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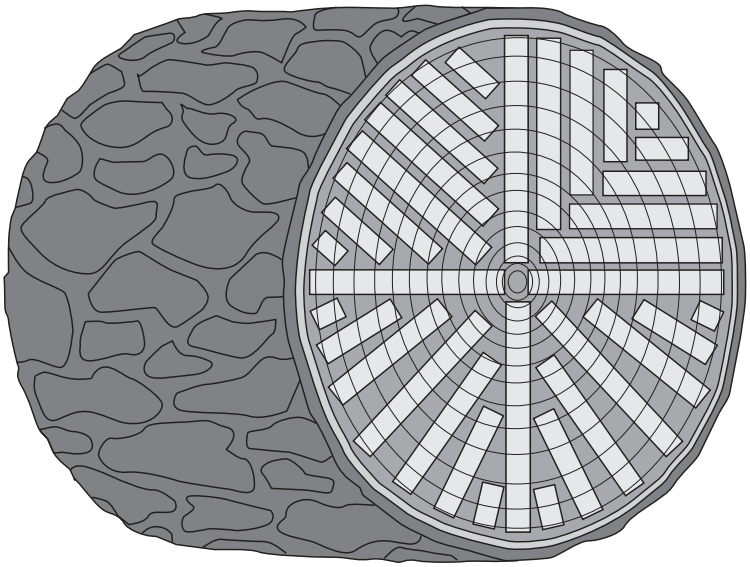
Agricultural Extension Service
The University of Tennessee

PB1693

Sawing Logs for Quartersawn Lumber



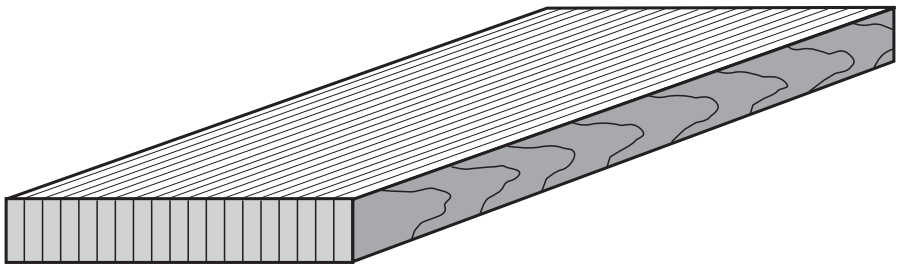


Table of Contents

What Does Quartersawn Mean? 3
- Planes of Reference 3
- Terms Quartersawn and Plain-sawn 4
- Characteristics of Quartersawn and Plain-sawn Lumber 5
- Drying Characteristics 5

Producing Quartersawn Lumber 6

Quartersawing on Sawmills with Carriages 6
- Procedure for Quartersawing 16-19 inch Diameter Logs 7
- Procedure for Quartersawing 20+ inch Diameter Logs 7

Quartersawing on Portable Sawmills with a Stationary Log Bed 8
- Procedure for Sawing Logs on a Portable Sawmill (method 1) 8
- Procedure for Sawing Logs on a Portable Sawmill (method 2) 9

Sawing Logs for Quartersawn Lumber

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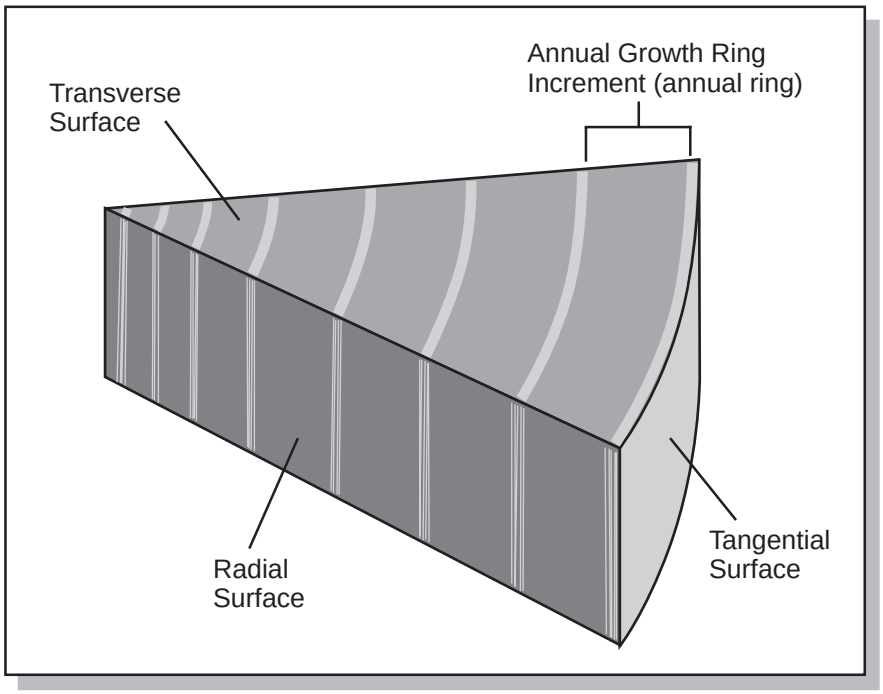
Hardwood lumber producers are constantly looking for ways to increase the value of their products. One way to increase lumber value is to saw logs using a method that will produce quartersawn lumber where growth rings appear parallel to one another on the wide face of the board. Quartersawn lumber is more valuable than lumber sawn using other methods and is very desirable for applications such as furniture and cabinet making. This publication describes quartersawn lumber, explains how it differs from lumber with other grain patterns and details several methods for producing quartersawn lumber on either a sawmill with a log carriage or a portable sawmill with a stationary bed.

What Does Quartersawn Mean?

A particular surface of wood can be classified into one of three categories, or geometric planes of reference: transverse, radial and tangential (**Figure 1)**. These reference planes differ based on the orientation of cells and the types of cells that can be viewed on wood surfaces cut along each plane. The cross sectional or transverse plane is produced by cutting the cells perpendicular to the direction of growth in the tree. Lumber cut along this plane would be viewed at the ends of a board. The radial plane passes through the center of the tree outward towards the bark. Since the radial plane passes through the center of the tree, the cross section of which is essentially a circle, it is following a radius, hence the name radial section. The radial plane of many species has a specific desirable figure created by the wood rays. Wood rays are cellular structures that carry water and nutrients from the living tissue under the bark to wood cells located toward the center of the tree. When lumber is produced with the wide surface showing the radial plane, these wood rays can often be clearly seen. The visibility of rays in the radial plane will vary, depending on the species and the angle of the growth ring to the wide surface of the board. For example, the small rays in yellow-poplar are not vis-

Figure 1. Planes of Reference



ible in a quartersawn board, but in red and white oak the rays are large and visible. Oak is one of the most popular quartersawn species. The figure created by the wood rays is very desirable for specific styles of furniture and cabinets.

The tangential plane lies perpendicular to the radial section. The tangential plane forms tangents to the growth rings; hence the name. The ends of the narrow wood rays in the tangential plane are very difficult to see without a hand lens or microscope.

Lumber that has its widest face in the radial plane is called *quartersawn*. In quartersawn lumber, the edges of the growth rings emerge at the wide surface. When viewed from the cross section of the board, the growth rings appear vertical (**Figure 2a**). The terms *quartersawn, radial grain, edge grain, vertical grained quartergrain* or *rift-grain* all relate to lumber in which the growth rings oriented to form angles between 45 to 90 degrees with the wide or top surface.

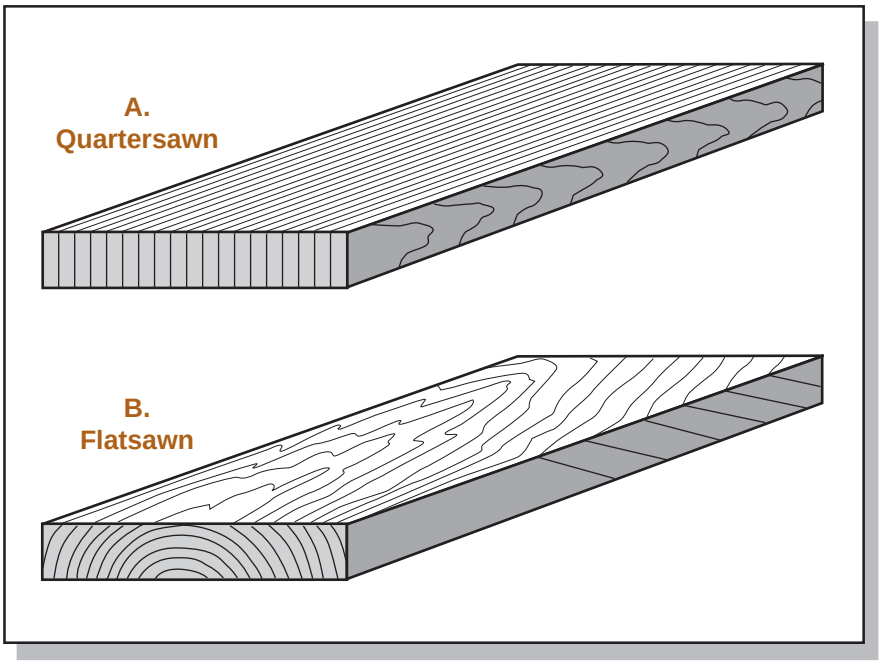
The terms that describe quartersawn lumber are often confusing, because the figure produced from splitting the wood ray is not usually as pronounced in wood with the growth rings forming lower angles (45-75 degrees) with the wide surface of the board as with wide rays at the steeper angles (75-90 degrees). The terms "*fully quartersawn*" or "*fully riftsawn*" are often used when the angle of the growth rings to the widest surface is between 75 and 90 degrees.

Confusion often arises, since there are many terms used to describe quartersawn lumber, and occasionally terms will be interchanged to compare quartersawn with "fully quartersawn." To add to the confusion, several institutions have published differing definitions concerning quartersawn lumber. The U.S. Forest Service and Forest Products Laboratory defines quartersawn as lumber with growth rings at angles of 45 to 90 degrees to the widest face. The National Hardwood Lumber Association (NHLA) states that quartersawn red oak, white oak and locust will have 90 percent of one face of the required cutting area show figure. As defined by the NHLA, the figure produced from splitting the wood ray in the radial surface should be visible on 90 percent of the wide face.

Flat-sawn, plain-sawn, flat-grained, tangentially grained, plain-grained or *slash-grained* relate to lumber with growth ring orientations from 0 to 45 degrees to the widest face **(Figure 2b).** Often in plain-sawn boards, the surfaces next to the edges are far from being tangent from the rings. *Mixed-grain* refers to quantities of lumber that have both *edge-grain* and *flatsawn-grain* in the same piece. Hardwood lumber in which annual rings make angles of 30 degrees and 60 degrees with the wide surface is sometimes called "*bastard sawn*."

Quartersawn lumber usually brings a higher price than plain-sawn boards. Hardwoods, especially oak, are often quartersawn, since the exposure of the rays produces a figure greatly sought for special furniture and cabinet making. Quartersawn boards cup less during drying, the radial surfaces have more uniform wearing and finish properties, and the boards have greater dimensional stability across the width. However, quartersawn boards require more time to produce, and the sawing methods produce more waste. Defects such as knots are more likely to occur along the wider boards,

Figure 2. Orientation of Annual Rings as Influenced by Sawing



especially in smaller logs. Much of the outer clear material in the log, which is usually defect-free, will be found in the narrowest boards.

The purposes for quartersawing lumber are to show the figure in the wood, to secure a hard-wearing surface that will not splinter and to secure material that will hold its shape with minimum shrinkage and warping. Since quartersawn lumber is more dimensionally stable, it is often used for siding and exterior exposure. Wood exposed to weather experiences wide ranges of relative humidity and periodic wetting that lead to equally wide ranges of swelling and shrinking. For this reason, vertical or edge-grained surfaces are far better than flat-grained surfaces for all species.

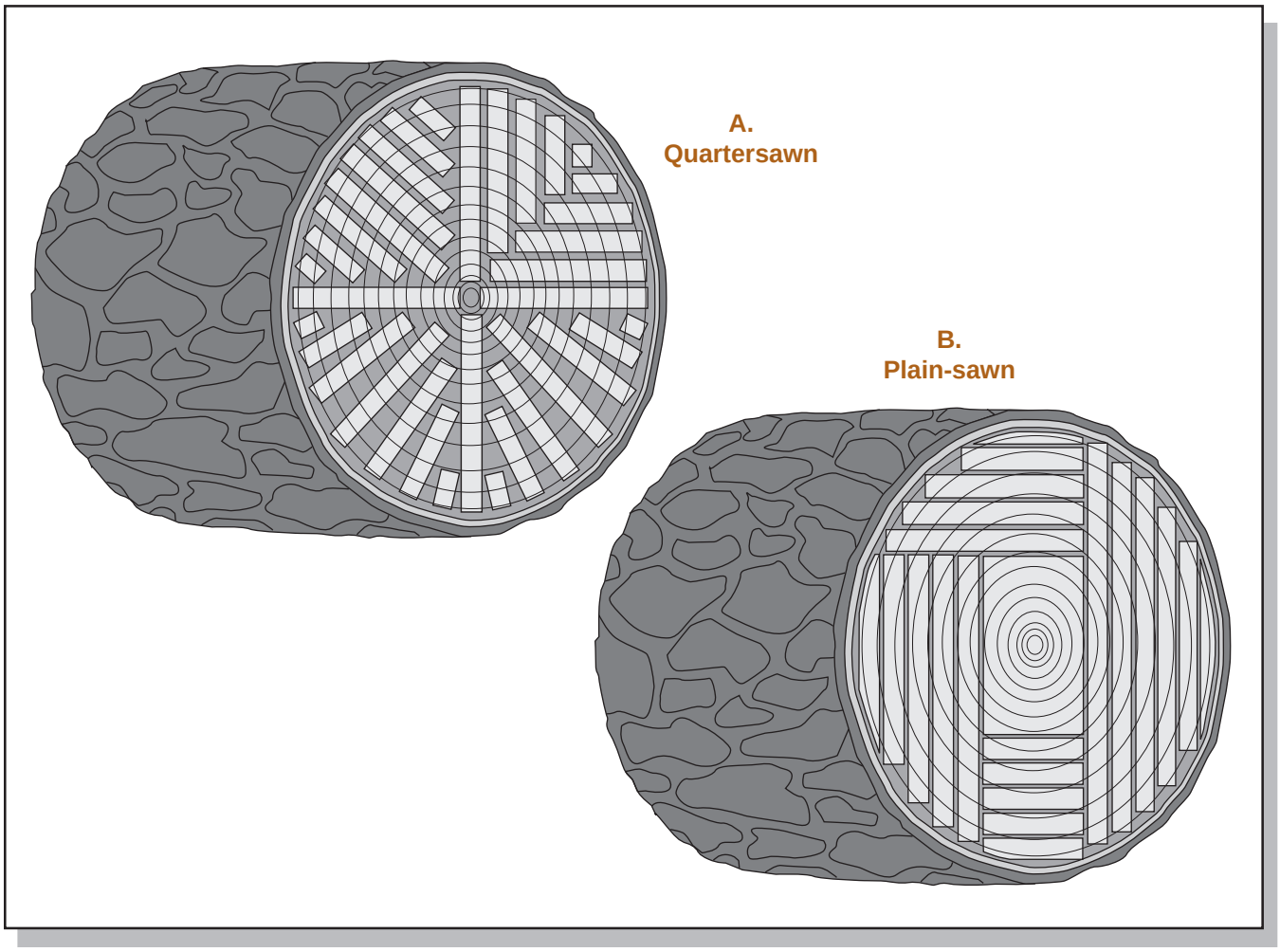
Quartersawing is most appropriate for fairly large or reasonably clear logs, or where products need not be very wide (as in strip flooring). Smaller producers of quartersawn lumber will benefit greatly by identifying a local market of custom woodworkers who will accept narrow boards.

Drying characteristics: Quartersawn lumber dries much slower than plain-sawn lumber; however, it is less susceptible to drying defects such as surface checks, end checks and honeycomb. When large quantities of quartersawn lumber are dried, they should be separated from plain-sawn lumber because of differences in drying time.

Table 1. Characteristics of Quartersawn and Plain-sawn Lumber

Plain-sawn Lumber	Quartersawn Lumber
Figure patterns resulting from the annual rings and other anatomical patterns are brought out more conspicuously.	Quartersawn lumber shrinks and swells less in width than plain-sawn lumber.
Round or oval knots that may occur in plain-sawed boards will affect the surface appearance less than spike knots that may occur in quartersawn boards. Also, a board with a round or oval knot is stronger than a board with a spike knot.	Twists and cups less. Surface checks and splits less during drying and in use.
Shakes and pitch pockets, when present, extend through fewer boards.	Raised grain caused by separation in annual rings does not become so pronounced.
Less susceptible to collapse in drying.	Wears more evenly.
Shrinks and swells less in thickness.	Types of figure due to pronounced rays, interlocked grain and wavy grain are brought out more conspicuously.
May cost less because it is easier to obtain.	Does not allow liquids to pass into or through it so readily in some species.
	Holds paint better in some species.
	The sapwood appearing in boards is at the edges and its width is limited according to the width of the sapwood in the log.

Figure 3. Patterns for Producing Lumber



Producing Quartersawn Lumber

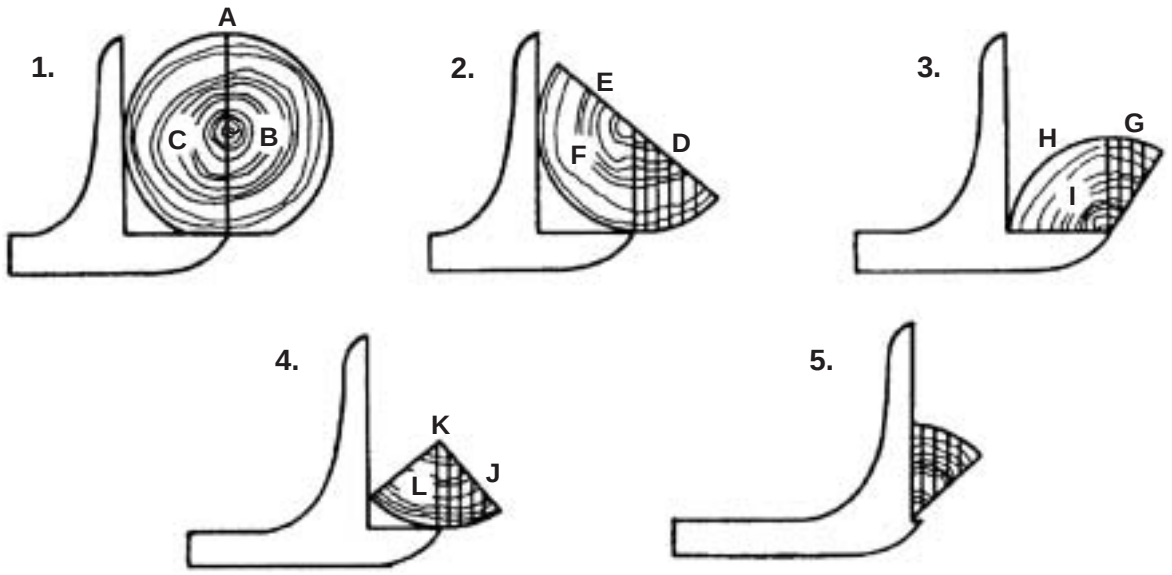
Logs are typically sawn by removing boards from the outside of the log and continually turning the log 90 degrees, resulting in mostly plain-sawn lumber (**Figure 3b**). When quartersawn lumber is desired, the log must be cut in such a way that the growth rings of the log will be oriented 45-90 degrees to the widest face in the lumber produced (**Figure 3a**). Since most sawmills are designed to cut 90-degree planes, it would appear that quartersawing is only possible for the center of the log and its 90-degree axis or with the use of special equipment. However, several procedures have been developed that cut large quantities of quartersawn lumber with minimal waste.

Some methods of producing quartersawn lumber yield a greater percent of lumber than others. Often the sawing methods that result in the most "fully quartersawn" lumber produce the least total amount of yield. Producing lumber that is all "fully quartersawn" is a wasteful process and can lead to losses of 20 percent or more of the log volume as compared to yields from plain-sawing. The choice of quartering method is usually based upon the size of the log and the sawing equipment used. It is seldom profitable to quarter saw logs under 16 inches in diameter because of excessive waste. The following sawing methods are broken down into (1) methods for sawmills with carriages and (2) methods for portable sawmills with stationary log decks.

Quartersawing on Sawmills with Carriages

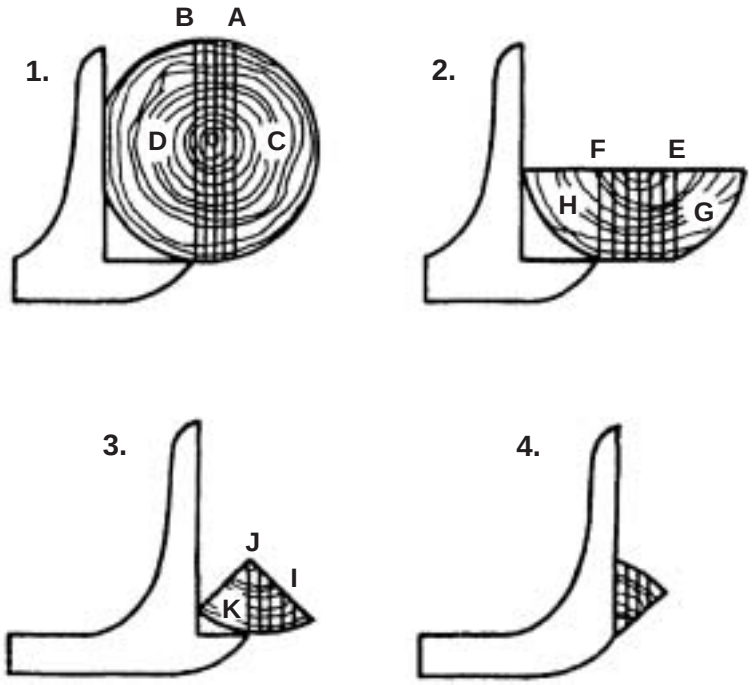
Two methods are recommended for quartersawing lumber with a log carriage for either a band saw or circular saw head rig (**Figure 4 and Figure 5**). These methods differ based on the size of the log to be sawn.

Figure 4. Procedure for Sawing Logs 16-19 Inches in Diameter



1. Slab the log on one side and turn that side down on the headblocks; split the log at (A) and drop cant on the log deck.
2. Turn cant (C) to the position shown and beginning at (D); cut boards to the heart at (E).
3. Turn cant (F) to the position shown and beginning at (G), cut boards to the heart at (H).
4. Turn the cant (I) to an angle of 45 degrees to the headblocks and beginning at (J), cut the boards to (K) or until cant (L) has a sharp point.
5. Turn cant (L) to the position shown, cut boards until finished, cut cant (B) the same as cant (C).

Figure 5. Procedure for Sawing Logs 20 Inches in Diameter and Over

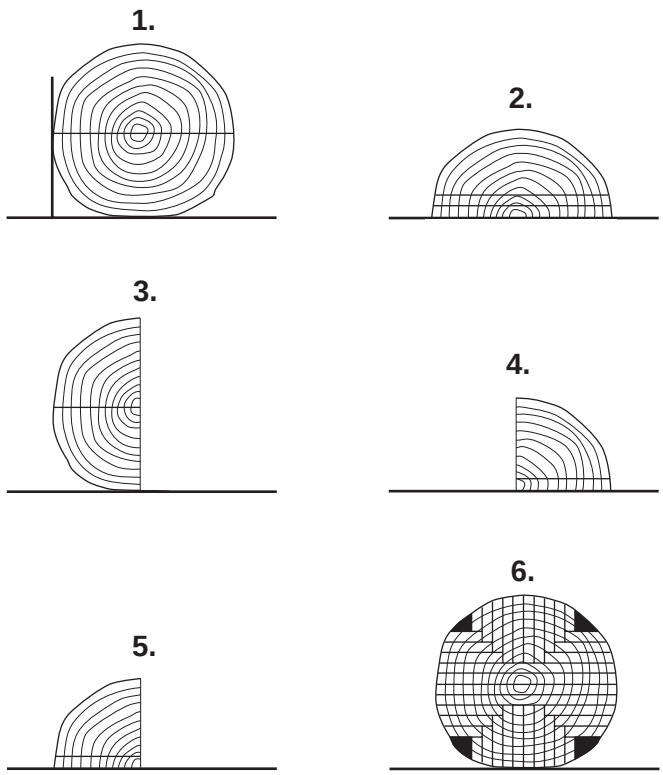


1. Slab the log lightly on one side and turn that side against the knees, beginning at (A), slab heavy and drop the cant (C) on the log deck; cut boards the full width of the log to (B), continue cutting as long as boards show a satisfactory quartered figure.
2. Turn cant (D) with the lightly slabbed face on the headblocks and beginning at (E), slab heavy and drop cant (G) on the log deck; cut boards to (F) as long as they show satisfactory quartered figure.
3. Turn cant (H) at an angle of 45 degrees to the headblocks and beginning at (I), cut the boards to (J) or until cant (K) has a sharp point.
4. Turn cant (K) over, align as shown and cut boards until finished; cut cant (G) the same as cant (H), cut cant (C) the same as cant (D) except that the wide face is turned down on the headblocks.

Quartersawing on Portable Sawmills with a Stationary Log Bed

Two methods are recommended for quartersawing lumber on a portable sawmill with a stationary bed (**Figure 6 and Figure 7**). These methods vary based on the size of the log to be sawn, the equipment used and the desired width of the boards produced. Variations include slabbing the outside of the log to produce a better bearing surface.

Figure 6. Procedure for Sawing Logs on a Portable Sawmill (method 1)



1. Align one end of the log so that the blade will cut through the center of the log (to set taper). Cut through the log center. Then remove half of the log.
2. Remove several boards from the bottom of one of the halves.
3. * Place the log on edge and quarter the halves. Then remove one quarter.
4. * Saw a board off the bottom of one quarter.
5. * Rotate the quarter 90 degrees and saw another board. Return 90 degrees and saw the next board. Continue to rotate the quarter until all merchantable lumber has been sawn. Repeat with all quarters.

* A common variation is to cut two quarters at the same time to save time and labor.

While the techniques to produce quartersawn lumber require the use of more labor and produce more waste than conventional sawing methods, the lumber produced has a greater value. For green, 4/4-inch red oak, the value of quartersawn lumber can be 5-13 percent greater than plainsawn, and for green, 4/4-inch white oak, the difference ranges between 16-46 percent. Of the many methods that have been used to produce quartersawn lumber, those presented are known to produce a significant amount of quartersawn material with minimal waste.

Two important aspects of selling quartersawn lumber are to make sure that the customer and sawyer understand the difference of quartersawn and "true quartersawn" material and to identify potential users for the many narrow, defect-free boards that will be produced. For more information on sawing logs into lumber and short courses concerning lumber production hosted by the University of Tennessee and the Tennessee Forest Products Center, please contact:

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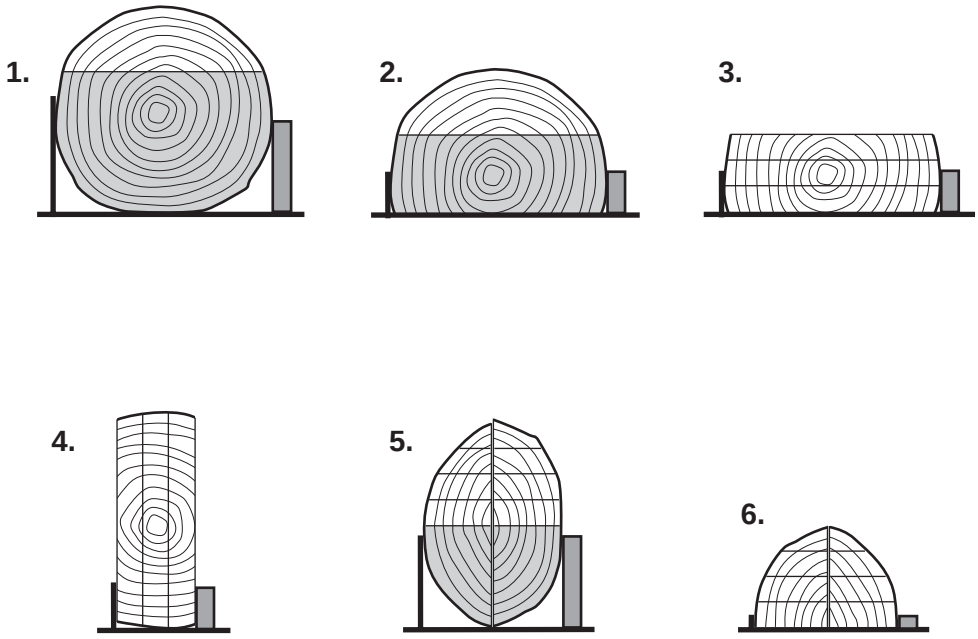
Figure 7. Procedure for Sawing Logs on a Portable Sawmill (method 2)



1. Set the taper and then align the blade and remove 1/3 of the log. Then set the cut 1/3 aside.
2. Turn the log and remove another 1/3. Set the cut 1/3 aside.
3. Saw the log center into boards.
4. Remove pith from the center boards.
5. Place the two 1/3 log cuts together and saw boards out of the top half.
6. Turn the remaining pieces 90 degrees and saw the remaining boards.

NOTES

NOTES

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