screw is even; if lead screw is odd, close the split nut on any inch distance from the stopping point.

4. For all odd threads close the split nut on any inch distance from the stopping point.

5. For half-threads (for example 11½ threads per inch), close the split nut any 2-in. distance from the stopping point.

It is advisable to mark the definite distance from the stopping point of the carriage, perhaps with a lead pencil on the ways of the lathe. Then when the carriage is run back by hand to this mark the split nut will properly engage the lead screw and the thread tool will track. This operation is often spoken of as *catching the thread.*

To Cut a Left-hand Thread. To cut a left-hand thread it is necessary to reverse the direction of rotation of the lead screw. This causes the carriage to move toward the tailstock with a forward motion of the spindle. When cutting a left-hand thread start the cut on the end of the thread nearest the dog (usually in a groove already turned) and cut toward the tailstock. Set compound rest 30 deg. to the left.

To Cut a Thread on a Taper. When cutting a thread on a tapering piece (for example, on a pipe) the thread tool should be set square with the *center line* of the piece to be threaded. The taper attachment is best and, if available, should be used; if one is not available, and the piece is provided with centers, the tailstock may be offset to give the desired amount of taper. If the work must be held in a chuck and the lathe is not provided with a taper attachment, a fairly good job can be done by slowly feeding the tool towards the operator as the work turns.

The Square Thread. For transmitting motion an Acme thread or a square thread is nearly always used, as for example on a lead screw or on a feed screw. These threads are much used for obtaining and maintaining pressure as on vise screws and jackscrews.

If one has learned to cut an American National thread intelligently, he should have no great difficulty in learning quickly to cut a square thread. That is, if it is understood that the centers must be true and in line; that the tool must be the right shape with sharp cutting edges, set accurately to gage and on center; that there must be room for the carriage to travel without interference from the

beginning to the end of the thread; that the gears must be right for the given pitch of thread; that the depth of the cut is important; and that smoothness of the finished thread is very necessary, then nine-tenths of the art of cutting any kind of thread has been learned.

The chief difference in cutting a 60-deg. thread and a square thread is in the tool, although it should be added that to cut a square thread probably calls for patience, carefulness, and strict attention to a somewhat greater degree.

The Square-thread Tool. Although the square-thread tool (Fig. 17-28*a*) looks something like a short cutting-off tool, it differs in

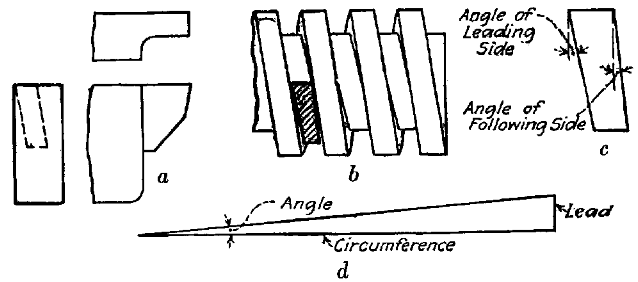

Fig. 17-28. The square-thread tool.

one very important respect: The blade is not square with the bottom as in a cutting-off tool but is canted to conform to the "slant"[3] of the thread. This is illustrated in Fig. 17-28*b*. Before attempting to make a tool for cutting a square thread one should know how to determine the correct amount of slant of the tool for the given thread.

The amount the tool slants depends upon two things: (1) The slant angle changes for each different *lead* of thread on a given diameter. The greater the lead the greater the angle. (2) It changes for each different diameter of thread of any given lead. The larger the diameter the less the slant.

In addition to the slant which the tool blade must have, it must be made thinner toward the bottom, otherwise it could not enter

[3] The reason that the thread slants is because it is a helix, and the amount the thread slants depends on the helix angle, "the angle made by the helix of the thread at the pitch diameter with a plane perpendicular to the axis."

the thread at all, let alone have clearance, because a piece with parallel sides cannot fit in a curved slot, and the groove of a square thread is a curved slot. The slant of the leading side of the tool therefore must be greater than the slant of the following side of the tool. But notice that both slant in the same general direction (Fig. 17-28*c*).

The amount of the slant of either side for any thread may be represented by a right triangle (Fig. 17-28*d*). One of the right-angle sides equals the *lead* of the thread and the other the *circumference* (1) of the minor diameter of the thread for the leading side, and (2) of the major diameter of the thread for the following side. The number of degrees of slant is measured between the hypotenuse and the side representing the circumference (Fig. 17-28*d*). (The triangle may be drawn to larger scale if desired.)

EXAMPLE: Find the slant of the following side and of the leading side of the blade of a tool for cutting 1¼ in.–4 square threads.

SOLUTION:

Lead equals 0.250 in.
Major diameter = 1.250 in.
Minor diameter = 1.000 in.
1.250 in. × 3.14 = 3.92 in. = circumference (major diameter of thread).
1.000 in. × 3.14 = 3.14 in. = circumference (minor diameter of thread).

Draw a right triangle, one right-angle side equal to 0.250 in. (lead) and the other equal to 3.92 in. (circumference of major diameter); draw the hypotenuse and measure the angle between the circumference line and the hypotenuse. It will equal 3⅔ deg. as nearly as can be measured with a bevel protractor. This is the angle of the following side. Draw another right triangle with *L* (lead) equal to 0.250 in. and *C* (circumference) equal to 3.14 in. (circumference at the minor diameter of thread); draw the hypotenuse and measure the angle. It will equal 4½ deg. as nearly as can be measured with the protractor. This is the angle of the leading side.

Another way of finding the slant angles of a square-thread tool is by means of a simple calculation if a table of tangents is at hand.

On the next page the above example is solved by this method. The portion of the table of tangents given is sufficient for any square thread.

Clearance. Theoretically a cutting-off tool need have no side clearance, but for practical purposes it must be given clearance, say, 1 deg. on each side, or it will rub. In the same way a square-thread tool must have clearance; *in addition to its theoretical shape* it must be made still thinner at the bottom, say, about 1 deg. on each side (Fig. 17-28*b*). Suppose the square-thread tool in the example just solved is given 1-deg. clearance on each side; then the angle to grind on the leading side will be the calculated angle *plus* 1 deg. (4½ deg. plus 1 deg equals 5½ deg.), and on the following side the angle will be 1 deg. *less* than the calculated theoretical angle (3⅔ deg. *minus* 1 deg. equals 2⅔ deg.). This is illustrated in Fig. 17-29. It is difficult at first to reason why the clearance on a square-thread tool is plus on one side and minus on the other, but it is very necessary to understand it. It is a typical machine-shop problem.

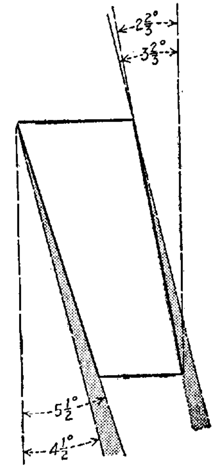

Fig. 17-29. Showing the *theoretical* and the *clearance* angles for a 1¼-in., four square threads.

Suggestions. Have the tool a trifle wider than half the pitch, say, 0.003 in. on a quarter-inch pitch thread (tool, 0.125 plus 0.003 in.).

Most machinists prefer to grind the tool in a surface grinder or in some other exact way rather than by hand.

If impracticable to grind it, then file the annealed tool to shape and harden and temper it.

If many threads are to be cut, it will be advisable to set a blade of the right thickness in a toolholder having a slot milled to fit the blade and at an angle to conform to the slant of the thread. The part of the blade that projects from the holder may be given clearance by grinding a little on each side, making it a little thinner at the bottom. Do not, however, change the thickness of the top of the tool, that is, the width of the cutting edge.

Cutting a Square Thread. The operation of cutting a square thread differs in no particular respect from cutting an American National thread. If the thread is half-inch pitch or greater it is usually advisable to cut it somewhat narrower with a stocking tool before finishing. Some mechanics prefer to finish the sides of the thread with a side tool; others prefer the regular square-thread tool ground to full size. In any event the object is to secure a thread with smooth sides. Proceed as follows:

OPERATION SHEET

1. Set the work in the lathe. Be sure the centers are in line. Tighten the dog on the work securely, using a protecting piece of soft brass or copper, and adjust the work fairly tight between centers with plenty of oil (check up on this adjustment occasionally because the strain of the cut tends to enlarge the dead-center hole).
2. Set the compound rest at an angle 30 deg. to the right. This is to get it out of the way of the cross-feed handle, and to be able to use it later if necessary to catch the thread.
3. Set the lathe for lead of thread desired; oil lead screw and ways.
4. Set the tool to the left of the tool rest, on center and square.
5. Put in the split nut and "cut air" to the end of the thread. This is to make sure that there is room for the travel of the carriage to the end of the thread, and also that the thread will end exactly in the center of the hole, if a hole has been drilled for this purpose. If necessary move both the compound-rest feed and the cross feed until the thread ends exactly in the hole.
6. Run the tool in to touch the work, note the graduation, and calculate what the graduation should read when the thread is cut the full depth (depth equals one-half pitch plus three or four thousandths for clearance).

   Square- and Acme-threaded screws are frequently designed to permit the end to be turned for a distance of 1/16 in. or more to the minor diameter size. This helps in determining when the thread has been cut full depth. The tool as set for the thread may be used to turn this short shoulder distance.
7. If the length of the thread warrants it, use the chasing dial.
8. Proceed to cut the thread full depth and fit to a nut or gage. Feed-in for each cut will depend upon size of thread, say, 0.005 to 0.010 in. for a 1/4-in. pitch. Use lard oil or cutting compound.

The Square-thread Tap. A tap may be used to finish the inside thread; or several taps, each succeeding tap being larger, should be used to cut the smaller threads, especially when fairly long in proportion to diameter.

When making a square-thread tap the thread is somewhat wider than the groove in order that the screw that goes into the tapped hole will have a trifle clearance on the side. Also the diameter of the tap should be a few thousandths oversize to prevent the outside of the screw thread from rubbing in the tapped hole. Further, the groove should be cut a trifle deeper than the root diameter because this part of the tap does not cut since the hole for the thread is bored at least full root-diameter size. Great care must be taken to back off the sides and top of a square-thread tap clear to the cutting edge, but only a very little. If too much clearance is given a tap, chips will wedge between the tap and the thread when turning the tap backward thus scoring and perhaps spoiling the thread.

The Acme Thread.[4] The Acme thread (Fig. 17-30) is intended to take the place of the square thread because (1) it is easier to cut

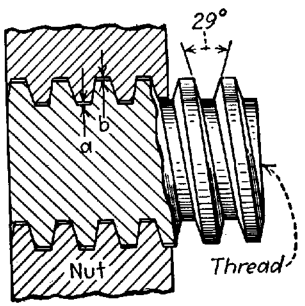

Fig. 17-30. Acme screw in nut: *a*, clearance of 0.010 in. is obtained by cutting the thread 0.020 in. larger than the major diameter of the screw; *b*, clearance of 0.010 in. is obtained by making the major diameter of the tap 0.020 in. larger than the major diameter of the screw.

Acme threads with taps and dies, and (2) the Acme thread is stronger.

It is important to know about the standard clearance in Acme threads. The bearing between any screw and nut is on the *sides* of the threads, and clearance is provided between crest and root, in American National form, square, Acme, and other shapes. The *tap-drill size*, that is, the hole in the nut, is made large enough and the major diameter of the tap is made enough oversize to take care of the clearance.

[4] Table of Acme threads, page 534.