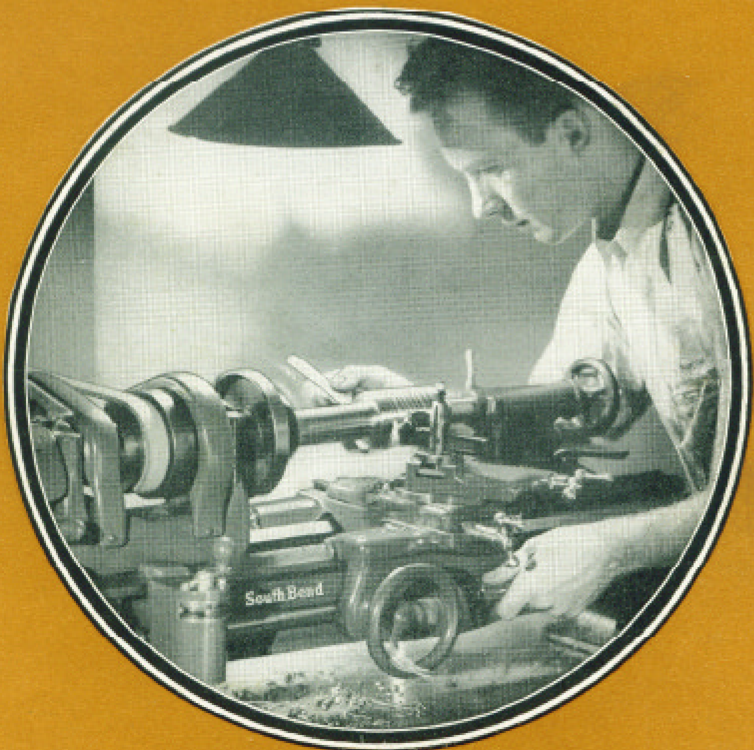
BULLETIN NO. 36A

How to Cut Screw Threads in the Lathe



Cutting a Screw Thread.

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SOUTH BEND LATHE WORKS
456 NILES AVE. SOUTH BEND, INDIANA, U. S. A.

Screw Threads

The history of the origin and development of the screw thread is lost in antiquity. However, it is known that screw threads were used more than 2000 years ago and that screws and bolts were used for fastening together various parts of the armor worn by ancient Roman warriors. Threaded devices were also used to open and close heavy doors and drawbridges of ancient castles.

The development of modern mechanical devices has been made possible by the invention and development of the screw thread. The most important use of threads is for fastening parts of machinery and equipment together. With screws and bolts parts can easily be assembled and taken apart without damage, but when fastened by other methods, such as welding, rivets, nails, etc., this is not possible.

Screws are also used for transmitting motion, such as the lead screw, cross feed screw, etc. of a lathe, also for leverage as in jack screws, vises and clamps. The screw is also used in precision measuring instruments, such as micrometer calipers, cross feed of lathe, etc.

South Bend Lathe Works

Fig. 1. Cutting a Screw Thread in the Lathe.

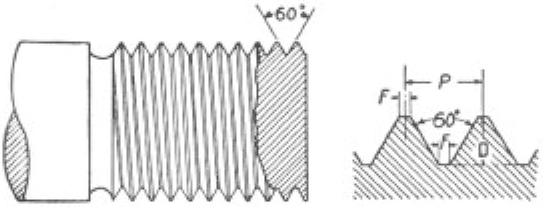
How to Cut Screw Threads In the Lathe

Cutting screw threads in the lathe is accomplished by connecting the headstock spindle of the lathe with the lead screw by a series of gears so that a positive carriage feed is obtained and the lead screw is driven at the required speed with relation to the headstock spindle.

The gearing between the headstock spindle and lead screw may be arranged so that any desired pitch of the thread may be cut. For example, if the lead screw has eight threads per inch and the gears are arranged so that the headstock spindle revolves four times while the lead screw revolves once, the thread cut will be four times as fine as the thread on the lead screw or 32 threads per inch.

The cutting tool is ground to the shape required for the form of the thread to be cut, that is "V," Acme, square, etc. The depth of the thread is determined by adjusting the cross slide.

Either right hand or left hand threads may be cut by reversing the direction of rotation of the lead screw. This may be accomplished either by adding or removing one idler gear in the change gear train, or by shifting the tumbler gears on the headstock.



FORMULA

$$P = \text{Pitch} = \frac{1}{\text{No. Th'ds. Per In.}}$$

$$D = \text{Depth} = P. \times .64952$$

$$F = \text{Flat} = \frac{P}{8}$$

Fig. 2. American National Screw Thread (Formerly U.S. Standard Screw Thread).

American National Screw Threads

The National Screw Thread Commission in 1928 was authorized by Congress to establish a standard system of screw threads for use in the United States. As a result this commission established the American National Screw Thread System which has been approved by the Secretary of War, Secretary of the Navy, and Congress, and is now generally used by all shops in the United States.

The form of the thread adopted is shown above and tables for both the Fine Thread Series and Coarse Thread Series are given on the opposite page. The tabulation at the bottom of page 3 lists a number of special pitches of screw threads that are commonly used. However, the standard screw threads should always be used, if possible.

A report of the National Screw Thread Commission applying to screw threads, bolts, machine screws, etc. defines the following terms.

Terms Relating to Screw Threads

Screw Thread. A ridge of uniform section in the form of a helix on the surface of a cylinder or cone.

External and Internal Threads. An external thread is a thread on the outside of a member. Example: A threaded plug. An internal thread is a thread on the inside of a member. Example: A threaded hole.

Major Diameter (formerly known as "outside diameter"). The largest diameter of the thread of the screw or nut. The term "major diameter" replaces the term "outside diameter" as applied to the thread of a screw and also the term "full diameter" as applied to the thread of a nut.

Minor Diameter (formerly known as "core diameter"). The smallest diameter of the thread of the screw or nut. The term "minor diameter" replaces the term "core diameter" as applied to the thread of a screw and also the term "inside diameter" as applied to the thread of a nut.

Pitch Diameter. On a straight screw thread, the diameter of an imaginary cylinder, the surface of which would pass through the threads at such points as to make equal the width of the threads and the width of the spaces cut by the surface of the cylinder.

Pitch. The distance from a point on a screw thread to a corresponding point on the next thread measured parallel to the axis.

Lead. The distance a screw thread advances axially in one turn. On a single-thread screw, the lead and pitch are identical; on a double-thread screw the lead is twice the pitch; on a triple-thread screw, the lead is three times the pitch, etc.

Tables of Standard Screw Thread Pitches and Recommended Tap Drill Sizes

American National Coarse Thread Series Standard Thread (N.C.)

Formerly U. S. Standard

No. or Diam.	Threads Per Inch	Outside Diameter of Screw	Tap Drill Sizes	Decimal Equivalent of Drill
1	64	.073	53	0.0595
2	56	.086	50	0.0700
3	48	.099	47	0.0785
4	40	.112	43	0.0890
5	40	.125	38	0.1015
6	32	.138	36	0.1065
8	32	.164	29	0.1360
10	24	.190	25	0.1495
12	24	.216	16	0.1770
1/4	20	.250	7	0.2010
5/16	18	.3125	F	0.2570
3/8	16	.375	5/16	0.3125
7/16	14	.4375	U	0.3680
1/2	13	.500	27/64	0.4219
9/16	12	.5625	31/64	0.4843
5/8	11	.625	17/32	0.5312
3/4	10	.750	21/32	0.6562
7/8	9	.875	49/64	0.7656
1	8	1.000	7/8	0.875
1 1/8	7	1.125	63/64	0.9843
1 1/4	7	1.250	1 7/64	1.1093

American National Fine Thread Series Standard Thread (N.F.)

Formerly S. A. E. Thread

No. or Diam.	Threads Per Inch	Outside Diameter of Screw	Tap Drill Sizes	Decimal Equivalent of Drill
0	80	.060	3/64	0.0469
1	72	.073	53	0.0595
2	64	.086	50	0.0700
3	56	.099	45	0.0820
4	48	.112	42	0.0935
5	44	.125	37	0.1040
6	40	.138	33	0.1130
8	36	.164	29	0.1360
10	32	.190	21	0.1590
12	28	.216	14	0.1820
1/4	28	.250	3	0.2130
5/16	24	.3125	I	0.2720
3/8	24	.375	Q	0.3320
7/16	20	.4375	25/64	0.3906
1/2	20	.500	29/64	0.4531
9/16	18	.5625	0.5062	0.5062
5/8	18	.625	0.5687	0.5687
3/4	16	.750	11/16	0.6875
7/8	14	.875	0.8020	0.8020
1	14	1.000	0.9274	0.9274
1 1/8	12	1.125	1 3/64	1.0468
1 1/4	12	1.250	1 11/64	1.1718

Tables of American National Special Screw Thread Pitches (N.S.) and Recommended Tap Drill Sizes

No. or Diam.	Threads Per Inch	Outside Diameter of Screw	Tap Drill Sizes	Decimal Equivalent of Drill
1/4	24	.250	4	0.2090
	27		3	0.2130
	32		7/32	0.2187
5/16	20	.3125	17/64	0.2656
	27		J	0.2770
	32		9/32	0.2812
3/8	20	.375	21/64	0.3281
	27		R	0.3390
7/16	24	.4375	X	0.3970
	27		Y	0.4040

No. or Diam.	Threads Per Inch	Outside Diameter of Screw	Tap Drill Sizes	Decimal Equivalent of Drill
1/2	12	.500	27/64	0.4219
	24		29/64	0.4531
	27		15/32	0.4687
9/16	27	.5625	17/32	0.5312
5/8	12	.625	35/64	0.5469
	27		19/32	0.5937
3/4	12	.750	43/64	0.6719
	27		23/32	0.7187
7/8	12	.875	51/64	0.7969
	18		53/64	0.8281
	27		27/32	0.8437
1	12	1.000	59/64	0.9219
	27		31/32	0.9687

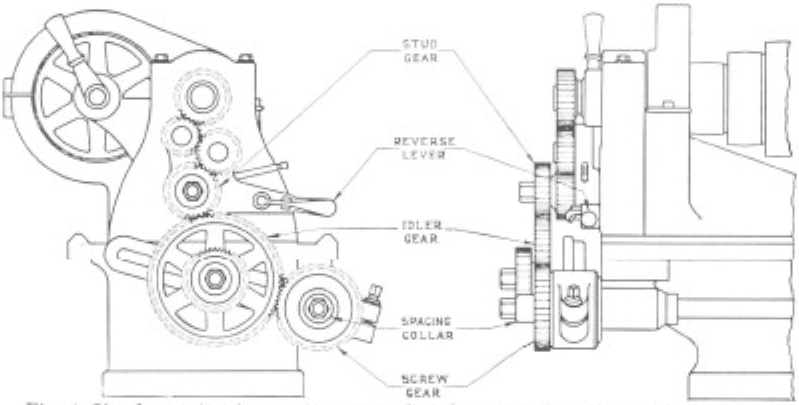


Fig. 4. Simple gearing for cutting screw threads on standard change gear lathes.

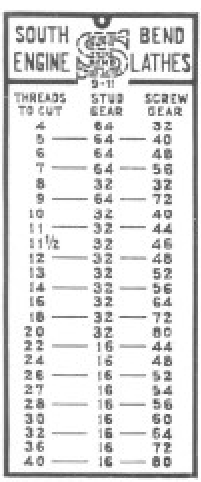
Setting Up Standard Change Gear Lathe for Cutting Screw Threads

Screw threads are cut on the Standard Change Gear Lathe by engaging the apron half nuts with the lead screw. The pitch of thread to be cut is determined by the number of teeth in the change gears used on the reverse stud and the lead screw.

To set up the lathe for cutting a screw thread, first determine the number of threads per inch to be cut. By referring to the index chart attached to the lathe (Fig. 5) the change gears required can be determined. The thread to be cut should be located in the first column under the heading "Threads to Cut." In the second column under the heading "Stud Gear" is listed the number of teeth in the change gear which should be placed on the reverse stud of the lathe. (See Figs. 4 and 6.) In the third column under the heading "Screw Gear" is listed the number of teeth in the gear to be placed on the lead screw.

After selecting the change gears necessary for cutting the desired thread, place them on the reverse stud and lead screw respectively and connect them with the idler gear, as shown in Figs. 4 and 6.

This arrangement is known as simple gearing and is used for cutting all screw threads on the smaller sizes of lathes. Note that the gear on the lead screw is in line with the gear on the reverse stud, and these two gears are connected by a simple idler gear. The spacing collar for the lead screw is in this case placed outside of the change gear.



SOUTH BEND ENGINE LATHES

9-11

THREADS TO CUT	STUD GEAR	SCREW GEAR
4	64	32
5	64	40
6	64	48
7	64	56
8	32	32
9	64	72
10	32	40
11	32	44
11½	32	46
12	32	48
13	32	52
14	32	56
16	32	64
18	32	72
20	32	80
22	16	44
24	16	48
26	16	52
27	16	54
28	16	56
30	16	60
32	16	64
36	16	72
40	16	80

Fig. 5. Index plate for 9" and 11" lathes.

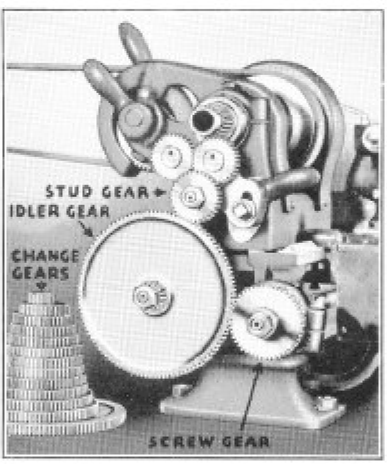


Fig. 6. Change gear equipment used on standard change gear lathes.

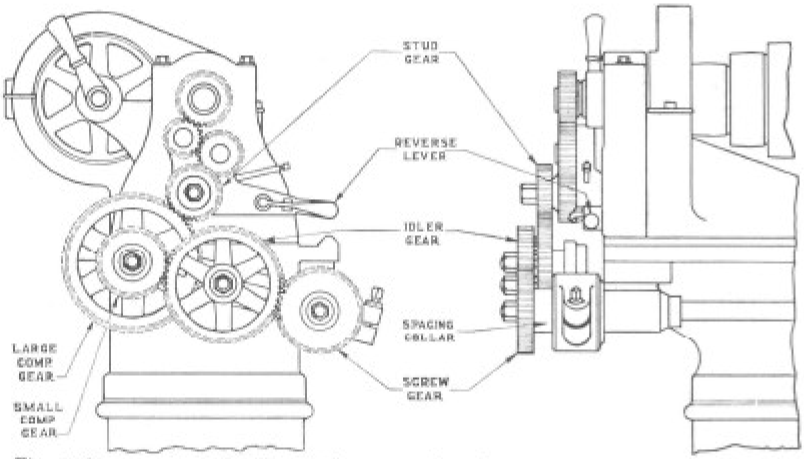


Fig. 7. Compound gearing for cutting screw threads on standard change gear lathe.

Compound Gearing for Cutting Screw Threads

Compound gearing as illustrated above in Fig. 7, is used for cutting fine pitches of screw threads on large lathes having coarse pitch lead screws. A compound idler gear having a two to one ratio is inserted between the stud gear and lead screw gear so that just twice as many threads per inch will be cut as if simple gearing were used.

The index plate illustrated in Fig. 8 at the right shows the arrangement of the change gears for cutting screw threads on the 13″ and 16″ South Bend Standard Change Gear Lathes. Simple gearing, as described on page 4, is indicated for 2 to 20 threads per inch. Compound gearing is indicated for threads 22 to 40 per inch, which are listed below the heavy line.

Note that the spacing collar on the lead screw is placed between the change gear and the lead screw bracket so that the gear on the lead screw may be connected with the small compound gear through an idler gear.

SOUTH BEND ENGINE LATHES
13-16

THREADS TO CUT	STUD GEAR	SCREW GEAR
2	72	24
3	48	24
4	48	32
5	48	40
6	48	48
7	48	56
8	48	64
9	48	72
10	48	80
11	24	44
11½	24	46
12	24	48
13	24	52
14	24	56
16	24	64
18	24	72
20	24	80
22	24-1-2	44
24	24 1-2	48
26	24-1-2	52
27	24 1-2	54
28	24-1-2	56
30	24 1-2	60
32	24-1-2	64
36	24 1-2	72
40	24-1-2	80

Fig. 8. Index plate for 13″ and 16″ lathes.

Special Gears for Fine Threads

If it is necessary to cut threads finer than 40 per inch on a Standard Change Gear Lathe, special gearing is required. This gearing consists of additional change gears or additional compound gears to permit setting up the lathe for the desired pitch of thread. Fig. 9 at right shows an index chart for cutting fine screw threads from 44 to 80 per inch on a 9″ or 11″ South Bend Standard Change Gear Lathe using a compound idler gear.

SPECIAL FINE THREADS
9 11

THREADS TO CUT	STUD GEAR	COMP GEAR	SCREW GEAR
44	16	1-2	44
46	16	1-2	46
48	16	1-2	48
52	16	1-2	52
54	16	1-2	54
56	16	1-2	56
60	16	1-2	60
64	16	1-2	64
72	16	1-2	72
80	16	1-2	80

Fig. 9. Fine thread cutting index plate.

Lathe Tools Used for Cutting Screw Threads

The point of the cutter bit must be ground to an angle of 60° for cutting screw threads in the lathe, as shown in Fig. 10 at right. A center gage or angle gage is used for grinding the tool to the exact angle required. The top of the tool is usually ground flat, with no side rake or back rake. However, for cutting threads in steel, side rake is sometimes used.

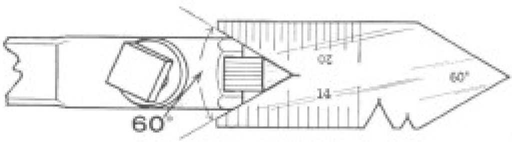


Fig. 10. Center gage used for checking angle of cutter bit ground for cutting screw threads.

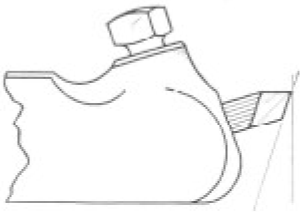


Fig. 10-A. Side View of lathe tool cutter bit ground for cutting screw threads.

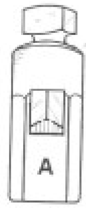


Fig. 10-B. End View of lathe tool cutter bit ground for cutting screw threads.

A formed threading tool is usually used if considerable threading is to be done. Figs. 11 and 12 illustrate two good types of formed threading tools. The formed threading tools require grinding on top edge only to sharpen and therefore always remain true to form and correct angle.


Fig. 11. Formed threading tool, solid type.

For cutting American National Standard Screw Threads finer than 10 per inch, the point of the tool is usually left sharp or with a very small flat to provide clearance at the bottom of the thread. However, for cutting coarser pitches of threads and when maximum strength is desired, the point of the tool may be ground flat, as shown in Fig. 13. The flat on the point of the tool should be one-eighth of the pitch. (See Fig. 2, Page 2.)

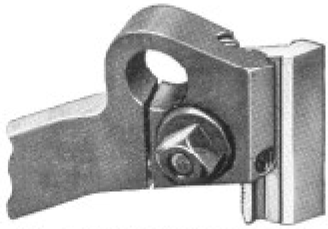


Fig. 12 Formed threading tool, spring type.

The illustration at the bottom of the page, Fig. 14, shows a gage which may be used for grinding threading tools to the exact angle required for standard screw threads. Note that the gage shows the flat for the point of the tool as well as the exact angle and depth of thread.

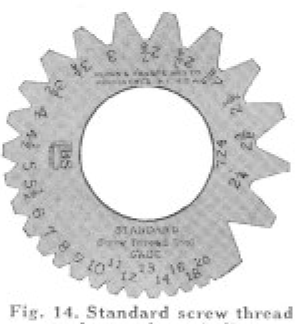


Fig. 14. Standard screw thread tool gage for grinding threading tools.

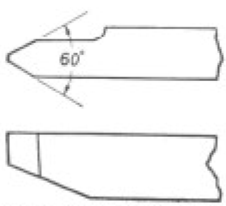


Fig. 13. Forged steel threading tool.

When cutting screw threads in steel use plenty of oil and a smooth thread will result.

Correct Position of Lathe Tool for Cutting Screw Threads

For External Threads

The top of the threading tool should be placed exactly on center, as shown in Fig. 15 at right, for cutting external screw threads. Note that the top of the tool is ground flat and is in exact alignment with the lathe center. This is necessary to obtain the correct angle of the thread.

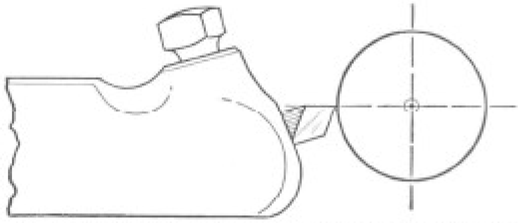


Fig. 15. Top of cutter bit should be set on center for cutting screw threads.

The threading tool must be set square with the work, as shown in Fig. 16. The center gage is used to adjust the point of the threading tool and if the tool is carefully set a perfect thread will result. Of course, if the threading tool is not set perfectly square with the work, the angle of the thread will be incorrect.

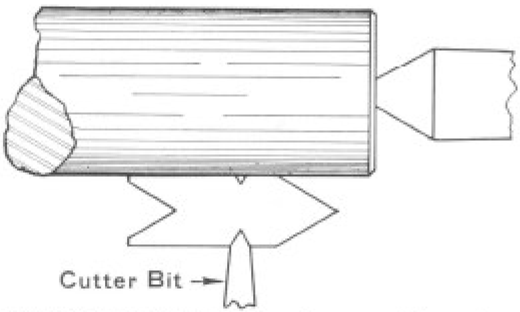
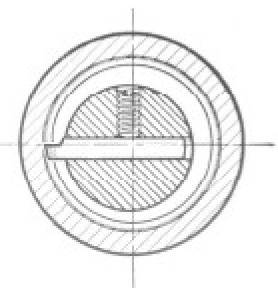


Fig. 16. Cutter bit should be set square with work, as shown above, for cutting external screw threads.

For Internal Threads

The point of the threading tool is also placed exactly on center as shown in Fig. 17 at right for cutting internal screw threads. The point of the tool must be set perfectly square with the work. This may be accomplished by fitting the point of the tool into the center gage, as shown in Fig. 18 at right.

Fig. 17. For cutting internal screw threads, top of cutter bit should be set exactly on center.



When adjusting the threading tool for cutting internal threads, allow sufficient clearance between the tool and the inside diameter of the hole to permit backing out the tool when the end of the cut has been reached. However the boring bar should be as large in diameter and as short as possible to prevent springing.

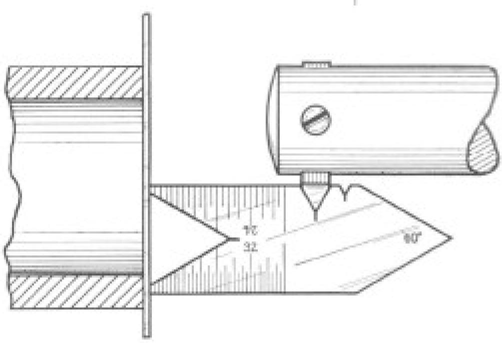


Fig. 18. Cutter bit should be set square with work, as shown above for cutting internal screw threads.

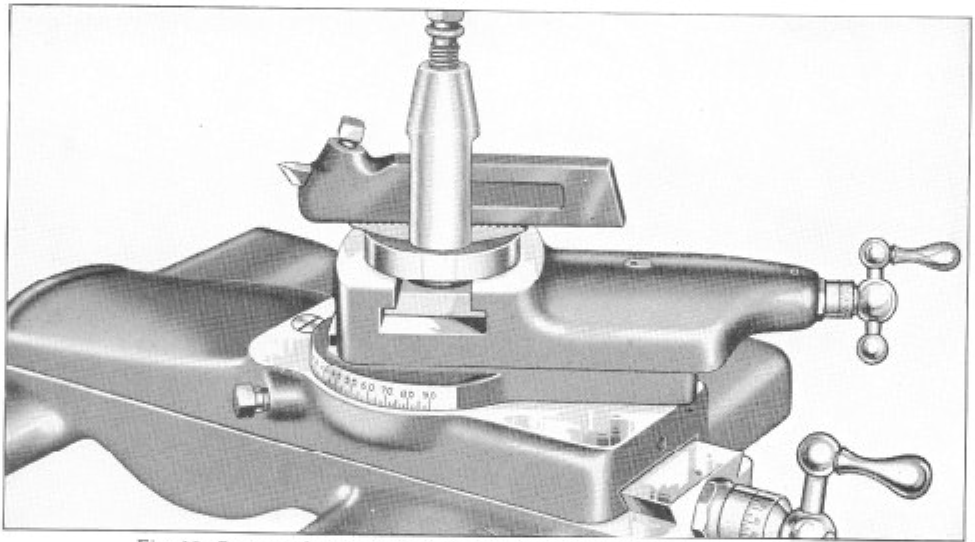


Fig. 19. Compound rest of lathe set at 29° angle for cutting screw threads.

Position of Compound Rest for Cutting Screw Threads

In manufacturing plants where maximum production is desired it is customary to place the compound rest of the lathe at an angle of 29° for cutting screw threads. The compound rest is swung around to the right, as shown in Figs. 19 and 20. When the compound rest is set in this position and the compound rest screw is used for adjusting the depth of cut, most of the metal is removed by the left side of the threading tool. (See Fig. 21.) This permits the chip to curl out of the way better than if tool is fed straight in, and prevents tearing the thread. Since the angle on the side of the threading tool is 30°, the right side of the tool will shave the thread smooth and produce a nice finish, although it does not remove enough metal to interfere with the main chip which is taken by the left side of the tool.

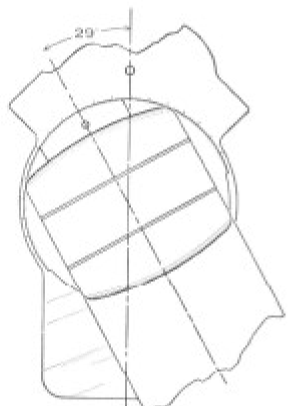


Fig. 20. Correct angle of compound rest for thread cutting.

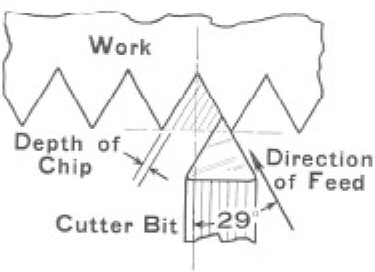


Fig. 21. Action of thread cutting tool when compound rest is set at 29° angle.

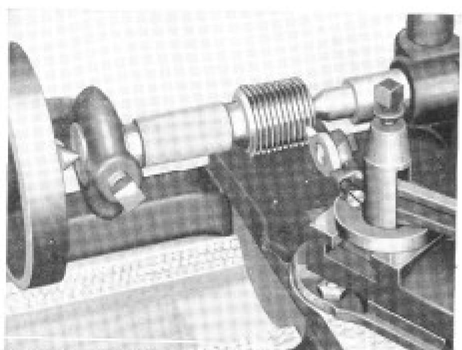


Fig. 22. Cutting a screw thread on a precision thread gage.

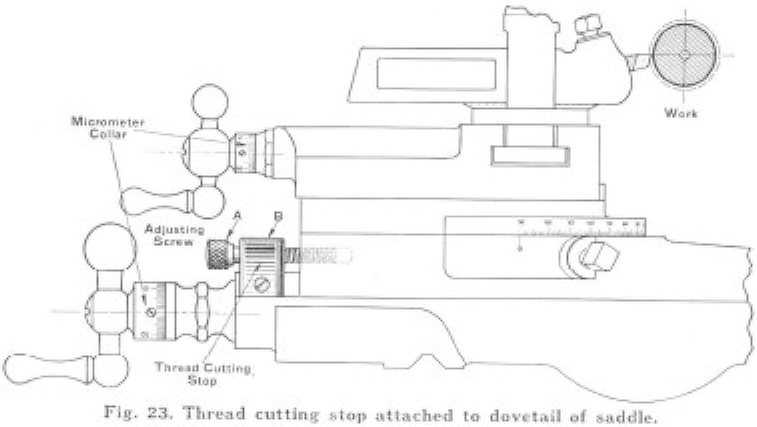


Fig. 23. Thread cutting stop attached to dovetail of saddle.

Adjusting the Thread Cutting Stop

On account of the lost motion caused by the play necessary for smooth operation of the change gears, leadscrew, half nuts, etc., the thread cutting tool must be withdrawn quickly at the end of each cut, before the lathe spindle is reversed to return the tool to the starting point. If this is not done, the point of the tool will dig into the thread and may be broken off. The thread cutting stop may be used for regulating the depth of each successive chip.

The point of the tool should first be set so that it just touches the work, then lock the thread cutting stop and turn the thread cutting stop screw until the shoulder is tight against the stop. When ready to take the first chip run the tool rest back by turning the cross feed screw to the left several times and move the tool to the point where the thread is to start. Then turn the cross feed screw to the right until the thread cutting stop screw strikes the thread cutting stop. The tool rest is now in the original position, and by turning the compound rest feed screw in .002″ or .003″ the tool will be in a position to take the first cut.

Micrometer Collar May Be Used in Place of Stop

The micrometer collar on the cross feed screw of the lathe may be used in place of the thread cutting stop, if desired. To do this, first bring the point of threading tool up so that it just touches the work, then adjust the micrometer collar on the cross feed screw to zero.

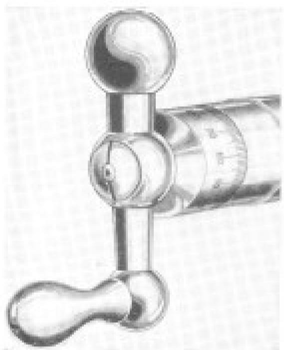


Fig. 24. Micrometer collar on cross feed screw of lathe.

All adjusting for obtaining the desired depth of cut should be done with the compound rest screw. Withdraw the tool at the end of each cut by turning the cross feed screw to the left one complete turn, return the tool to the starting point and turn the cross feed screw to the right one turn, stopping at zero. The compound rest feed screw may then be adjusted for any desired depth of chip.

Taking the First Cut on a Screw Thread

Take Light Trial Cut to Check Lathe Set-up

After setting up the lathe, as explained on the preceding pages, take a very light trial cut just deep enough to scribe a line on the surface of the work, as shown in Fig. 25. The purpose of this trial cut is to check up and make sure that the lathe is arranged for cutting the desired pitch of thread.

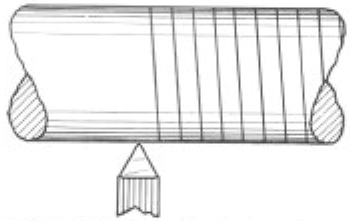


Fig. 25. Trial cut to check set-up for thread cutting.

To check the number of threads per inch, place a scale against the work, as shown in Fig. 26 so that the end of the scale rests on the point of the thread or on one of the scribed lines. Count the spaces between the end of the scale and the first inch mark, and this will give you the number of threads per inch.

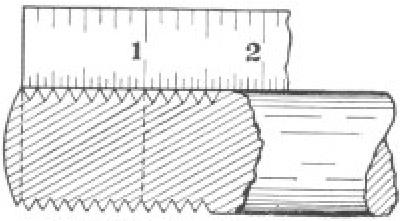


Fig. 26. Measuring screw threads.

It is quite difficult to accurately count fine pitches of screw threads, as described above. A screw thread gage as illustrated in Fig. 27 is very convenient for checking the finer pitches of screw threads. This gage consists of a number of sheet metal plates in which are cut the exact form of the various pitches of threads and each plate is stamped with a number indicating the number of threads per inch for which it is to be used.

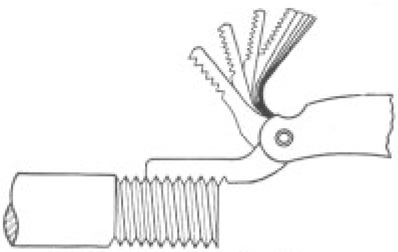


Fig. 27. Screw thread pitch gage.

The final check for both the diameter and pitch of the thread may be made with the nut that is to be used or with a ring thread gage, if one is available. Fig. 28 shows how the nut may be used for checking the thread. The nut should fit snugly without play or shake but should not bind on the thread at any point.

If the angle of the thread is correct and the thread is cut to the correct depth it will fit the nut perfectly. However, if the angle of the thread is incorrect or the lead is incorrect, the thread may appear to fit the nut but will only be touching at a few points. For this reason the thread should be checked by other methods in addition to the nut or ring gage.

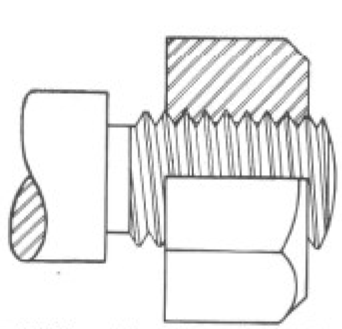


Fig. 28. Screw thread properly fitted to nut.

Fig. 29. Applying lard oil to work with small paint brush while cutting screw threads in a tool steel thread gage.

Use Lard Oil When Cutting Screw Threads in Steel

Lard oil should be used when cutting screw threads in steel in order to produce a smooth thread. If the oil is not used a very rough finish will be caused by tearing of the steel by the cutting tool.

If lard oil is not available any good cutting oil or machine oil may be used. If trouble is experienced in producing a smooth thread, a little powdered sulphur may be added to the oil.

The oil should be applied generously preceding each cut. A small paint brush is ideal for applying the oil when cutting external screw threads, as illustrated above. Since lard oil is quite expensive, many mechanics place a small tray or cup just below the cutting tool on the cross slide of the lathe to catch the surplus oil which drips off the work. In manufacturing plants where the lathe is to be used exclusively for cutting screw threads in steel it is customary to equip the lathe with an oil pan and oil pump to provide a continuous flow of oil.

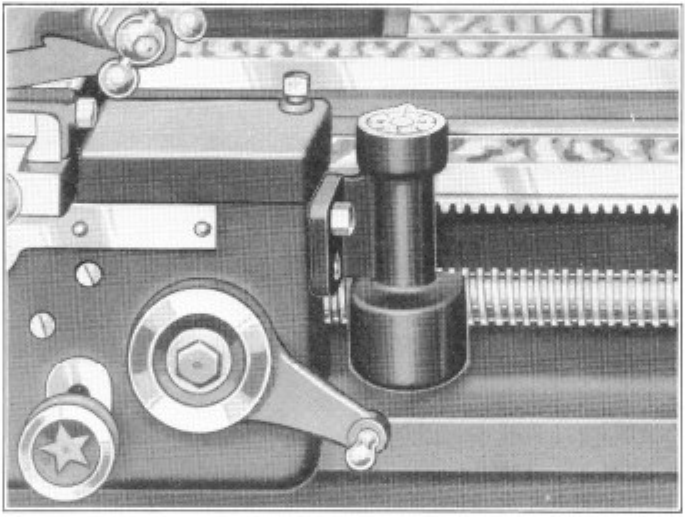


Fig. 30. Thread dial indicator attached to lathe carriage.

Use of Thread Dial Indicator in Cutting Screw Threads

A thread dial indicator or threading clock is usually used for cutting long screw threads. This device permits disengaging the half-nuts at the end of the cut, returning the carriage to the starting point by hand, and then engaging the half nuts at the correct time so that the tool will follow the original cut. This saves time on long threads and it also eliminates the necessity of reversing the lathe spindle.

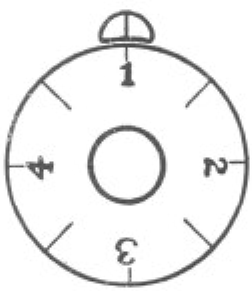


Fig. 31. Face of thread dial indicator.

The threading dial consists of a worm wheel which is attached to the lower end of a shaft and meshed with the lead screw. On the upper end of the shaft is the dial. As the lead screw revolves, the dial is turned and the numbers on the dial indicate points at which the half nuts may be engaged.

When cutting short threads it is better to leave the half-nuts engaged with the lead screw, and when the end of the cut is reached, withdraw the tool and reverse the lathe spindle to return the tool to the starting point.

Rules for Operating Thread Dial on South Bend Lathe

For all even numbered threads, close the half nuts at any line on the dial.

For all odd numbered threads, close the half nuts at any numbered line on dial.

For all threads involving one-half of a thread in each inch, such as 11½, close the half nuts at any odd numbered line.

Resetting the Tool After the Thread Has Been Started

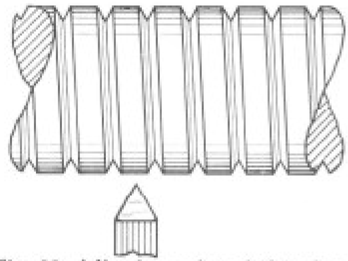


Fig. 32. Adjusting point of threading tool to conform with thread.

If the thread cutting tool should need re-sharpening, or if for any other reason it is necessary to remove the thread cutting tool before the thread has been completed, the tool must be carefully re-adjusted so that it will follow the original groove when it is replaced in the lathe. There are several methods by which this can be accomplished.

Before adjusting the tool, set the point of the cutter bit square with the work, as described on page 7, and take up all the lost motion in the change gears, half nuts, etc., by pulling the belt forward by hand.

If the lathe has a compound rest, the compound rest top may be set at an angle, and by adjusting the cross feed screw and compound rest feed screw simultaneously the point of the tool can be made to enter exactly into the original groove.

If it is not convenient to use the compound rest for readjusting the threading tool, the lathe dog may be loosened, the work turned so that the threading tool will match the groove and the lathe dog tightened.

Another method that is sometimes used is to disconnect the reverse gears or the change gears, turn the headstock spindle until the point of the threading tool enters the groove in the work, and then reconnect the gears.

Finishing the End of a Threaded Piece

The end of the thread may be finished by any one of several methods. The 45° chamfer on the end of the thread, as shown in Fig. 33, is commonly used for bolts, cap screws, etc. For machined parts and special screws the end is often finished by rounding with a forming tool, as shown in Fig. 34.

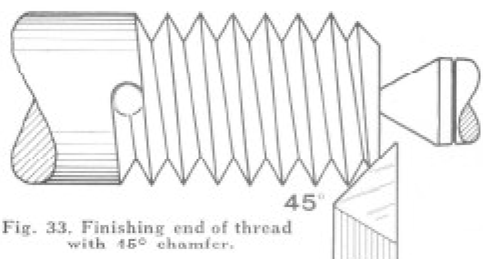


Fig. 33. Finishing end of thread with 45° chamfer.

It is difficult to stop the threading tool abruptly so some provision is usually made for clearance at the end of the cut. In Fig. 33 a hole has been drilled in the end of the shaft, and in Fig. 34 a neck or groove has been cut around the shaft. The groove is preferable as the lathe must be run very slowly in order to obtain satisfactory results with the drilled hole.

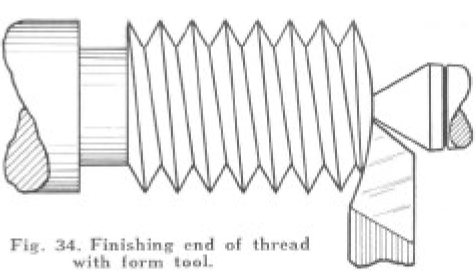


Fig. 34. Finishing end of thread with form tool.

Cutting Multiple Screw Threads

Multiple screw threads are used for adjusting screws and other applications where a coarse lead is desired. The depth of the thread is less than for a single thread of equal lead, making a stronger screw.

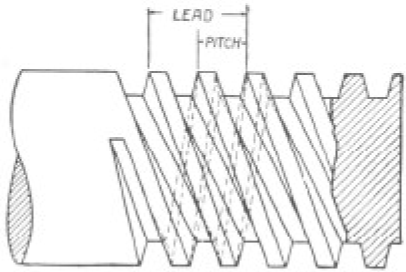


Fig. 35. A multiple screw thread having two grooves (Double Thread)

A multiple thread having two grooves is known as a double thread, one having three grooves a triple thread, etc. (See Fig. 35.) The pitch and lead of a multiple thread should not be confused. The pitch is the distance from a point on one thread to the corresponding point on the next thread, while the lead is the distance a screw thread advances in one turn.

When cutting multiple threads in the lathe the first thread is cut to the desired depth. The work is then revolved part of a turn, and the second thread cut, etc. In order to obtain an exact spacing it is advisable to mill as many equally spaced slots in the face plate for the lathe dog as there are multiple threads to be cut. For a double thread, two slots; a triple thread, three slots, etc. If it is not convenient to cut slots in the face plate, equally spaced studs may be attached to the face plate and a straight tail lathe dog used.

Another method for indexing the work when cutting multiple threads is to disengage the change gears after the first thread has been completed and turn the spindle to the required position for starting the next cut. If a double thread is being cut and there are 48 teeth in the stud gear, the spindle should be turned until 24 teeth have been passed, then the gears engaged and the second thread cut.

Cutting Left Hand Screw Threads

A left hand screw is one that turns counter-clockwise when advancing (looking at head of screw) as shown in Fig. 37. This is just the opposite of a right hand screw. Left hand threads are used for the cross feed screws of lathes, the left hand end of axles for automobiles and wagons, one end of a turnbuckle, some pipe threads, etc.

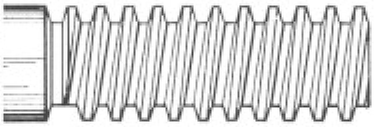
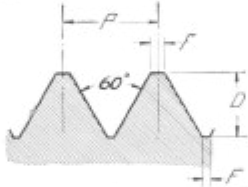


Fig. 36. A left hand screw thread.

In cutting left hand screw threads the lathe is set up exactly the same as for cutting right hand screw threads, except that the lathe must be arranged to feed the tool from left to right, instead of from right to left, when the spindle is revolving forward.


Fig. 37. A left hand screw advances when turned counter-clockwise.

French and International Standard Metric Screw Threads



FORMULA

P = Pitch in MM.

D = Depth = P. x .64952

F = Flat = $\frac{P}{8}$

Fig. 38. International Standard Metric Screw Thread Form.

In France and other parts of Europe the International Standard Metric Screw Threads are used. These threads are used extensively on microscopes, telescopes and other optical and scientific instruments, also many surgical instruments which are imported from Europe.

Metric threads are measured in the Metric System instead of in the English System, and in order to cut them on a lathe having an English lead screw, metric transposing gears must be used. The ratio between the English System and Metric System of measurement is such that compound transposing gears having 127 teeth and 100 teeth or 127 teeth and 50 teeth may be used, depending on the pitch of the lead screw. See Figs. 41 and 42.

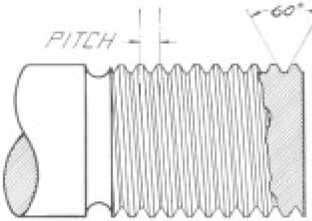


Fig. 39. 2.5 Mm. pitch metric screw thread.

Additional change gears are necessary in order to cut the various pitches of standard metric screw threads. The chart, Fig. 40, shows the change gears used for cutting standard metric threads .5 to 8 mm. pitch on the 9" Workshop Lathe.

The form of the metric thread is similar to the American National Screw Thread form having a 60° included angle and a flat at the top and bottom of the thread. (See Fig. 38.)

Metric screw threads are always measured in millimeter pitch and not in threads per centimeter. The thread shown in Fig. 39 is 2.5 mm. pitch.

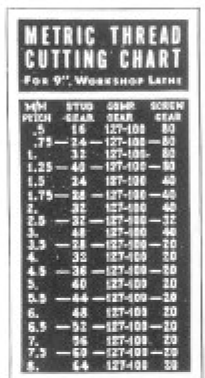


Fig. 40. Metric Thread Cutting Chart.

International Standard Metric Screw Thread

Diameter Mm.	Pitch Mm.	Diameter Mm.	Pitch Mm.	Diameter Mm.	Pitch Mm.
6	1.0	20	2.5	48	5.0
7	1.0	22	2.5	52	5.0
8	1.25	24	3.0	56	5.5
9	1.25	27	3.0	60	5.5
10	1.5	30	3.5	64	6.0
11	1.5	33	3.5	68	6.0
12	1.75	36	4.0	72	6.5
14	2.0	39	4.0	76	6.5
16	2.0	42	4.5	80	7.0
18	2.5	45	4.5		

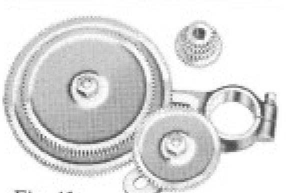


Fig. 41. Metric Transposing Gear Attachment for 9" Workshop Lathe.

Fig. 42. Metric Transposing Gear Attachment for 16" Lathe.

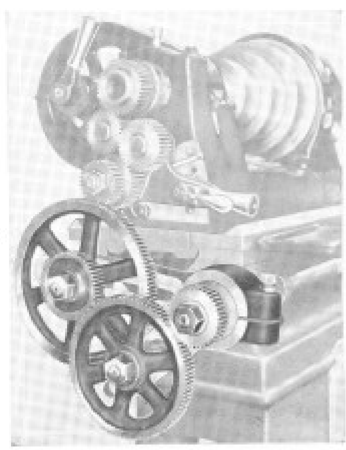


Fig. 43. Metric Transposing Gears Fitted to Lathe.

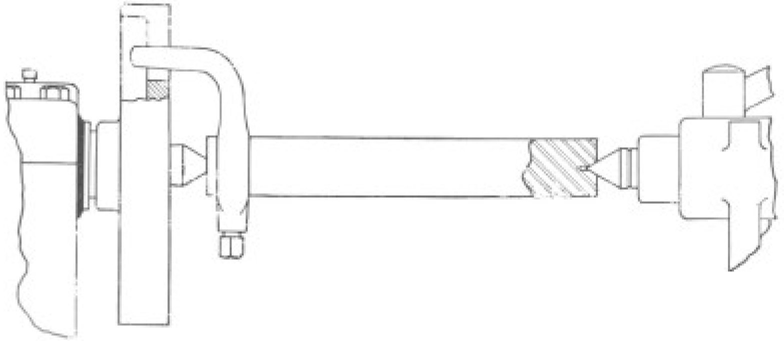


Fig. 44. Lathe dog should be tight when work is mounted between the lathe centers for cutting screw threads.

Mounting the Work in the Lathe

When mounting work between the lathe centers for cutting screw threads, make sure the lathe dog is securely attached before starting to cut the thread. If the dog should slip the thread will be ruined. Never remove the lathe dog from the work until the thread has been completed, and if it is necessary to remove the work from the lathe before the thread is finished make sure that the lathe dog is replaced in the same slot in the face plate.

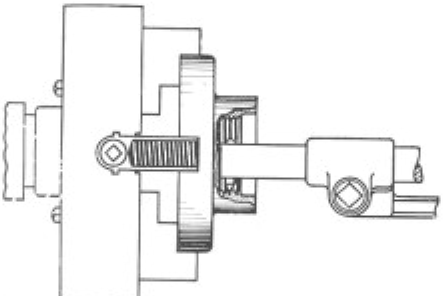


Fig. 45. Chuck jaws should be tight when cutting screw threads.

When threading work in the lathe chuck make sure the chuck jaws are tight and the work is well supported. The chuck must be tight enough on the spindle to prevent unscrewing when the lathe is reversed. Never remove the work from the chuck until the thread is finished.

When threading long slender shafts, use a follower rest, as shown in Fig. 47. The center rest may be used for supporting long work such as pipe which is to be threaded on the inside. (See Fig. 48.)

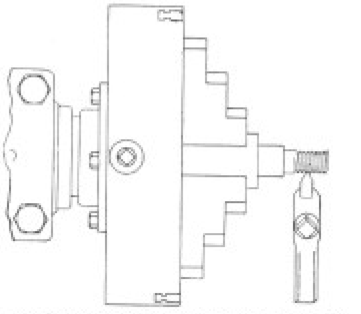


Fig. 46. Work should be pushed back in chuck and well supported.

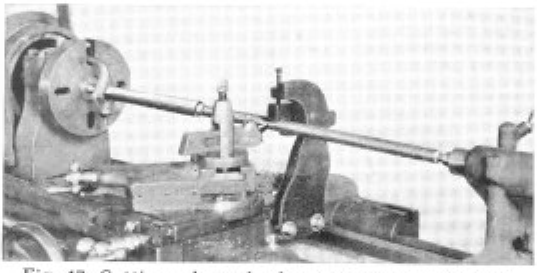


Fig. 47. Cutting a long slender screw thread, with the aid of a follower rest.

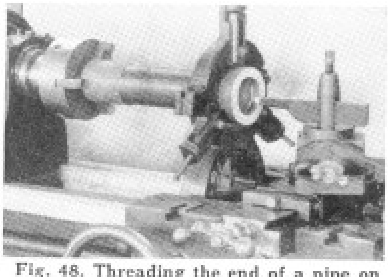


Fig. 48. Threading the end of a pipe on the inside with a center rest.

Adjusting Levers of Quick Change Gear Box for Cutting Various Pitches of Screw Threads

The only difference between the Quick Change Gear Lathe and the Standard Change Gear Lathe is that the Quick Change Gear Lathe is fitted with a gear box which permits obtaining various pitches of screw threads without the use of loose change gears. (See Fig. 49.)

The screw thread chart is attached to the gear box, as shown in Fig. 50 below. This chart reads directly in threads per inch. It is only necessary to arrange the levers of the gear box as indicated on the index plate in order to obtain various screw threads and feeds.

The pitch of the thread to be cut is determined by shifting the sliding gear A, top lever B and tumbler lever C of the quick change gear box so that they conform with the thread cutting chart. For example, to cut 3 threads per inch the sliding gear A is pushed in, the top lever B on the gear box is pushed to the extreme left position and the tumbler lever C is placed just below the column in which the thread appears on the index chart. (See Figs. 49 and 50.)

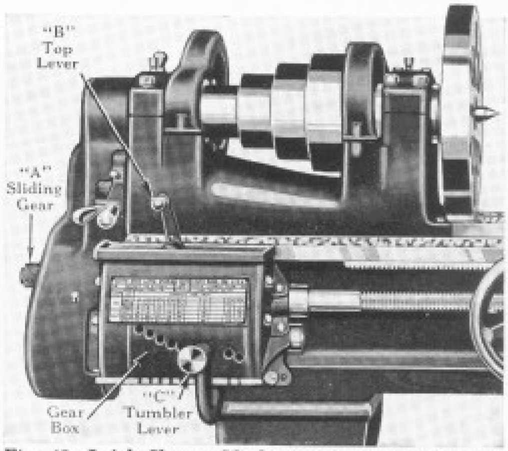


Fig. 49. Quick Change Mechanism used on all South Bend Quick Change Gear Lathes.

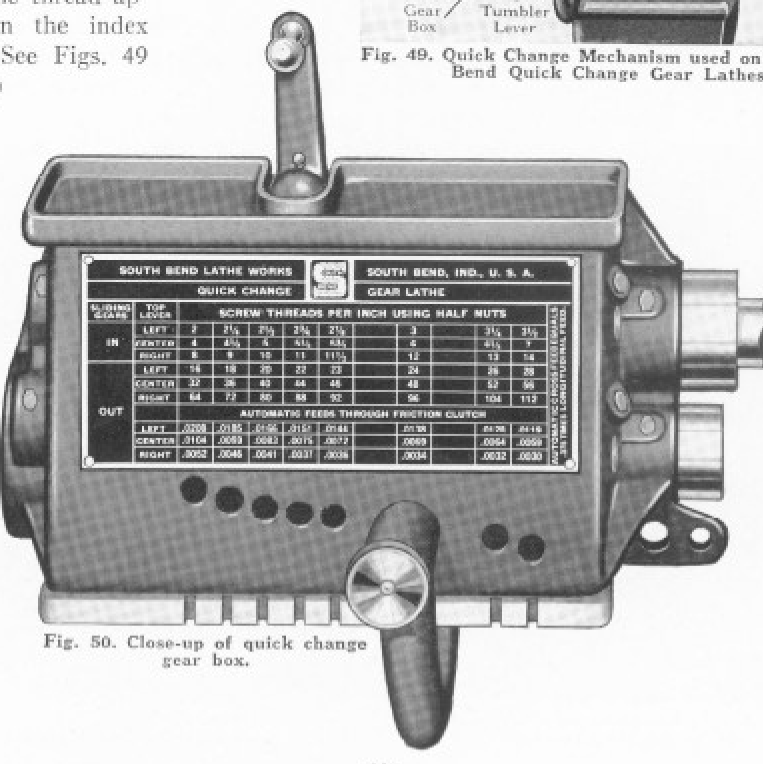


Fig. 50. Close-up of quick change gear box.

How to Calculate Change Gears for Cutting Screw Threads

If it is necessary to cut a special thread that does not appear on the index chart of a lathe or if no index chart is available, the gears required can easily be calculated. All South Bend Lathes are even geared; that is, the stud gear revolves the same number of revolutions as the headstock spindle, and when gears of the same size are used on both the lead screw and stud, the lead screw and spindle revolve the same number of revolutions, so it is not necessary to consider the gearing between the headstock spindle and the stud gear when calculating change gears.

If simple gearing is to be used, as shown in Fig. 51, the ratio of the number of teeth in the change gears used will be the same as the ratio between the thread to be cut and the thread on the lead screw. For example, if 10 threads per inch are to be cut on a lathe having a lead screw with 6 threads per inch, the ratio of the change gears would be 6 to 10. These numbers may be multiplied by any common multiplier to obtain the number of teeth in the change gears that should be used.

Rule—To calculate change gears, multiply the number of threads per inch to be cut and the number of threads per inch in the lead screw by the same number.

Example: Problem—To cut 10 threads per inch on lathe having lead screw with 6 threads per inch.

Solution— $6 \times 8 = 48$ — No. of teeth in gear on stud.
$10 \times 8 = 80$ — No. of teeth in gear on lead screw.

If these gears are not to be found in the change gear set, any other number may be used as a common multiplier, such as 3, 5, 7, etc.

When compound gearing, as shown in Fig. 52, is used, the ratio of the compound idler gears must also be taken into consideration, but otherwise the calculations are the same as for simple gearing. Usually, the compound idler gear ratio is 2 to 1, so that the threads cut are just twice the number per inch as when simple gearing is used.

Diagram Showing Simple and Compound Gearing

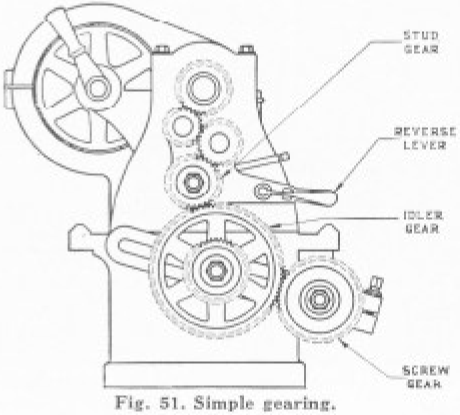


Fig. 51. Simple gearing.

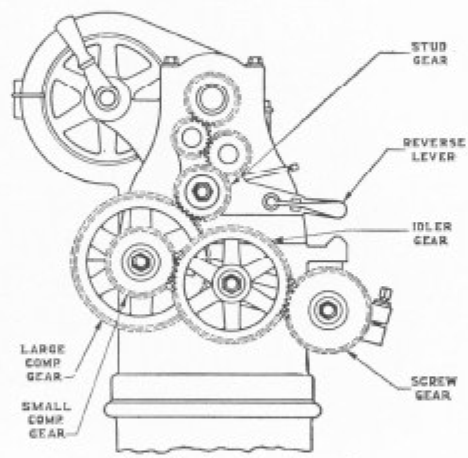


Fig. 52. Compound gearing.

Using Taps and Dies to Cut Screw Threads in the Lathe

Taps and dies are often used for cutting screw threads in the lathe, especially in factories where maximum production is important. There are several ways in which the lathe may be set up for this kind of work, as illustrated below.

Fig. 53 shows a common hand tap being used to thread a nut which is held in the lathe chuck. The handle of the tap wrench rests against the V way of the lathe bed, and as the lathe spindle revolves slowly the tail-stock hand wheel is turned to feed the tap through the nut. Plenty of oil should be used on the tap if the nut is made of steel.

Fig. 54 shows a self-opening die mounted in the tailtsock spindle of the lathe for cutting threads on studs. After starting the lathe spindle the tailstock is pushed by hand along the lathe bed until the tie takes hold and starts to cut the thread, after which the die will pull the tailstock along. A die holder can be made for the tailstock to hold common button dies, but if they are used it is necessary to reverse the lathe spindle when the end of the thread has been reached.

Fig. 55 shows a die mounted in the tool rest of the lathe. When mounted in this manner the lead screw and half nuts of the lathe may be used to feed the die so a perfect lead is obtained in the thread cut.

Fig. 56 shows a lathe equipped with special fixture for holding the work on the face plate, and a turret for holding drills, boring bar and taps for boring and threading the hole.

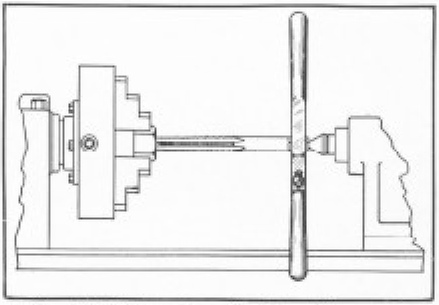


Fig. 53. Using a tap for threading a nut in the lathe.

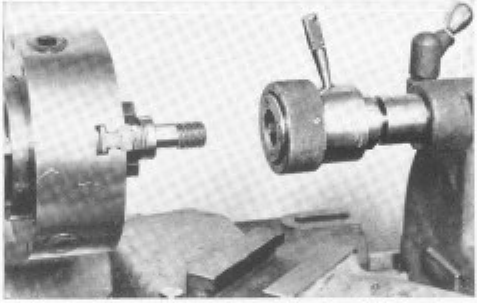


Fig. 54. Die mounted in tailstock of lathe for threading studs.

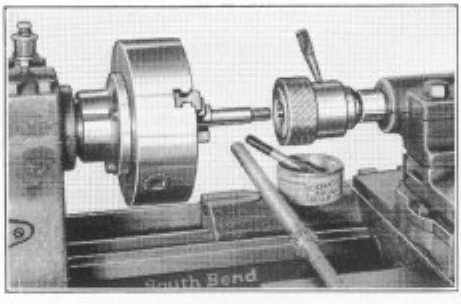


Fig. 55. Die mounted on lathe carriage for cutting accurate threads.

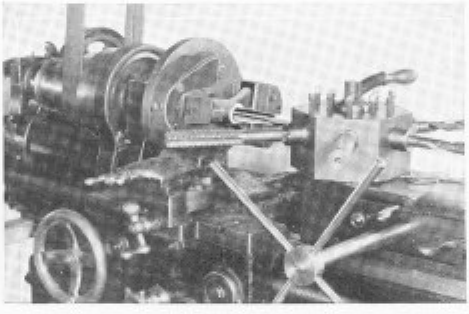
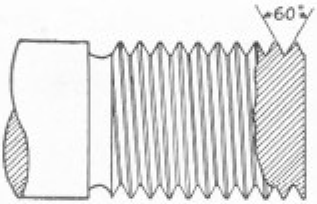
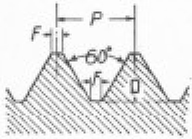


Fig. 56. Tap mounted in lathe turret for threading special nuts.

Standard Screw Thread Forms



AMERICAN NATIONAL SCREW THREAD
(Formerly U. S. Standard Screw Thread)

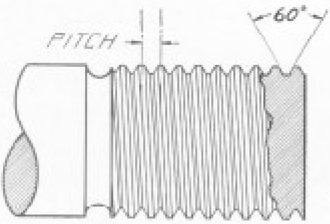


FORMULA

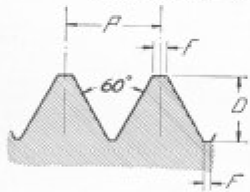
$P = \text{Pitch} = \dfrac{1}{\text{No. Th'ds. Per In.}}$

$D = \text{Depth} = P. \times .64952$

$F = \text{Flat} = \dfrac{P}{8}$



FRENCH AND INTERNATIONAL SYSTEM STANDARD SCREW THREAD

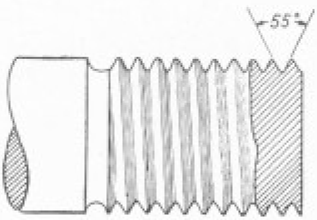


FORMULA

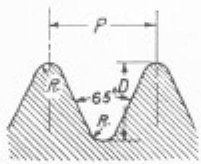
$P = \text{Pitch in MM.}$

$D = \text{Depth} = P. \times .64952$

$F = \text{Flat} = \dfrac{P}{8}$



WHITWORTH STANDARD SCREW THREAD

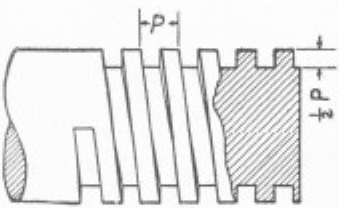


FORMULA

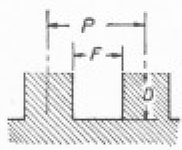
$P = \text{Pitch} = \dfrac{1}{\text{No. Th'ds. Per In.}}$

$D = \text{Depth} = P. \times .6403$

$R. = \text{Radius} = .1373P \dfrac{1}{\text{No. Th'ds. Per In.}}$



SQUARE SCREW THREAD

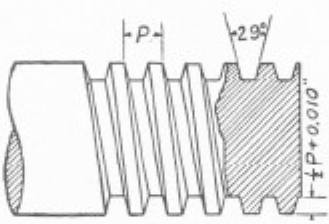


FORMULA

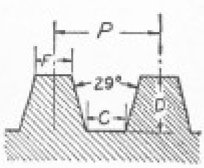
$P = \text{Pitch} - \dfrac{1}{\text{No. Th'ds. Per In.}}$

$D = \text{Depth} = P. \times .500$

$F = \text{Space} = P. \times .500$



ACME SCREW THREAD



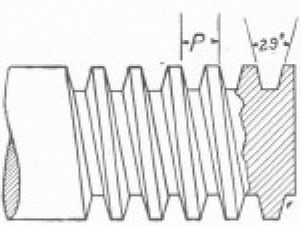
FORMULA

$P = \text{Pitch} = \dfrac{1}{\text{No. Th'ds. Per In.}}$

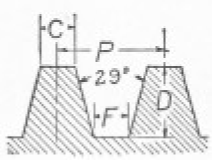
$D = \text{Depth} - \frac{1}{2} P. + .010$

$F = \text{Flat} = .3707 P.$

$C = \text{Flat} = .3707 P. - .0052$



BROWN & SHARPE 29° WORM SCREW THREAD



FORMULA

$P = \text{Pitch} = \dfrac{1}{\text{No. Th'ds. Per In.}}$

$D = \text{Depth} = .6866 P.$

$F = \text{Flat} = .31 P.$

$C = \text{Flat} = .335 P.$

"How to Grind Lathe Tool Cutter Bits"

BULLETIN NO. 35

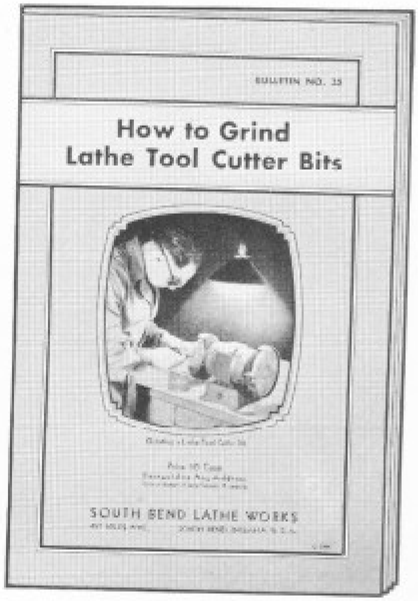
Shows How to Grind Correct Shape, Clearance, and Rake.

This booklet will be a big help to the beginner in lathe work as it shows just how to grind and sharpen lathe tool cutter bits for various classes of work. Contains a full size pattern of a gage for grinding the correct clearance, rake, angle, etc. on cutter bits.

Knowing how to grind cutter bits correctly is essential if metals are to be machined efficiently.

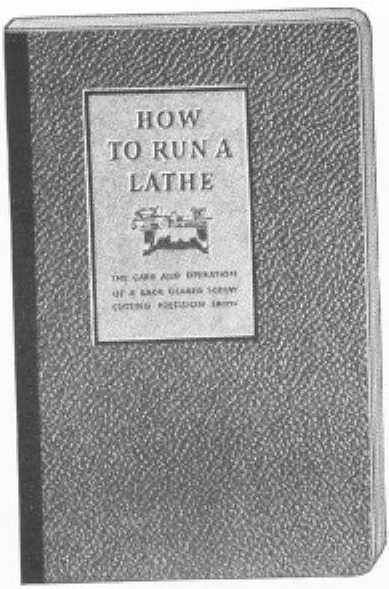
The amateur machinist will find this booklet valuable as a handy reference on cutter bit grinding. Contains 16 pages, size 6" x 9" and 50 illustrations.

Price 10c postpaid. Coin or stamps of any country accepted.



Contains 16 pages, size 6" x 9".

"How to Run a Lathe"



Contains 160 pages, size $5\frac{1}{4}$" x 8" and more than 300 illustrations.

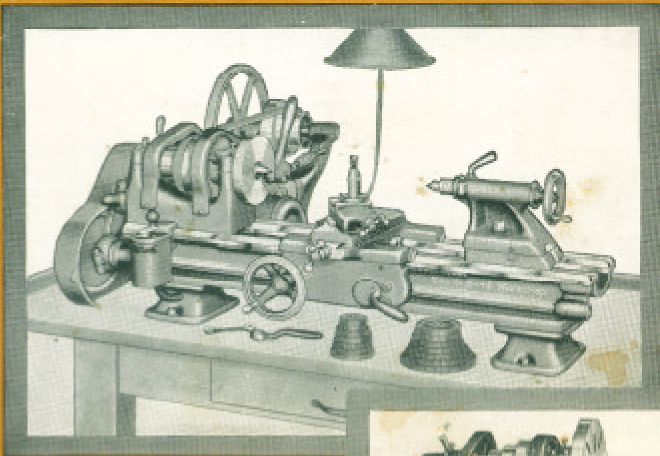
32nd EDITION

A Valuable Reference Book on Lathe Work

"How to Run a Lathe" is an authorative and instructive manual completely covering the care and operation of a back-geared, screw cutting lathe and gives the fundamentals of lathe operation in detail with illustrations. Contains 160 pages, size $5\frac{1}{4}$" x 8" and more than 300 illustrations.

More than 1,500,000 copies of this book have been printed and are in use throughout the world. Editions have been printed in English, Spanish, Portugese and Chinese. This book is used as a handy reference book by machinists and apprentices in industrial plants, and also used as a text book by students in educational institutions.

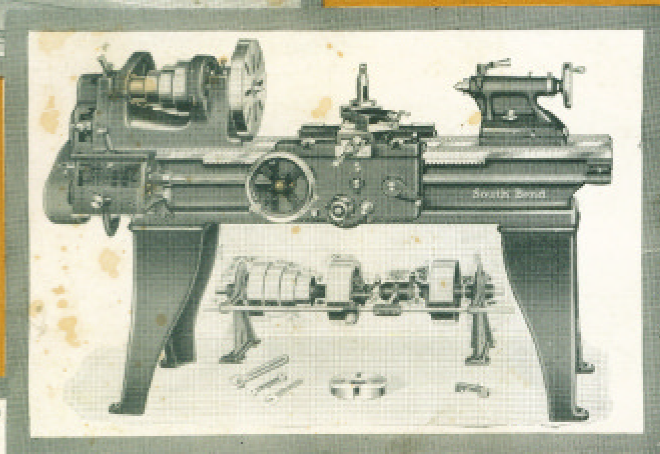
A copy of "How to Run a Lathe" will be mailed anywhere in the world postpaid, 25c for the paper bound copy, and 75c for the leatherette bound copy. Coin or stamps of any country accepted.



At Left—No. 415-YA 9″ x 3′ 1937 Model South Bend "Workshop" Adjustable Horizontal Motor Driven, Back-Geared Screw Cutting Precision Bench Lathe.

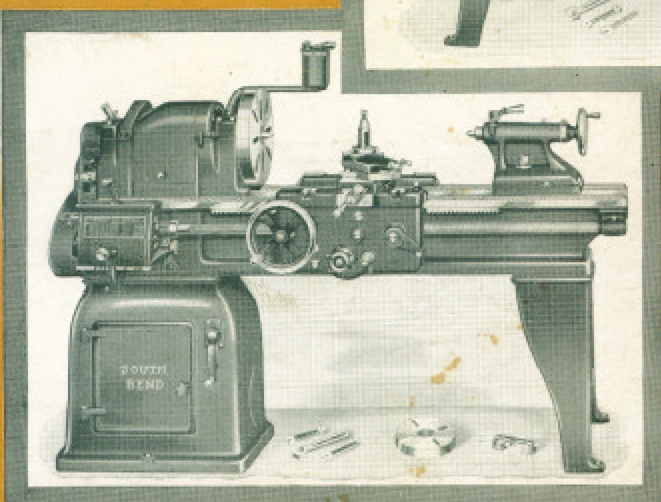
One of the finest small lathes we have ever built.

Prices of lathe, less motor drive, range from $75.00 up.



At Right—No. 17-C 16″x 6′ 1937 Model South Bend Overhead Countershaft Driven, Quick Change Gear, Back-Geared Screw Cutting Precision Lathe.

A popular type high quality precision lathe.



At Left—No. 117-C 16″ x 6′ 1937 Model South Bend Underneath Belt Motor Driven, Quick Change Gear, Back-Geared Screw Cutting Precision Lathe.

A practical, efficient and popular motor driven lathe.

Below—The plant of the South Bend Lathe Works at South Bend, Indiana. This organization was founded in 1906 and has grown and developed to an enterprise occupying the buildings shown here, which have a floor space of 180,000 square feet and with a ground area of 4½ acres devoted exclusively to the manufacture of South Bend Back-Geared Screw Cutting Precision Lathes.

South Bend Lathe Works
SOUTH BEND, INDIANA, U. S. A.

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