

UNI Turn & UNIMill

The cool tool



3" LATHE THREAD CUTTING ATTACHMENT

P/N 3100

AN INTRODUCTION TO THREAD CUTTING IN THE REAL WORLD

After designing and putting the enclosed screw cutting attachment into production, we sat down and started reading what other people have written about cutting screw threads before writing our own instructions. It amazed us that we had been able to cut threads all these years knowing so little. How and why we were able to do this is going to be the subject of our instructions. There are sufficient books available at any library to go into additional detail on the subject if required. These instructions are based on using sharp pointed 60° tools and cutting threads for your own use.

The reason other books go into such great detail on the precise methods used commercially is that they are telling you how to cut threads from specifications for other people. They have to have exact methods and standards to make sure that a bolt made in California will screw into a nut manufactured in New York. Fortunately, we have the tremendous advantage of having both pieces at hand and we can just "keep cutting until they fit". It's as simple as that! You simply select the proper gear from the chart; put in a 60° threading tool and have at it.

A point to ponder about thread cutting is how a lathe produces a thread. It doesn't matter whether the lathe is a 20" or a 3". The principle is the same. The lead screw that drives the saddle is geared directly to the spindle. When the spindle turns, the saddle moves. If they were geared one to one, the pitch cut would be the same as the pitch of the lead screw. On the 3" lathe, this would be 20 Threads Per Inch (TPI). If we turned the lead screw 180° while we turned the spindle 360° (by using a 20 tooth to a 40 tooth gear arrangement) we would cut 40 TPI. Please note that we did not have to consider the stock's diameter. The only requirement is that the major diameter is at least twice the depth of the thread plus enough material to support these threads while cutting them. One gets used to hearing a diameter called out with the threads, such as 1/4" - 20, 6 - 32, 10 - 24, etcetra, but while it's unusual to think of 40 threads per inch cut on something 2" in diameter. Yet, in some cases it may be entirely practicable to do so.

It may interest you to know how a metric thread can be cut

on a 3" lathe that has American National screw threads on its lead screw. The 127 T conversion gear does this by driving the lead screw at a ratio that converts 20 TPI to 1mm. Consider 100T on the spindle driving a 127T. The ratio is .7874 to 1. The lead screw has 20 TPI: $.050" P \times .7874 = .03937" = 1 \text{ mm}$.

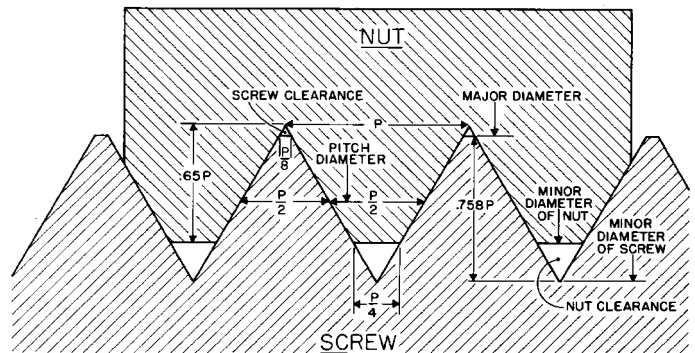


Figure 1—Component parts of a thread cut with a sharp pointed 60° vee tool.

- MAJOR DIAMETER - Largest diameter of the thread of either the screw or the nut.
- MINOR DIAMETER - Smallest diameter of the thread of either the screw or the nut.
- PITCH DIAMETER - The theoretical diameter that falls on a point where the thread width and the groove width are the same.
- PITCH (P) - The distance from point to point measured parallel to the axis. Metric threads are always expressed in Pitch
- LEAD - The distance a screw thread advances axially in one turn. On a double lead screw, the lead is twice the pitch.

NOTE: The same methods can be used in figuring dimensions for American or Metric screw threads.

$$1 \text{ mm} = .03937"$$

Pitch (Metric) $\times .03937" \times .758 =$ depth of screw thread in inches

Take the time to familiarize yourself with component parts of the screw thread from Figure 1. The pitch diameter is the important one to consider. Before going on, let's take the time to really understand why. The pitch diameter determines

how a screw or thread will fit, not the major diameter. Suppose you were cutting 20 TPI and the major diameter was .010 undersize and the pitch diameter was correct. About the only thing wrong would be that the flat on the point of the thread would be a little wide, but it would still have approximately 75 % of its strength and work well.

Now let us suppose we cut the pitch diameter undersize by .010. We would end up with a nut that fits so loose and a thread that was so weak that we would have to scrap it. There is where "cutting to fit" comes in. You can compensate for some pretty bad errors on the major and minor diameters by having the pitch diameter correct. To get it correct, all you have to do is to keep trying it for size as you cut. Don't ever take the part out of the chuck to try it because it would be next to impossible to re-chuck it in exactly the same place. However, the entire chuck, along with the part, could be removed from the lathe to try it for size. Don't force anything when trying the part for size, because you might move the part slightly in the chuck, and really "screw things up".

Why have we made such a point about having the major or minor diameter wrong and still making the part work? Read on. You're probably thinking we must really be a "hacker" if we can't cut a diameter within .010. Well, the problem in many cases, is not how close you can cut to a diameter, but what the diameter should be.

Example: Your buddy just heard you bought a nice new shiny lathe complete with a screw cutting attachment, and like all good friends, immediately goes to work trying to figure out how you and your new lathe will be of some use to him. It doesn't take him long! He has a camera which he tried to repair himself last year, but lost an important part. Of course the missing part has metric threads, but that's a "snap" for a 3" lathe. A quick check with a thread gauge indicates that it has .4 mm Pitch. No problem, yet. It is an internal thread, so you will have to cut a screw to mate with it. Here's the problem: What is the major diameter? You can measure the diameter of the hole, but you can't be assured that the thread form is perfect and that this is really the minor diameter. You can only assume that it's close. Now you take this dimension and add to it twice the depth of the thread, which should give you the major diameter. To get the depth of one thread, multiply the Pitch x .6. (Note: Pitch x 1.2 + Minor Diameter = Major Diameter). Total depth of thread using a sharp pointed 60° tool = $P \times .65 = .036" \times .65 = .023"$.

The constant .6 is not used to figure depth of an external thread, it is just one used to get you in the "ball park" in a situation such as this.

At least we have a fairly reliable place to start now and can probably get one cut that will work on the first try. Always keep track of the total depth cut in case it comes out undersized. At least you'll know how deep not to cut it on the second one!

The example we gave you was one of the more difficult situations you may run into, not only because you had to do the job for free to keep a friend, but also because you had very limited information from which to work.

Usually, you will be cutting both the screw and nut. This is a case where two wrongs can almost equal one right. You can rectify any error you may have had in cutting the first one by compensating for it in the mating part.

Left-hand threads can be cut as easily as right-hand threads on a lathe; the only difference being the addition of an idler gear which reverses tool movement so that it travels left to right.

It's hard to appreciate just how much money an inexpensive lathe like this, with a screw cutting attachment can save you, until you have had to have a special part made that doesn't have a standard thread size. Even though there may be taps or dies available, a left-hand 1"-32 would probably cost half as much as your entire thread cutting attachment.

What we have tried to do in these opening remarks is to show that screw-cutting is really easy, and to give you the self-confidence it takes to do any job well. Too often, good craftsmen are stopped from venturing forth because the only information available shows the technically perfect way to do things rather than the simple, practical methods everyone really uses.

THREAD CUTTING CONVERSION KIT

This kit has been engineered to add additional versatility to your 3" Lathe. With this attachment, a wide variety of threads, both right-handed and left-handed may be produced. Most American Standard and Metric threads may be cut with equal ease and precision. The accompanying charts list the entire range from which you may choose. (See *Figure 5.*)

CONVERSION INSTRUCTIONS (Refer also to illustrations)

- STEP 1. Carefully drive furnished small sheet metal screw into hole located in spindle which extends from the left side of the drive pulleys. Use a proper size screwdriver for this operation and avoid installing the screw at an angle since it must seat squarely against the spindle. After driving, remove the screw and dress down the "burr" which will be raised around the edge of the hole. A small fine file is suitable for this. Next slide two thin spacer washers over the tube and against the pulley. Reinsert the sheet metal screw and tighten firmly.
- STEP 2. Remove the headstock and loosen the flat head socket screw a few turns.
- STEP 3. Remove cap screw under base and directly below headstock.
- STEP 4. Grease shaft with flats on both ends and slide shaft into the lead screw support (situated directly below pulley). Be sure end with small flat enters first. Now slide shaft with a single flat into the lead screw support. To guarantee that the shaft is "home", turn shaft one or two revolutions while applying gentle inward pressure to the end of the shaft.
- STEP 5. Replace screw from STEP 3 making sure that

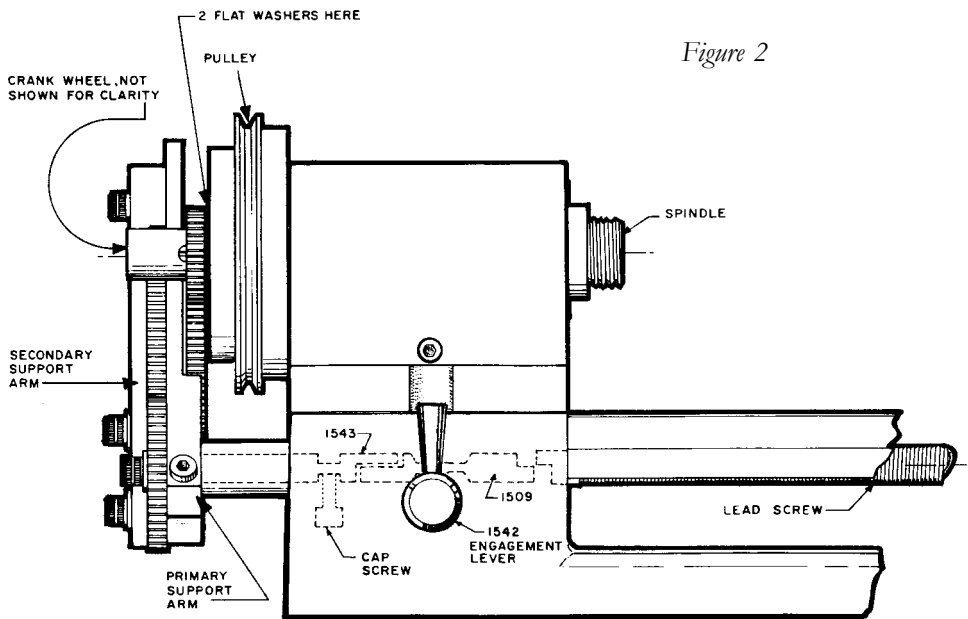


Figure 2

SIDE VIEW, THREAD CUTTING ATTACHMENT INSTALLED

point of screw goes into machined groove. Check that shaft is free to rotate. Retighten the flat head socket screw and replace the headstock.

STEP 6. Pull out the black plug below the name plate and slide the remaining shaft (with handle) into the hole (handle upward). It may be necessary to rotate the shaft about 30° backwards and forwards to get it completely “home”.

NOTE: If insertion or movement of the Engagement Lever is difficult, try loosening the two screws on the bottom of the machine that hold the bed to the base. Move the bed slightly until a good fit occurs.

STEP 7. It may be necessary to deburr parts for smooth operation.

NOTE: The section below entitled "Cutting A Thread for Practice" uses the example of cutting a 28 pitch right hand thread on a 1/4" diameter piece of stock. The following numbers are based on that setup.

STEP 8. Refer to chart (Figure 5) and select type of thread to be cut. As an example, we have chosen American Standard, 28 TPI, right hand lead.

Figure 3

Setup for cutting 28 Threads Per Inch

GEAR	A	B	C	D	E
TEETH	100	100	20	28	40

NOTE: Idler Gear "E" is used for Right Hand Threads, Idler Gears "F" and "G" are used for Left Hand Threads and are, therefore, not used in this example.

Remove motor assembly (see OPERATING INSTRUCTIONS STEP 2).

Slide gear “A” (100) onto spindle engaging slot with previously installed sheet metal screw head.

Install “B” gear (100) and “C” gear (20) onto primary support arm. The drive pin is used not only to drive the “C” gear, but also to hold the “B” gear on the arm.

Install “E” gear (40) on secondary support arm.

Slide lower split end of primary support arm over the lead screw support. Adjust until “B” gear meshes properly with “A” gear (100). When mesh is satisfactory, tighten clamp screw.

Install “D” gear (28) and secure with Allen head screw and small washer. NOTE: This screw need only be finger tight and should not be used when it interferes with the secondary support arm. Adjust secondary support arm and gear for proper engagement with mating

gears. When satisfactory, tighten retaining screw and pivot screw.

Install crank wheel by sliding over spindle.

Line slot up with protruding sheet metal screw head and tighten down crank wheel set screw using Allen wrench. A few drops of oil on moving parts will be helpful.

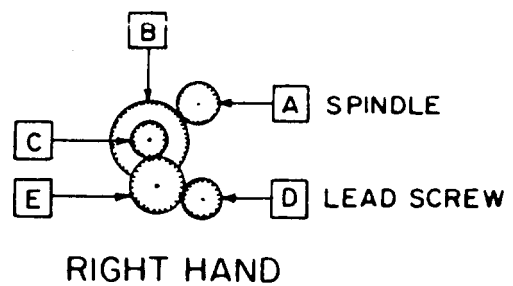


Figure 4 Gear Setup Diagram for Example

CUTTING A THREAD FOR PRACTICE

We believe the time has come to “HAVE AT IT” and start by chucking up a piece of aluminum and turning it to 1/4" diameter. Let's cut 28 TPI on it. Be sure to have a nut to check it with. Looking at the chart we see we need an “A” 100T on the spindle, driving a “B” 100T, which is attached to the “C” 20T, driving the lead screw “D” 28T, using the idler “E” 40T that mounts on the swing arm. The gears should mesh so they run “free” and have a reasonable amount of backlash. NOTE: All gear trains have some “backlash” and it will not effect the quality of the thread, but it does have to be allowed for. This is why the tool has to be backed out before the lathe spindle is reversed.

Over 90% of the threads cut on a lathe of this type will have

a pitch less the .070, and be less than 3/8" long. Now and then you may have to cut a fairly course thread (more than .070" pitch) and a good idea is to "rough out" the thread by moving the tool post slightly to the left between passes. This keeps the tool from having to cut on both sides. On a standard lathe, the tool is advanced by the compound rest which is set at 29°. This allows only one side of the tool to cut and lessens the load considerably. The final cut is then taken with the crossslide being advanced to "clean up" the thread. We can get the same effect by moving the tool post. When cutting fine threads you can get away with cutting "straight in". The crank drive gives you the "feel" and a precise method of stopping needed in single-pointing fine threads. Cranking the spindle counter clock wise gives you reverse. This allows you to cut the entire thread without disengaging the lead screw.

Establish the depth of the first cut by bringing the tool in to the point where it just touches the surface. Write the dial setting down, and move the tool past the starting point of the thread. Now engage the lead screw lever. The lead screw may have to be turned while applying slight pressure on the lever in order to get it to engage properly.

DO NOT DISENGAGE UNTIL THE THREAD HAS BEEN COMPLETELY CUT.

Now advance tool .003" for first cut. Turn the spindle counter clockwise until the desired length of thread has been cut. Back the tool out until it is completely clear of the part. Crank spindle clockwise until tool is at the original starting point. Advance the tool to its last point plus .002". We've always found it useful to write these dial settings down too, it is amazing how fast you can forget one! Now take the second pass by cranking the spindle counter clockwise. The amount the tool should be advanced from this point on should be governed by the amount of force it took the last pass. The cut will get progressively heavier each time the tool is advanced. Remember, you can't ruin your part by taking too light a cut. To figure what the total amount the tool should be advanced if you are using a sharp Vee form tool (standard form of tool used in single pointing threads) simply multiply the pitch times .758.

Example: Pitch of 28 TPI = 1/28

Pointed tool depth = $P \times .758 = 1/28 \times .758 = .027$

If you are not too good with math and don't like to do it, just keep cutting and looking at the flat on the top of the thread. When the flat is 1/8 the pitch, the nut should fit. Either way, check it long before you think it is finished to be on the safe side until more experience is gained. The last two passes should be repeats of previous dial settings to clean up threads. Not too hard was it? No matter what type of threads you may cut, the basic method will remain the same. Internal threads are very seldom cut full depth. To figure the hole size you should start with: take the pitch of thread you are cutting and multiply it by 1.083 and subtract this from the major diameter. To figure the total depth using a sharp pointed 60° tool, multiply the pitch by .65.

EXAMPLE: To cut an internal 1-1/2"-28 TPI:

Major Diameter = 1.5

$P = 1/28 = .036"$

Major Diameter - $(P \times 1.083) = \text{Hole Size}$

$1.500" - (.036" \times 1.083) = \text{Hole Size}$

$1.500" - .039 = 1.461$

Hole size = 1.461

A double lead could be cut by picking change gears that are one-half the pitch and indexing the "A" gear 180° after cutting the first thread to depth.

NOTE: There isn't any way to check a double lead until it is completely cut, therefore, the depth must be figured mathematically. It has always been fun for us to do jobs like this, not because they were needed, but just to see if we could!

SCREW CUTTING OPERATION

(Read detailed instructions before proceeding.)

- STEP 1. Turn or bore stock to proper diameter.
- STEP 2. Remove the motor assembly from the lathe by unscrewing the two socket head cap screws that hold the motor bracket to the headstock.
- STEP 3. Install thread cutting tool in post holder.
- STEP 4. Place tool bit at starting point of thread and set for .003" cut.
- STEP 5. Engage lever at base of lathe by turning lead screw support handle clockwise. Turn lead screw handwheel until full engagement occurs.
- STEP 6. Turn spindle crank wheel until tool bit has traveled full length of intended thread.
- STEP 7. Back crossslide out to clear tool from thread.
- STEP 8. Turn crank wheel backwards until tool bit has traveled past starting point of thread.
- STEP 9. Return crossslide to its original position plus .002".
- STEP 10. Repeat STEPS 6, 7, 8, and 9 until full depth of threads has been cut. Cutting oil will make cutting easier, and will give a better finish.

FIGURE 5—GEAR SELECTION CHART FOR THREAD CUTTING ATTACHMENT

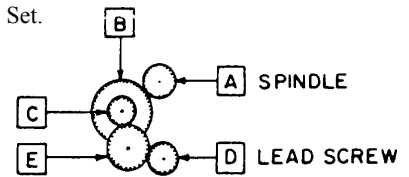
ENGLISH THREADS

THREADS PER IN.	GEAR A	GEAR B	GEAR C	GEAR D	GEAR E	GEAR F	GEAR G
80	50	100	20	40	38	28	22
76	50	100	20	38	40	30	22
72	50	100	20	36	40	28	34
68	50	100	20	34	40	28	30
64	50	100	20	32	40	28	30
60	50	100	20	30	40	28	26
56	50	100	20	28	40	26	30
52	50	100	20	26	40	24	34
48	50	100	20	24	40	26	30
44	50	100	20	22	40	26	30
40	100	100	20	40	38	28	22
38	100	100	20	38	40	30	22
36	100	100	20	36	40	28	34
34	100	100	20	34	40	28	30
32	100	100	20	32	40	28	30
30	100	100	20	30	40	28	26
28	100	100	20	28	40	26	30
26	100	100	20	26	40	24	30
24	100	100	20	24	40	26	30
22	100	100	20	22	40	26	30
20	100	100	20	20	40	26	24
19R	100	100	40	38	30		
19L	100	50	20	38		30	22
18R	100	100	40	36	30		
18L	100	50	20	36		28	34
17R	100	100	40	34	30		
17L	100	50	20	34		28	30
16R	100	100	40	32	30		
16L	100	50	20	32		28	30
15R	100	100	40	30	32		
15L	100	50	20	30		28	26
14R	100	100	40	28	30		
14L	100	50	20	28		26	30
13R	100	100	40	26	30		
13L	100	50	20	26		24	30
12R	100	100	40	24	30		
12L	100	50	20	24		26	30
11R	100	100	40	22	30		
11L	100	50	20	22		26	30
10R	100	100	40	20	30		
10L	100	50	20	20		26	24

METRIC THREADS

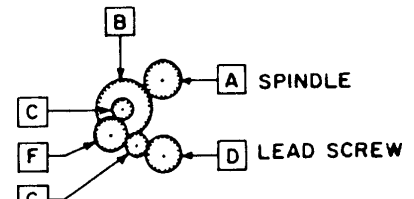
PITCH (mm)	GEAR A	GEAR B	GEAR C	GEAR D	GEAR E	GEAR F	GEAR G
.25	50	127	20	40	30	28	22
.3	50	127	24	40	30	26	22
.35	50	127	28	40	30	26	22
.4	50	127	32	40	30	24	22
.45	50	127	36	40	30	20	22
.5	100	127	20	40	30	28	22
.55	100	127	22	40	30	28	20
.6	100	127	24	40	30	28	22
.65	100	127	26	40	30	28	22
.7	100	127	28	40	30	26	22
.75	100	127	30	40	28	24	22
.8	100	127	32	40	30	24	22
.85	100	127	34	40	30	20	22
.9	100	127	36	40	30	20	22
1.R	50	127	40	20	30		
1.L	100	127	20	20		26	24
1.1	100	127	22	20	40	24	26
1.2	100	127	24	20	40	22	26
1.25	100	127	30	24	38	22	26
1.3	100	127	26	20	40	22	24
1.4	100	127	28	20	38	22	24
1.5	100	127	30	20	38	20	26
1.6	100	127	32	20	38	20	26
1.7	100	127	34	20	38	20	22
1.75	100	127	35*	20	38	20	22
1.8	100	127	36	20	38		
1.9	100	127	38	20	36		
2.0	100	127	40	20	30		

* Not included in Standard Set.



RIGHT HAND

NOTE: Gear "E" or "F" and "G" are idler gears and are used to transmit power and control direction of rotation only.



LEFT HAND

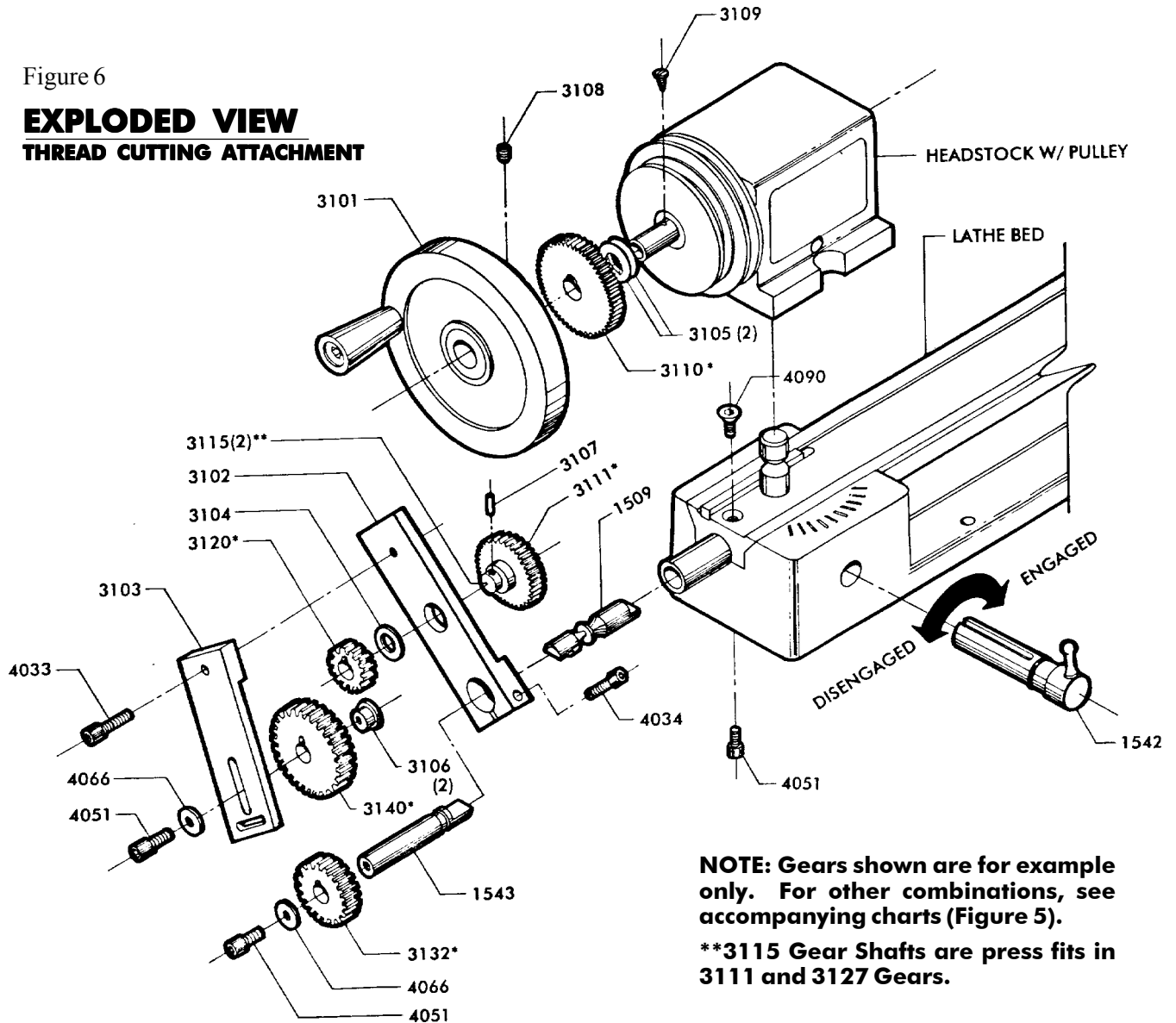
NOTE

When cutting right hand threads, Gear "E" is used in the vertical slot of the Secondary Support Arm, Part Number 3103. When cutting left hand threads, Gear "F" is used in the vertical slot and Gear "G" is used in the horizontal slot and Gear "E" is not used.

To use this chart with the model 4100 (Metric) Lathe, use the 100 tooth gear in place of the 127 tooth gear when cutting metric threads and the 127 tooth gear in place of the 100 tooth ("A" Gear) when cutting American threads. Press the shaft out of the 127 tooth gear and into the 100 tooth gear. American threads finer than 40 TPI cannot be cut.

Figure 6

**EXPLODED VIEW
THREAD CUTTING ATTACHMENT**



NOTE: Gears shown are for example only. For other combinations, see accompanying charts (Figure 5).
****3115 Gear Shafts are press fits in 3111 and 3127 Gears.**

PARTS LIST, THREAD CUTTING ATTACHMENT

PART NO.	DESCRIPTION	PART NO.	DESCRIPTION
3101	HANDWHEEL	3120	20 TOOTH GEAR, 24 PITCH
3102	PRIMARY SUPPORT ARM	3122	22 TOOTH GEAR, 24 PITCH
3103	SECONDARY SUPPORT ARM	3124	24 TOOTH GEAR, 24 PITCH
3104	SMALL SHIM WASHER	3126	26 TOOTH GEAR, 24 PITCH
3105	LARGE SHIM WASHER (2)	3127	127 TOOTH GEAR, 56 PITCH
3106	GEAR BUSHING (2)	3128	28 TOOTH GEAR, 24 PITCH
3107	GEAR DRIVE PIN	3130	30 TOOTH GEAR, 24 PITCH
3108	10/32 x 3/8" SET SCREW	3132	32 TOOTH GEAR, 24 PITCH
3109	SHEET METAL SCREW, PAN HEAD, NO. 6 x 3/16", TYPE A	3134	34 TOOTH GEAR, 24 PITCH
3110	100 TOOTH GEAR, 56 PITCH (w/ notch)	3136	36 TOOTH GEAR, 24 PITCH
3111	100 TOOTH GEAR, 56 PITCH	3138	38 TOOTH GEAR, 24 PITCH
4034	10-32 x 1" SKT HD CAP SCREW	3140	40 TOOTH GEAR, 24 PITCH
4051	10-32 x 3/8" SKT HD CAP SCREW (3)	3150	50 TOOTH GEAR, 56 PITCH
4033	10-32 x 5/8" SKT HD CAP SCREW	1509	SLIDING SHAFT
4066	NO. 10 WASHER	1542	ENGAGEMENT LEVER
3115	GEAR SHAFT (2)	1543	FIXED SHAFT