bearings had to be made, and its size governed the diameter of the mandrel. The mandrel was machined from a piece of a truck axle, and although it had been annealed it was a difficult job for the only high-speed steel lathe tool the workshop possessed. The leadscrew and a brass nut were made on a Sunday, and, with a rack and pinion from a damaged typewriter, were hidden until required.

The slides were now checked again and found to have warped slightly, but after correction they were marked out and drilled for fixing screws and used as templates for drilling the holes in the bed, which were tapped No. 0 B.A. (This would be about 1/4 x 25 tpi. GBL.) The fitted screws were made with slotted heads to facilitate their insertion and possible future withdrawal, in case at any time it should become necessary to jettison the comparatively heavy bed and to preserve the accurate slides and the components made to fit them. When the fitted screws and some dowels were driven in and filed and scraped flush, the top surface was very nearly flat and required little correction. The rear edge was selected as the "master" edge and checked for straightness. Split brass bearings for the leadscrew were made by hand, and when the headstock fixing studs were fitted the lathe bed was considered finished and work was resumed on the saddle. It was built up so that the dovetail for the cross slide could be adjusted dead square, without scraping, when the machine was running. The cross slide, chipped out of a piece of 1/2" plate, was therefore set as nearly true as possible, and gibs, adjusting screws and a 1/4" Whitworth feedscrew were fitted.

So far, there was no suitable piece of metal out of which to carve the headstock, and while arrangements were being made for a piece to be obtained from the Japanese workshops the topslide was added to the assembly and ball handles were made and fitted. The leadscrew and complete apron had been fitted by the time a piece of steel 4" x 3" arrived, but after so many hours of drilling, chipping, filing and scraping, the author decided to try casting a headstock instead.

The workshop had developed considerably by this time, and several aluminum brackets, pulleys and bearing housings had been cast in sand bonded with chopped grass. In order to produce a dense casting, a deep mold was bent up out of 16-s.w.g. steel (part of a barrack-room locker) into the form of the headstock as seen from the front. This U-section mold was stood on end on the ground, sealed with clay and surrounded with sand, and pouring commenced. It was a complete failure. The furnace consisted of wood burning in an enclosure of red-hot bricks, and owing to difficulty in pouring, more molten aluminum went onto the floor than into the mold. However, a second attempt with the mold supported in a large mass of clay was successful, and there were no blow-holes apparent in the lower portion of the casting which was sawn off. The external surfaces were faced in the lathe and the remainder trimmed up with saw and file, making a very satisfactory headstock in a short time. The job was then set up on the cross slide of the 3-1/2" lathe, and with the bearing caps in position, bored for the phosphor-bronze bearings. They were bored 'in situ', the mandrel was fitted, and provided with a temporary aluminum pulley, and the headstock bolted in place on the bed.

This stage of the work was very interesting, and the author spent every available minute making the many small parts still required to complete the machine. A No. 0 Morse taper plug was made on the 3-1/2" lathe and the same taper was turned on some short lengths of 1/2" bar which were to serve as test pieces when adjusting the lathe. With the machine incomplete there was no time to scrape in the bearings to a perfect fit, and after a short period of running-in on the drilling machine table, with the mandrel driven by a leather bootlace, it was decided to bore the mandrel 'in situ' to fit the taper gauge. It was then possible to turn a test piece, and the headstock was adjusted until the machine turned parallel within 0.00025" on a 2" length. There was a piece of 1" steel plate in the scrap box, and, by drilling a circle of holes in it, the blank for a faceplate was obtained. This was chucked in the 6" lathe, machined all over, and tapped 5/8" Whitworth to suit the mandrel nose, but it did not run truly when fitted and had to be corrected by very light cuts at a low speed. A light cut across the face produced a slight concavity, and as this was desirable the remainder of the screws holding the cross slide dovetail to the saddle were fitted.

The next problem was the construction of the tailstock, which had to be made of two pieces of steel dovetailed together, but the joint was made to serve as the set-over slide for taper turning. Into the lower piece the cam-locking device for clamping the tailstock was fitted, and a tenon piece was added to fit between the main shears of the bed. The upper portion was carved out by hand, the rectangular bosses, one of which can be seen in Fig. 1, being left to take a screw adjustment for the tailstock set-over - a refinement that was never provided. The tailstock was assembled on the bed, between the headstock and the saddle, so that the latter could provide the feed in the operation of drilling and boring the tailstock barrel. Due to the overhang of the tool, which had a single cutter fixed by a setscrew, the finish of the bore was poor, but rather than make a new and longer bar and a steady bearing for it, it was decided to enlarge the bore and bush it. A bronze bush was bored and turned to fit, and after being pressed into the barrel in a vice it was reamed to 15/32" with one of the four reamers the workshop possessed, and so the job was made satisfactory without undue delay. The following Sunday, the only day on which the 3-1/2" lathe was available for any length of time, the tailstock spindle was machined, and threaded with a left-hand square thread; a keyway was "shaped" along the length of it, and a hole bored right through. Then a bronze nut was made to suit and, while still in the chuck, the spindle was screwed into it and bored No. 0 Morse taper to match the plug gauge mentioned above.

This work had been spread over a period of six months, and although still lacking a backgear the new machine could now be used. Before driving gear could be made, however, the Japanese ordered an early evacuation of the area, which was wanted in connection with the development of their new aerodrome. The hospital was divided into two, and the section which was to have the workshop was ordered to a site in the vicinity of the Changi jail. The 6" lathe and most of the heavier tools went to a new camp maintenance workshop, but after a few weeks the artificial limb factory was re-established in a newly-erected hut thatched with atap leaves. The workshop staff helped in the building of the hut, and arrangements were made for installing the new lathe in a screened-off corner which was to be the "toolroom" and office.

The 3-1/2" lathe was first set up, and the countershaft was mounted on a timber framework built on heavy timbers driven into the earth floor, and the motor was fixed on a platform below the shaft. Behind the motor was fixed a 12-volt car dynamo and cut-out (which appeared to the layman as part of the lathe driving gear); the leads were "lost" among the general wiring of the building and so conveyed to the office two 6-volt accumulators (spares from the operating-theatre emergency lighting set) which were kept charged up. This source of power, which was always available, drove another car generator as a motor. A switch was made to control the motor field, giving four speeds, an "off" position, and an induction brake, and the motor spindle was fitted with an aluminum 3-step V-pulley made to match that on the lathe.

The lathe was mounted on a wooden base and fastened down on the bench in contact with backstops by a single woodscrew through the front of the base at the headstock end. The motor was pivoted on its fixing lugs, so that its weight kept the belt tight, and yet the arrangements permitted the lathe to be removed quickly in the event of a Japanese guard coming into the workshop. When not in use the machine was housed in a wooden box with a drop-front, kept on a shelf in the tool cupboard, and experience showed that it could be whipped off the bench and moved about 4 feet into its box in a matter of seconds. In their searches of the camp for wireless sets - searches which became more frequent as the war turned in the Allies' favour - the Japanese were furious if they uncovered anything, no matter how innocuous, which they suspected had been hidden from them, so if everyone were ordered out on parade at an unusual time the author left cupboard doors open with the toolboxes on view.

The Japanese Command had been changed by now and the camp was completely reorganized. Rations were worse than ever, and many petty restrictions, which seemed calculated to annoy, were imposed on the prisoners, and it became necessary to proceed very cautiously to avoid beatings. The Japanese used to punish prisoners for breaking rules by locking them up, handcuffed, in a cell with practically no food. An officer of the British Staff managed to get possession of the handcuff key for about half an hour and sent it to the author who measured it, made a lead pattern of the peculiar thread within the sleeve, and returned the key unmarked. Two days later, British Headquarters had five handcuff keys and they were henceforth able to release the "criminals" for several hours a day.

With the workshop in production again, it was obvious that the small lathe would have to be completed quickly, and so one evening after roll-call the backgear pinions were cut with a fly cutter. The 18-teeth pinions were made integral with the bronze sleeves, and were designed to mesh with a pair of 48-teeth wheels which had been taken from a cinema projector when the lathe was first planned. The blanks were mounted together on a mandrel, clamped in hardwood V-blocks on the saddle of the 3-1/2" lathe, and indexed by a suitable gear wheel pinned to the mandrel. After a few more hours fitting, the small lathe with its four-speed electrical drive had 24 spindle speeds between about 50 and 2,000 rpm.

There were no longer any aluminum rivets available, and as rivets were required in the assembling of the artificial limbs, and increasing numbers were needed for the maintenance and alterations to the many appliances which were in use by this time, rivets had to be made out of copper salvaged from overhead transmission lines. Here was an obvious production job for the new lathe, and so the mandrel was bored right through 9/32"Ø (with a long D-bit made for the job) to clear the copper rod. A simple collet chuck and some collet blanks were made on the machine itself. Thereafter, the supply of rivets kept pace with the demand, but it was not long before the new machine was overloaded with jobs that had had to be refused previously. The solution was to provide the 4-tool turret with an indexing plunger and to make a 4-station tailstock turret. The button which releases the turret for manual indexing is just below the underside of the tailstock turret. There was a substantial increase in the quantity and quality of workshop productions, as components which had only been filed where necessary could now be machined in the 3-1/2" lathe, and there was no waiting for small parts to be made. The number of special tools and accessories for the new lathe increased week by week, and several spares, such as nuts for the leadscrew and feedscrews, were machined; the bearings were scraped true, felt wipers were fitted to the saddle, and much thought was given to the problem of providing the new machine with an efficient chuck.

Permission was given for a piece of metal to be supplied by the Japanese workshop, and as the result of a quiet talk with a colleague the metal arrived rough machined, tapped 5/8" Whitworth, and with 2 diametral slots 3/8" wide cut at right angles. One evening after roll-call parade, a cast steel T-slot cutter was "shaped" on the 3-1/2" lathe; next morning the cutter was hardened and tempered and that evening the T-slots were cut in the chuck body. The chuck jaws were milled with a fly cutter in the small lathe, then clamped base to base on the faceplate and the left hand square threads cut in them. Screws and horn blocks were made to suit. The jaws were made of annealed high-speed steel, and although, in any case, they could not be hardened in the workshop, they were considered hard enough as they were and the chuck was assembled.

Any temporary handles and levers on the machine were now replaced by new ones made on it from stainless steel which had been obtained from the shafting of a gun mechanism, and a big improvement was effected by removing the tumbler reverse and replacing it with a constant-mesh reversing gear, with sliding dogs, on the leadscrew. The basis of this gear is a small differential, and the shift lever visible in the illustrations operates in a gate with "left-hand", "neutral" and "right-hand" positions. The half-nut locking device was modified, and the machine pronounced complete, some refinements intended from the beginning of the project having seemed to be unnecessary. Once again, however, the author was wrong, and more accessories had to be made.

Allied bombers were now in evidence, and the Japanese reacted to the threat of invasion by imposing more restrictions on the camp. Rations were still further reduced, and nearly every man who was not actually in hospital or crippled was taken to work as a navvy on military defensive points. There were many rumours of what was in store for the prisoners, and one of the least gruesome was that, at the first sign of Allied activity, they would be herded within the walls of Changi jail. Any bombarding of Singapore would probably have resulted in the power supply to the camp being cut off, and with it the carefully organised radio news service, which at such a time might have been the means of receiving important instructions from the Allied forces.

A battery set was therefore designed by the experts, and arrangements were made for the materials for the primary cells to be taken into the jail with some medical equipment. The author was consulted on the mechanical details of the set, which had to be housed within the leg of a small table, and when machining the components in the small lathe, its battery power supply enabled him to work silently when the workshop appeared deserted, without even his closest friends suspecting that he had any connection with the secret wireless "ring". One of the hidden AC-powered radio sets was operated by a screwdriver pushed through a knothole in a hollow beam, but in the new set the author was able to reduce the hole diameter so that it could be mistaken for a worm hole. A toolpost grinder had to be made, but it was a simple job as a 1-1/2" dia. abrasive wheel was available, and also some small ball races salvaged from an instrument. When completed, the spindle was driven at 8,000 rpm from a large wooden pulley on a fan motor fixed to a beam 6 ft. above the lathe, and the belt was a length of gut carefully removed from an old tennis racquet. A fine taper reamer of about 3 deg. taper was made - the flutes being "shaped" out - and after hardening, was ground true. Some pieces of steel wire about 1/16" dia. had one end hardened and ground to the same taper. The spindles of the main condenser and trimmers (which complete occupied a space of only 4" x 2" x 2") were bored axially and reamered with the special taper reamer, so that, to tune the set, the wireless operator had merely to bend one of the wires to a right angle, poke the pointed end through the "wormhole", engage the taper and turn the wire.

While this work was going on in secret, the new lathe was used to great advantage in the workshop and many "toolroom" jobs were done. The workshop taps and dies were in very bad condition, and on the little lathe quite serviceable replacements were made of 1/4-20 and 3/16-24 sizes. At the same time, one of the workshop staff made excellent small files by hand, and also many short twist drills, the spiral flutes of which he filed out with specially made files.

When the Japanese eventually capitulated, the lathe was equipped with a large range of tools, hollow mills, drills, boring tools, and stainless-steel box-keys and spanners (wrenches). A special turret for the boring tools was included, also a simple indexing device (not illustrated), which fitted on the threaded extension of the mandrel. A member of the workshop staff made the drip tray in stainless steel, and another made the very necessary aluminum pulley and belt guards and the swarf cover for the leadscrew. About 600 hours were spent by the author in building the machine and its accessories, but it was time well spent in view of the many hundreds of hours of work carried out on it in the two years it was in use.

FOOTNOTE: If you've ever thought of building a small lathe, perhaps the foregoing will have provided some inspiration. If you should be inclined to pursue the matter, you might like to know about a set of drawings (catalog # WE/28) available from Power Model Supply Co. for a small lathe of about 2-5/8″ centerheight. One would need the use of a larger lathe in order to make it, but it appears to be a practical design. It was fully described in Model Engineer Magazine starting at page 537 in Vol. 150 (Jan/June, 1983).

ADDED TO THE 18th PRINTING, SEPTEMBER 2006

I've recently come up with a new idea relating to the **"Ultimate Box Latch"** (see page 125 herein). The idea is to make the latch disk octagonal, rather than round. An octagon will give a very grippable shape, with no need for knurling, although round ones I've made without knurling have never been hard to operate.

Now you might ask, "Why not hexagonal?" Well, my thinking is that if you make it hexagonal, anyone who sees it is going to think, "Oh, it's a nut. You have to turn it to open it." With an octagonal box latch, there is – as with a round one – no particular or immediate visual clue as to how to operate it. I think this is desirable, for the sake of mystifying the uninitiated.

Also, a square workpiece will be slightly easier to hold in the 4-jaw chuck for machining the eccentric groove. On the other hand, if you made it hexagonal – in which case you would logically start with a slice off a piece of hex bar of the right size – you could chuck the disk very quickly in the 3-jaw chuck for machining the pivot hole, which is dead center.

If you like the octagon idea, start with a 3/8"+ slice off a 2" square piece of CRS, brass or aluminum, or with a piece of 3/8" thick plate sawn oversize, and machined down to an accurate square. (If I were doing this in my vertical mill, I'd machine the workpiece down almost to final dimensions, and then take a final pass over two adjacent faces with the quill/cutter height and knee locked. This should readily produce a dead square workpiece.)

Locate the center of the square on both front and back faces, and centerpunch same on the front face. On the back (inner) face, make a centerpunch mark offset 1/16" from dead center on a diameter line at 90° to one of the 4 faces of the square. This will be the center of the eccentric groove on the back face.

When you are ready to machine the eccentric groove, use a wobbler (see page 22 herein) to set the offset centerpunch mark to run true. Once the eccentric groove is done, reverse the job in the 4-jaw chuck, and use the centerpunch mark on the front face to set the job running true for boring the 2-diameter hole for the disk to pivot on. After that, reverse again, and indicate from the hole – or a plug in same – to get the disk running true for boring the washer recess on the back side.

To reduce the 2" square to a 2" A/F octagon, set it up in the milling machine vise in a V-block, so one of the square corners is "up". Use a piece of say 1"ø aluminum or CRS about as long as the V-block in the V-block to act as a pusher, to push the job hard up against the fixed jaw of the vise. Then mill off the corner. Assuming your box latch is in fact a 2.000" square, to turn it into an octagon, mill down 0.414" from first contact of a sharp cutter with each sharp 90° corner of the workpiece. Then a few strokes with a #2 cut hand file and a rub with 320 wet/dry paper to get rid of the tool marks, and you're done. Also, of course, file a slight bevel at the edge of the disk on each of the 8 flats so everything feels nice. See also something more re this at page 196/197.

SOME FACEPLATE IDEAS

Part I

A SELF CENTERING FACEPLATE FOR HIGH SPEED AND/OR SECOND OPERATION WORK

Normally, lathe faceplates are made from cast iron, and are not machined all over. Thus, they are rarely suitable for high speed running, even with a completely symmetrical job in place, unless the faceplate has been treated to some careful balancing. Such ministrations would be largely a waste of time, because the majority of faceplate jobs are by their very nature out of balance.

> TIP: Balance is an important factor on some jobs. When boring a hole in a job on the lathe, if the job is chucked or faceplate mounted, and much out of balance, keep in mind that, (aside from the obvious fact that it <u>cannot</u> be run very fast), even though it be run so slow as to <u>seem</u> ok, the bored hole will very likely not be round. The out-of-balance condition, even at low speed, induces this. So apply balance weights whenever possible.

The self-centering faceplate described here is built up from machined-all-over parts, and hence should be able to run at high speeds without vibration. The ability to be run at speed can be advantageous when dealing with well balanced workpieces, particularly when the work is in brass or aluminum, where higher cutting speeds are appropriate.

When work is mounted on a self-centering faceplate, the workpiece can be removed for examination, or to permit other machining operations, and can then be returned to the faceplate, where, without the slightest pains being taken, it will immediately run true again, given a good fit between the centering stud and the central hole in the job in the first place.

An example: in making clock wheels (gears), the gear blanks' center holes could be reamed in the 3-jaw chuck, one after another. Install the self-centering faceplate, and turn each gear blank to specified O.D. one after the other. (If the workpiece diameter is smaller than that of the faceplate, use a spacer of sheet brass or aluminum slightly under the size of the job, to permit machining the O.D. without cutting into the fixture.)

After all the gear blanks are turned to size, the lathe is set up for indexing, and a gear cutting spindle is rigged on the vertical slide, or the fixture is removed to a dividing head set up on the vertical mill. Gear blanks are replaced on the fixture one at a time, and the teeth cut into them, all true with the original center and O.D.

PART (A)

The **Spindle Nose Fitting** (A) can be made from a piece of scrap steel of suitable dimensions - or buy a factory made chuck back plate to fit your lathe.

PART (B)

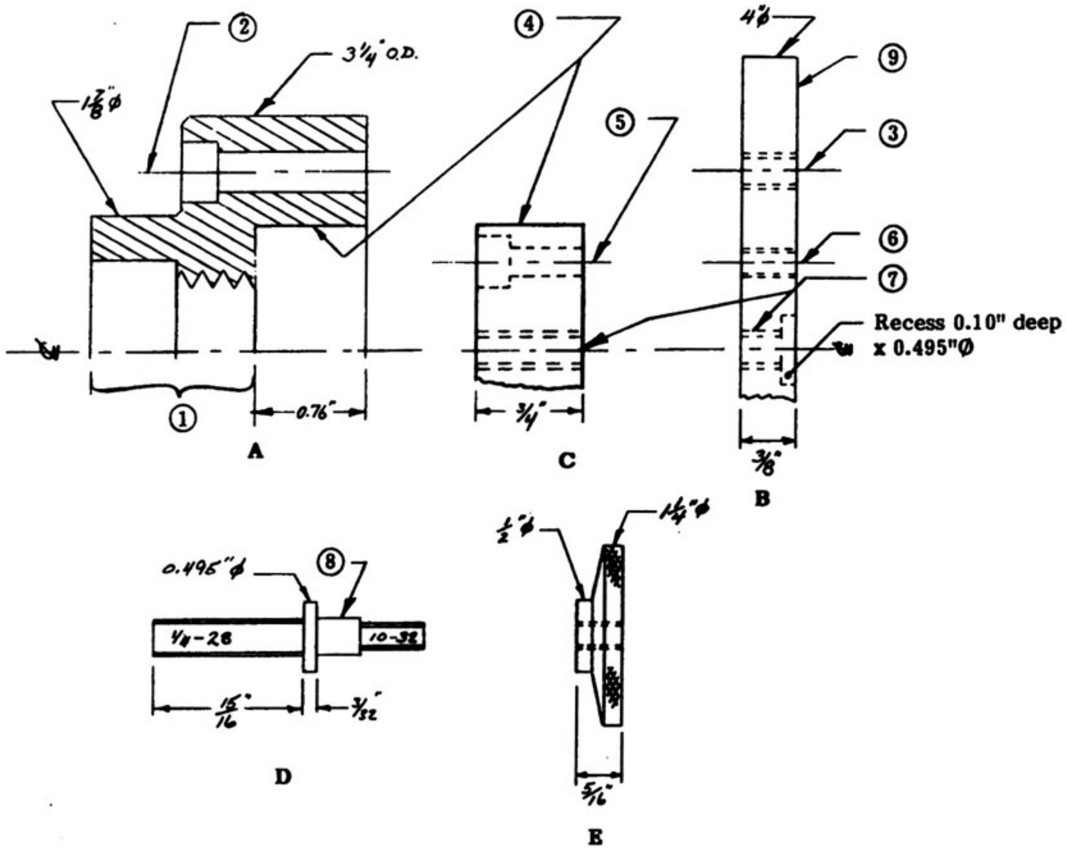
The **Main Plate** (B) can be steel, brass, or aluminum. All these are susceptible to dings and burrs, but this is a fixture which is worthy of careful treatment, yea even unto being stored in its own box or on a little silk pillow, so burrs and knocks are not anticipated. The plate can be 1/4" or thicker: 1/2" is more than thick enough for almost any conceivable application in the small shop.

Another idea: make 2 or 3 plates of different sizes to suit jobs of various sizes, all interchangeable on the one Spindle Nose Fitting (A).

PART (C)

Make up the **Boss** (C), but *DO NOT* drill and tap the center hole at this time. Note: (C) should be a *very* good fit in a bored hole in the nose of (A). Move chuck, with item (C) undisturbed therein,

A SELF CENTERING FACEPLATE



① To suit lathe spindle nose.

② Four holes drilled and counterbored to take 1/4-28 socket cap screws on 2-1/2"Ø pitch circle.

③ Four holes tapped 1/4-28 to match ②.

④ Snug push fit, say 1-3/4"Ø.

⑤ Four holes drilled & counterbored to take 10-32 soc. cap screws on 1-1/4"Ø pitch circle.

⑥ Four holes tapped 10-32 to match ⑤.

⑦ Drill & tap 1/4-28, and machine the 0.495"Ø x 0.10" deep recess on face of B, after assembly of A, B, & C.

⑧ Length & Ø to suit a given workpiece.

⑨ See Note re Driving Pegs in text.

to vertical mill, where a rotary table (R/T) is already set up in the horizontal mode. Drill and counterbore 4 holes for 10-32 socket cap screws on a 1-1/4" Ø pitch circle. Remove chuck and job from R/T, but leave R/T and mill exactly as is, for the next work.

Chuck (B) in the 4-jaw chuck, and skim one face true. Move the chuck, with the job undisturbed in it, over to the vertical mill where R/T is already set up and waiting. Drill and tap four 10-32 mounting holes for the Boss on a pitch circle (PC) Ø of 1.25". Move out to a PC Ø of 2.5", and drill and tap 4 more holes, these to be 1/4-28. Leave R/T and mill exactly as then set up, but remove the 4-jaw chuck.

Grab (A) in the 3-jaw chuck, with the Spindle Nose socket facing the tailstock and running as true as you can get it - this is worth considerable effort if need be, even to using the odd paper shim. Check also for wobble (true running of face of job). Plop this set-up onto your R/T and drill and counterbore for four 1/4-28 socket head cap screws on a 2.5" Ø pitch circle. Dechuck.

Assemble (B) and (C) and then (A) and (B) with socket head cap screws. Mount on your lathe spindle nose, and skim second face of (B), and then its O.D. This can now be regarded as a permanent assembly. While still mounted on the lathe spindle, drill and tap the central hole 1/4-28 in (B) and (C) and carefully bore out a recess in the face of (B) to 0.495"Ø x 0.100" deep. Why 0.495"? You'll see in a minute.

PART (D)

The **Centering Studs** (D) can be made up as required from 1/2"Ø CRS or brass. Chuck and screwcut or die the 1/4-28 thread, skim O.D. to 0.495", and screw solidly home in the central hole of the self-centering faceplate. Turn outboard portion of Stud to suit, first doing the 10-32 thread, with full 1/2"Ø stock behind, then turning down bearing portion to the desired diameter. Now you see why 0.495": it saves having to have the 1/2" CRS running perfectly true. You can just chuck it, and skin it to spec, the thread and O.D. thus being made concentric automatically, and with no pains taken.

PART (E)

The **Knurled Nut** (E) is straightforward. Spacers or washers will be needed between it and a workpiece mounted on this fixture if the work is thinner than the length of the bearing portion of the Stud.

If the center hole in a particular job is bigger than the available Stud, a bushing can be made up to let the work proceed.

DRIVING PEGS

Scribe a diameter line across the face of (B) where it will not intersect the 1/4-28 or 10-32 tapped holes in (B). Drill and tap a series of 10-32 holes in pairs (i.e. one on either side of center) at each of several distances out from the center. These are to take a Driving Peg, e.g. a threaded stud and nut, which may be needed for positive drive in addition to (E) where holes for such exist or can be tolerated in the workpiece.

If a workpiece cannot have a center hole, it may be possible to attach it to the face of the fixture with shellac or Super Glue. Heat to remove after machining. Another means of sticking a job to a fixture such as this is double sided adhesive tape. This is obviously a technique that must be used with some discretion - it is not for heavy cuts, but there are times when it can get your tail out of a crack.

Final note: Part (C) could be shortened from 3/4" to perhaps 3/8", and Part (A) made correspondingly shorter to reduce overhang - the dimensions given are not chiselled in stone.

This project and the one at page 169 are based largely on ideas found in issues of *Model Engineer Magazine* dating back to the 1920's.

SOME FACEPLATE IDEAS

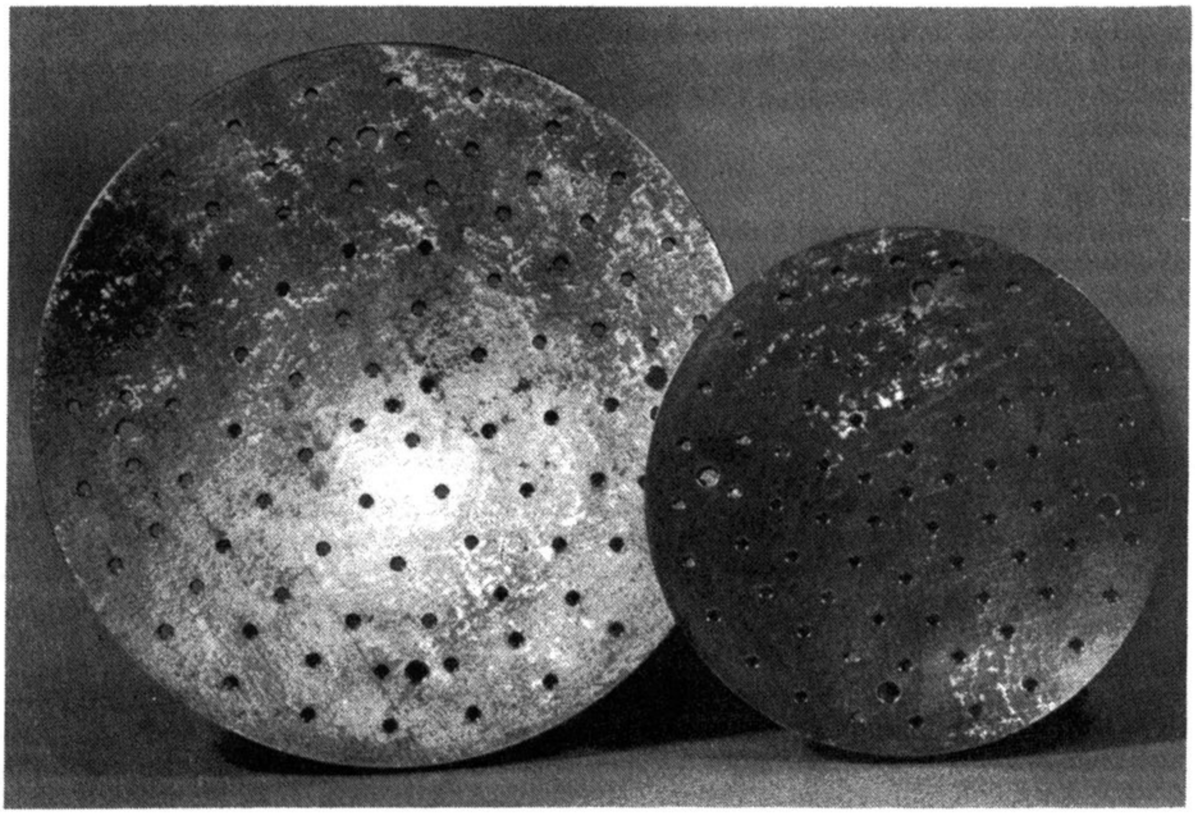
Part II

A SUBFACEPLATE

Here's an idea for a simple faceplate accessory for dealing with certain hard-to-chuck jobs. Say you need to turn a washer from a scrap of 1/16" sheet steel, O.D. = 3", I.D. = 2.5". Not fun, normally. But with a subfaceplate such as described below, you can clamp the material by its outside edges, bore the I.D., reclamp from the I.D. without disturbing the location, and then remove the outside clamps, and turn the O.D. to spec.

This subfaceplate was inspired by a "Practical Idea" by John Uram which appeared at page 133, April 1984 *American Machinist* Magazine. At about that time I was cooking up a system of rocker equipped clamps, part of which is described elsewhere in this book. I could immediately see how the two ideas would dovetail.

What I made is not exactly the same as what Uram showed, in that his gadget had an integral chucking stub, but the resulting fixture will take care of the same types of work. I made 2 subfaceplate fixtures from 1/2" aluminum plate, one about 9"Ø, the other 6-1/2"Ø. These can be attached to my regular lathe faceplate(s) via 5/16-NC bolts entered from the back side of the faceplate. This leaves the entire face of the subfaceplate clear to receive work.



HOW TO MAKE ONE

Mark one side of your 1/2" aluminum plate "Side 1" with a felt pen. (The other side is Side 2.) Make a centerpunch mark at the center, and scribe the O.D. Bandsaw roughly to shape. From the centerpunch mark, lay out centers for four 5/16-NC mounting holes, spacing and pitch circle diameter to suit the slots in your faceplates. (Obviously, these holes do not have to be located with extreme precision.) Drill and tap 5/16-NC.

Bolt to your regular faceplate with Side 1 outboard, and indicate the centerpunch mark to run true.

If same size as, or smaller than faceplate, space out from faceplate with 4 pieces of aluminum plate all of the same thickness about 1" sq., drilled clearing size for 5/16"Ø bolts.

> TIP: A useful way to spend a spare hour is to hacksaw a bunch of little rectangles from a piece of 1/8" aluminum plate. Make them all about the same size, maybe 3/4 or 1" square. Dress edges, break corners, and generally deburr each piece. Drill holes in some to serve as washers, if need be. Store 'em in a little box where they'll stay found. Mighty handy. Slow to make, but better to make 20 at one go than have to stop and make four in the middle of an interesting job!

Turn O.D. of job to size.

Remove, reverse on faceplate (Side 2 outboard), and indicate true from O.D.

Take a cut about 5 or 10 thou deep across the face, under fine power cross feed if available.

THE HOLE PATTERN

There is nothing magic about the hole patterns detailed below. I just arbitrarily decided that the smaller fixture would have its holes no more than 5/8" apart, and the larger one's holes would be about 1" apart.

The tapped holes need not be located with great precision. If you don't have a geared rotary table with which to space them out, scribe the necessary concentric circles, lay out the various rows of holes using dividers, protractor, etc.

If you have a dividing head or geared rotary table on which you can mount your lathe faceplate, remove and reverse job on faceplate, (Side 1 outboard) and indicate true once more.

Move the faceplate and job to rotary table (R/T), which you will have already set up on your vertical mill, and centered under spindle of same. **Start** all the holes that are to be tapped 10-24. Do this with a 1/4"Ø center drill, to a depth sufficient to serve as a counterbore for the tapped hole.

Remove job from faceplate. Remove faceplate from R/T. Remove R/T from vertical mill. Put a couple of pieces of 1/2" particle board or similar on the mill table for "parallels" - pieces about 3" x 6" is good. Flop the job down on top of them, and drill tapping size holes. Drill undersize first - say #35 drill. Drill clear through, holding the job with one hand. Don't rush it or you may jam the drill. Let the job "float" into alignment under the drill as you start each hole. Drill as many holes as you conveniently can before stopping to remove burrs from the underside with a scraper and/or file.

> TIP: A very useful scraper can be made by silver soldering a triangular "carbide insert" to the end of a piece of 3/16 x 3/8" CRS about 7 or 8 inches long. Put a file handle on it.

When all the holes are drilled through, repeat with tapping size drill (= #25 for 10-24 thread) and then tap each hole 10-24.

> TIP: To speed the job of getting the tap started nice and square in each of all those holes, face a chunk of steel about 3/4"Ø x 5/8" long, and drill it #10, which for me just nicely passed a 10-24 tap. Slip this over tap, set tap in hole to be tapped, and press the "tap starter" down on the job with first two fingers of left hand. Start the tap - about 5 or 6 full turns worked well for me, as I recall. Back out, remove and set aside tap starter, blow chips off tap, and finish tapping.

There are a lot of holes to tap on a 6-1/2"Ø plate, and more on a 9" one!

Optional Extra: If you have a horizontal/vertical R/T you might want to drill a row of index holes on the rim of the subfaceplate (or on the face, near the periphery). These might come in handy at some future date - now is the time to do them if you want them.

TO MAKE A FINISHED JOB OF IT

1. Number the four mounting holes 1 to 4, (same as the jaws of a chuck are numbered - it's convenient, see?)

2. Stamp the mounting hole thread spec "5/16-18" beside one mounting hole.

3. Stamp "10-24" beside a nearby tapped hole.

4. Now take a #2 cut hand file, clean it out good with a file brush, and dress down all the burrs thrown up by your stamping operation and any other little pimples or bumps which may be present on the unmachined face of the job.

This completes the subfaceplate. Put it away for future use - a faithful servant ever ready to help you with those oddball jobs not otherwise easily done. Being aluminum, it will want a little greater care than if steel or cast iron. Being something you made yourself, it's likely to get that kind of care.

HOLE SPACING for 6-1/2"Ø subfaceplate:

clamping holes	pitch circle diameter in inches
5 holes	1
10 "	2-1/8
15 "	3-1/4
20 "	4-5/16
24 "	5-11/16

Mounting holes: four tapped 5/16-NC, on a 5"Ø pitch cirle.

HOLE SPACING for a 9"Ø subfaceplate:

clamping holes	pitch circle diameter in inches
4 holes	1
8 "	2-1/2
13 "	4
18 "	5-1/2
24 "	6-3/4
24 "	8

Mounting holes: same as for 6.5"Ø unit, but on a 6.75"Ø pitch circle.

TIP: Start the first hole in the row of 24 little holes which lies on same size pitch circle at a point 7.5° past the center of one of the 5/16-NC mounting bolt holes, and then space out the little holes every 15° (= 24 holes) thereafter, thus neatly bracketing the 5/16-NC holes, which occur every 90°.

SOME FACEPLATE IDEAS

Part III

A V-GROOVED FACEPLATE AND CLAMPS FOR DRILLING AND BORING AWKWARD JOBS

A standard chuck backplate to fit your lathe can be made into a useful accessory for accurate cross drilling of round stock, and for other work.

Install the backplate on your lathe, and take a light cut across the face and O.D. to true it.

Next, machine a V-groove across the face of the backplate. This V-groove must be exactly centered (see details 1 & 2). If you have a geared rotary table (R/T) and a 1/2" end mill reground to a 90 deg. point (see FOOTNOTE at end of chapter), making this V-groove will be easy.

The first step is to run a relief groove across the face as close to centered as you can get it, using a slitting saw or a small diameter end mill. (The latter are prone to breakage, so a slitting saw is probably the better approach.) Clamp the job to an angle plate, or in a milling machine vise, to make the cut.

When the relief groove is done, set up the rotary table in the horizontal mode on the vertical mill, and set up the job on a lathe spindle nose adaptor on the rotary table. Put a 90° end mill in the mill's spindle nose, and get set up to start the first roughing cut. Don't rush the job.

When the roughing cut is done, shift the mill table to one side 10-20 thou and make a pass <u>down one side of the cut</u>. Rotate the R/T (and job) 180 deg. exactly, and repeat. You now have a V-groove that is pretty much perfectly centered on your chuck backplate. Continue with this procedure, deepening and widening the cut until the V-groove dimensions suit you and your cutter.

While still set up on the R/T, drill holes for the clamp studs. Additional holes are shown beyond those which might be considered the minimum needed. The extra holes are optional, but may be wanted for other clamping points, broadening the capabilities of the finished fixture.

CLAMP

Make two, as shown, plus rockers, washers, knurled nuts, and studs as for the Finger Plate project elsewhere in this book.

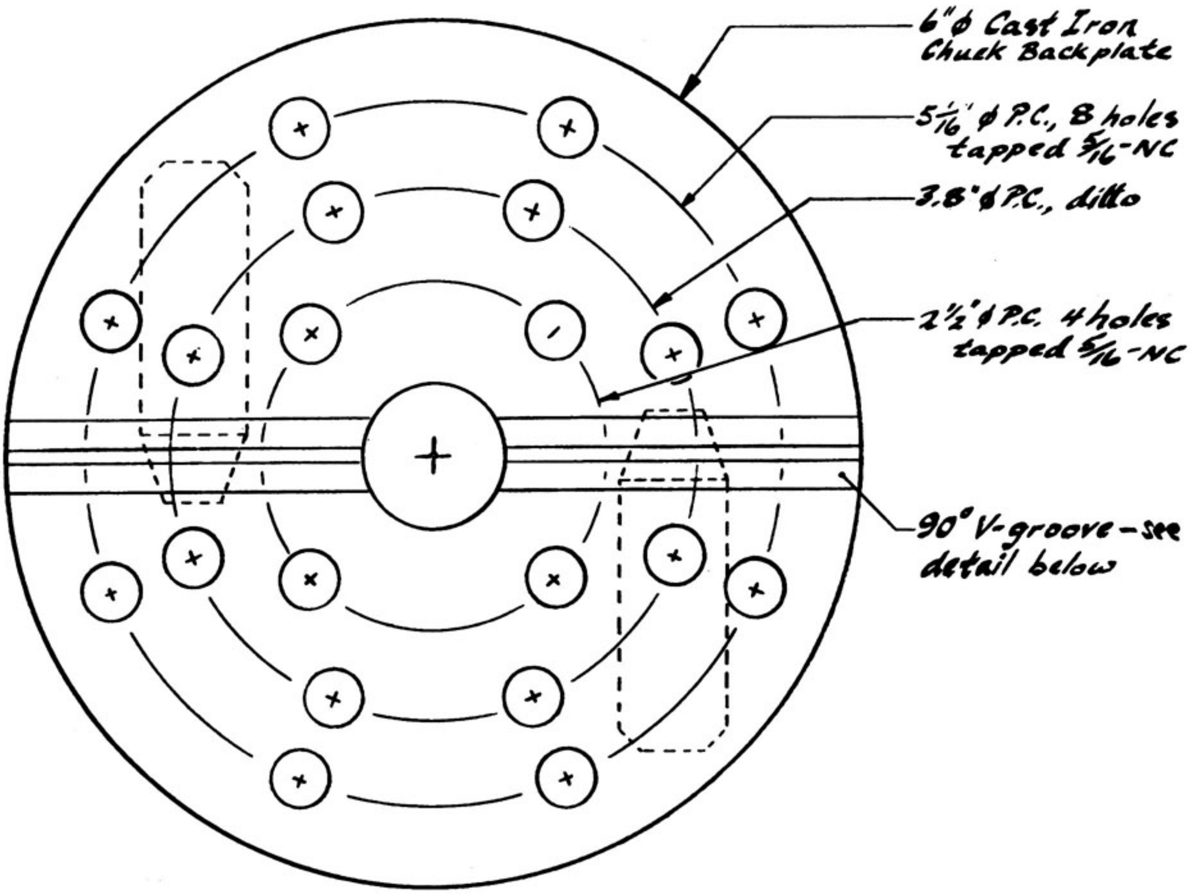
NOTE: For heelscrews, buy two 1/4-28 socket head cap screws 3/4" long under head. Brass tip these as follows: Screw bolt into a piece of round stock about 3/4"Ø x 1/2" long, which has been drilled and tapped 1/4-28 full length. Chuck this in your 3-jaw, with tip of screw exposed, and drill into end of screw. Dechuck. Make a brass tip, Loctite in place in screw, and rechuck to face true and make slightly dome shaped.

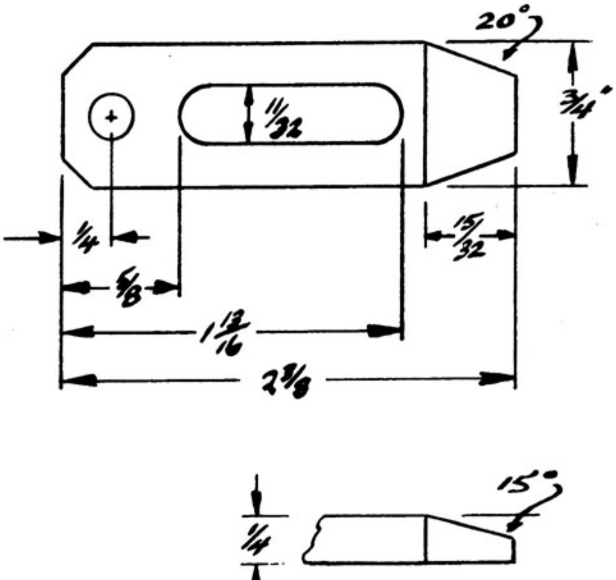
FOOTNOTE

I was interested to learn, recently, of the commercial availability of 90° point slot drills. Made by Morse Cutting Tool Division, Morse Tool, Inc., New Bedford, Mass. 02742, these are available through industrial distributors.

At about $30 for the 1/2" one, they're not exactly giving them away, but if you want to buy one, don't be scared off by the price - 'twill have more than one use. You can cut V-grooves in this project and in the Finger Plate project, plus use for machining internal and external 45 deg. champhers on edges. Other uses for it will also arise.

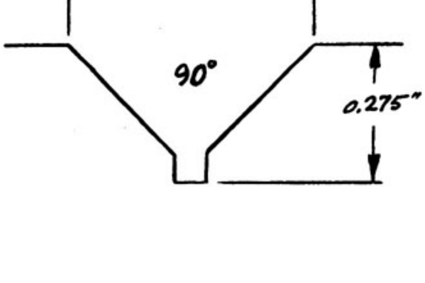
If you have a 1/2" slot drill that has seen better days, and have a friendly tool and cutter grinding shop in your area, that 1/2" slot drill can be reground to a 90 deg. point. 'Twill serve you just as well, and the cost will be less.





Studs, rockers, washers, and knurled nuts same as for Finger Plate project shown elsewhere in this book.

For heelscrews, use 1/4-28 x 3/4" socket capscrews. Brass tip these as follows: Screw tightly into a piece of round stock about 3/4" x 1/2" long which has been drilled and tapped 1/4-28 full length. Chuck this in your 3-jaw and drill into end of screw. Dechuck. Make a brass tip, Loctite in place in end of screw, and rechuck as before. Face true and file slightly dome shaped.



METAL POLISH

There is a product called Holcomb Metal Luster, of which every machinist could do well to have a little bottle. This stuff is great for cleaning up stained and rusted steel surfaces that otherwise have a good finish. Say you dig out a tool you've had stored for some time, and find it has developed a coat of light rust. This polish will help get it looking good again.

Made by: Holcomb Mfg. Division, Premier Industries Corp., 4500 -4415 Euclid Ave., Cleveland, Ohio 44103. Phone (216)-391-8300.

Here's another type of **metal polish you can make up for yourself:**

Get hold of some cast iron swarf. Using an ordinary kitchen sieve, sift enough of it to get about a cup of the fraction which passes the screen. Mix these fine cast iron cuttings in a dish or mortar with an equal volume of unslaked powdered lime. Add sufficient olive oil and 20% strength hydrogen peroxide to make a soft black paste. Use about equal amounts of each of the two liquids.

Rub this paste on rusty iron or steel with a rag. Rub hard. The rust will be easily removed. Wipe off any remaining paste and polish up the work. If the paste becomes hard over a period of time, soften by adding a little olive oil.

> NOTE: The hydrogen peroxide may be designated "20 volume" instead of 20 percent - not to worry, it is the same thing, and that is what you want, not the weaker 12% stuff.

According to a chemist friend, the hydrogen peroxide causes some reaction which exposes carbides in the cast iron dust, which is what makes the stuff cut better. The olive oil is just to keep it gooey.

The whole mass swells up a little during the iron/hydrogen peroxide reaction, so don't wad it into a glass jar and screw the lid down tight at an early stage. Also, if you wash your hands with detergent after making this stuff - and you will want to, because your hands will be dirty! - you will notice the smell of ammonia. I think this comes from the hydrogen peroxide reacting with something in the detergent. No sweat - just open the window and keep scrubbin'.

Make sure you use fairly fresh hydrogen peroxide. If it's been sitting on the shelf for a good length of time, chances are it has turned to water.

THE BLUEING OF STEEL

This chapter is directed not only at those readers interested in gunsmithing. Whether you make tools, models, or whatever, being able to "blue" steel is a useful piece of knowhow.

I am tempted to launch into a full blown treatise on this subject, but the blueing of steel is a study in itself, and it is covered emminently well by others who know far more than I ever will.

What I will do is summarize the matter for those who want to use one or other blueing techniques from time to time; and for those who want more info than is practical to include in a book such as this, references to the works of those "emminent others" will also be given.

BLUEING - WHAT IS IT?

Blueing is an oxidized surface layer, tightly adherent to the steel beneath, which it both beautifies and protects from further oxidation. The gunmaking trade has developed the matter of blueing practically to an art form, and the gun factories have debased it into an obscene imitation of the real thing - or so the connoisseur will say. The average guy sees a cheap, mass produced .22 rimfire rifle, and he thinks it looks pretty good - until you show him a slow rust blue done over a proper polishing job.

The first thing to learn about blueing is that whatever the blueing method, 90% of the final result is dependent upon the degree of polish applied to the metal before blueing begins. A lousy polishing job cannot be hidden by any blueing method.

Not all of us like glittery, mirror polished finishes. Personally, I do not. My preference is to work down to a piece of worn 400 grit crocus cloth, applied in several directions, which gives a nice 'soft' polish. For a really fast, attractive and highly practical finish, a bead blast finish, using fine glass beads, is hard to beat for a lot of jobs. It looks good, masks minor tool marks, retains oil and seems (in my cold but reasonably dry basement shop) not prone to rusting. It can be blued over, which gives a soft, velvety blue/black look which I like.

COLD BLUES

If you want a fast wipe-it-on, wipe-it-off blue, get thee to a local gun store and buy a little bottle of gun blue - one make is probably as good as another, and there are many makers' potions on the market. The one I have used most, and always with good success, is Brownells' "T4". They also recommend their Oxpho Blue. I would say that, among the touch-up blues, these two are probably hard to beat - Brownells' catalog speaks of them pretty highly, and Brownells' have a policy that if they get 2 legitimate complaints about a product, it's bounced out of the catalog.

Brownells' own instructions are, basically, to degrease the job, apply the blue, leave it on for a few seconds, or until the desired color develops, and then wipe off or buff with steel wool, repeating as often as necessary to get the desired depth of color.

To that I'd add the following, some of which I found in **Gunsmith Kinks**, (mentioned elsewhere): Before applying the blue, wash the part in hot, soapy water, rinse in hot water, **swab over with bleach**, and **then** apply the blue. The result, in some cases, is better in 2 passes than in 6 without the bleach.

Another way to use cold blueing solutions is to heat the part up til it's just a little too hot to hold onto, then dab the blueing on with a cotton swab. The result? A quick and durable imitation of a color casehardening job. (Adapted from **Gunsmith Kinks**, Vol. 1, p.280 and 282.)

HOT OIL DIP BLUE

Another way to blue steel is to heat it dull red, and dip it, still hot, in oil. What kind of oil? Used engine oil, thick brown cutting oil, etc. I've tried the latter (Procut SC40) and it smokes most impressively. On one occasion I got a deep blue black, polished/shiny result, almost like the part had been lacquered, even though I made no effort to give it any more of a polish than given by an oil soaked fine cut file while in the lathe. On other occasions, when I have tried used engine oil, the results have been not so good, although I have been told this works.

SLOW RUST BLUEING

This is the old, slow way, and if you want a really fine blue job on something you've made, one of the ultimate ways. Basically, the method is, after polishing and degreasing, to allow the part to rust, or to induce it to do so by the use of a "blueing solution". Boiling after rusting causes the red/brown ferrous oxide to change to ferric oxide which is blue/black. The rusted surface is then "carded" or scratched via fast turning brushes of fine wire (e.g. 0.005"Ø wire), or by hand, using **degreased** fine steel wool. The boiling also makes the surplus rust readily removable. The three steps - rusting, boiling, and carding - are repeated as many as a dozen times - 6 or more passes being usual.

> TIP: To degrease steel wool, wash it in liquid dishwashing detergent, rinse well, and dry in a warm oven or over a hot air register. (Another idea from **Gunsmith Kinks**, Vol. II, p.197.)

For full details on how to do Slow Rust Blueing, the first book to get is, without a doubt, **Firearms Blueing and Browning**, by Angier. Angier was educated as a chemist, employed in the firearms industry in Europe, and collected, compared, tested, classified (and in some cases debunked) hundreds of blueing formulae, as only one with such a background as his could have done.

Of the blueing formulae listed in his book, Angier rates, as one of the best, that of the Swiss Federal Armoury at Berne, Switzerland. Angier reports upon the original formula, and then suggests some modifications to it. My gunsmith friend Eric Marles made up some of this particular stuff and tried it. He said that for him, in limited trials, it hadn't worked all that well, giving splotchy results. Such is the nature of slow rust blueing: you have to work with a given formula 'til you learn what works best for you.

ACID FUME BLUEING

What Eric does find very effective is another method, not far removed from slow slow rust blueing, called acid fume blueing. Here, the parts are exposed to the fumes of concentrated nitric and sulfuric acids (a drop or two of each - not mixed together) on a piece of glass in a closed container along with the item to be blued. The acid fumes cause a uniform coating of rust to form on the metal parts in 5 or 6 hours. The parts are then boiled and scratched, as in the conventional rust blueing process.

Acid fume blueing gives a similar result on most of the various steels one might encounter in a single gun. This is obviously preferable to having the receiver acquire one shade and the barrel another. The method is not a short cut to a good job; it still takes time and effort, but the rusting is sure and uniform, which is the result sought from all the blueing formulae ever devised, from plain old salt water right on through...

Eric has found the fume blueing technique causes pitting when applied to low carbon steels.

A USEFUL REPRINT

John Bivens is a prolific writer on gunsmithing, primarily as it relates to modern re-creations of early American flintlock rifles. He has reported some of his methods in *Rifle* magazine. Brownells reprinted these articles and can supply you with a copy if interested. There is much of value in Bivens' material on blueing, and if the subject interests you, order it from Brownells.

AN EFFORTLESS METHOD OF BLUEING, and BLUEING vs BROWNING

One last point. I mentioned that boiling converts the newly formed rust from ferrous to ferric oxide, in which form the surplus oxide is more easily removed. I also mentioned fume blueing. I had some nitric acid in a plastic chemical bottle - just a little old bottle about the size of your thumb. I put this little bottle in a glass mayonnaise jar, along with a couple or three squares of paper towelling for cushioning. I put the lid on the mayonnaise jar, and set it on a shelf in the workshop. Eventually, a piece of 1/2" drill rod got put up on the same shelf. Next time I looked at it, probably six months later, it had acquired a coating of dusty red rust on the portion nearest the mayonnaise jar.

That nitric acid must be potent stuff! It had also turned the paper towels inside the bottle from white to brown-grey. Some while yet later, I steel wooled the loose rust off that piece of drill rod, and was left with the nicest, plum-brown, pit free finish you could ever want. No amount of steel wooling would remove it!

I think that if a fella exposed that piece of drill rod a couple more times to the nitric acid, maybe on more intimate terms, and steel wooled it between times, he'd have a 'brown' the equal of anything he could ever desire. And remember, I never even tried to degrease that drill rod! The extra two or three exposures and steel woolings would even up the finish, and it'd look mighty nice, and I bet it would not wear off! (If you boiled it each time before steel wooling it, it'd come out blue. Therein lies the difference between "browning" and "blueing".)

In the 'old days', guns were browned rather than blued. Then somebody discovered the effect of boiling the parts in hot water, and eventually blue came to be the preferred color. Either way, carefully done, it makes a very handsome finish. And as Angier says, any school boy with patience and attention to a very few basic details, can, without any elaborate plant, produce results comparable to that of the finest custom gun makers.

MORE HINTS

If you want more info on blueing, there is, as you might well guess, a great many kinks and much instruction on this topic in **Gunsmith Kinks**, (both Volumes). Tricks you'd never think of, like dipping a part alternately in ice water and boiling water to enhance the results, and methods different guys have stumbled across, or developed, that give various good results.

SHOULD YOU TURN WOOD ON YOUR METAL LATHE?

I asked this question when I was relatively new at this game, and got answers both pro and con, so I wrote to the Myford factory. (Why mess around?)

Go ahead, they said, but wood dust will soak up oil, and work its way into places you might not want it. So take steps to prevent the ingress of dust into critical areas, and do a good clean up after.

They also said the speed range might be a little on the low side. (At the time I had a Myford ML7, which has a top speed of about 1000 rpm. My more recently acquired Myford Super 7 will do 2500. As it turned out, for what little I've had occasion to do, lack of speed was not a problem.)
I made a tool from 3/8" drill rod, mounted it in the toolpost, and made a nice pile of file handles from branches I'd been seasoning for some months. A turning speed of 700/1000 rpm works fine. Yes, faster would probably be better, but certainly the results are quite good enough at lower speeds.

And, yes, it did take a good clean-up after.

Better idea: cultivate a friend who has a wood lathe, and do your wood turning on his lathe. In return, do some metal working favor for him.

SOME THOUGHTS ON LATHE CLEANING

When I got my first lathe, Bill Fenton gave me some good advice about oiling it and keeping it clean. To what he told me, I can add a few other ideas - maybe you will find something interesting herein.

First of all, get yourself a really good 2" paint brush. Use it only to clean your lathe, and **keep it clean**. Actually, I have two such brushes hung on a nail behind the lathe. (There's another one on a wire hook on the milling machine, but let's leave the mill out of this, for the sake of brevity.) When oil and steel chips foul the brush, it is taken outside, sloshed in a soup can full of varsol, and batted against a stick kept there for the purpose. This makes it like brand new again. Dirt can be settled out of the varsol between cleanings and separated by pouring the good stuff into a clean can.

The paint brush and varsol together are used for cleaning the leadscrew. Dry, the brush quickly whisks chips from the lathe. Always work from the top down, to save going over the same parts twice. When everything is in the chip tray, I use a small home made "dust pan" to scoop up about 80% of it into the swarf bucket in about two shots. What remains is brushed out of the chip tray onto the floor behind the lathe.

My lathe stand is a welded pipe structure. Once everything has been brushed onto the floor, I stick my head and shoulders part way through the lathe stand - not unlike a cow going after the grass beyond the fence - and, with a carpenter's horsehair bench brush, sweep everything into a pile up against the wall. After another shot with the dustpan, the Shop Vac is used to finish the job.

The lathe is then wiped down and its cover (an old curtain) draped over. All this takes maybe ten minutes. The lathe is thus left almost showroom clean. I don't always feel like doing such a thorough clean up job, but when I do I go to bed satisfied the lathe has been treated properly, and at the next session, it's a pleasure to take the cover off a spotless machine and start work immediately.

Every so often the felt wiper at the front edge of the lathe carriage is removed, dunked in varsol, and squeezed out several times. New felt wipers are made every few years.

The previous owner of my first lathe had allowed dribbling oil to remain on the lathe until it had dried in place. Myford's castings are finished almost like porcelain, and this mess couldn't stay: I wiped it down with **Hoppe's No. 9**, a nitro powder solvent widely used for gun cleaning. Hoppe's took off the oil stains in about 2-3 strokes. Every machinist should have a bottle of Hoppe's No. 9 in his shop. There is nothing in the world that smells quite like Hoppe's No. 9. It is pure ambrosia. If I had to pick between roses and Hoppe's for the last thing I'd ever smell, I think I'd probably pick the Hoppe's.

Another tip from master machinist Bill Fenton: To get fine swarf etc., out from under the lathe saddle, wipe off the bed and run the saddle up within a few inches of the headstock. Lay a streak of oil across the lathe bed, just to the left of the saddle. Run the saddle left onto this streak, then withdraw it, halting a little to the right of the previous position. Lay another oil streak, also further to the right of the previous streak, and repeat. Repeat several times, each time stopping a bit further down the bed. Wipe up the oil, which will have pulled much of the fine swarf out from under the left hand side of the saddle. Then do the same thing on the tailstock side of the saddle.

I find toilet paper ideal for wiping up around the lathe. I have, as a result of a mighty stroke of genius, mounted a toilet paper dispenser (roll type) conveniently beneath the chip tray.

When doing any machining of rusty or scaly material, I lay down a cloth from in the gap right up onto the saddle and around the toolpost. As soon as the dirty part of the job is done, off comes the cloth and 99% of the dirt. PAPER WOULD BE SAFER, but by placing the cloth carefully, giving all motions a trial under hand power, and then paying close attention while the lathe is on, cloth is okay.

(Rust, mill scale, and cast iron cuttings, let it be said, are all abrasive, and should not be left on the lathe bed. Clean them up, and you will be doing your lathe a favour.)

Every home should have its home shop machinist, but few who share the building with him will appreciate stepping barefoot on pieces of swarf from the workshop. I have "found" a few sharp pieces this way myself, these being first driven into one's boot soles by the concrete shop floor, then coming loose on less (more?) hallowed ground. To cure this, I placed two pieces of old carpeting, about 3' x 4' in front of the lathe: the amount of swarf leaving the shop has since been minimal - the carpet, rather than the (harder) boot soles, absorbs the chips. An added advantage of the carpeting is that it affords some protection to items dropped by the resident maladroit. The remainder of the old carpet was halved and double-layered in front of the workbench for the sole purpose of saving my work from this ever present hazard.

Recently, the carpets have been replaced by "Dri Dek", an anti-fatigue matting made by Kendall Plastics Inc., Kendallville, Indiana 46755. This outfit, which advertizes regularly in *American Machinist*, has a toll-free phone number, and will send you a small sample of Dri Dek on request. If you want something comfortable to stand on, you will like this stuff. A salesman came here one day and tried to sell me some other brand of matting. It cost twice as much as the Dri Dek and was not as good.

If you have an air compressor, you may think it a great gadget for cleaning up around the lathe, but don't be too free with it. That blast of fast moving air can drive small pieces of swarf into a whole lot of places you don't want it to get to, and where it won't thereafter do your lathe any good. Also, take care not to aim the blast in the wrong direction, lest you find it plus a load of swarf deflected back into your eyes.

IMPORTANT NOTICE
to those who have a 1st, 2nd, or 3rd printing of
The Machinist's Third Bedside Reader:

Please make a note at, or securely attach a photocopy of the following notice to, pages 34 and 35 of your copy of **The Machinist's Third Bedside Reader**:

The use of the electrical cord caddy design shown at pages 34 and 35 of this book is NOT recommended.

A CORROSION PREVENTIVE CUTTING COMPOUND FOR GENERAL SHOP USE

by Thomas E. Dunn
Works Manager, The Bullard Co.
AMERICAN MACHINIST Magazine
June 11, 1931

(NOTE TO READER: While it is likely that some progress has been made in the field of cutting compounds and coolants in the 55 years since this item was reported, nevertheless, what worked then should work now. Most of us will not want a 50 gallon supply; the recipe can be scaled down. I get a big kick out of old stuff like this - hope you do, too. GBL)

For a number of years we had trouble in the use of cutting compound on our milling machines, grinders, lathes and vertical turret lathes. Ordinarily, the better type of prepared paste or powder was purchased. but notwithstanding, the cutting compound changed chemically after short runs, and corroded both the machine tables and work. Furthermore, the compound developed a very offensive odor and a "slimy" appearance. These conditions also arose when soluble oil was mixed with water and alkali.

For these reasons, an investigation of the underlying causes for the chemical break-down of cutting solutions was undertaken. The odor of the unsatisfactory compound led us to believe that the tap water contained bacteria and organic matter which shortly caused a chemical change. Our first step was unsuccessful; that is, addition of alkaki, which saponified the mixture to some extent, but which did not have a permanent effect.

Finally, to kill bacteria and remove organic matter, we evolved the following procedure. Water, boiled and allowed to cool to room temperature, is then softened with a weak alkali such as borax. The borax saponifies the soluble oil which should be added next. Finally, a small quantity of tri-sodium phosphate is added to emulsify the solution. A recipe for 50 gal. of this solution is as follows:

47 gal. boiled water (cooled to room temperature)
3 lb. borax
3 gal. soluble oil
1 lb. tri-sodium phosphate

The solution should be made up in the order of listing the ingredients.

From the experience of using this cutting compound for a period of six months, we deduce the following:

1. Milling cutters, reamers, drills, cutting tools and grinding wheels have 30 percent longer life because of the superior lubricating and heat-absorbing qualities of the compound.

2. Machined parts are left with a thin film of oil that prevents rusting for a considerable period of time.

3. Tables, ways, and other parts of machines, as well as the cutters and tools, are left with a thin film of oil that prevents rusting.

4. Savings made in the amount of soluble oil used approximate one-third, since we have determined the exact quantity of oil to be used in this universally applicable compound.

5. No tendency to develop odors or "slime" has been discovered in the compound used for a period of four months.

6. When this solution is employed on grinders, the wheel cuts freely and the work does not tarnish or rust. For example, work that was inspected one week after being ground, but which had not been wiped or dried in any way, was found to be free of any evidence of corrosion. This was found to apply to cast iron as well as to steel.

After six months' experience with this cutting compound, we believe it can be used as a universal lubricant throughout the plant. We have standardized on it.

SHIPYARDS AND HOME SHOP MACHINISTS ARE IN THE SAME BOAT

Had a most enjoyable visit here one day with Robert Schnieder of New Jersey. He told me had spent much of his working life as a ship designer in small shipyards on the East Coast.

Shipyards such as those he'd worked in tend to have older, otherwise obsolete machine tools, because their work is not of the rush rush, hump-it-out, make-'em-by-the-mile-and-chop-'em-off-by-the-yard type. Rather, the job will be to make one of something, or perhaps two, one right handed, and the other left handed - e.g. prop shafts. Sound familiar?

So a great big old lathe that first reared its headstock from the foundryman's sand in 1920, providing it is still accurate, or can be made to be so again, can find a happy home in a shipyard.

When you stop and think about it for a minute, it makes sense. As Mr. Schnieder said, a lot of it is simply model engineering on a big scale. Often he designed around what the yard's machine shop equipment could handle. Sound familiar?

And as an aside on that, I saw an item in a mid-Thirties issue of *American Machinist,* showing a new lathe just installed at the Bremerton Navy Yard.

It was a great big sucker - 'twould probably have swung a faceplate 6 feet across, and taken 60 feet betwen centers, though I don't remember the specs now, nor are they important.

Anyway, it was replacing a smaller one that had been built about 1868, and probably not new when put into service at Bremerton.

It'd be interesting to know if that second lathe is still in service at Bremerton Navy Yard today. If it's not, I bet it's still working, somewhere else. One thing you can bet is that it would have been kept busy right through WWII and way on into the 50's or 60's.

Post Script to the 2nd printing: I heard, from a reader who works at the Bremerton Navy Yard, that this big lathe is still there and in at least occasional use.

A FAIR RETURN FOR ONE'S WORK

adapted from
"Don'ts for Estimators"
AMERICAN MACHINIST Magazine
May 7, 1931

(For the chap who likes to make a bit of money from his shop, the following are extremely cogent. There was a whole page of little ideas, like annual cost of broken cutters etc., but the following are the ones most pertinent for most of us. I've added a few of my own at the end. GBL)

Don't waste time and money on a customer who will not allow you a profit. Cut him out entirely.

Don't forget that your best insurance against a job done at a loss is the time and expense taken to make a thorough and accurate estimate.

Don't forget to consider and allow for designing time; your customer's job may require more of that than he (or you) realizes.

Don't forget that some firms fail and don't pay their bills. Some never intend to pay in the first place. A sure way to get rid of the second type, and a good policy in any case, is to get some money up front. Make this an iron clad rule and you will save yourself some losses and much aggravation.

Don't expect to get every job you bid on. A lot of business is not worth having.

If you get every job you bid on, you are probably bidding too low.

If you are asked to build a machine for some business-oriented purpose, and to do it "on the cheap", remember this: your only chance to get anything out of the machine you build is when you sell it. You will get your profit then or never. Your customer will profit continually from the machine he is asking you to build for him. If necessary, tell him this.

Any time somebody introduces his little job with the phrase "all you've got to do is..." you can be pretty sure you are about to be stung! It will probably turn out to be the classic 5-minute job that takes an hour. And if it does, and if you get paid for 5 minutes work, you have been stung, well and truly, have you not?

Also: if you do a job for somebody for less than it's worth, you are subsidizing him. If you *choose* to do that, that's up to you. If he *expects* you to do that, show him the door.

If you're not making money at it, you might as well be doing something for yourself.....Think about that one the next time there is something you want to work at for yourself and Herbert Bloggins asks you to make up some little trinket for his $30,000 motor home. Better still, think about it before 'Erbie comes along. Do you want to spend your time on his hobby or yours?

(I have a feeling that the above may sound terribly selfish to some guys who read it. I've got nothing against doing the other guy a favour, but if it gets to be a one way street, I can lose interest awfully fast.)

If somebody asks you if you could do such-and-such a job for him, **tell him to bring it around to your shop** and you'll take a look at it. If he is willing to do that, you may have a paying customer on your hands. Never offer to drop around and have a look at the job at his place. If he is not interested enough to bring his work to you, he's not very interested. This is a tactic that took me a long while to tumble to, but I have found it to be a good measure of the prospect. It applies most strongly to the "new customer" - if you have done business with the guy before, and figure the possibilities are good, then it may not be out of line to go see the job at his place. Think about it: when you want something done, do you not take it to the guy who you want to do it, or expect to pay him for coming around to your place to have a look at it? Expect the same for yourself, from your potential customer.

Stay away from the independent inventor types. If not, deal on one basis only: payment for services rendered, some if not all of said payment to be in advance. Never take on this guy's work for the promise of a future share of the profits. Chances are good they will never materialize.

Michaelangelo, who was a pretty fair hand with a cold chisel, apparently said: "I finally realized the world would have paid me anything I had asked....if only I had asked." Put your own price on your work. If it's a fair price, it'll be paid. If it's too high you'll starve, and lower your prices. If the customer is too cheap to pay a fair price, spend the time doing something for yourself. Which goes right back to the first point - if he won't allow you a profit, show him the door.

COLD WORKING OF STEEL

AMERICAN MACHINIST Magazine
April 30, 1931

In forging carbon-steel tools we were always told never to hammer below a red heat. But, according to Richard H. Kiddle, there are exceptions to all rules: way back before the days of HSS and T-C tools, he had to drill a hole in an old vault. No carbon drill he had would touch it, so he forged a drill and kept hammering it until the steel was black, using lighter blows as it cooled off. This drill did not quite get through the vault, but it would put a hole through a file without much trouble. Cold working increased the hardness, just as it does today in drawing or swaging cold metal.

(This same individual used) cold hammered drills for drilling chilled iron plowshares. (And you'd better believe they'd be hard! GBL) He drilled from the back side, and as soon as the drill broke through, he stopped drilling and used a punch - still working from the back side - to break out the rest of the metal. This left a good countersink on the face side of the plowshare for the flat head of the rivets.

> (I believe there's something pretty interesting here for the guy who wants to use it. GBL)

Friend Charlie MacKenzie tells me that years ago, before high speed steel and carbide cutting tools were available, chilled cast iron rolls were used in steel rolling mills. The lathe tools used to machine these rolls to finished dimensions were high carbon tool steel, heat treated much as we would heat treat drill rod cutters in our shops today, but left just as hard as they could get them. They'd cut that ferociously hard chilled cast iron, but you sure couldn't hurry the job.

It is also well known that if you must tap a particularly hard piece of steel, as often comes up in gunsmithing, you can heat a high carbon steel tap up and quench it in mercury. It'll be HARD. It'll also be extremely brittle, and if it does break off in the job, you can probably shatter it with one shot from a punch. Some proponents of this technique say to heat the tap well above the normal level used in heat treating, while others say to bring it up only to a dull red. Use of the higher heat makes for greater brittleness, such that even a little vibration is enough to reduce the tap's cutting edges to powder! (With a nod to **Gunsmith Kinks**, Vol. I, but I've seen this elsewhere too.)

I don't suppose I need to tell you that you should not pull off a quench-in-mercury stunt indoors!

A COBALT-FREE TOOL STEEL THAT OUT-PERFORMS HSS

I ran across something in 1985 that you may find interesting. The Chinese (who had seismographs, paper, and printed money when our ancestors were herding goats) have developed a cutting tool material that out-performs M-2 and M-7 High Speed Steel. It is a cobalt-free steel which is subject to very precise heat treatment. Milling cutters made from this material are given somewhat different geometry than we use. The end result is superior tool performance.

For example: Side cutting in mild steel with a top quality American-made 1.25"ϕ end mill in a good milling machine, the rate was 5-1/2 inches per minute (ipm). In the same material, same machine, and using an even more expensive end mill, the cutting rate was 12 ipm.

The Chinese tool (cheaper than the first above cutter) was able to do 30 ipm!

In another case, a carbide tool (about 4 times the cost of the Chinese cutter) was getting 2 ipm with a cutter speed of 200 rpm. The Chinese cutter did the job at 600 rpm and 6-1/4 ipm.

This stuff also stands up to cast iron better than HSS, but not as well as does Tungsten Carbide.

The nice thing is that this material is being used in American and Swiss pattern files, drills, taps, reamers, end mills, and lathe toolbit blanks, and is available in the U.S. from UIS International Corp., 8510 Warner Drive, Culver City, CA 90232, phone (213) 870-6936).

Added Feb. '94: Apparently UIS International is no longer in business. I called MSC and TTC, and learned that the material used in these Chinese cutters is designated "M2AL". Availability of Chinese-made cutters in M2AL varies from year to year, and while both MSC and TTC sell 1/4" to 2"ϕ roughing endmills in this material, neither company carries the variety of tools that were being imported by UIS. Some other Chinese-made cutters that MSC or TTC carry may be made from M2AL, but this fact may not be revealed by the makers.

GOOD ADVICE ON GETTING AHEAD

Peter Paganelli
Diesel Truck Machinist
Westport Machine Works, Sacramento, CA.

"Pete, ya can't be afraid of nothin'." That's what my boss said when I asked him where he learned to repair dial indicators. Although he was a couple of months younger than me, he knew more than most machinists his age. We work at different shops now - but I remember what John said whenever I tackle a new job.

Another piece of advice came from a teacher at a Junior College where I was taking an auto mechanics course. He said, "You can't move up, unless you move around."

The beauty of the machinists' trade is that you can never learn it all. Many shops teach you a job and keep you on it until you finally burn out. If the shop moves me around it's a lot easier to go to work each day.

A SOURCE OF INFORMATION ON OLD-TIME PACK CASEHARDENING METHODS

THE BULLSEYE MIXTURE

The Bullseye Mixture is the story of two men working together to build a very special rifle.

Sam is a retired tool and die maker in his late 80's. He is terminally ill, and wants the rifle done and tested before he dies. He has been teaching the machinist's trade to his friend Stan for the past 5 years and the two have grown closer than brothers despite an age difference of more than half a century.

As they work on the rifle night after night, he begins to unfold for Stan the secrets of old time pack casehardening methods and how he can apply them right in his own backyard. But there is one aspect of the process he will not tell - Stan must learn it for himself. Through their conversations you will learn:

What casehardening is and where and why it is used.
How to build a simple, portable furnace.
Where to scrounge and how to make and mix the materials used in the casehardening pack.
How to make containers in which to do the casehardening.
How to judge the temperature of the work by eye.
How to achieve the beautiful play of mottled colors on a casehardened part when desired, and how to preserve it.
And much more, both about casehardening and other shop tricks and methods.

Stan has his eye on Sam's granddaughter Nora. She hates him. Stan has learned much from his old friend, about metalwork, about life, and people, and friendship, and loyalty, but the thing he will value most is what he learns when Sam dies - the secret of **The Bullseye Mixture**.

The Bullseye Mixture was printed in The Machinist's Second Bedside Reader, wherein it runs to about 34 pages. It has moved strong men to tears, and you might enjoy it too. See also page 31 herein.

HOW BILL FENTON CAME TO JOIN THE ARMY

In 1940, Bill Fenton was working as a machinist at a fair sized machine shop here in Vancouver. From what Bill tells me, the place could have been the inspiration for the machine shop scenes featured in J.R. Williams' "Bull Of The Woods" and "Out Our Way" cartoons.

Most of the shop's equipment was long past its prime, including some long-bed gun barrel lathes of WWI vintage. To give these machines greater capacity, the shop owners had raised the headstocks and tailstocks by putting them up on blocks planed in matched pairs on the planer. One of these lathes had had a 4' block put under the headstock only, for large faceplate work. The topslides had of course been jacked up to suit.

The shop had a contract to face off some bed plate castings for ships' anchor winches. These bed plates were on the order of 4' x 8' for size, and it would take a shift and a half to take a cut across one - there were no carbide tools in those days, or if there were, they were not used in that shop.

To save the cost of an operator, the owners had rigged up an eccentric on the overhead shaft, with a long wooden pole connected to a ratchet on the cross slide feed screw - a crude automatic feed.

On a another faceplate lathe, they were facing 12" steam pipe elbows. The elbows were clamped to a very large angle plate, which alone would have weighed several hundred pounds. There was a variety of scrap iron bolted to the faceplate to counterbalance the offset mass. The man who ran this lathe was a rancher who, as a machinist, would have done better to stick to milking cows. One particular night, it being wartime and all, he decided it was his patriotic duty to speed up his lathe. With the higher peripheral speed, some of the balancing lumps began to come adrift, thumping the bed of the lathe, flying off in all directions, and generally scaring those working nearby. One man dove under his lathe for fear of getting hit by the debris.

Well, I guess you see what I mean about the similarity with the "Bull Of The Woods" scenarios...

Knowing that he was a pretty fair draftsman, the foreman asked Bill if he could work up some drawings for a taper turning attachment for one of these old gun barrel lathes. Bill said he would see what he could do. Being on night shift, and being young and keen, he spent the next several days of his own spare time on the project. In due course he brought in a complete set of working drawings and showed them to the foreman, who was much impressed.

"Oh my, Bill, that's a lovely job! I want to show this to the Superintendent.....but take your name off and we'll surprise him."

"...and he did, too - when they brought the drawings back to me to make it, I found he'd passed them off as his own work! When I saw that, I told them what they could do with the drawings, and the lathe too, and I joined the Army!"

After basic training Bill was transferred to the Ordnance Corps, which later became the R.C.E.M.E. Some notes about Bill's experiences overseas appear elsewhere in this book. I have often thought that a book titled "A Machinist Went to War" might well be written about his adventures there. Maybe I'll do it one of these days.... If I do, the following is one story that'd be in it:

MATILDA JANE

Bill Fenton (speaking of himself and the other men of his group in Italy) says:

"... our enthusiasm was such that if we needed materials not supplied by the Ordnance Corps, we went out into the surrounding countryside armed with cutting torches and similar instruments to "requisition" what we needed from bombed out factories, high tension towers, etc. .....anything to keep the equipment rolling at the front.

"We requisitioned a hydraulic olive press and modified it to press off the steel lined solid rubber tired bogey wheels from the Sherman tanks, and press on new ones. Otherwise the whole bogey wheel assembly, bearings and all, would have had to be scrapped, at a much higher cost. We mounted this press on trunnions on a cut-down Jerry truck chassis that had taken a shell in the engine room. In use, the press stood upright. When we were moving, it was laid down, and it looked like a cross between a railway cannon and an anti-aircraft gun. The "Eye Ties" thought it was a secret weapon of some sort. We called her 'Matilda Jane'."

"STEALING THE TRADE"

Tom White
AMERICAN MACHINIST Magazine
May 7, 1931

(An old-timer considers machinists in general and recounts some anecdotes about one machinist in particular.)

As far as I know there is but one statue of a machinist, as a machinist, in the United States today. This is the statue of Seth Boyden. Boyden was a machinist and an inventor, but the artist has depicted him with the leather apron of a blacksmith, standing at an anvil. This, I suppose, is the average sculptor's conception of a machinist. However, we will not quarrel about a little thing like that. The fact that gear wheels are seldom made with a hammer and anvil does not alter the fact that a lot of people think that is the way they are produced. This is, if they think at all. But speaking of the blacksmith, what a breed he has sired! Wherever one has settled, civilization has blossomed. The machinist is the legitimate son of the blacksmith and like his mighty sire he bends the fractious metal to his will. Look where you will, wherever men congregate, the work of the machinist is visible. In all the fields of war, transportation, communication, farming, building, mining, in fact in every phase of our modern civilization, the machinist has supplied the means to carry on.

Every important invention that has ever been made has been the father of hundreds of attendant inventions that no one ever hears of. In every machine shop and toolroom throughout the land, there is being produced every day some new device or new method of doing a job that should rank as an invention. It is not uncommon for a machinist to produce an idea that revolutionizes the entire production of a shop. And only one single statue to him!

When I say machinist, I include the engineer, the blacksmith, the patternmaker, and the molder. The same creative urge is strong in each of them. They belong to the same clan, differing only in the amount of dirt they accumulate in the day's work. They tell me the old-time all-around machinist is taking his place with the dodo and the carrier pigeon, but I know better. We are getting just as many good machinists as we ever did, but they are spread out thinner. If a shop has one crackerjack machinist, it thinks it is lucky; if it has two, it knows it is.

Most good machinists have served their time, but some others manage to ..."steal the trade". These men, unless they have a tremendous aptitude and a winning disposition, pass through a terrible ordeal before they acquire enough knowledge of the business to have the other men accept them as machinists. I would not advise anyone to try to "steal the trade", though I have known some excellent machinists who took this route, either by accident or design. One whom I know well got into the business quite accidentally, and he got much amusement out of his own ludicrous mistakes. He took delight in telling me of them long after he had become a finished machinist.

One morning, about 7 a.m., he joined a group of about 25 or 30 men outside the gate of a large machine shop. He was then about 21 or 22 years old, and was looking for any kind of work that he could get. The employment agent singled him out of the crowd and said, "We need a lathe hand; you're a lathe hand ain't you? Come on in. That's all we need this morning, men, come around tomorrow." He then sent Herman up to the small lathe department, and the boss put him to work. The first job he took on was a shaft about an inch in diameter and six or seven feet long, to be cut in two. The shaft was centered on one end, and as there was a chuck on the lathe, he chucked one end and put the center up to the other end. He then put the parting tool in, and started the lathe up. The lathe was speeded up pretty fast but that meant nothing to him. He jammed the tool into the job and started to cut.

He said that he noticed that all the men near him suddenly found important business somewhere else, and that they all seemed in a hurry to get there, but he steamed merrily along and cut the shaft off without a mishap. He said that someone told him afterward that they all expected to see the shaft wrap itself around his neck, but as he put it, "There is a special providence that watches over children and fools, and it was on the job that day." I asked him how he happened to chuck one end of the shaft, and he said he didn't know that the chuck was removable. He said also that he learned about a steady rest some six months afterward.

Herman told me of another fool stunt he pulled off in the next shop he worked in. He hired out as a machinist, and the boss put him on a planer. He got along all right for a few days, then he got a job that was quite particular. After he had squared the job up and clamped it down, the boss told him that he didn't trust the square he had used, and to get the new square from the crib, and check it. He went to the crib and asked for the new 12-inch square. The boy handed him a wooden box shaped like a square, with the square inside. He never suspected that there was a square inside, but thought it was rather strange that the boss wouldn't trust the steel square, even if it was old, rather than a wooden one, but who was he to question the boss's judgement, so he shoved the wooden box up to the job, found that it was O.K., and proceeded to finish the job. Fortunately the job turned out all right so that there was no harm done. About a week later he saw someone pull a fine new steel square out of that same wooden box!

Notwithstanding the inauspicious start, this man eventually became one of the best machinists I ever had the good fortune to meet. But he was one in a thousand.

HELPING THE WAR EFFORT

The following story was told to me by a most interesting and likeable chap who, for reasons of his own, prefers to remain anonymous. We will call him "Jack".

During WWII, Jack had a little machine shop in his basement in Vancouver, and he got himself a Government contract to rough out plugs for depth charge casings. Pretty soon he had several men working for him.

His next-door neighbour started complaining about the presence of a machine shop in a residential area of the city. After a few complaints, Jack was told he'd have to get a business licence, but he told City Hall he was too busy to do that.

The neighbour kept complaining, so City Hall sent Jack the licence application forms, with everything all filled out - all he had to do was sign it and send it back and he'd have a licence. So he signed it and kept on makin' depth charge plugs.

The neighbour (whose main concern was the possible adverse effect on his property value) was still complaining. Jack was getting somewhat fed up by this time, so he phoned the Government man who was co-ordinating the work of sub-contractors such as Jack. Could he please get this guy off his back? Yes, he could, and he would.

"And he did," chuckled Jack, telling me this story. "I happened to be standing at the basement door when he came around to talk to my neighbour, and I overheard the whole thing." (It went something like this:)

"Are you the fella who's been complaining about the machine shop next door?"

"Yes, I am."

"Listen, Mister. There's a war on. If there's another peep out of you, we'll assume you're in league with the enemy. If we prove it, you'll spend the rest of the war in a concentration camp."

Needless to say, there were no further complaints.

HOW NOT TO GET A WELDING TICKET

Peter Jones
Haverpordwest, Dyeed, Wales

A close friend of mine was just coming to the end of many years' service in the Royal Naval Air Service. He was a skilled aircraft mechanic, experienced in all aspects of workshop practice. Like many before him he was unhappy about the fact that, for various reasons - mostly union pressure - skills learned during his military career would count for nothing in civilian life, and he would be unable to get a job without first qualifying for a trade.

He decided to take a Government Training Course in welding to get a 'ticket' of some sort. The course he chose was a residential one lasting six months. He was already in a bad frame of mind when he went. Within an hour of starting the course, this turned to anger when he was told that as he was a complete novice he was not allowed to touch any tools without permission. When he was foolish enough to mention his Navy experience, the instructor (who was an ex-Army man) publicly berated him and made some unflattering remarks concerning the abilities of Navy craftsmen.

My friend bided his time until mid-day. This being the first morning of the course, they were given the rest of the day to familiarize themselves with the layout of the school and the town in general. This was the signal for most of the group to adjourn to the local pub. However, my chum put the remainder of the day into a wide-ranging demonstration of his abilities. His first exercise was carried out in the machine shop, where he produced, all in brass, a beautiful example of turned work, the identity of which will be left to the reader's imagination. He then made up a simple birdcage in welded aluminum rods.

Alas at this stage his sense of fun took over, and he decided to weld a wrench solidly to the steel topped workbench. Thus inspired, he welded all the vises shut. He then delicately silver soldered the zipper of the instructor's white coveralls, without damaging the cloth.

By now he had gone too far to remain in the course whether he wanted to or not, so he proceeded to weld anything metal in sight. It was nearly midnight by the time he finished. He climbed into his car and drove off, leaving behind as his finale the steel toecaps of the instructor's safety boots welded to the bottom of a steel tank under 2 feet of water.

By the end of the following week he was running a small machine shop in a remote town in Nigeria - I still get a postcard from somewhere exotic at Christmas.

SHARPENING SAFTEY RAZOR BLADES

AMERICAN MACHINIST Magazine
June 18, 1931

"Old time barbers magnetized their straight razors with a permanent magnet after honing. Recently, several patents have been issued on safety-razor blade sharpeners of the magnetic type. These arrangements use permanent magnets, the blade being held at right angles to the magnet surface with the edge almost, but not quite, touching. E.T. Birdsall, Chief Engineer of the Lawrance Engineering & Research Corporation, New York City, upon looking over the patents, decided the same object could be accomplished with a magnetic chuck. He tried it. It worked, so he told us. We're telling you. He suggests laying the blade flat on the chuck with one of the lines of insulation in the center of the blade. Then close the switch for half a minute, open it, turn the blade over, repeat the treatment, and you have a resharpened blade."

(No guarantee from this writer! GBL.)

MAKING WELDED STEEL BOXES

In 1984 I took a course in oxyacetylene welding. 50 hours of instruction and practice didn't make me a welder, but it did make me very aware of the high degree of skill a good welder must develop. Although I don't claim to be a skilled welder, one area in which I had some success (and good instruction) was in fusion welding of sheet steel boxes.

I like to make boxes - always have, ever since I was a kid. Boxes to store stuff in, and like that. Well, I thought it'd be nice if I could make steel boxes by means of welding. It seems there are several tricks which will aid in producing a good result, with minimal distortion.

First, use nice clean, flat material, e.g. 1/16" sheet steel. Second, cut the parts - top, bottom, and sides - nice and square, and to exact size. A file and a square can be applied to good purpose here if you don't have access to a sheet metal shear heavy enough to cut your material.

A piece of angle iron of a size suitable for the box you are making will serve as a **welding jig**. Make sure the outside angle is 90°. File or machine the ends square: although not vital to the use of the jig, 'twill do no harm, and will encourage its proper care for future use.

Provide yourself with some slips of steel that are flat and smooth, and free of nicks, burrs, etc - these will be used as spacers - 1/16" to 1/8" is a good thickness.

Clamp the bottom and a side, or a pair of sides, to the welding jig as at Fig. 1. The use of spacer slips between the box components and the jig prevents welding the box to the jig. Make the initial set-up carefully, for upon it the finished result depends. The components' edges should meet as at Fig. 2. The arrangement at Fig. 3 will help the inexperienced welder achieve a neater weld but is not good welding practice.

Have a pan of water at hand, or a hose, or whatever, with which to cool the job frequently.

"Tack" the ends of the joint. Check that the components are in proper relation to each other. Now commence welding.

Weld about 1/2" at a time, then move to some other point along the joint, and weld a little more. If you try to make the joint by means of one continuous weld, by the time you reach the far end of the weld, the work will be much hotter than it was at the start. To avoid problems from heat build up, cool the job in water frequently. When one seam is done, set up another side, and proceed as before.

When you start putting on a piece in a third plane - e.g. an end where bottom and side are already in place - tack first at the open end (see Fig. 4) of the seam. When the new piece is tacked in, weld down towards where the 3 pieces of metal meet, and then do the joint between. Always use short welds, not one continuous run, as recommended above. Cool frequently.

The finished welds can be cleaned up by filing or grinding - a belt grinder works nice for this. The discoloration due to welding can be removed entirely by salt and vinegar treatment, which see elsewhere in this book.

Fig. 1

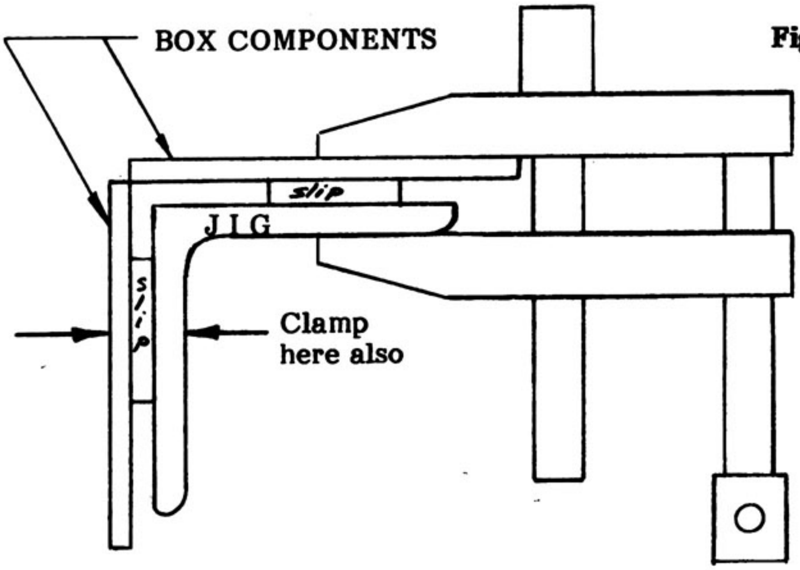


Fig. 2

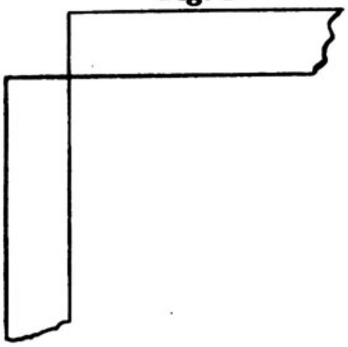


Fig. 3

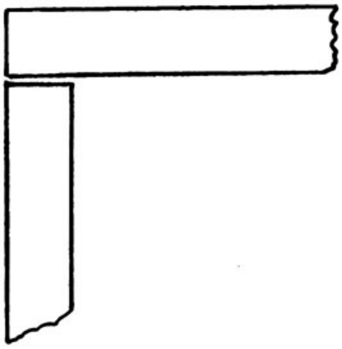
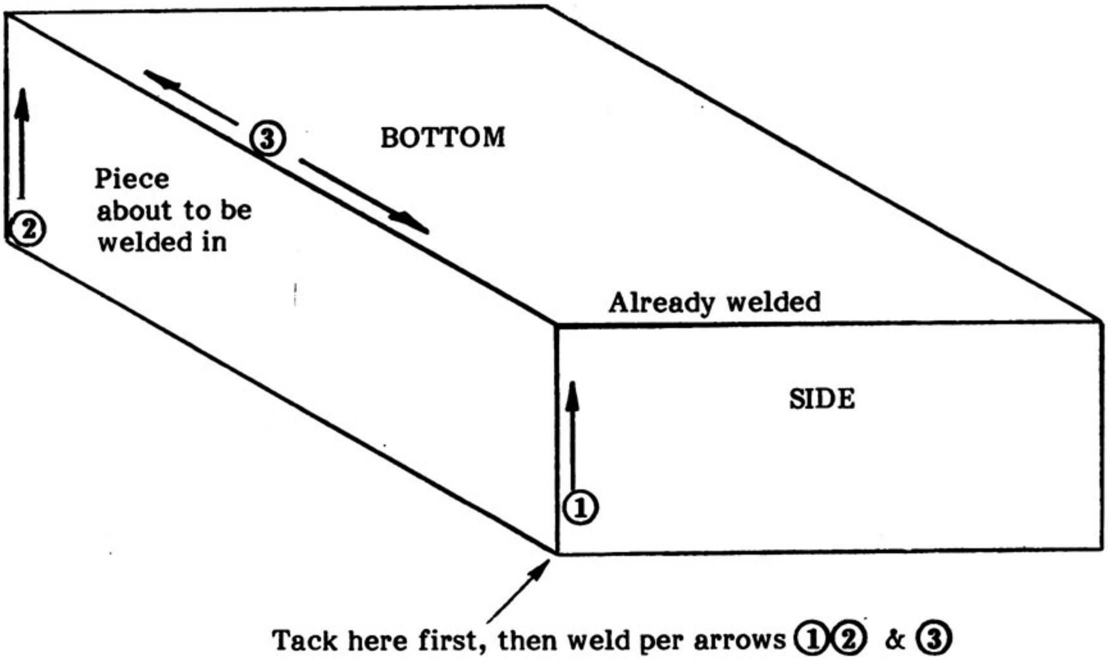


Fig. 4 (Job upside down)



DELPHON AND THE ADDING MACHINE

S.W. Hathaway
(Electrical engineer from Union College, Schenectady NY.
Worked 31 years at Raytheon Company and was involved
in development of early microwave radar.)

This incident took place around the turn of the century and was told to me by my father many years ago. Perhaps a little background will be helpful.

For about 20 years prior to his death in 1910, my uncle was the Superintendent of the Fall River Iron Works in Fall River, Massachusetts. This somewhat misnamed Company had nothing to do with working iron, but was in fact the second largest cotton cloth manufacturing firm in the world, with a complex of seven large mills. The central character in this story was the Master Mechanic of the mills, and as such he was in charge of the mill shops, and all maintenance and repair of the mill machinery.

This individual was a French Canadian named Delphon. (Although he was a great friend of my grandfather, my uncle, and my father, I never learned his full name, nor ever heard him called anything but simply Delphon.) According to my father, Delphon could do anything any of his men could do, and a number of things none of them could do. He was not only a master machinist but also a skilled cabinet maker. Because he liked to experiment, and made many important improvements in the plant's textile machinery, my uncle fitted out a small private shop for Delphon's own use in back of his (Delphon's) shop office.

Delphon had a couple of interesting traits. The first was an insatiable curiosity about any mechanism new to him. Secondly he was an extreme individualist. If he knew and liked you, there was nothing he wouldn't tackle for you, but you had better limit your request to describing what you wanted done. Any suggestion as to how he might go about the project brought things to an immediate and permanent stop.

Sometime before the occurence of the incident described below, the mill had bought 4 Burroughs adding machines for the mill office. These were early models, with a keyboard of eighty or so keys. They were entirely mechanical, and manually operated. One punched in the numbers and then pulled a long handle on the side. The case was filled with gears, cams, springs, etc. At this time the only Burroughs office and sales room in New England was in Boston, and these were the first machines they had sold in Fall River. As part of the original deal, Burroughs agreed to send a qualified repairman to Fall River by the next train upon receipt of a telegram reporting trouble with any of the machines.

It was Delphon's habit to stop by my uncle's office nearly every morning for a few minutes' chat. On the day in question, as he passed through the outer office, he noticed that one of the machines had been moved to a table in the back corner. He asked if something was wrong with it. My uncle told him it wasn't working right and that a wire had been sent to Boston.

Seeing his chance, Delphon asked if he could have the machine taken to his shop for a look at it. My uncle, knowing both his curiosity as well as his skill, told him to go ahead. Delphon immediately sent for a couple of men to come up and take the machine down to his little private shop, into which he disappeared, shutting the door.

In due course, the Burroughs man arrived. He asked where was the machine, and was there a place where he could work on it? As they started down to Delphon's office, my uncle, guessing what they would find, told the Burroughs man that no matter what they might see, if he opened his mouth or said a word, it would be the last bit of business Burroughs would ever do with the Fall River Iron Works.

They found Delphon's office empty, so my uncle quietly opened the door to the shop and beckoned the Burroughs man to look in. What they saw was an almost completely disassembled machine, whose bits and pieces were meticulously laid out in rows on the bench, while Delphon was studying one of the parts so intently he never noticed the door being opened.

While my uncle quietly closed the door, the Burroughs man collapsed into a chair, an anguished look on his face, muttering that it would take him a week to put it back together again. My uncle told him not to worry, he wouldn't have to, and that the best thing he could do was to take the next train back to Boston.

As my uncle expected, in a few days, the machine was back in the office, working perfectly. Then came the real denoument. Having found and studied the broken part, Delphon decided it was improperly designed and would never work for very long. So he designed and made four new pieces, which he installed, one in each of the four machines. Having put things right and satisfied his curiosity, he lost all interest in the machines, and as far as I know another wire was never sent to Boston.

THE SLEEPY APPRENTICE BOY

The following story, told by my friend Bob Haralson, took place shortly after WWII in Oregon, at Hobbs' Machine Works, where Bob was then employed as a machinist.

One of the apprentices was a little chap who had a fondness for nodding off to sleep while his (large) lathe was cutting under power feed.

One day the boss (Dick Hobbs) caught him dozing, and stuck a length of 1" x 6" lumber into the teeth of the lathe's bull gear, which would have been 5 or 6 feet in diameter. Needless to say, the ensuing racket accomplished the desired result.

Once would have been enough for most people, I guess, but not for this particular chap.

A few days later Dick Hobbs caught him flat on his back on a cleared off shelf, his lathe busy on a long, slow turning cut, with many minutes to go before it would need his attention.

This time Dick snagged a 4' x 8' piece of 3/4" steel plate from a rack at the far end of the shop, and brought it up behind the lathe, by means of an overhead crane. He swept the smooth concrete floor clean, and called over two men to balance the plate on edge, on the floor, while he unhooked the crane.

By this time everybody except the apprentice had become interested in what was about to happen.

When the plate was let go, it hit the shop floor with a clang like the closing of the gates of Hell.

According to Bob, the apprentice's feet never touched the ground on his way over to his lathe to shut it off.

It took him an hour to get the plate back into the rack at the end of the shop, working first with wedges to get it up off the concrete floor. When he reported back to Mr. Hobbs, who incidentally was a man of considerable physical dimensions, he was picked up bodily by the shoulders and deposited outside the front door of the machine shop.

"Town," said Dick, "is down there, Son."

A MACHINIST'S APPRENTICESHIP SERVED BEFORE THE TURN OF THE CENTURY

Bill Fenton's father started his apprenticeship as a machinist about 1888, at Fenton Engineering - no relation - on the south side of the River Tweed in England. Many months were spent at the bench before he began to learn the use of machine tools. Bill recalls his father's account of watching an old machinist cut a coarse thread on a piece of steel perhaps 12 inches in diameter and several feet long. Nothing unusual in that, you might think, but the job was done freehand, on a plain lathe - i.e. one not graced with a leadscrew and other amenities one might want for the purpose.

The machinist laid out a series of parallel lines down the length of the work. He then stepped off, with dividers, the pitch of the thread on one of these lines, and on the next, did the same, but further along the work by the amount the thread would have advanced in the interval between the lines. This was done for every line around the work; the points thus laid out were then marked with a centerpunch and chalked for visibility.

The threading tool was held freehand on a tool rest much as a wood turner would use. The lathe was started and the machinist made several trial passes down the work to get the "feel" of the thread he was about to cut, and then took a very light scratch cut to initiate the thread. Subsequent cuts deepened the thread, which took many hours to cut to full depth.

Naturally, the first light cut would guide the tool on subsequent passes, and where the machinist noted a discrepancy between the laid out pitch and the cut he would correct this, probably almost subconsciously, by "hurrying" or dragging the tool, as the case might be.

During the course of Bill's father's apprenticeship the Company got an order to build a steam engine destined for hoisting duty in the diamond mines at Bloemfontein, South Africa. The flywheel for this engine was 16 feet in diameter. It was made from several cast segments whose mating radial faces were first machined on a large planer so that they could be assembled into a single unit. This done, the flywheel was bolted onto a large vertical boring mill (or some functional equivalent - Bill is a little hazy on this part) and the central hole was bored. Needless to say, much shimming and checking must have gone into setting up for this job.

The flywheel was then keyed to its own shaft and the shaft placed in its own bearings, temporarily bolted to the shop floor beside a brick lined pit which accommodated the lower half of the flywheel rim. A heavy slide rest was fixed to the shop floor at one end of the pit, so that the face of the flywheel could be machined.

Power for this turning operation was supplied by the "barring engine", a much smaller steam engine which, once the entire power plant was completed and installed, would be used to turn the main engine over when necessary so that it could be started. The barring engine drove the flywheel by means of gear teeth cast into the inside of the flywheel rim.

Bill's father finished his apprenticeship in the Spring of 1894, and went out to Africa with this engine to erect it. In Africa he contracted a very bad case of malaria and was advised to seek a cooler climate, such as in Canada. He arrived in Vancouver in 1897. I met his son 78 years later.

AN IN-SITU SHAFT REPAIR

by T.E. Jarnigan
AMERICAN MACHINIST Magazine
May 21, 1931

Our plant fabricated corrugated ends for freight cars and was, at the time, running a special type which had the bottom flange bent back on the same side as the corrugations. The bend was too close to the last corrugation to permit flanging in the regular hydraulic press, hence a special press operation was required. We dug up an ancient V-die which fitted a 10 foot shear, and set up the job on this machine. The male die, V-pointed, was only about an inch and a half thick, hence cleared the edge of the corrugation. We found the sheets could be run under the die, flanged with one stroke, caught by the operators as the bending tipped them, and then slid out of the end of the press onto a pile. The set-up had been running successfully for several days, bending the 1/4" sheet exactly to specification.

Suddenly there was a crash, a tremor that shook the building, and the strangled roar that means a jammed press. The pressman had let his foot linger just a moment too long on the treadle. The clutch had stayed in, and a plate had its just-finished flange jammed against the male die holder, stopping the press dead and jamming the clutch. The driving gear, about 5 ft. in diameter and mounted on the eccentric shaft, stood at a crazy angle, half clear of the driving pinion.

It was a simple job to remove the gears, but the clutch was a different matter. The shaft was bent just at the outer bearing, and that, combined with the twisted keyway in which the clutch key fitted, held the clutch tightly. (The shaft was approximately 8" in diameter where it passed through the clutch, the clutch being about 2 feet in diameter and 20 inches long, of the conventional toggle type.) We finally succeeded in forcing the clutch off and found the shaft sprung about 5/8" out of line, and also twisted about 1/4" in the approximately 20" it extended from the housing. The twist could be taken care of easily by widening the keyway and inserting a larger key, but the shaft looked like a hydraulic press job.

But then we learned something else about straight-line production. In laying out the line, the big press had been put within 3 feet of a twin, with the resulting necessity of moving one of the presses before we could draw the shaft. Each press weighed somewhere between 25 and 30 tons, and was bolted and grouted securely to its foundation. Even if we could have drawn the shaft, we had no tools around the shop to hold the job successfully.

It was finally decided to straighten the shaft without removing it from the press. Much jacking and prying, with the assistance of the overhead crane, got the plate from under the ram and permitted us to turn the shaft over so that the bent end was downward. We then set a 100-ton hydraulic jack under the end. Heating the shaft was necessary to assist in straightening. We knew the heat would cause little difficulty in the bearing because the heavy cast iron housing would absorb the heat too rapidly to permit injury. The only means of heating were oxy-acetylene torches. We tried them all one day and half the next, with alternate heating and jacking, with a conspicuous lack of success. The torches were capable of getting the shaft red hot in spots, but could not supply heat fast enough to get a red heat at the core. Any effort at jacking simply lifted both press and foundation as a unit.

We finally thought of the crude oil "blowtorch" - the type which throw a 30-inch flame, 6" in diameter - and got our hands on two of them. They were set on opposite sides of the shaft, and their flames soon accomplished the heating job. As soon as they were out of the way, slight jack pressure was put on while a copper bar over the heel of the bend was tapped with a sledge. Finally the shaft bent, but went past center and into a kink on the opposite side. Two days' work gone for naught!

There was nothing to do but allow the shaft to cool. The whole wearisome process had to be repeated. This time we sledged harder and used less jack pressure, with the result that the square showed the shaft less than a sixty-fourth of an inch out. In that position it was allowed to cool, with the result that our shaft was almost perfectly straight. Then the keyway was filed wider, a key made to fit and the clutch reassembled. The next morning dawned with a press ready to go and carrying a spring kickout so that the pressman could sit down on the treadle and still get only one stroke, no more, no less.

This impromptu repair, though unorthodox, was successful, for the machine has been running six years now with no further trouble.

HOW TO IMPRESS YOUR MOTHER-IN-LAW

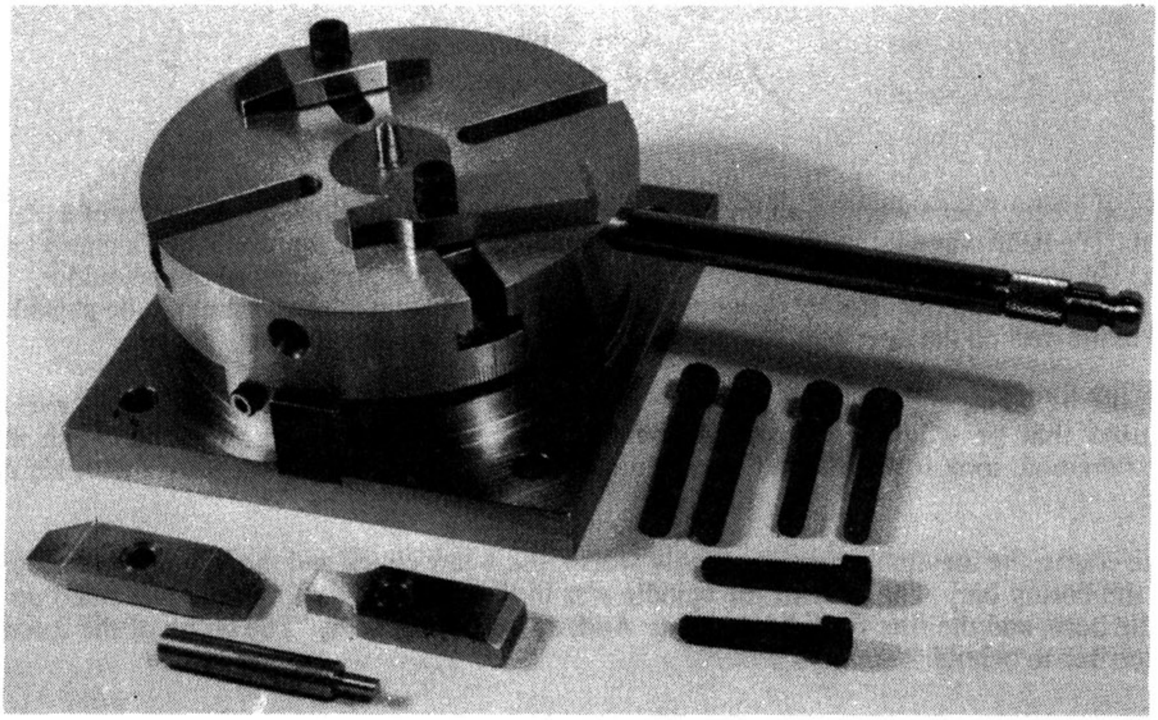
I made myself a little rotary table about five or six years ago, and if I do say so myself, I made a pretty nice job of it. I took it out to the monthly meeting of the B.C. Society of Model Engineers, where everybody thought it was very nice.

One of the guys asked me how I'd engraved the 0-360 degree scale around the skirt of the table, and I told him. (Reader: If you want to know, see elsewhere herein the excerpt from **Strike While the Iron is Hot.**) He looked at it some more, then handed it back, saying, "Very impressive."

"Thanks. I'll tell you something - it even impressed my mother-in-law."

"That is difficult."

"Yes," says I, with timing that would have done justice to Bob Hope himself, "it is."



HOW TO REMOVE A CHUCK THAT IS JAMMED ON TIGHT

Jarvis Williams
Los Angeles, CA

I had a large, short piece of steel bar, about 12" diameter, in a big 4-jaw chuck, on a 16" South Bend lathe with a threaded spindle nose. I had the lathe running at a pretty good clip, but without tailstock support. The chuck and bar together must have weighed more than a hundred pounds. At one point in the job when I reached over to turn off the motor, I went through 'off' to 'reverse'. That big 3-phase motor grunted and went into full speed astern. The belts didn't jump off the pulleys, and the next thing I knew I could see the chuck unscrewing itself from the spindle.

There was only one thing to do - full speed ahead. That chuck wound back onto the spindle and bottomed out with a thunk that could be heard around the world.

We tried all afternoon to get the chuck off the spindle nose. Nothing would work. We ran it backward in back gear and jammed a piece of 4x4 between the jaws and lathe bed, hoping to jar it loose - no way. (Normally, this will loosen the most stubborn chuck. GBL)

Fortunately the chuck was backplate mounted. The only thing I could see to do was to remove the chuck from the backplate, and machine the backplate off the spindle nose. This was done late at night when there weren't a bunch of idiots standing around asking stupid questions.

ONE WAY TO RUIN A LATHE

Len Gale
Auckland, New Zealand.

In a shop where I once worked, a machinist was boring out a huge block of steel, part of a plastic mould. The lathe was a Dean Smith & Grace. (A DS&G is not what you would call a cheap lathe. GBL.) He was using a hefty boring bar with a knife tool in it to produce a square shoulder. The feed must have been fine. Rather than stop the lathe while he went to the washroom, he passed the word to the man on the next lathe to keep an eye on his machine for a minute.

Well, off he went, and on re-entering the toolroom he happened to catch his mate's eye and signalled that he would go further down the workshop to speak to someone. The mate misunderstood, took it that the lathe was no longer his responsibility, and got on with his own work.

In due course the inevitable happened, only worse: the 4-jaw chuck and the job together dropped onto the boring bar! The nose of the spindle was in line with the tool, the bar just fitted up the spindle bore, and the fine feed did the rest. And, as the saying goes, "The wrath of the foreman was terrible to behold."

A COAL MINER'S CURE FOR HEADACHES

John Vermillion
Bluefield, WV
(Retired from 43-1/2 years electric meter work
with Appalachian Power Co. of the American Electric Power System.)

I was visiting the machine shop section of the National Electric Coal Co. (now a part of McGraw Edison Co.) in Bluefield, West Virginia, on the eastern edge of the Pocahontas Coal Field. I had a life-long friend working there as a lathe operator by the name of Ira Crews. Red Elmore, the shop foreman, was a good friend of mine also.

On this particular day, while we were talking, they told me the following story, which had happened at the mine in recent days.

Coal miners used to work in pairs, or small groups. Two men were working together. Joe said he had a headache, and was invited by his partner Jim to take a couple of tablets and some water, both of which he would find in his (Jim's) lunch bucket. Joe got the tablets out of the bottle, and remarked that they were kinda large. Jim agreed, and being busy working, didn't pay much attention. Joe popped them in his mouth, followed by a big drink of water, and very shortly afterward, nearly exploded. About a half hour later, after the belching had subsided somewhat, and they were able to talk again, Jim said, "I thought you knew how to take Alka Seltzer."

WHERE GEARS COME FROM

John Higman
Santa Barbara, CA
(A marine engineer for 50 years, his last ship was the "Hughes Glomar Explorer". Prior
to going to sea, served time as a machinist, then worked a number of years in a Navy Yard.)

Back in the late '30's I was working for Keystone Engineering, a jobbing machine shop in Los Angeles. I had just brought up a finished gear to the shipping department which opened out onto the street. As I was filling out the paperwork, a salesman walked in, said he carried a line of cleaning materials, brushes, etc., and wanted to know where he could find the shop foreman. I told him to wait right there because the foreman would be coming along a minute or so.

"Fine," he said. "By the way, what kind of work does this shop do?"

"We make gears, all kinds of gears," I told him.

"Gears? I didn't know you could make gears. I always thought you had to buy gears!"

SOME TRICKS YOU MAY NOT KNOW ABOUT HANDLING A TRIANGULAR SCRAPER

It is well known that a triangular scraper can be easily made by hollow grinding and then stoning the three faces of a small triangular file that has seen better days. Such a scraper is handier than a monkey's tail, both at the workbench and around the lathe.

If you have a part gripped in the bench vise and want to champher the edge of a recess or hole therein, the scraper will do it nicely, but there is a slight tendency for it to chatter. To avoid this, use a shearing action, in other words, pull the scraper upward as you pull it along the edge being championed. Bob Haralson taught me this.

If you apply a triangular scraper to the mouth of a hole you have just bored in a piece of material chucked in the lathe, chatter is almost a certainty, unless the spindle speed is quite low. Try this: Pick up your scraper and at the same time turn the lathe motor off but do not release the clutch. The momentum of the motor as it slows down will give you "power" on the headstock and you can apply the scraper to the edge of the hole as the speed drops to an appropriate level. The drive provided by the momentum of the motor is usually just about enough for the job. I have found this works much better than trying to slip the belt with one hand on the clutch lever while manipulating the scraper with the other, while pouring electricity into the motor.

A SALEABLE PRODUCT

Some who read this book may wish for something that they can make in their own basement and then sell. Well, here's an idea...

Who is as well fixed to build **a good wood lathe** as is a machinist?

I heard of a chap in a small town who put an ad in his local paper saying, "Wood Lathe for sale, $xxx, phone so-and-so." At the time, he didn't actually have one to sell, but he got a whole lot of calls, so he knew there were guys out there who wanted to buy one. He got busy and built several, ran another ad, and sold them all.

I think that's what you call a marketing survey, or something. My wife thinks it is a shocking idea to run the ad if you don't really have a lathe to sell, but it's one way of finding out if there's anybody out there who might want one. Anyway, it worked for him, so why not you, if you want to do something like that? And like I said, who better to build a decent wood lathe than a machinist?

There's a good design for a wood lathe in *Mechanix Illustrated*, Feb. 1969, page 86. Also, in the March/April 1986 issue of *Fine Woodworking*, there are two articles on building wood lathes.

Added to the 18th printing, September 2006:

How to make an Octagon from a square.

(This relates to info at the bottom of page 162.)

I did some digging in **Machinery's H'book,** and some calculating of my own, in an effort to find a simple way to make an octagon for a box latch. I didn't like anything I came up with, so I made a big drawing, and from it devised the formulae given with the drawing at the top of the next page.

If you plan to put the part in a V-block in your milling machine vise, and mill the corners off the original square, F would be the dimension to find and use. You could probably take each corner off at the rate of about 0.075" per pass, and likely more, until you get down very close to your final pass. You could then lock the cutter height at the final position, and take a cleanup cut over each corner in turn. The only thing wrong with this approach is the extra times you have to clean the chips out, knock burrs off, and re-make the set-up of the part in the V-block.

On a square of size = D x D,

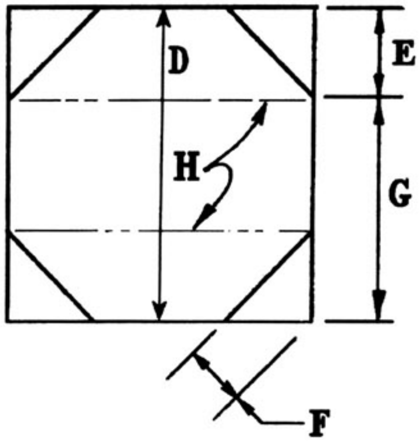
E = D x 0.2932

F = D x 0.2071

G = D x 0.7068

H and H are at distance E from the top and bottom of the square

For a 2" square, D = 2.000" both ways



If you want to lay out an octagon on the face of a square of metal, one way to do it would be to mark in lines **H** and **H** on the face, perhaps with a vernier height gage and a surface plate. Then draw a line at 45°, perhaps with a combination square, from the point where **H** meets the edges of the square. You could then mill the corners off to your layout lines, or hacksaw them off, and then file down to your layout lines.

SOME INTERESTING ITEMS IN *POPULAR SCIENCE* MAGAZINE

Including working drawings for a
4-cylinder swash-plate steam engine
your grandchildren would love.

Popular Science magazine is so widely available that anyone interested in the following items can easily track them down. If your local library does not have a collection of back issues of *Popular Science*, they can get them for you on "Interlibrary Loan". If you don't know what interlibrary loan is, you should talk to your librarian, because anybody who wants **anything** from almost any library can get it.

A POWER HACKSAW

Built from angle iron, pipe, and a pair of auto engine conrods. Author claims it'll saw discs 50 thou thick off "a solid steel bar". (He doesn't say what diameter of bar.) It looks like a sound design. See P.S. Magazine, Feb 1964, p.162-166, plus p.216.

HOW TO ANODIZE ALUMINUM

See *Popular Science*, Feb. 1963, p.144-146.

A CENTRIFUGE -TYPE AUTOMOTIVE OIL FILTER

Popular Science, March 1965.
This is a particularly interesting item, with room for some detective work......

The article does not give working drawings, but there are enough details to enable a machinist to make one for himself if he put his mind to it. Prototypes were installed on a couple of Dade County (Florida) Sheriff's cars. The cars had no other oil filter. They ran 50,000 and 35,000 miles respectively, without oil changes and without ill effects.

The slant of the article was that this might herald the availability of an improved unit for widespread automotive use, with which oil change intervals would be 30/35,000 miles. The maker was Bergstrom Engineering Co. of Miami, Florida. The device was patented in 1957, and was apparently a runaway success in aircraft engines, for which it was designed.

Now here's the funny part: today, there seems to be no trace of an outfit called Bergstrom Engineering. *Popular Science* had no record of further developments, when I wrote to them about this article. If you try the telephone info people for Florida, you'll draw a complete blank.

So what happened?.

Is this one of those murky tales wherein "the oil companies bought him out"? Maybe. It'd be interesting to know. On the other hand, more sleuthing might unearth the Company at a new location.

Also, a clever idea for **holding small round parts** in a bench vise without damage appears in the same (March '65) issue, at page 151.

A STEAM ENGINE OF UNUSUAL DESIGN

There are complete working drawings for a simple little 4-cylinder swashplate steam engine made from telescoping brass tubing at page 140 of *Popular Science* for January 1963. Just the thing to make for your grandchildren.....

FINGER KNOBS

Neat plastic finger knobs with which to make good looking and practical thumbscrews are made under the "Shear-Loc" trade name. They can be had in three styles - knurled, fluted or T-shaped; four colors - black, grey, beige and red; and in several sizes to fit standard socket head cap screws from #4 to 3/8". You simply press them onto the head of the screw, where they then stay permanently. About the only way to get 'em off would be to smash them with a hammer. I have used them, and I like them.

Here are a couple of tips about their installation, arising from my own experience - the maker's literature does not tell you these things.

1. In pressing the knurled type onto a socket head cap screw head, I use my bench vise. If you do it this way, do **not** use a piece of soft wood between the knob and the serrated vise jaw. The wood will "give" or crush under the forces involved, and the knob will crack. Use a piece of smooth steel or similar. (I suspect this would be true for the fluted ones too, altho I have never used that type.)

2. A **very** small amount of oil on the screw head lets the knob be pressed into place much more easily.

Cost? On the order of 25 cents each - more, or less, depending on size, etc.

Source: Swiss Precision Instruments, Inc., 875 N. Virgil Ave., Los Angeles, CA 90029, (phone (213)-666-1188), or
Shear-Loc Products, 23191 Peralta Drive, Laguna Hills, CA 92653.

CALCULATIONS RE V-BELT DRIVES

FIGURING V-BELT LENGTHS

The following formula will give the length of V-belt required for a particular pair of pulleys, diameters d and D, and center-to-center distance L:

$$(d + D) \times 1.56 + 2L = \text{Belt Length}$$

If you measure the outside diameter of the pulleys, the above formula will give you the outside diameter of the belt. (If you use the pitch diameter of the pulleys, you'll get the pitch diameter of the belt, but who among us poor dumb boobs will be able to measure the pitch diameter of a pulley? Just thought I'd mention it to cover all the spots.)

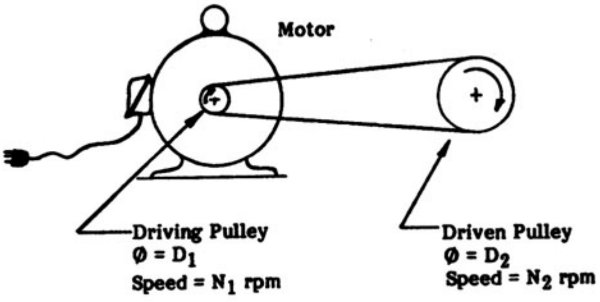
If you want to set up a variable speed drive via stepped pulleys, how do you go about selecting a set of pulley diameters for the motor and drive shafts such that you don't have to move the motor base 6" fore and aft every time you change speeds? A friend asked me about this, and I spent an hour or two wading around in a sea of pulley sizes, speeds, and belt lengths, with no luck. Finally, having become emotionally involved with the problem, I had a brilliant insight and called a place that sells V-belts.

What do you do? Very simple: install a pair of **identical (stepped) pulleys** on the two shafts, facing opposite ways. It was so simple I nearly cried when the guy explained it to me.

CALCULATING SHAFT SPEEDS AND PULLEY SIZES

The general formula is: $D_1N_1 = D_2N_2$

Then, we shuffle the stuff in the formula about for whatever factor we want to solve.



Example 1: What pulley size will give 750 rpm on the driven shaft, given a 1750 rpm motor fitted with a 3"Ø pulley?

$$D_2 = \frac{D_1N_1}{N_2} = \frac{3 \times 1750}{750} = 7\text{"Ø}$$

Example 2: What shaft speed results if a 3400 rpm motor and 12" pulley drives a 2.5"Ø pulley?

$$N_2 = \frac{D_1N_1}{D_2} = \frac{12 \times 3400}{2.5} = 16{,}320 \text{ rpm}$$

SOME USEFUL TEMPERATURE BENCHMARKS

This happens at........	°C	°F
Water boils	100	212
Tin melts	232	450
Lead melts	327	620
Mercury boils	357	675
Zinc melts	419	786
Aluminum melts	657	1215
Zinc boils	918	1686
Silver melts	961	1762
Gold melts	1062	1944
Copper melts	1083	1981
Cast iron melts	1100	2012
Pure iron melts	1500	2732
Firebrick softens	1400-1800	2500-3270
Silica softens	1500	2732
Platinum melts	1750	3182
Iron boils	2450	4442
Tungsten melts	3000	5432
Bunsen burner flame	1200	2192
Petroleum blowpipe flame	1500	2732
Oxy hydrogen blowpipe flame	2000	3632
Oxy acetylene blowpipe flame	2400	4352
Electric arc	3500	6332

JUDGING TEMPERATURE BY APPEARANCE

very dull red	500	930
dull red	700	1290
cherry red	900	1650
orange	1100	2010
white	1300	2375
dazzling white	1500	2750

ADDED TO THE 18th PRINTING, SEPTEMBER 2006:

I've recently discovered PVC plastic machines very nicely. I was simply facing off the ends of some 2" white PVC pipe, but if a guy wanted to make something out of a solid block of this material, he should be able to end up with something pretty cute. It looks somewhat like ivory.

> **WARNING**: You don't want to inhale the dust from (any) plastic. Therefore wear a respirator. Vacuum up the cuttings from machining plastic, rather than brushing them off your machine tools. If you are a smoker, DO NOT get the chips from it in your tobacco, and inhale the resulting burning plastic fumes with the tobacco smoke. HEED THESE WARNINGS, WHICH ARE NOT EXHAUSTIVE – I'M NOT AN EXPERT ON MACHINING PLASTICS, NOR ON INDUSTRIAL HEALTH AND SAFETY. OTHER PRECAUTIONS MAY ALSO BE REQUIRED.

SOME SCREW THREAD DATA

and North American equivalent thread sizes to substitute for some British thread specs commonly encountered in model engineering

UNF 60° V-thread, flat root and crest, flat width = l/8 pitch

Size	TPI	O.D.	Tap Drill
0	80	0.060	3/64 or #56
2	72	0.073	53
2	64	0.086	50
3	56	0.099	46
4	48	0.112	42
5	44	0.125	37
6	40	0.138	33
8	36	0.164	29
10	32	0.190	21
12	28	0.216	15
l/4	28	0.250	#3
5/l6	24	0.3125	I (0.272"Ø)
3/8	24	0.375	Q (0.332"Ø)
7/16	20	0.4375	25/64 (0.3906)
1/2	20	0.500	29/64 (0.4531)
9/16	18	0.5625	33/64 (0.5156)
5/8	18	0.625	33/64 (0.5781)
3/4	16	0.750	11/16 (0.6875)
7/8	14	0.875	13/16 (0.8125)
1	12	1.000	59/64 (0.9219)

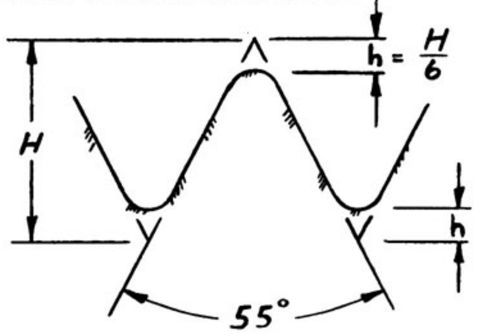
UNC 60° V-thread, same as above.

Size	TPI	O.D.	Tap Drill
0	-	-	-
1	64	0.073	53
2	56	0.086	50
3	48	0.099	47
4	40	0.112	43
5	40	0.125	38
6	32	0.138	36
8	32	0.164	29
10	24	0.190	21
12	24	0.216	16
1/4	20	0.250	#7
5/16	18	0.3125	F (0.2570)
3/8	16	0.375	5/16
7/16	14	0.4375	U (0.3680)
1/2	13	0.500	27/64 (0.4219)
9/16	12	0.5625	31/64 (0.4844)
5/8	11	0.625	17/32 (0.5312)
3/4	10	0.750	21/32 (0.6562)
7/8	9	0.875	49/64 (0.7656)
1	8	1.0	7/8 (0.875)

BSW (British Standard Whitworth)
55° V-thread, rounded root and crest

Size	TPI	O.D.	Tap Drill
1/16	60	0.062	58
3/32	48	0.094	49
1/8	40	0.125	38
5/32	32	0.156	31
3/16	24	0.187	26
7/32	24	0.218	15
1/4	20	0.250	7
5/16	18	0.312	F(0.257")
3/8	16	0.375	O(0.316)
7/16	14	0.4375	U(0.368)
1/2	12	0.500	27/64(0.4219)

ESSENTIALS OF THE BSW & BSF THREAD PROFILE



BSF (British Standard Fine)
(Whitworth form, as for BSW)

Size	TPI	O.D.	Tap Drill
7/32	28	0.218	14
1/4	26	0.250	3
9/32	26	0.281	C(0.242)
5/16	22	0.312	H(0.266)
3/8	20	0.375	21/64(0.328)
7/16	18	0.4375	W(0.386)
1/2	16	0.500	7/16(0.4375)

"MODEL ENGINEER" THREAD SERIES

This thread series was developed as a fine thread series for model work, where metal thickness is often limited and a greater number of threads per inch is therefore desirable.

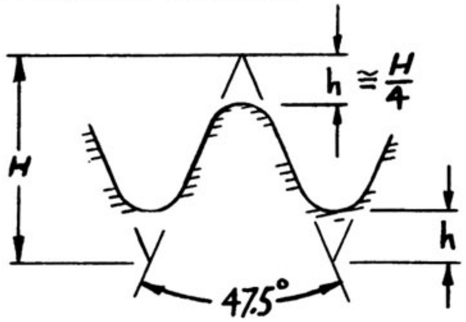
Size	TPI	O.D.	Tap Drill
1/8	40	0.125	38
5/32	40	0.1563	30
3/16	40	0.188	20
7/32	40	0.219	9
1/4	40	0.250	1
9/32	32	0.281	1/4
5/16	32	0.3125	9/32
3/8	32	0.375	11/32
7/16	26	0.4375	X(0.397)
1/2	26	0.500	15/32

BA (British Association)

47 1/2° V-thread, radiussed root and crest

Size	TPI	O.D.	Tap Drill	Nearest N.A. Equiv.
0	25.4	0.236	7	-
1	28.2	0.209	16	12-28
2	31.4	0.185	22	10-32
3	34.8	0.161	29	8-36
4	38.5	0.142	31	6-40
5	43.0	0.126	37	5-44
6	47.9	0.110	43	4-48
7	52.9	0.098	45	3-56
8	59.1	0.087	50	2-56 or 2-64
9	65.1	0.075	53	1-64
10	72.6	0.067	54	0-80
11	81.9	0.059	56	
12	90.9	0.051	59	
13	102.0	0.047	62	
14	109.9	0.039	68	
15	120.5	0.035	70	
16	133.3	0.031	73	

ESSENTIALS OF THE BA THREAD PROFILE



NOTE: In the BA series, Pitch = 0.9^n, n being the BA number of the thread: e.g. for 4BA, $P=0.9^4$ = 0.066 mm/thread = 38.5 threads per inch.

Also note: BA a/f hex size is 1.75 x body Ø of screw. One can of course use a smaller size of hex stock if making his own screws, in order to have neater heads.

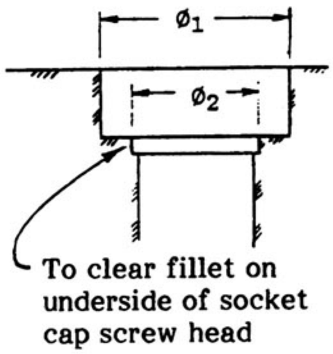
MUNK, THE FLYING CHIPMUNK

The table below will be found useful in the "drafting office" when designing split cotters, or whenever else a socket head cap screw is to be used. Xerox this page of the book, cut out the table, and stick it up on the wall handy to your drafting area.

SOCKET HEAD CAP SCREW DIMENSIONS

Nominal Screw Size	Body Ø	Head* Ø	Socket Size	Counter-bore $Ø_1$	Counter-sink $Ø_2$
0	0.060	0.096	0.050	0.115	0.074
1	0.073	0.118	1/16	0.140	0.087
2	0.086	0.140	5/64	0.172	0.102
3	0.099	0.161	5/64	0.194	0.115
4	0.112	0.183	3/32	0.219	0.130
5	0.125	0.205	3/32	0.250	0.145
6	0.138	0.226	7/64	0.272	0.158
8	0.164	0.270	9/64	0.316	0.188
10	0.190	0.312	5/32	0.359	0.218
1/4	0.250	0.375	3/16	0.422	0.278
5/16	0.313	0.469	1/4	0.515	0.346
3/8	0.375	0.562	5/16	0.609	0.415
7/16	0.438	0.656	3/8	0.703	0.483
1/2	0.500	0.750	3/8	0.797	0.552

Note: Height is always same as Body Ø



NOTE: The normal counterbore sizes for socket cap screws, as given in Machinery's Handbook, etc., are larger than necessary in some cases. For example, in the Tool for Straight Knurling project, the counterbore for the 1/4-NF screw in Part 2 is dimensioned at 0.395"Ø, which is plenty. The standard counterbore size for 1/4" soc. cap screw is 0.422"Ø, as in the above table. See Machinery's Handbook and American Machinists' Handbook for additional information.

THE DAREX M3 DRILL SHARPENER

Several years ago I bought a well-known "hardware store" brand of drill sharpener. I never liked it, and eventually sold it. It worked - after a fashion. Its main fault was its lack of rigidity. I think much practice and care would be required to get even reasonably good results with it.

The Darex M3 Drill Sharpener, which is regularly advertised in *Home Shop Machinist* Magazine, is a horse of a different color - I know because I recently got one. So far I have not had time (primarily because of getting this book ready for the printer) to give the M3 more than a preliminary trial, but I thought you might like to know my first impressions.

The Darex M3 is solidly built. Where appropriate, its movements are spring loaded. It is an industrial quality item throughout and should last the average hsm a lifetime. It will handle drills from 1/16" to 1/2", and with an optional larger chuck, drills from 1/2 to 3/4". It has adjustments for drill size, point angle, and relief angle. Feed onto the grinding wheel is via a screw with a fluted handwheel about 2" for easy and precise control. The instructions are fully illustrated, and excellent, covering not only "how-to" but trouble shooting, adjustment for wear, disassembly and cleaning, wheel dressing, and how to grind other than a conventional drill point.

Installation is easy: the grinder and the M3 are mounted on a common surface, e.g. a piece of 3/4" plywood. A full dimensioned paper template is provided for this, as are all mounting bolts, washers, etc.

The next order of business will likely be to dress the wheel. This is readily done by chucking a diamond dressing tool in the M3's drill chuck, and then rocking the sharpener across the face of the grinding wheel.

> TIP: In dressing a grinding wheel, take the dressing tool across the wheel in a reasonably quick pass - you want to **cut** the abrasive grains, not polish them down.

The very first drill I sharpened was a 19/64" (0.2969) drill of unknown make - just one my father-in-law had used for years for anything except precision metal work. The actual sharpening is easy: you set the drill correctly in the chuck via a separate setting fixture, and then put the drill and chuck in the sharpening fixture, bring the drill up to contact the wheel, and then rotate the chuck in the fixture; radial and axial camming surfaces provide correct motions for the geometry desired. I then tried it in a piece of 1/2" black iron plate in the vertical mill. I drilled a center hole, drilled a pilot hole, and then proceeded to mash the 19/64" drill through, with a couple of stops to clear chips and brush on some more cutting oil - one could be cruder, but not much. The result was about what I'd expect from a factory-new drill used similarly: the hole finish was a little rough, and the small hole gauge miked 0.2975", although the rough finish made "gaugemaker feel" and so on impossible.

I could open the gauge up a couple more thou and still wiggle it into the hole, but I doubt you'd have got a 0.2985" plug gauge into it. (Also, the average drilled hole doesn't need to be tight on size: if you want it so, you must ream it, bore it, or take more pains in sharpening and using the drill than I did here.)

The next drill sharpened - and the last so far - was a 3/16 drill, and in testing it, even less pains were taken: I just drilled a center hole, and then drilled 3/16" - no pilot hole - I just gobbed on some cutting oil, and staubed it through. The hole finish was as before: rough, and quite in keeping with the technique used! The hole measured about 0.193" - again oversize, which is exactly what one would expect, doing things this way. Another hole was drilled thus: center drill, drill #15, drill #13 (=0.185") drill 3/16" with the Darex'd drill. This hole, close as I could measure it, is 0.188" - nuthin' wrong with that.

If a duffer like me can get this sort of results with the first 2 drills and without being at all fussy, I think it fair to say that with a little practice, and taking normal care to get the best out of the Sharpener and the newly sharpened drill, the Darex M3 will become a valued addition to any machinist's shop, enabling its owner to keep his drills as good as factory new - or better. I once bought a new 19/32" drill which was so far off being symmetrical it wouldn't drill - it just went into the 1/2" pilot hole about a quarter inch and began to scream. I took it back and got a replacement, which was exactly like unto the first one! At that point (no pun intended) I got disgusted, and proceeded to grind it properly, freehand. This I can do - Bill Fenton taught me how - but I am not very fast at it. I doubt I'm going to get much better at it: from now on I will just stick 'em in the M3 and tune 'em up right on the first try.

DAREX Inc.
P.O. Box 277
Ashland, Oregon 97520
(800) 547-0222

MORE INFO ON BALL TURNING

IN 1990 we brought out a little book called **"Tables & Instructions for Ball & Radius Generation"**. This is a 3-part, 104-page book. **Part 1** explains the basic method (explained elsewhere herein), which requires nothing more than a parting tool in the lathe to make ball handles, ball end mill blanks, etc. **Part 2** explains how to generate male and female radii with a ball end mill, or the side of an end mill, in a vertical mill. Say you wanted to machine a 1/4" radius on the corner of a piece of material. If you have a 1/4, 5/16, 3/8", 1/2" or other size of ball end mill at hand, you can do it. You can also do it with the side of an end mill. And it's fast, easy, and accurate. **Part 3** consists of over 70 tables - one per page so they're uncluttered - for generating both balls and radii from 1/64" to 1" radius. There's also a handy memory aid on the inside back cover, so you can flip to it if you need to, and then go to work from the table that suits your job at the moment. It's just 4" x 6", so it fits in your tool box, and it's coil bound, so it'll lie flat in use.

NEW PLANS FROM GUY LAUTARD

I now offer a set of plans for **a REALLY good tire pump***. The original was made by one of my guys. He loaned it to me to make a set of drawings of it for sale. Along with the tire pump plans comes **several pages of excellent info on spring making**. You can read all about it, and see lots of nice color photos of the tire pump, on my website, which is here: **www.lautard.com**.

* The US Military has been using the same tire pump, unchanged, for the last 65 years or so. I think mine is better.

GRUPPO #1

In the Fall of 2005, I brought out something entirely new and different – **a CD containing 100+ pages of stuff** (sort of a **mini-Bedside Reader**), containing plans for excellent 3 tools, info on a very nice way to make small boxes to store things like V-blocks, levels, and similar tools that deserve better protection than afforded simply by a place in your toolbox, lots of nice color photos, and various info on quite a few topics. This publication has been very well received, and is fully described on my website. It's called **Gruppo #1**. (Will there be another Gruppo? I don't know.)

APPENDIX

(A far-from-complete listing of suppliers & magazines catering to the interests of people who would be reading this book.)

Brownells, Inc.
Route 2, Box 1
Montezuma, IA 50171
1-800-741-0015
www.brownells.com

Cole's Power Models, Inc.
5539 Riverton Ave.
North Hollywood, CA 91601
www.colespowermodels.com

For a tap to cut the Myford lathe spindle nose thread,
Contact me at GuyLautard@telus.net,
or see my website, www.lautard.com

Gilliom Manufacturing Inc.
P.O. Box 1018
St. Charles, MO 63302-1018
636-724-1812
(kits for various shop tools)

J&L Industrial Supply Co
Livonia, MI 48151-3359
(800) 521-9520 or (313) 458-7000

Centaur Forge
117 N Spring St.
Burlington, WI 53105
800-666-9175
www.centaurforge.com

Pieh Tool Company, Inc.
661 E. Howards Rd., Suite J
Camp Verde, AZ 86322
888-743-4866
www.piehtoolco.com

Manhattan Supply Co. (MSC)
(800)-645-7270
www.mscdirect.com

Reid Tool Supply Co.
(800)-253-0421
www.reidtool.com

Production Tool Supply Co.
(800)-366-2600
www.pts-tools.com

Smithy Company
(800) 345-6342
www.smithy.com

KBC Tools
(800) 521-1740
www.kbctools.com

Harbor Freight
(800) 423-2567
www.harborfreight.com

Home Shop Machinist Magazine and
Live Steam Magazine
Traverse City, MI 49685
(800) 447-7367

*Model Engine Builder Magazin*e
see page 146

Model Engineer Magazine,
Encanta Media Ltd.
Berwick House
8-10 Knoll Rise
Orpington, Kent BR6 0EL
ENGLAND

Engineering In Miniature
TEE Publishing
The Fosse, Fosse Way
Nr. Leamington Spa
Warwickshire CV31 1XN
ENGLAND
www.fotec.co.uk/mehs/tee/

Rifle Magazine
Wolfe Publishing Co.
2625 Stearman Rd., Suite A
Prescott, AZ 86301
www.riflemagazine.com

The British Horological Journal
Upton Hall
Upton, Newark
Nottinghamshire NG23 5TE
ENGLAND
www.bhi.co.uk/oldindex.htm

THE MACHINIST'S SECOND BEDSIDE READER and THE BULLSEYE MIXTURE

More great plans and shop info in this
all new sequel to TMBR#1

Complete working drawings and instructions for:

- A small **Pantograph Engraving Machine** you can build. (The commercial equivalent would cost you over a thousand dollars!)
- **A Toolmaker's Block** - a rectangular relative to Lautard's Octopus.
- **A Bench Vise Accessory** for holding flat work by its edges.
- **The Poor Man's Jig Borer** - a WWII-era device which allows high accuracy hole location on your drill press.
- An **"Overhead Drive"** for milling and drilling spindles on your lathe, plus details of a couple of milling & drilling spindles.
- **"Zero Wear" improvements** to the Drill Sharpening Jig shown at page 26 of TMBR#1.
- A small steam or air operated whistle (after an original **"Lunkenheimer"** whistle).
- **A kerosene-burning blowtorch** which can be set low enough to silver solder 1/16"Ø copper pipe, or turned up enough to melt 1/4"Ø solid copper rod in one minute. (Try that with the average propane torch!)

PLUS complete details on:

- A super-simple **indexing device** which can be made and/or elaborated to suit your particular purposes and equipment.
- An easy way of originating high accuracy **master division plates.**
- Two methods of originating a **master reference square** (or trueing up an existing square).
- A simple **shop made sine bar** and a **sine fixture** for your milling machine.
- How to make a **true square** (commercial ones sell for about $800), plus info on how to make your own **"space blocks"** and **"angle blocks"**.
- **An old gagemaker's methods and basement workshop equipment** for spot grinding and lapping. You can duplicate his simple arrangements for surface grinding and lapping for flat, square, and finish tolerances far beyond the limits of conventional machining techniques.

IN ADDITION TO THE ABOVE, there's also:

- Five ideas for projects (3 complete with working drawings) that could be used as gifts. (Want to have a very well equipped shop? Can't afford it? Three of these projects have the potential to be serious money makers.)
- Full info on **how to sharpen straight razors and other fine edged tools** to perfection.

PLUS more drawings/info for:

- an offset tailstock center for taper turning
- a fixture for cutting multiple-start threads
- an elegant between-centers boring bar
- two designs for shop-made hand hacksaw frames
- filing buttons and toolmaker's buttons
- a toolpost fixture for rounding the ends of small parts
- a simple lathe tracing attachment
- adjustable-for-balance wheel flanges for your bench grinder, **and.....** info on where to get:
  - working drawings for an EDM machine
  - a kit of working drawings and materials for a bench gear cutting machine, and
  - a super article on how to make your own small, fine quality aluminum castings.

And much more, including several anecdotes and a **multitude of hints and tips.**

PLUS ... "The Bullseye Mixture"

An enjoyable story which incorporates complete details of **old time carbon pack color casehardening methods.** (Have you ever read the comment, "These parts should be casehardened", in an article and felt like grabbing the author by the neck and saying, "Well, why don't you give us some idea of HOW to do it, then?!!) When you've read "The Bullseye Mixture" you will understand not only WHY you would caseharden certain parts, but you will also know, in detail, HOW to do it yourself, at home.)

Illustrated, 213 pages, 8½ x 11", soft covers

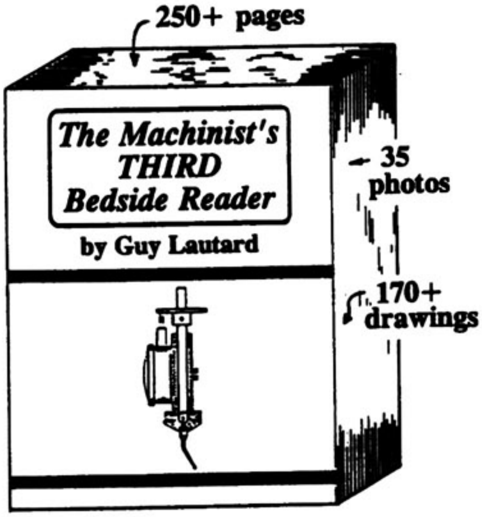
All our publications and numerous other fun goodies for machinists are described in our catalog, which can be obtained by sending $1 to the address below. Be sure to indicate if you are interested in our clock-related plans and/or the Hemingway plans, and/or the TINKER Tool & Cutter Grinding Jig.

GUY LAUTARD, 2570 Rosebery Avenue, West Vancouver, B.C., CANADA V7V 2Z9

Available in late September 1993

The Machinist's THIRD Bedside Reader

More new ideas, shop know-how and plans



FULL WORKING DRAWINGS and HOW-TO-MAKE INFO ON:

- A **"Co-Ax" type indicator unit** for use on your milling machine. (Also how to make and use edge finders, center finders, and "Wigglers".)
- A complete **sandblast outfit**, including 2 sandblast guns, and 3 ideas for sandblast cabinets, from very simple to as nice as any factory-made unit.
- **A rotating base** for a jointed arm ("Luxo") lamp that enables you to spin the lamp around and around without twisting the cord. (Takes about half an hour to make one.)
- **A simple, no-shake workbench** - readily made by the non-woodworker; also, more and better info on making wooden tool storage boxes, plus how to make **special, shop-made hinges.**

IN-DEPTH SECTIONS ON:

- **Taper turning** (3 different approaches)
- Making **target quality triggers** for **Mauser-type bolt-action rifles**; also, how to make muzzle brakes, & rifle cleaning rods.
- Hand stoning chambering and other reamers *(You simply will not get this info elsewhere!!)*
- Some more info on **casehardening**, and on **sharpening fine edged tools.** (*These are real "frosting-on-the-cake" items* that follow on from info in TMBR#2.)

PLUS:

- How to make working miniature spar tree blocks ("Loggers' jewelry"), and some notes on making wire-bending jigs.
- How to do a *deluxe* overhaul on a keyless drill chuck.

And that's only a start... there's more, including several ideas on *how to make money in your shop*, or just plain have fun and make good tools and accessories:

- Good tips on dialing in the head of a milling machine and how to keep from getting maimed or killed while doing it.
- Another slant on Osborn's manoeuvre
- Some excellent info on making good springs with professional-looking closed ends
- An aid to setting up work on a faceplate
- A simple collet chuck system for your lathe
- A miniature 4-jaw chuck for small work
- Making and using firm joint calipers
- Making special taps
- A device for making wax sticks to aid the tapping of blind holes
- A handy deburr-&-smooth tool (a ½ hr job)
- Some ideas on quick-change jaw inserts for your bench vise
- A flexible "pusher" for the milling machine vise
- A "small stock" storage system
- Source of the best file handle ferrules ever
- *The* Recipe for that all-time best smelling gun cleaning solvent
- A Machinist's backscratcher
- How to make a Turner's Cube - cube-within-a-cube-within-a-cube "headscratcher"
- A handy on/off button for your mill-drill
- How to use your sine bar to *measure* angles
- How to make etched brass name plates
- More info on machine-controlled engraving and useful notes on buying a used Gravermeister
- How to make fired glass "car badges" or similar that look like the real thing
- Recipe for an extremely effective cutting lube, and a simple-to-make spillproof cutting oil bottle

And more on how to:

- Modify your lathe spindle nose thread so it'll clean the thread in the chuck
- Fit a backplate to a lathe chuck
- Knurl the edge of a rectangular block
- Get broken taps out of aluminum
- Improve your magnetic indicator base
- Pull a tee in a pipe wall
- Hold a gib strip for machining
- Use an edgefinder to best advantage
- "Pick up" an edge in a hurry
- File off that last half thou
- Lube a milling machine spindle & quill
- Lay out an angle with a combination square (and probably beat the accuracy of a vernier protractor!)
- Freehand grind the flat on a rod for a beam compass
- Sharpen very small drills
- Do some very fine silver soldering

PLUS:

- Info on a hand-powered drill that will drill through 2" plate glass, truck frams, HSS end mills, etc.
- A few anecdotes, including a machinist's "Coincidence Maximus" - you'll have to read it to believe it!!

259 pages, 8½ x 11", soft covers, 196 illustrations