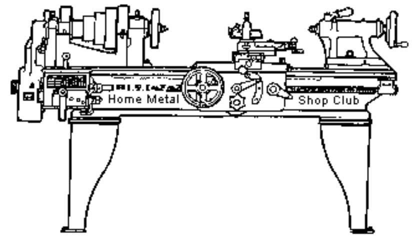
Home Metal Shop Club

March 2011
Newsletter

Volume 16 - Number 3



http://www.homemetalshopclub.org/

Since its founding by John Korman in 1996, The Home Metal Shop Club has brought together metal workers from all over the Southeast Texas area.

Our members' interests include Model Engineering, Casting, Blacksmithing, Gunsmithing, Sheet Metal Fabrication, Robotics, CNC, Welding, Metal Art, and others. Members always like to talk about their craft and shops. Shops range from full machine shops to those limited to a bench vise and hacksaw.

If you like to make things, run metal working machines, or just talk about tools, this is your place. Meetings generally consist of a presentation with Q&A, followed by ***show and tell*** where the members can share their work and experiences.

President *Vance Burns*	Vice President *John Hoff*	Secretary *Martin Kennedy*	Treasurer *Emmett Carstens*	Librarian *Dan Harper*
Webmaster/Editor *Dick Kostelnicek*	Photographer *Jan Rowland*	CNC SIG *Dennis Cranston*	Casting SIG *Tom Moore*	Novice SIG *Rich Pichler*

About the Upcoming April 16 Meeting 3rd Saturday

General meetings are usually held on the second Saturday of each month at 12:00 noon in the meeting rooms of the Parker Williams County Library, 10851 Scarsdale Boulevard, Houston, TX 77089. Due to use of the meeting rooms during tax season, this month's meeting only will be held on the 3rd Saturday, April 16th. Visit our website for up-to-the-minute details.

Perry Ruppe of Centroid CNC Controls will speak on Putting CNC on a Mill.

Recap of the March 12 General Meeting

By Martin Kennedy, with photos by Jan Rowland

Thirty four members and one guest, Ed Braesman, attended the 12:00 noon meeting at the Parker Williams County Library. President *Vance Burns* led the meeting. A video of the meeting is available on the club's web site.

Before the meeting, members celebrated the birthday of David Ballinger with a tasty birthday cake that he provided.

Presentation

Dave Wintz gave a presentation on Manufacturing Guitars. Dave is the owner of Rio Grande Pickups, a manufacturer of guitar pickups located here in Houston, and Robin Guitars, which ceased taking new orders last year. Dave became interested in music in 1964 after watching the Beatles on the Ed Sullivan Show. In 1972 he and a friend opened Rockin Robin, Houston's oldest guitar shop. In 1982 he began Robin Guitars, which has produced hand-made guitars since 1988.

The presentation began with a short video on Robin Guitars.

Robin Guitars

Robin built between 5 and 60 semi-hollow and solid body electric guitars per month. They did not make hollow body or acoustic guitars. Robin made high-end guitars that cost between $2,800 and $6,000 retail.

Guitar bodies and necks are roughed using a Fadal 4020 CNC (right photo) and hand finished. G-code for the Fadal is produced using an older release of MasterCAM. Dave found the software very powerful, but difficult to learn. He thinks he only uses 5-10% of the capabilities of the program. Parts are made using cuts limited to about ½" -7/8" deep in maple. Feeds are slower than maximum to produce better finishes. Although the Fadal's spindle is rated to 15,000 RPM, he rarely runs over 10,000 RPM. Some of the operations performed on guitars can be seen in the above video.

The type of wood and the material for the hardware used to build guitars affects tone. Dense and hard woods are desirable. Wood has been the choice material for guitars for a very long time, although people have sometimes made them from other materials, such as aluminum. Guitars made of aluminum have extra holes in the design to reduce weight. One undesirable problem of aluminum guitars is that they are physically cold when held. Two companies now make acoustical guitars using graphite.

It is important that the wood used to make guitars is properly dried to prevent splitting. The most important part to properly dry is the neck. Generally, the wood is first dried at the source, then again at the distributor, and finally at the shop. When not being worked, the wood and the partially completed guitars are kept in a controlled environment. Ultimately, painting seals the wood for long-term stability.

Finishing, or painting guitars is a critical operation in producing a high-quality guitar. For small production runs, the painting is done by hand. It is very difficult to get a flawless finish, and painting is one of the main reasons Dave gave for getting out of the business.

Dave passed around a beautiful completed guitar as well as guitar parts in varying stages of completion.

Rio Grande Pickups

Pickups are fairly simple in concept, while making a great one is not. Minor variances in the materials and design produce pickups that sound different.

Pickups consist of magnetic cores wrapped in copper wire. 10,000 turns of 42 or 43 gauge wire is typically used. One large coil surrounds all six poles, one for each string. The top and bottom plates are vulcanized fiber. The coil is 4-10k ohm resistance. Another type of pickup shown in the above picture, the Humbucker, has two coils and has the advantage of cancelling the pickup of 60 cycle hum. The magnets used in pickups are usually Alnico. Different types of magnets make different sounds. Dave says that Alnico #5 sand cast magnets have a warm, smooth sound, and ceramic magnets have a harsher sound.

About 95% of pickups sold are passive, including all those that Dave builds. Active pickups have a weak coil and utilize a battery powered pre-amp to boost the signal. The primary advantage to active pickups is that they do not experience 60 cycle hum. The disadvantage of active pickups is that they sound more sterile.

The location of pickups on the guitar also impacts the tone. A guitar string vibrates less closer its end, which gives a brighter sound. Towards the middle of the string, the sound is fuller. Having a guitar with two or three pickups allows the player to vary the tone.

It is desirable to have the string close to the magnet, but not touching it when it is strummed. If it’s too close, the magnets can affect the string vibration and produce an undesirable warble.

Show & Tell

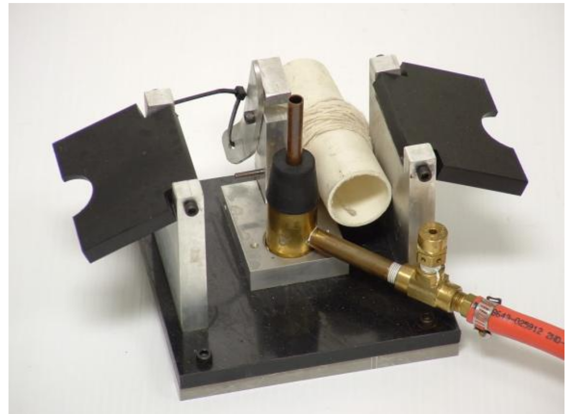
Joe Williams brought a tiny short screwdriver that he ground from a socket head screw. It was needed to remove a screw with limited access.

Jan Rowland brought in a box of surplus parts to give away. Thanks, Jan!

Martin Kennedy brought a spill-resistant oil can that he made out of a soft drink bottle by folding it into itself. The bottle (left photo) contains swarf to weight the bottom and contains “only as much oil as you can clean up with a rag”.

Joe Scott showed a Hardinge lever-action slide. He demonstrated how he had used it to mass produce a tapered tail cone for a Mercury 10 racing motor.

Ed Gladkowski brought in what he called an "ethnic" chain saw "Aggie Chain Saw for Texans" (left photo).



Mike Gibson had a very interesting 1 quart bottle launcher that he made (right photo). The design came from the Oct/Nov 2002 issue of Mechanic's Workshop. The fixture held the bottle by the spout. The bottle was half filled with water, and then pressurized with air. Mike used about 110 psi, and then remotely released the fixture's hold on the neck with a string. According to the article, the bottle could go up to 300' with the addition of an aerodynamic cone and fins! Mike said that what it was really good at was hosing down all the observers with water!

Problems and Solutions

Dean Henning brought in the shredder /chipper blade and hammers from a 7 ½ HP shredder that had been bent and broken during use. He wanted to know whether he should buy a new blade, or redesign the blade to be more robust. Members observed that the base plate for the shredder was made of thin steel, and should probably be made of much thicker steel. The forged hammers could be replaced with steel hammers and bushings to make them easier to make.

Novice SIG Activities

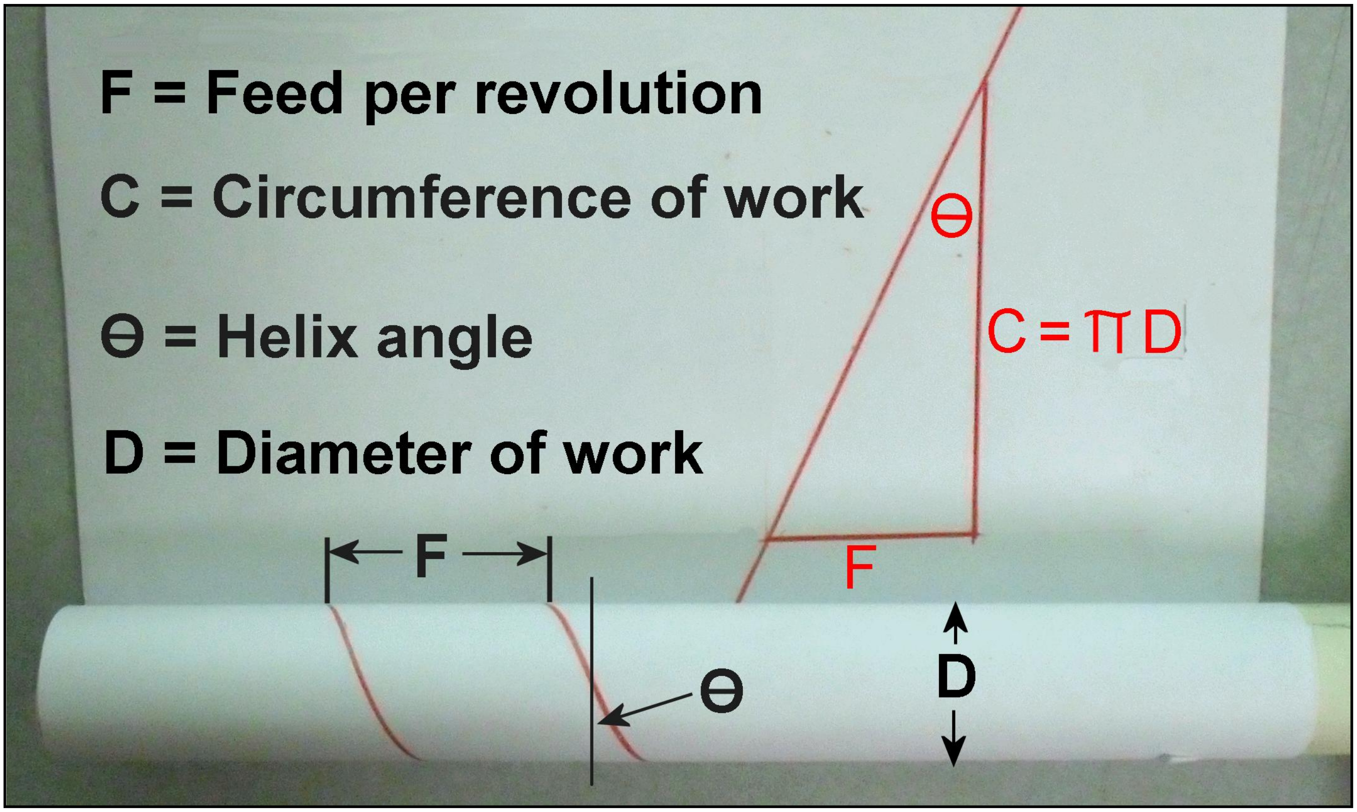
Dick Kostelnicek demonstrated the operation of a Geared Slip Roller that he designed and built. He rolled lengths of 5/16" square key stock into full circles of several diameters. Dick will post plans for the roller with an explanatory article at a future date.

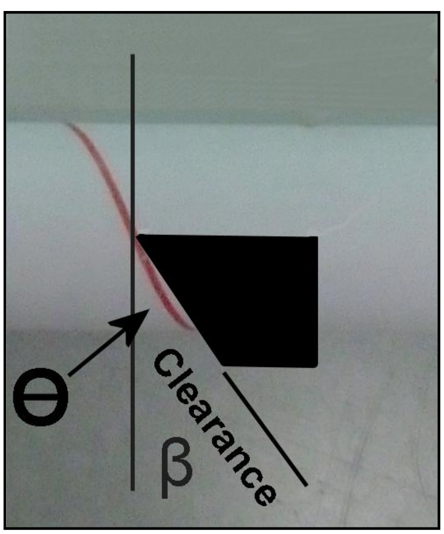
Articles

Flank Clearance, Helix Angle, and Threading

By *Dick Kostelnicek*

When work is turned in the lathe, the tool bit usually removes metal along a spiral path. To illustrate this, I've drawn a diagonal line on a sheet of paper and wrapped it several times around a mandrel. This spring-like or helical path, shown in red color, is often referred to by its helix angle **Θ**. This angle is determined by both the lateral feed per revolution **F** and the distance around the work or circumference **C = πD,** where **D** is the work's diameter. The mathematical relationship between **F**, **D** and **Θ** is determined by the red colored right triangle, **tan(Θ) = F / C**. The helix angle **Θ** is also seen as the slope that the spiral cut makes with a vertical line drawn across the turned work.

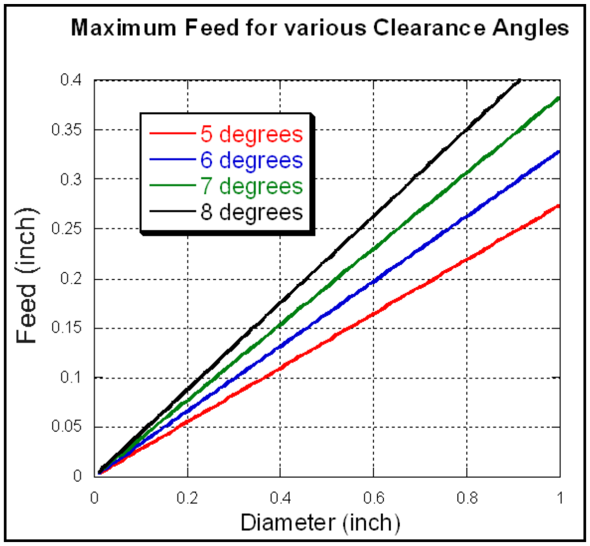




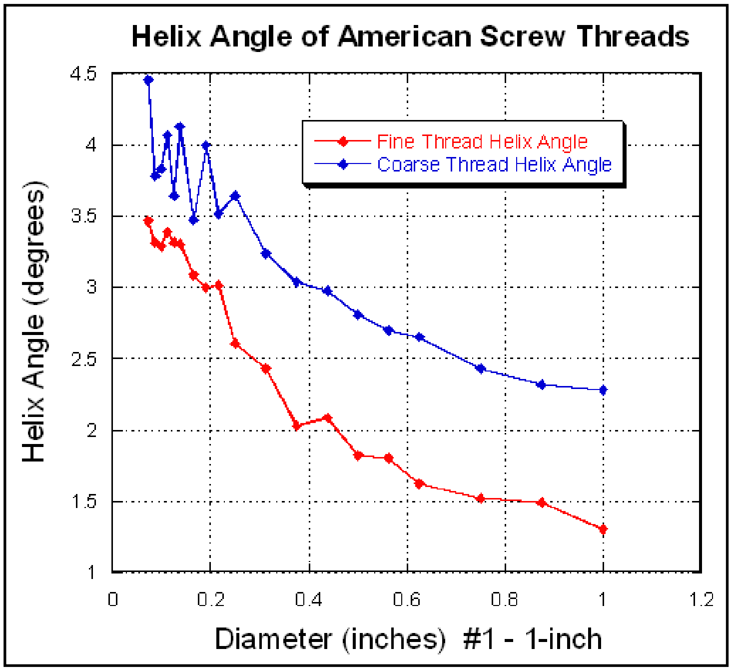
Now, let's get back to the tool bit. It must have sufficient flank clearance, as shown in the left illustration. In other words, the bit must not crowd the cut as it moves to the left and slices into the work. Insufficient clearance means that the face of the spiral cut just made bears against the bit's left flank, thereby preventing it from cutting further into the work. How much flank clearance is required? Certainly the bit's flank clearance angle **β** must be greater than the work's helix angle **Θ**, which itself depends on both the diameter **D** of the work and the feed per revolution **F**.

Flank Clearance $\beta > \Theta = \arctan(F / \pi D)$

Now, an unfortunate thing may happen when you take multiple passes to reduce the diameter of the work. When the feed remains constant, the above formula indicates that the helix angle **Θ** increases with each pass. At some reduced diameter the bit's flank clearance angle may no longer exceed the work's helix angle, so the bit crowds the work. The result is a poor, usually rough, surface finish. You may have run into this phenomenon as the diameter was reduced. After repeated passes, the finish went from good to poor, even though the bit remained keen. You may have even tried to hone the bit, but to no avail. What to do? As the work becomes smaller, reduce the feed **F** in proportion to its diameter **D** so that the ratio **F / D** is nearly constant (see right graph). This will keep the helix angle **Θ** constant and accommodate the flank clearance of your bit.



Generous flank clearance is required when you turn screw threads. How much is enough? The graph shows the helix angle or minimum amount of flank clearance required to produce American screw threads between #1 and 1-inch diameter. The maximum helix angle and hence the minimum flank clearance is 4.5-degrees. The usual recommended clearance of 5 to 7-degrees will easily accommodate all common American screw threads.



We provide flank clearance on a threading bit by grinding a relief angle perpendicular to the left face of the bit's 60-degree point. But, flank clearance is prescribed in the direction of travel along the lathe's axis and not relative to the bit's angled face. So what flank clearance angle **β** will results from grinding a relief angle **Δ** on the angled face of the threading bit?

$$\tan(\Delta) = \cos(30) \tan(\beta)$$

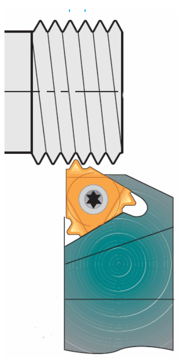
For small angles, the tangent of that angle is proportional to the angle itself. Hence, the relationship between the face relief and flank clearance angle becomes:

$$\Delta \approx 0.87\ \beta$$

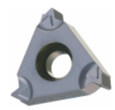
A relief angle **Δ,** ground on the left hand face of the threading bit, can be smaller than the thread's helix angle **Θ,** but not by much. As a rule of thumb, grind a relief angle Δ of 6-degrees on the leading face of a threading bit and you'll have a flank clearance angle **β** of about 7-degrees. That should accommodate all screw threads that you'll turn.

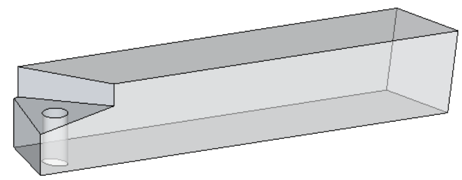
Threading B-Type Insert Tool Holder

By *Dick Kostelnicek*



The B-Type indexable, threading insert is convenient for turning screw threads in a lathe. No longer will you need to sharpen and maintain the thread form of your bit. When dull or broken, just index to a new point and you're ready to continue making threads. These inserts come in several profiles. Profile A-60 cuts 60 degree V-threads between 16-48 TPI (threads per inch) and G-60 cuts 8-14 TPI. They are also available in individual Unified thread sizes, where each insert cuts just one thread pitch between 8–32 TPI. As a bonus, they have a built in chip breaker, something that's difficult to grind on a single point threading bit while maintaining the thread's form.

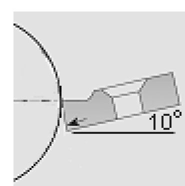


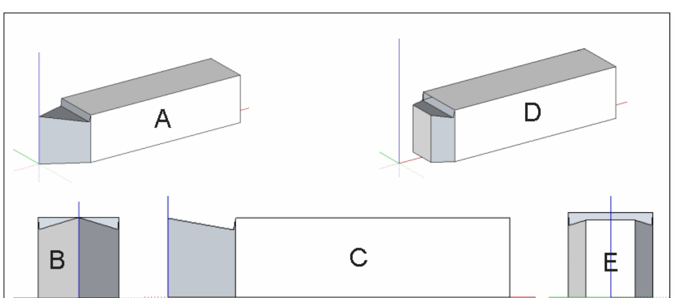


The tool holder for the B-Type insert is easy to machine. It takes just two passes of an end mill and one tapped hole to complete the job. However, the setup on a milling machine may challenge your geometrical skills. This article shows plans for the construction of a ½-inch square shank tool holder that carries a 3/8-inch IC (inscribed circle) insert for producing external right hand threads. Yes, these inserts are also made for left hand as well as both left and right hand internal threading. Unfortunately, each of the four styles of inserts requires a different tool holder.

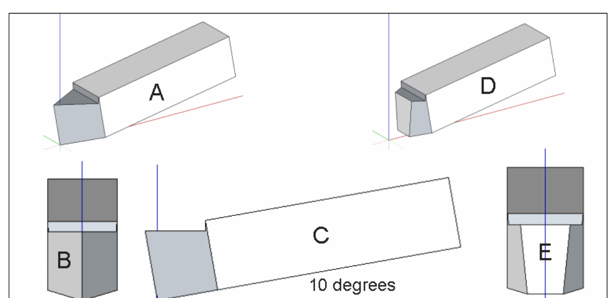
The insert's V-points are ground without side relief. Therefore, they can't be used to cut threads when mounted in the horizontal plane. The resulting lack of flank clearance would crowd the threads helix angle. A lack of side relief means that some of these inserts can be flipped over to use the opposite side of the points. When flipped, they are useful only for left hand external or right hand internal threading.

The insert must be tilted at an angle in the plane perpendicular to the work, usually 10-degrees for external and 15-degrees for internal threading (right drawing). When a bit is tilted 10-degrees, the zero side relief on the two faces of the 60-degree point generates a flank clearance of 5.72 degrees. This amount of flank clearance is sufficient to clear the helix angle of all common threads.





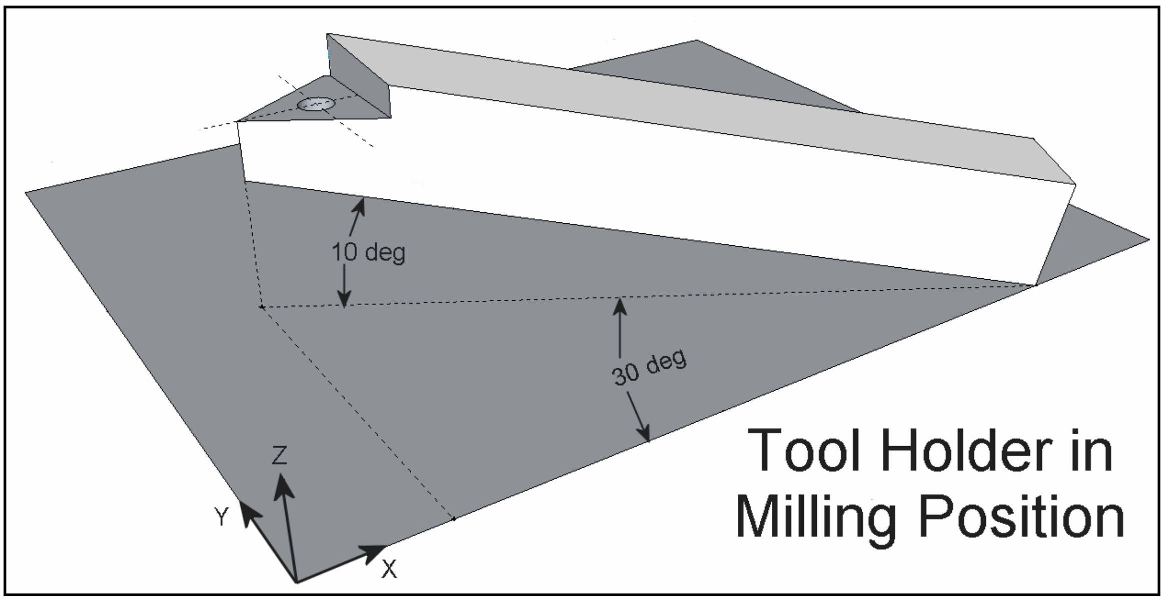
Bit without Side Relief and No Flank Clearance

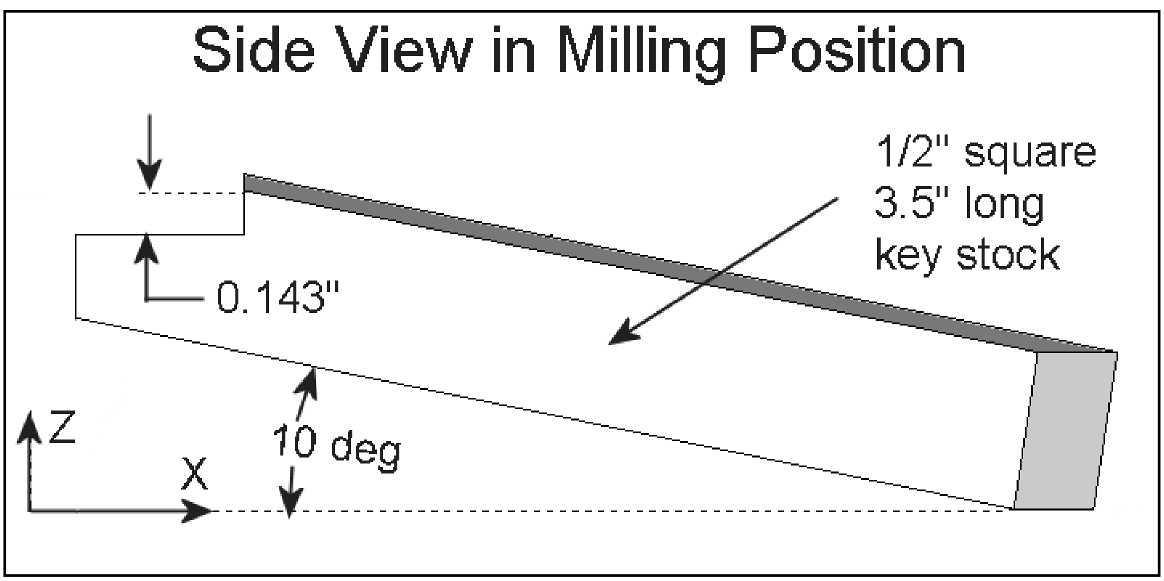


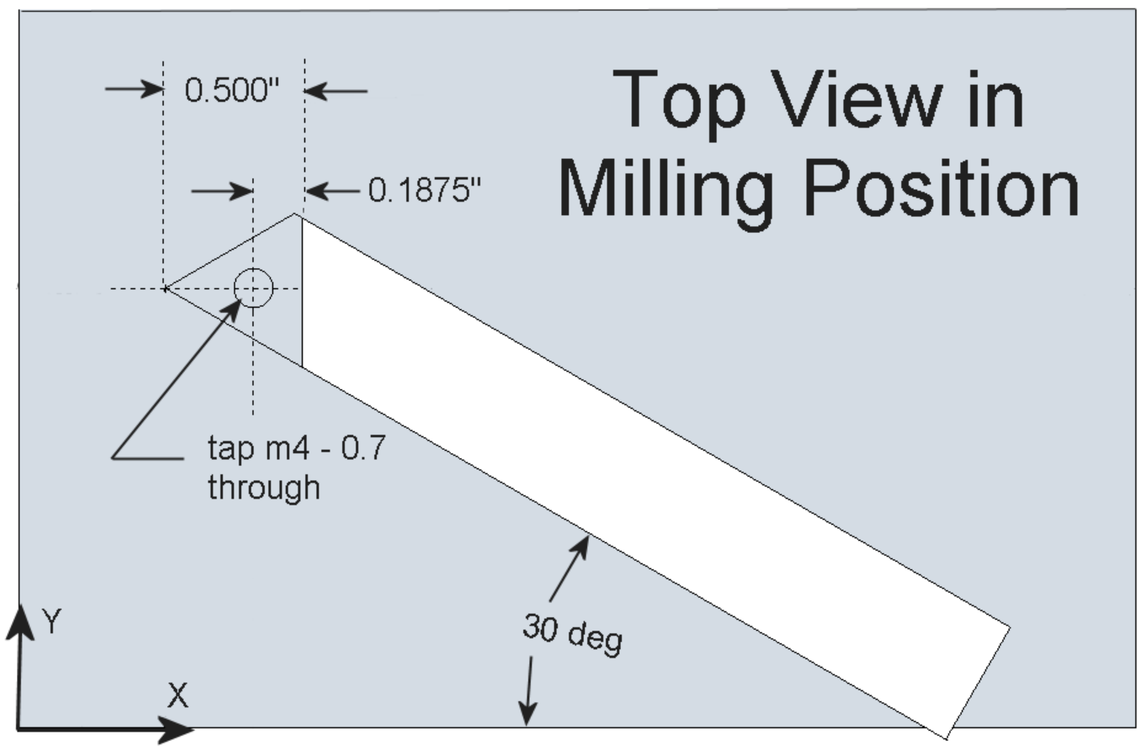
Bit Tipped 10-degrees Generates 5.72-degrees Flank Clearance

The above illustrations show how tilting a V-pointed bit with zero side relief produces flank clearance. The drawings labeled D and E show a section cut through the V-point in the vertical plane and the ensuing 5.72-degree flank clearance due to the 10-degree tilt.

The tool holder was made from a 3.5-inch length of ½-inch square key stock that was held in a vice tilted 10-degrees from the horizontal. The vice was then rotated 30 degrees clockwise and the top pocket that holds the B-type insert was cut with the end of a milling cutter. The vice was then rotated another 30 degrees and the sloped side of the tool holder's front face was milled with the side of the milling cutter. If the vice doesn't have a rotary base, use a 30-60 degree protractor along with the table's T-slot to align the vice. A through hole was drilled for the inserts hold down screw and tapped at M4-0.70. The hold down screw can be purchased from Wholesale Tool #1038-0205. Finally, the tool holder was Parkerized to inhibit corrosion.







Building an Ammeter to Indicate Load

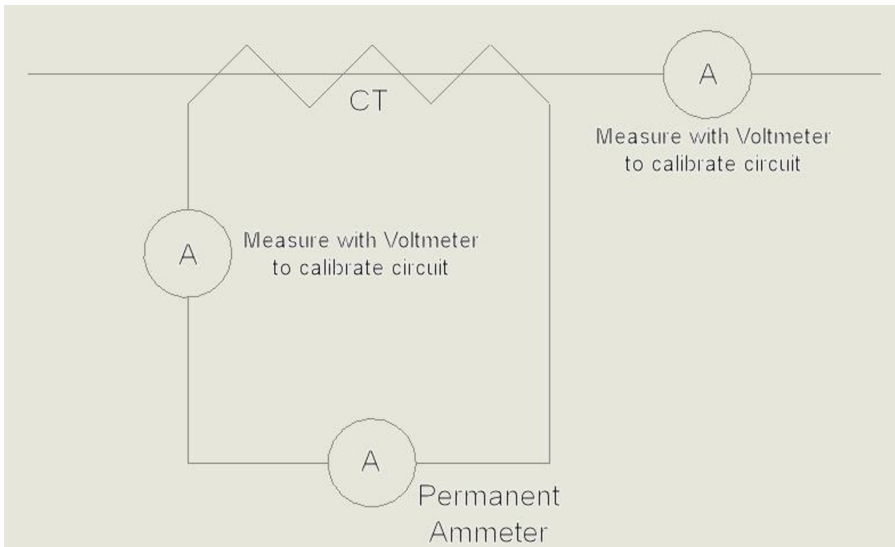
By *Martin Kennedy*

I have a CNC Mill and a surface grinder that run on 220V. I thought that it would be very useful to have an ammeter to show current while they were in operation. For the CNC Mill, it is difficult to have a feel for how hard the motor is working since the application of the load is controlled electronically by stepper motors. The only feedback you get if the feed and speed are too high is that you start to melt the mill. On the surface grinder, it's a little easier to get feedback. If you're grinding off way too much, the motor slows down. Still, it would be nice if I knew exactly how much current is drawn in order to get an idea of how hard the motors are working.

Some multi-meters (including mine) can measure current. I wanted a more permanent installation, so I wanted to use a stand-alone amp meter. Meters can be obtained that measure either AC or DC amps. For my application, I needed an AC meter. I could have purchased a meter rated for the appropriate current, but I wanted to use a surplus AC current meter that I believe came from a helicopter. The first thing that I had to do was to determine what current represented Full Scale or FS on the meter. Some meters are marked and say something like "5A FS", which means that they will show 100% on the meter at 5A. Mine was not marked. I guessed that it, like most meters, measured small current at the mA (0.001 amp) level.

To measure any appreciable current with this type of meter, you'll need a CT, or current transformer. A CT produces a reduced current in a secondary circuit, accurately in proportional to the current in the primary circuit. I had a few surplus current transformers, but again, they were not marked other than having numbers that I could not match on the internet. To figure out how my system worked, I set up a simple AC circuit. A CT measures current independent of the voltage. So to have a source of variable current that I could work with on my workbench, I used a hair dryer instead of using the mill or grinder. Hair driers, on their top setting, are huge loads. My dryer was rated for 1800 watts. Watts is equal to Volts x Amps, so at 110V, the dryer would use about 16A.

I ran just one of the two leads on the hair dryer through the CT. If you run both leads through a CT, they'll cancel out and the CT will not produce a signal. It's important to have the secondary winding of the CT connected to the ammeter or shorted out when you run current through it. CTs can produce high voltages on their outputs when not connected to a load or short circuit.
Here's the diagram of the circuit I used. My multi-meter can show mA and also up to 10 Amps when in current mode, so I temporarily put it at different places in the circuit to understand what was happening. I've labeled them in the circuit below.



Using this circuit, I determined that my meter was 10 mA FS, and my CT had a secondary-to-primary turns ratio of 10,000:1. In other words, if I ran 10,000 A through the CT, I'd generate 1 A on the secondary coil (and possibly burn up the CT, since I didn't know the maximum rating), and if I ran 100 A through the CT, I'd generate 10 mA on the secondary coil. Since I only wanted an indicative value for motor load, I've ignored the effect of the power factor (PF). Power factor is a way to quantify the amount that the current and the voltage are out of phase for AC loads. Watts = Volts * Amps * PF. In purely resistive loads, like the heating elements in the hair dryer, the power factor is 1. However, in electric motors, the power factor varies with load. Typical power factors for 1800 RPM electric motors up to 5 HP are 0.05 for no load, 0.53 for 25% load, 0.72 for 50% load, 0.81 for 75% load and 0.84 for full load. The effect of this on Amps is that although the Amps increase with load, they rise non-linearly with load.

Complicating this picture is the fact that my 2 HP motor is driven by a VFD (Variable Frequency Drive). VFDs have a near unity power factor, regardless of motor load. My 1 HP motor is driven by a Static Phase Converter, which consists of multiple capacitors. Capacitors help reduce the motor PF, but without measurement, I can't quantify how this reduces the PF variance from unity with load. I suspect that the net effect of these devices is to make the PF closer to unity, and remove some of the variance with load.

My mill has a 2HP motor, and my grinder has a 1HP motor. Watts = HP * 0.746. So 2HP is 1.5 kW, and at 220V, the 2HP motor should pull a maximum of about 7-8A, assuming a PF between 1 and 0.84. I decided that I wanted my meter to show 10 A at full scale. I knew from my calculations above that the meter connected to the CT would only show 1A full scale. This can be changed easily by looping the single 220V wire through the CT multiple times.

The main load goes through the hole in the center of the CT. The meter was connected between the two push-on terminals that are unconnected in the photos.


CT with 1 turn (primary coil)


CT with 3 turns (primary coil)

I made a spreadsheet to show the results:

Turns	10		Turns	FS Amp
Max	10.0	A	1	100.0
CT Ratio	10,000	:1	5	20.0
FS Meter	10	mA	10	10.0
			12	8.3
			13	7.7
			14	7.1
			15	6.7
			16	6.3
			17	5.9
			18	5.6
			19	5.3
			20	5.0

The formula to calculate the Max A is (FS Meter (in mA) / 1000) * CT Ratio / Turns
I selected 10 turns to get 10A full scale, which is a little more than I should get with a 2 HP motor.
I made a custom plate to house the meter and two 220V receptacles. The meter works great, and has proved to be useful in showing how hard my machines are working. You could build a similar circuit for any 110V equipment you have, but remember the currents will be twice as high for a given motor HP.