

## Tip 38 — A Permanently Mounted Thread-Cutting Gearbox/Jim Knighton

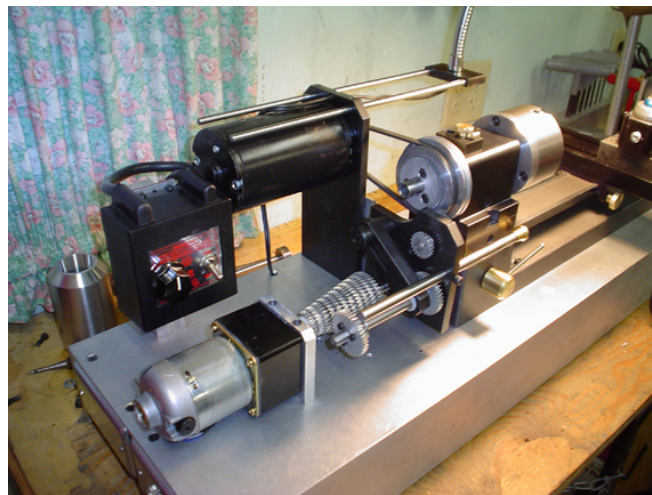
### Background

The screw-threading gearbox requires parts from the standard Sherline P/N 3100 threading attachment. The gear selection is for the most part as per the threading chart that accompanies it. The design of the gearbox places all eleven of the 24 pitch gears from the Sherline kit on the main shaft. This makes it impossible to use those gears elsewhere in the gear train, so a few “extras” are necessary. As built, this gearbox requires one each extra 20, 22, and 40 tooth gears and two 35 tooth gears. Their usage and placement is described in the following discussion.

The gearbox was built in two versions, the first being a prototype and the second as shown in these photos. One of the significant lessons learned from the prototype is that aluminum is not a good choice for the large parts. There is too much flex and twist, enough so as to potentially prevent the gearbox from operating appropriately. In the final version all of the large parts are machined from mild steel, either 1018 CRS or 12L14.

The prototype also made use of bronze bushings instead of the ball bearings used in the final version. Bronze bushings did not provide the solid support needed, especially in the idler arm assembly. I strongly urge caution if prospective users are inclined to go this route. The combination of bronze bushings and aluminum construction proved to be fatal, rendering the prototype unfit for serious use. It did, however, demonstrate the validity of the design and the feasibility of going forward with this project. The results are shown hereafter.

### Gearbox 01 – Final Installation



This photo illustrates the final gearbox installation with all attendant modifications. It is clearly evident that the main motor and controller are not in their Sherline standard locations. This is the result of previous modifications described on the Sherline web site, Item #20 in the Sherline Workshop page. I didn't have a digital camera at the time that document was put together and I apologize in advance for the poor photography. This photo shows a slightly different setup than illustrated in that document in that the pillow block style motor mount shown there and also visible in some of these photos has been replaced with the one shown here. This was done because the pillow block motor mount blocked the movement of the gearbox's idler arm making adjustment difficult in certain situations.

Please note that the relocation of the motor and controller are not essential to the construction or operation of the gearbox. However, these modifications open up considerable space around the headstock making it much easier to see what is going on and to make idler arm adjustments.

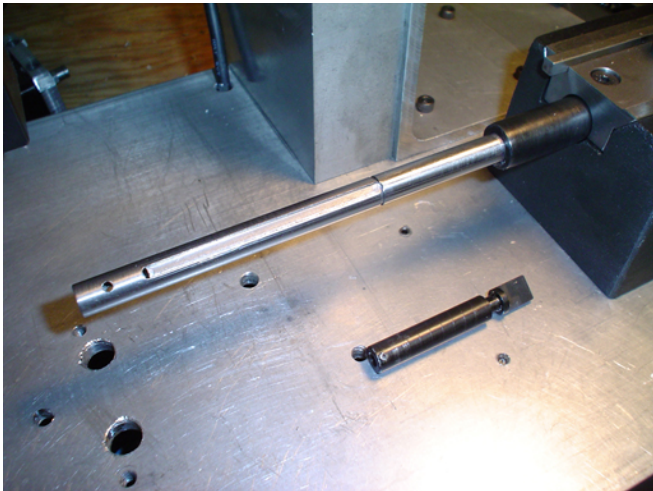
The motor mount is constructed of 3/8" x 3.5" x 7.625" mild steel (1018 CRS). Unlike the earlier

pillow block mount with its 3" diameter hole, the largest hole in this steel plate is 3/8" to provide clearance for the main motor's spindle shaft. It can be machined in its entirety on a Sherline mill. Not clearly visible in this photo is the 4" wide section of 1/4" aluminum angle on the backside. This has a couple of slots that permit the motor mount to be shifted fore and aft for adjusting belt tension. The belt is a Singer sewing machine part.

Also, as noted in the aforementioned document describing earlier modifications, the auxiliary power supply (24vdc) is mounted underneath the prominent aluminum channel I use as a base and the controls are located on the left end. In addition to the document noted above, better and clearer photos of the power supply and controls are located in the Yahoo Sherline User's forum in the files section in a folder bearing my name.

The following sequence of photos presents the final gearbox assembly along with construction notes as appropriate.

**Gearbox 02 - Main Shaft**

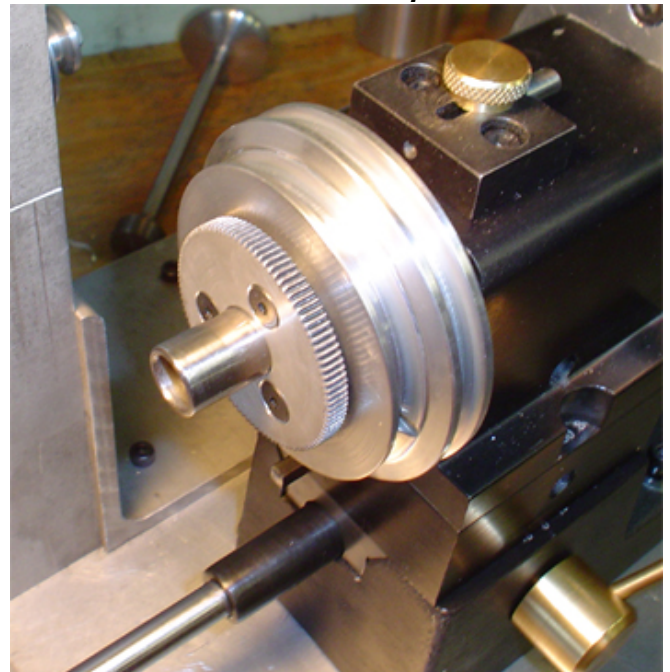


The main shaft for the gearbox is shown in this photo. It is a functional replacement for the Sherline fixed shaft, PN 15430, included with the Sherline threading kit (shown in the foreground). It is machined on the right end to exactly duplicate the flat and groove of the Sherline part. The photo also shows the narrow groove for a retaining ring (snap ring), a shallow (.050") channel for a 1/8" square key, and at the left end the details for affixing the shaft to the drive motor.

My drive motor has a .312" spindle and the main shaft is .375" diameter. The left end of the main shaft was drilled and reamed to .312" and the small hole shown in the photo is for a pin that locks this shaft and the motor's spindle together.

There is a notable idiosyncrasy regarding this shaft and the operation of the feed engagement lever that I discovered when testing the prototype gearbox. The lever can be rotated too far to the left (off position) pushing the shaft approx .050" - .070" too far out of the support tube. The standard Sherline part, being short and light, has a propensity to move back into it's proper position. The longer and heavier replacement has to be "persuaded" to return to that position. If it is not, the engagement lever will jam the next time the operator attempts to use it. The solution to this problem is to make sure that the feed motor is positioned so that this leftward movement is blocked, thus preventing the over-rotation. This is an important consideration and failure to do this can have serious and unpleasant consequences, as I discovered to my chagrin with the prototype gearbox.

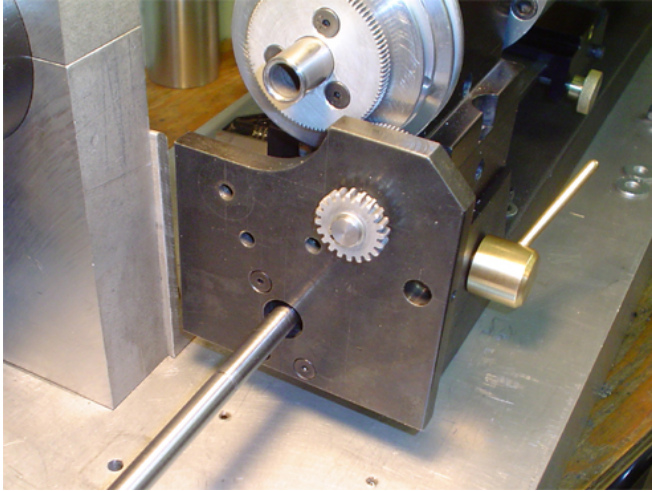
**Gearbox 03 – Pulley Gear**



As seen in the photo, the 100 tooth 56 pitch "A" gear is permanently attached to the pulley. Not visible is a 1/16" thick, wide nylon washer that acts as a spacer. This is the only non-reversible

modification to the lathe itself and is in fact not an essential feature. Rather than the permanent mounting shown here, the gear can be driven by the small screw Sherline supplies for that purpose in the threading kit. If this approach is used, a small retaining collar with a setscrew should be added to lock the gear into position.

#### **Gearbox 04 – Gear Mounting Plate**



The gear mounting plate is machined from mild steel and then blued. The bluing provides a nice color match with the rest of the lathe but it is in fact to eliminate the problem of surface rust that will form over time if the steel is left unfinished. Not visible in the photo is a clamping block on the backside. The clamping block is machined from aluminum and uses a SHCS to close the fixture and securely lock the plate into position on the “leadscrew support shaft” visible in the previous photo.

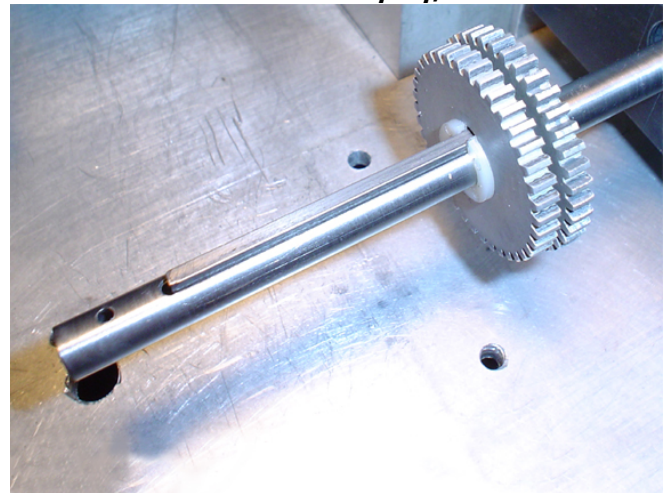
The gear mounting plate has three  $\frac{1}{4}$  x 20 tpi threaded holes – the two on the left provide alternate mounting positions for the idler arm, and the one close to the small “C” gear is for mounting an extra idler gear for cutting left-handed threads. More on this later. The camera angle distorts the apparent location of this threaded hole.

The 100 tooth 56 pitch “B” gear isn’t visible in this photo, but it is mounted on the backside of the plate on the same shaft as is the 20 tooth “C” gear. This shaft is supported by and rides in two  $\frac{3}{8}$ " ID ball bearings pressed into a appropriately sized hole in the mounting plate itself.

The large cutout at the upper left is an adaptation that allows easy access to the drive belt. When the mounting plate is rotated to the right, the cutout allows me to remove and replace the drive belt without difficulty. Prospective builders with the drive motor in the “normal” position will have to work out their own accommodations to resolve this issue.

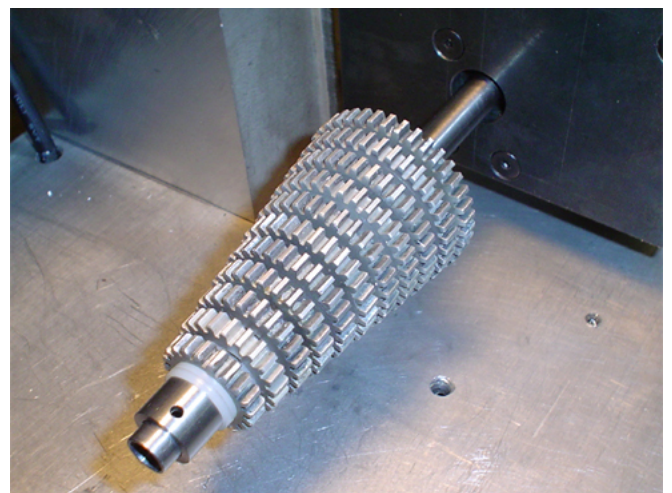
The hole located close to the right edge of the plate is for the cross slide travel stop and not essential to the operation of the gearbox. More on this later.

#### **Gearbox 05 – Keyway, etc.**



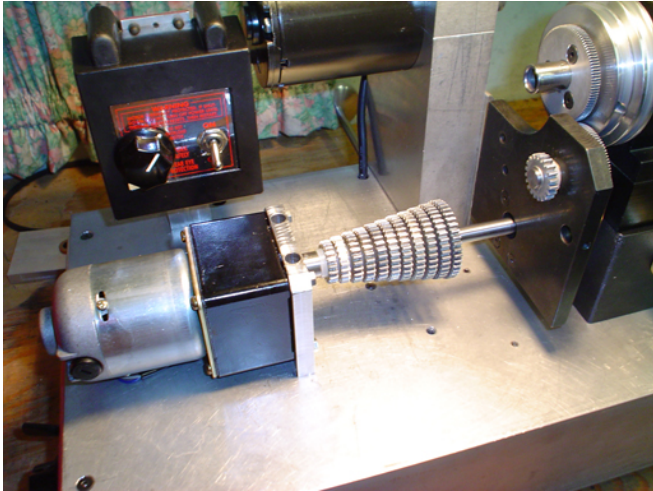
In this photo the gears are being stacked on the main shaft. Visible are the gears themselves, the nylon washers used as spacers (notched to fit around the  $\frac{1}{8}$ " square key mounted in it’s mating slot). Not visible is the retaining ring (snap ring) that limits rightward movement of the gear cone.

#### **Gearbox 06 – Main Shaft Gear Cone**



This photo shows the fully assembled gear cone as well as the retainer collar. The retaining collar is drilled to match the pin holes in the shaft itself and also in the feed motor spindle. Nylon washers (not slotted) are used here as spacers.

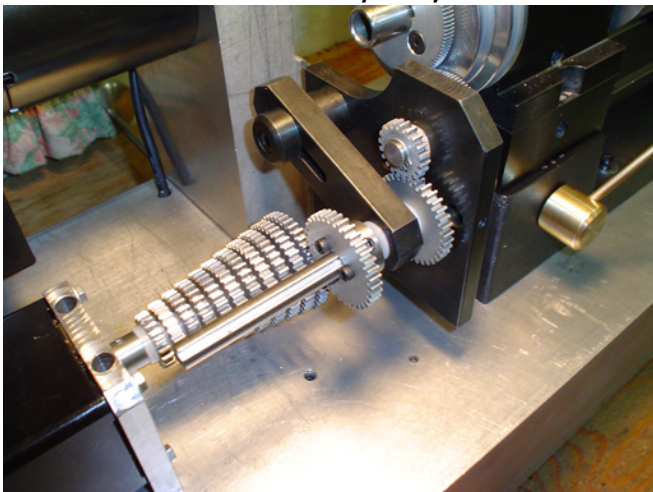
#### **Gearbox 07 – Feed Motor**



The feed motor shown in the photo is a Japan Servo gear motor rated at 35.8 RPM at 24vdc. It is reversible and as installed is driven by a simple power supply with three speed settings, 24vdc, 16vdc and 8vdc. The details of the power supply are in the aforementioned document on the Sherline Workshop page, item #20.

Prospective builders will have to build a mount and power supply to match the motor they select.

#### **Gearbox 08 – Idler Arm, Shaft, and Gears**



In this photo the idler arm is shown mounted in the upper threaded hole and positioned for cutting

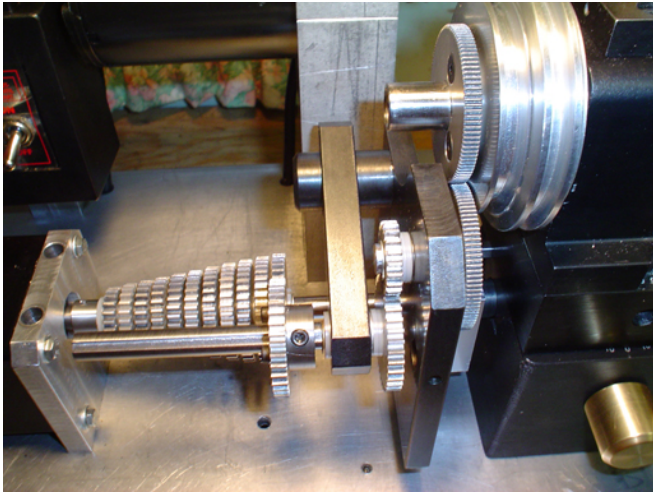
40 tpi threads, one of the two extreme positions. The arm is machined from 1/2" x 1" mild steel and as built is 3.75" long. The shaft is a rotating part supported by and riding in a row of three 3/8" ID ball bearings. Nylon washers are used on both sides as spacers and retaining rings (snap rings) are used on both sides to prevent possible unwanted movement.

The two gears on this shaft are both 35-tooth Sherline accessories not included with the threading kit. The gear on the rightmost end of the shaft is fixed in position and meshes with the "C" gear on the mounting plate. The gear on the left side of the arm is mounted to a sliding collar that it allows it to be aligned with any of the 11 gears on the main shaft. The channel visible in the photo is for a matching setscrew in the sliding collar to lock the movable gear into position. The setscrew is actually a 4-40 SHCS in a counterbored recess, not the tiny, headless creature normally suggested by this expression.

Conceptually, the idler arm, shaft, and gears are the logical equivalent of the "E" gear shown in the Sherline threading chart. This is an idler gear that transmits power and direction of rotation. It's size is not important and has no effect on the ratio between the driving and driven gears. Since the gears on both ends are the same size, think of the shaft assembly as a single, variable length gear – that is exactly what it is and how it operates in the gear train.

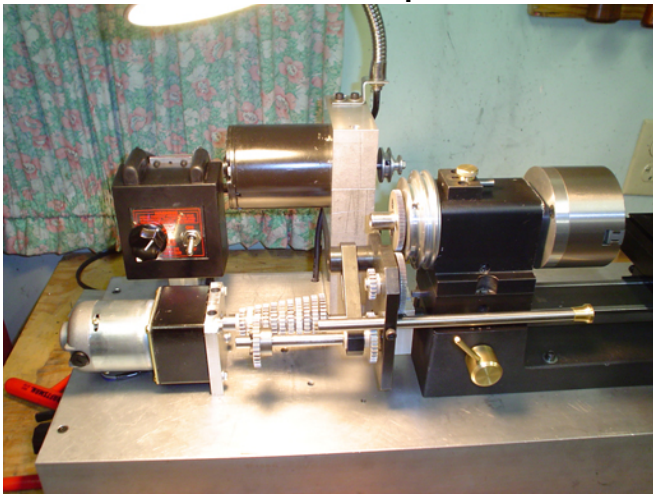
In use, the fixed gear has to mesh with the "C" gear on the mounting plate. The moveable gear similarly has to mesh with the chosen gear on the main shaft. The slot in the idler arm allows this to occur and the operator has to position the arm so that these two conditions are met. It takes longer to explain than to actually do it as this is not a difficult task. The operative word here is "mesh" – the idler gears should not "bottom" on either of the mating gears. In this regard, operation is exactly as prescribed in the Sherline instructions. Similarly, the 56 pitch "A" and "B" gears need to mesh, not collide, at the upper end of the gear train.

### **Gearbox 09 – Whole Mechanism**



This photo shows the whole gear train as configured to cut 40 tpi right handed threads and all of the gears are visible fully engaged in their respective locations.

### **Gearbox 10 – Travel Stop Mounted**



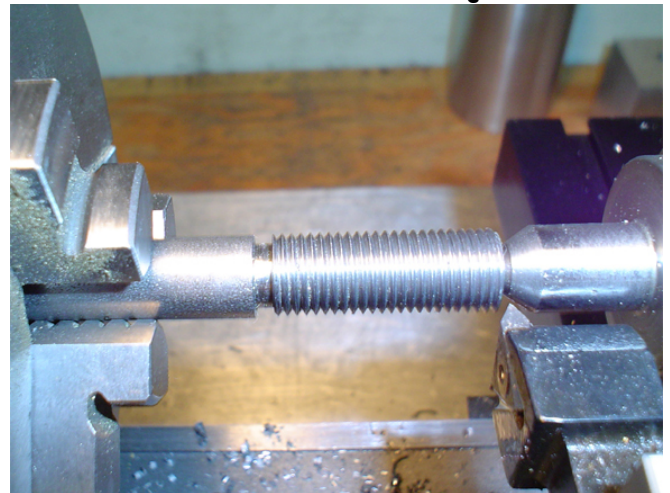
In my shop, and presumably others as well, threading is important but not the most frequently used operation performed on the lathe. Most of the time, therefore, the setup shown in this photo is the “normal” mode of operation. The gear train is fully in place, but disengaged. An oversight when taking this photo is that the drive belt is not installed. Sorry ‘bout that!

The gear plate has been rotated towards the front of the lathe disengaging the “A” and “B” gears. Similarly, the idler arm has been moved into a neutral position disengaging those gears as well.

When configured in this manner the feed motor is used as a leadscrew power feed in the same manner and using the same controls as I’ve been using it for several years. The long rod with the brass bumper on the right end is a travel stop that limits cross slide movement when performing operations close to the headstock. I have another, very effective, travel stop that can be located at any point on the ways, but it’s size is such that close to the headstock and underneath the chuck it isn’t effective – it’s too big for these close quarters. Details can be seen in my folder in the Yahoo Sherline User forum, in the “files” section.

This stop is a very simple adaptation of the mounting plate taking advantage of it’s width to equip the lathe with this secondary travel stop for circumstances when the other one’s size precludes it’s use. The stop rod is locked into position by a brass tipped SHCS. As an aside, I frequently use brass tipped screws in my projects to prevent marring mating surfaces.

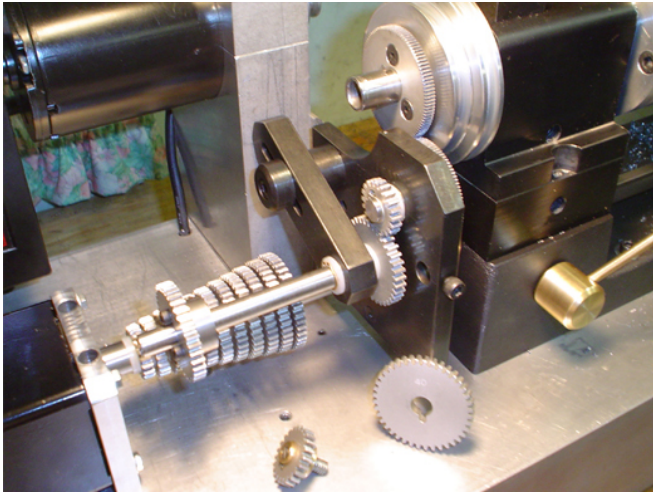
### **Gearbox 11 – Threads cut with gearbox**



The Gearbox works very well, as this photo illustrates. These are threads cut using the gearbox and the threading setup shown in the photo. These are 3/8" x 24 tpi threads cut in mild steel, and I believe the photo illustrates the quality of the finished product.

The threading cutter is the Sherline/Valenite carbide insert threading tool. The chuck and live center are non-Sherline modifications/upgrades beyond the scope of this discussion.

## Gearbox 12 – All Gearbox Parts



This photo illustrates the gearbox fully engaged and set up to cut the 24 tpi threads shown in the above photo. In the foreground are two additional parts.

The “C” gear mounted on the gear plate has 20 teeth and is used when cutting “fine” threads (even numbers, 20 to 40 tpi as per the Sherline threading chart). To cut “coarse” threads (10 to 20 tpi also as per the Sherline threading chart) this gear is replaced with the 40 tooth gear shown leaning against the mounting plate.

The “C” gear is held in position with a retaining ring (snap ring) which is easily removed and replaced making this an easy swap. Please note that when using the 40 tooth “C” gear and also when cutting left-handed threads the idler arm needs to be mounted in the alternative lower threaded hole in the gear plate. In all other respects operation is as described above.

The gearbox can be used to cut left-handed “fine” threads. This is accomplished by leaving the small “C” gear as shown in this photo and adding the small gear/carrier also shown in the foreground. This gear is an idler that reverses the spindle rotation relative to that of the leadscrew so that they rotate appropriately for left-handed screws. When cutting these threads, the cross slide table is fed left to right when cutting and right to left for the return. This is the reverse of the normal operation and an operational adaptation necessary to keep the spindle rotating in the appropriate direction relative to the threading cutter.

As I built it, I did not allow for cutting left handed “coarse” threads. I did not find an appropriate location on the mounting plate that would allow me to use the

extra idler necessary for cutting coarse left-handed threads although admittedly I didn’t pursue this issue too hard. Please note that the instructions for the Sherline threading kit clearly state that the lathe is not designed for cutting right-handed threads coarser than about 16 tpi or left-handed threads coarser than 20 tpi. In making my personal choices about the design of this gearbox I decided to accept these limitations at face value, although as built it will cut right handed threads as coarse as 10 tpi. Indeed, these limitations are of no operational consequence in my shop.

Other possible adaptations are indeed possible. The conceptual design of this gearbox is suggested by the Sherline instructions and threading charts. Close examination of the “inch” threading chart demonstrates that if one eliminates very coarse and very fine threads from consideration, i.e., all those that require the use of a 50-tooth gear in the “A” or “B” positions, all remaining threads can be cut with either the 20- or 40-tooth gear in the “C” position, and each of the 24 pitch gears in succession in the “D” position. Conceptually, this is exactly what this gearbox does, only it mounts all of them at the same time selectable using the movable gear on the idler arm.

Examination of the “metric” threading chart demonstrates a similar situation, the main difference being that the major variable is the gear mounted in the “C” position. There are only two significant options on the leadscrew shaft, once again the 20- or 40-tooth gears used to select “fine” and “coarse” ranges. Consequently, the principles demonstrated in my gearbox can be adapted to allow construction of a metric version. If this was done, the cone cluster would have to be in the “C” location probably necessitating a heavier mounting plate or other similar adaptation to provide adequate support for this shaft. The idler arm assembly, then, would select the appropriate “C” gear and mesh it with one of the two possible gears on the leadscrew shaft. Admittedly, I haven’t worked out the practical engineering necessary to build this configuration, but this is virtually the same starting point I used in designing the gearbox shown herein.

— Jim Knighton