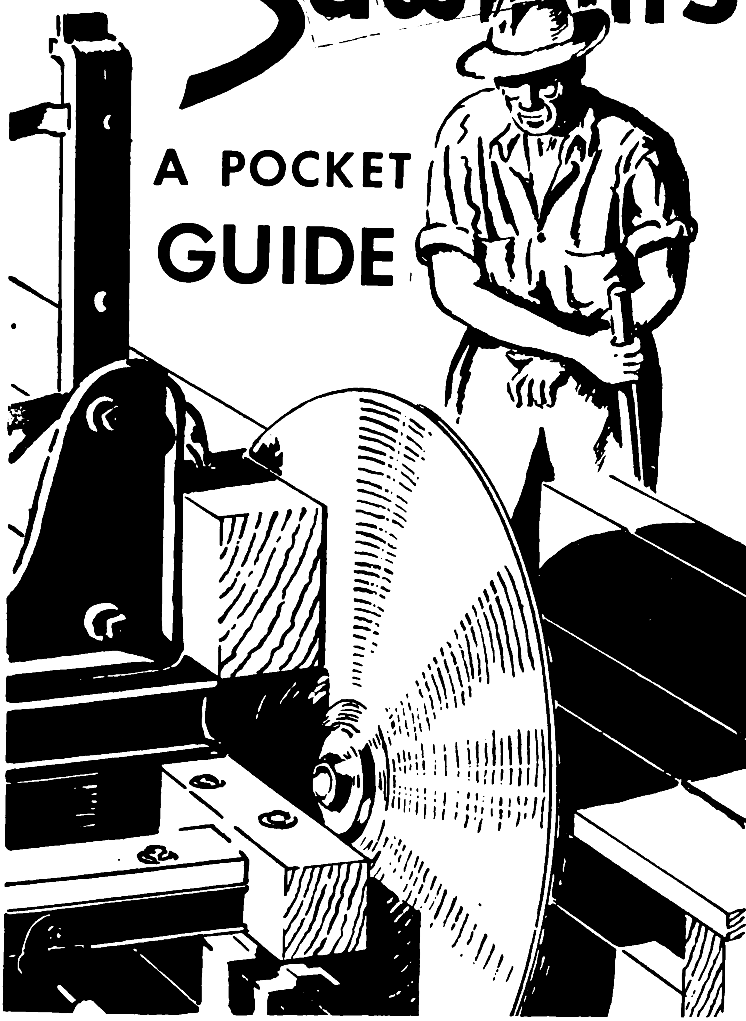
Small Sawmills

A POCKET GUIDE



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CONTENTS

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Small Sawmills: A Pocket Guide

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INTRODUCTION

Small sawmills play an important part in the harvesting of our timber crop. If properly installed and maintained, they can be an important asset in the general progress toward more efficient utilization of our forests.

For many years, the Forest Products Laboratory has studied ways to improve the efficiency of small sawmills. This guide, based on the results of these studies, is intended to serve as a handy reference for the operators, foremen, and workers of small mills. It contains suggestions for setting up a mill, keeping it in good condition, and increasing its output—thereby leading to the more efficient utilization of wood.

WHERE TO PUT THE MILL

For an unfloored mill placed directly upon the ground, choose an area about 30 feet by 80 feet where soil conditions assure a firm base that can be easily leveled and freed of obstructions. A downslope to the deck where the logs are delivered and adequate space for delivery are desirable; a sharp downslope outside the trackway helps in getting rid of sawdust and slabs. Finally, if lumber is package loaded, a drop of approximately 4 feet immediately back of the mill is necessary.

HOW TO SET UP THE MILL

Sills

For the sills or bed timbers of the foundation, choose timbers big enough to support the husk. These should be heartwood of a decay-resistant species. If an edger is to be used, double the sill thickness in order to make the rolls behind the saw level with the

[1] Maintained at Madison, Wis., in cooperation with the University of Wisconsin.

edger table. To do this, bolt two 10- by 10-inch sills together where 10- by 10-inch sills are normally used. The sills should be long enough to extend from the pulley side of the husk to about 1 foot outside the trackway. Lay sills in place as guides to mark the area for the sawdust pit, dig the pit, and drive or embed 10- by 10-inch supports for each sill at the trackway end (fig. 1). The tops of these supports should be at the proper height to support 4- by 8-inch caps under the sills (fig. 1), when the sills are leveled and bedded in the ground about 6 inches.

Husk

Bolt the husk to the sills and bed the sills in earth about 6 inches deep. The sills and husk must be leveled lengthwise and crosswise and must rest on a firm foundation throughout. Put a false lid on the saw compartment of the husk from the saw to the midbrace, in order to prevent chips and bark from fouling the saw. Construct this lid so that it will stay in place; for example, use hinges at the midbrace edge. The lid should extend to within 1/8 inch of the saw plate, and its top should be below the level of the top of the front and back roll bars on the husk.

Trackway Supports

For each track to be laid over the pit, place a cross support that extends from sill to sill and rests on 10- by 10-inch blocking (fig. 1). Grade a level bed for the stringers that support the ties on which the trackway rests. The top of the husk sills is the control level for the top of the ties—about 14 inches above the ground. Any combination can be used to insure this height, such as 6- by 8-inch stringers plus 8- by 8-inch ties. Use a level to make sure that the stringers are leveled lengthwise and crosswise. Place ties at 2-foot intervals.

Laying the Trackway

Bolt the center track section to the husk sills and ties. It must be parallel to the husk and fixed so that the end of the headblock base clears the saw by 1/2 to 5/8 inch, when the top of the headblock base is about 1 inch above the saw collar. Some manufacturers provide metal brackets for fixing this husk-sill-track relationship. Blocks and wedges, as shown in figure 1, are used for adjusting and holding the relationship. Level the tracks both lengthwise and crosswise as bolts to sills and ties are tightened. Anchor the other sections of the track, and check on their alinement with the central section and on the lengthwise and crosswise leveling.

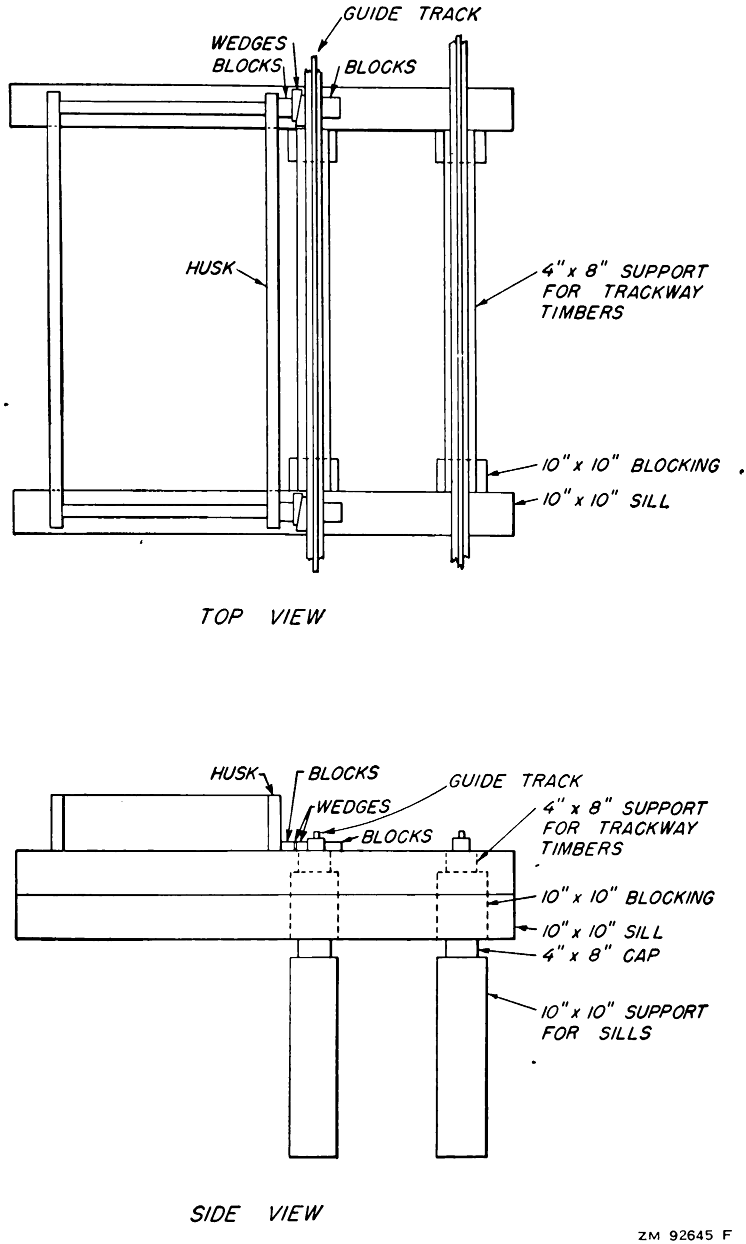

Figure 1.—Details of supports of mill at sawdust pit.

Carriage

Before placing the carriage on the tracks make sure that the guide-track wheels have no side play. Collars on the axles at the guide-track wheels should be snug against the hubs but should not bind. Wheels on the other track may have side play. Place the carriage on the tracks at the deck section.

Connecting the Carriage Cable

Connect the carriage cable as follows: Fasten one end of the cable to the attachment under the front end of the carriage, and bring the cable back under the carriage and over the sheave at the deck end. If the sheave wheels are vertical, the cable goes over the top of the sheave and returns at the bottom; if the wheels are horizontal, the cable enters the groove at the outside-track side of the sheave and leaves it at the opposite side. Thread the cable around the drum, starting near the outside-track end and passing the cable over the top and around the drum for three or more wraps. After the final wrap the cable should leave the drum at the top, pass through the other sheave, and be anchored to the attachment under the back end of the carriage (fig. 2). The cable should be taut.

Final checks on the fitness of the carriage are made after the saw is hung and connected to the power source.

Power Unit With Flat Belts

Place the power unit so that its shaft is absolutely parallel to the mandrel. If flat belts are used, the distance between the drive shaft and the driven shaft should be approximately 25 feet. A rider to depress the slack (top) portion of the belt should be placed near the pulley most subject to belt slippage; this one is the smaller if the pulleys are of similar material. An idler pulley ahead of the drive pulley usually serves the same purpose more efficiently. It is advisable to use an uncrossed belt drive. If the rotating direction of the power-unit pulley would require a cross-belt drive, this can be avoided by facing the power unit in the other direction, lengthening the mandrel if necessary. Anchor the power unit to the ground with pins or stakes to prevent creep from belt pull. Likewise, anchor the husk sills near the driven pulley.

Power Unit With V-Belts

For V-belt drives, the pulleys must be exactly alined. The recommended distance between the drive shaft and the driven shaft is not less than the diameter of the larger pulley nor greater than

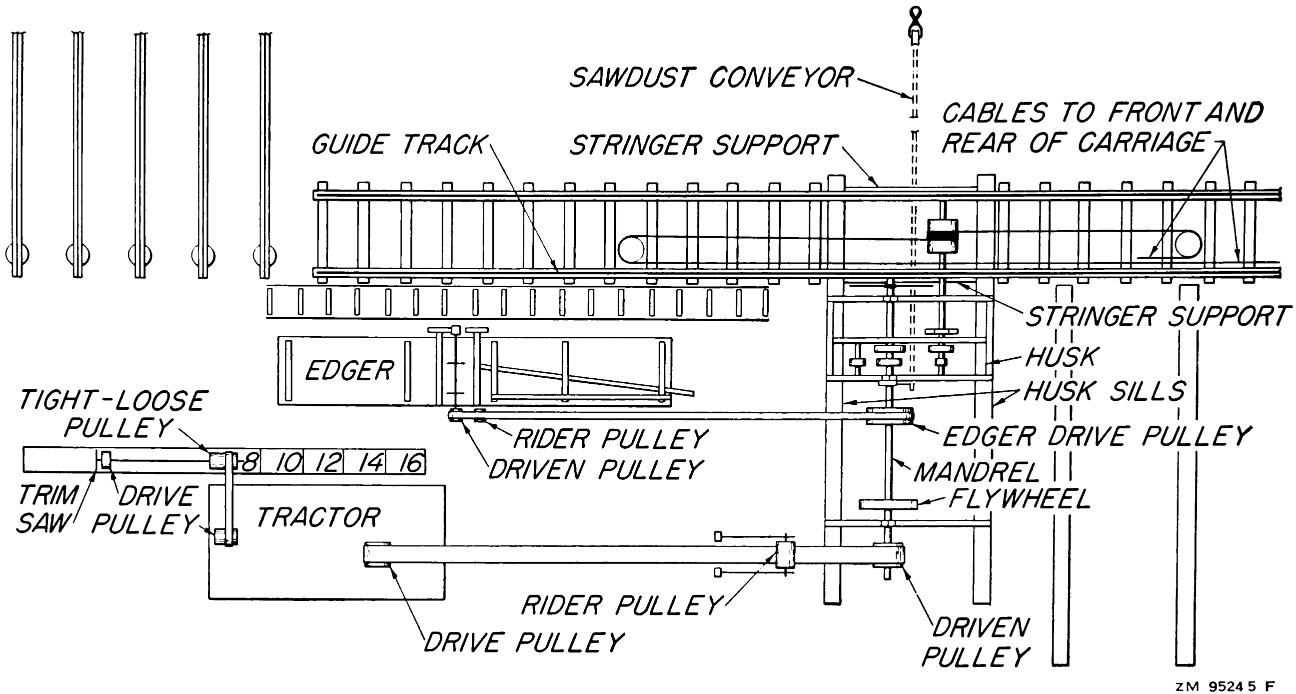

Figure 2.—Layout for unsheltered mill directly on the ground.

the sum of the diameters of the two pulleys. To test for tightness of V-belts, grasp the belt about midpoint between the pulleys and twist it a half turn with one hand. It should be tight enough to require considerable force to do this. Means should be provided to take up stretch in the belt equivalent to 5 percent of its length. A support should be wedged between the husk sills and the power-unit base to counteract creep from belt pull. A plank to which a jack is fastened is convenient and permits adjustment as the belts stretch.

Hanging the Saw

After the mill is set up and leveled with the foundation, and the different parts are properly alined, the saw may be placed on the mandrel. Wipe clean the inside or bearing face of each collar and the part of the saw fitting against the collars. Slide the saw onto the mandrel. It should not bind, but when snug against the fixed collar it should bear completely on the mandrel. Place the loose collar on the mandrel, turn the saw backward as far as the pins permit, and tighten the nut firmly with a wrench; do not hammer.

Spreader

Place the spreader with its front edge at least ½ inch clear of the saw teeth and its log face only far enough out to clear the sawed face of the log.

Testing the Lead in the Saw

Here is a simple method for testing the lead in the saw: Advance the carriage knees to about 1 inch from the saw line, bring the carriage so that a knee is opposite the saw near the guide position with the guide not in place, mark a point on the saw opposite the knee near its base, and measure exactly the horizontal distance from the mark to the knee face. This measurement is readily made by holding a match so as to span the distance and scoring the match with a knife blade flush with the knee face. Advance the carriage until the same knee is opposite the back of the saw, bring the marked spot on the saw exactly opposite the knee, and again measure the distance between the mark on the saw and the knee face. The mandrel should be adjusted so that this distance is approximately $1/16$ inch greater at the back of the saw than at the front. When moving the carriage ahead, be sure that the power is shut off. Then engage the feed mechanism, turn the driven pulley by hand until the carriage is at the desired position, put the feed lever in neutral, and again turn the driven pulley by hand until the marked point on the saw is opposite the knee.

Adjusting the Lead

To adjust the saw to give the required lead, loosen the set screws on the mandrel bearings controlling this adjustment and slew the mandrel the required amount with the screws on the bearing nearest the saw; then lock all screws to anchor the mandrel at this position. The lead thus given is tentative. When the mill set-up is finished and the sawing begun, note whether the saw heats. Other things than faulty lead may cause a saw to heat, but if it heats at the rim try less lead; if it heats near the center, increase the lead.

Saw Guide

Place the guide in position. When the saw is idle, adjust the guide pins so that they barely clear the saw plate on each face. This relationship between plate and pins should hold for a complete turn of the saw. How to correct for deviations will be explained later. The guide mechanism should be placed so that the guide pins clear the tooth holders by ¼ inch, and so that the top of the bracket is as near the level of the top of the saw collar as headblock-base clearance permits. When the saw is running, check the location of the saw in the guides. If the running saw holds against either pin, adjust the bracket to center the saw between the pins.

Rolls

Place the rolls, leaving a gap of 2 to 3 feet between the husk and the first roll section. The roll sections are approximately 10 feet in length, and usually at least 4 sections are placed so as to allow edger clearance but still to provide roll support at husk-top level for sawn stock.

Edger

Place the edger so as to allow standing room between the husk and the end of a full-length board about to enter the front rolls. For a mill mainly cutting stock 16 feet and less in length, the distance from husk to infeed edger roll should be about 18 feet. Place the edger as close as possible to the rolls, leaving no walkway. If the husk and trackway are elevated as recommended, the tops of the rolls will be at least at edger-table height. Connect the edger belt to the mandrel and edger pulleys and install a rider to touch the underside of the bottom belt near the edger driven pulley.

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Deck

For deck stringers the length recommended is 20 feet; the width, 6 inches; and the thickness, 8 inches. The first stringer is placed 4 feet from the husk. For a mill cutting 8-foot stock, the second stringer is placed 9 feet from the husk. For mills cutting logs ranging from 8 to 16 feet, the spacing of stringers from the husk is 4 feet—7 feet—10 feet—13 feet. The top of the stringer at the trackway end should be supported at carriage-headblock-base level; the top of the stringer at the other end should be about 1 foot higher. This usually requires that the stringers be shored up by short timbers set upright and bolted to the stringers. Timbers placed crosswise of the deck above the ground level as supports to the lower deck should be avoided as a hazard to footwork of deckmen, but a timber can be placed 10 inches from the trackway end and another at the outside deck end to anchor the deck in place. Cut out the end 3 inches from the top of each stringer at the trackway end to a depth of 2 inches, and install the log turner and sawdust chain.

Semipermanent Mills

The preceding instructions cover the installation of those parts basic to the majority of small mills set on the ground. Increased efficiencies usually follow from providing packaged load devices, trim saws, slab-disposal systems, and powered deck and other equipment. These accessories are usually installed on semipermanent mills that are housed in a building. Descriptions of such equipment and building plans may be found in Agriculture Handbook No. 27.[2]

CHECKING THE MILL FOR MECHANICAL FITNESS

Belt Slippage

As the power is applied, check the belts first to see that they are working properly. New V-belts stretch perceptibly, usually within the first 3 days of service, and must be kept tight. After considerable service a set of V-belts usually shows uneven stretch with some belts tight and others loose. To check on slippage, mark a line across the tops of all belts of the series, run them under load for several minutes, and note differences in belt travel as indicated by the relationship of the marked lines to one another. Slight differences in belt travel may be due only to different positions of belts in the pulley grooves. Large differences indicate belt slippage and a need to replace the belts.

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[2] See list of references on page 26.

Preferred practice is not to put a new belt into a series of worn ones, but to substitute all new belts, or put a serviceable worn belt into a worn series. Flat belts must be checked to insure that in running they hold to the pulley surfaces. A flat belt climbs the pulley on the tight side; this shows which way to slew the power unit in order to bring shafts parallel and keep belts centered on the pulleys.

Sprung Mandrel

Next, check the saw to be sure that it is running smoothly—usually a minor adjustment of the guide is needed to center the moving plate between the guide pins. If the saw chatters in the guides or heats at the guides, the mandrel may be sprung. Run the saw, not necessarily in the cut, for several seconds. A distorted mandrel will heat the bearings more than one that is unsprung. If the roller-bearing or ball-bearing case heats much beyond body temperature, the mandrel is probably sprung. A sprung mandrel must be straightened or replaced. Babbitt bearings may also heat under a perfectly running mandrel if they are too tight, and they should be checked to avoid either tightness or looseness. The bearings should hold the mandrel tight to eliminate end play.

General Cause of Chattering Saw

To check further on possible reasons for chatter in the guides, shut off the power, open the guides so that each pin shows clearance about the thickness of a dime, and, revolving the saw by hand, make a mark on the face where the plate closes the gap between it and one of the pins. Take the saw off, revolve it one-half turn without revolving the mandrel, and replace it. Check as before by hand turning the saw and observing how it touches the guides. If the pattern of contacts is the same as before, the cause of chattering is probably in the saw; if the contacts are on the face opposite to the previous marks, the cause is probably in the mandrel and its parts. The general cause can be verified by putting on another saw and using the same check. A saw that chatters but does not heat in the guides will sometimes work satisfactorily, but as a rule the lumber is scored and correction of the cause is advised. Saw irregularity usually means that the saw should be rehammered.

Fit of Saw on Mandrel

To correct for irregularity due to the mandrel and its parts, carefully check the behavior of the saw in the process of clamping it onto the mandrel. The saw eye should slip freely onto the mandrel but should fit it without any perceptible looseness when the saw touches the fixed collar. Looseness gives an effect in cutting of a saw not properly jointed (out of round). On the other hand, if in placing the saw snug against the fixed collar, the fit is too tight and the saw is forced on, it will be dished away from the log side when the nut is tightened. To check the fit of the saw, place the saw on the mandrel, tighten the loose collar by hand enough to steady the saw, and place a straightedge against the plate from a point near the collar to the guide line. Try the fit in three positions—from the front, top, and back of the plate to the collar. The straightedge should bear against the plate alike at all positions. Tighten the nut and repeat this check. If the saw does not now hang straight, the trouble is either in the pin-bearing contact, the eye-mandrel contact, or the collar-saw contact.

Pin-Bearing Contact

The pins should slip freely through the pin holes without binding. Any burr on the pin ends or at the junction of the pin and collar must be filed off.

Eye-Mandrel Contact

Looseness or tightness in the eye-mandrel contact should be corrected by precision equipment, usually a machine-shop job, but it is advisable to try one or more additional saws to make sure that the cause is an oversize or undersize mandrel, rather than an individual saw with an outsize eye.

Collar-Saw Contact

Correcting the collar-saw contact is also a precision-equipment job. Only the outer zone of the collar faces should bear against the saw plate, but such contact must be uniform throughout, and the saw plate must be held absolutely at right angles to the mandrel shaft. To test the uniformity of contact, put a thin lacquer of Prussian blue over the portion of each collar that normally bears on the saw, and carefully put the saw in place so as to avoid unnecessary smudging of the plate. Tighten the nut with a wrench, then remove the saw.

The uniformity of contact or its lack will be indicated by the smudge pattern on the plate. Since the collars must be tight against the plate at the outer rim, the smudge pattern must be unbroken there. The outer ¾ to 1 inch of the face of each collar, where it bears on the saw, is machined usually to a flat plane, but is sometimes 0.002 inch lower on the inside margin than at the rim of the fixed collar. Between this band and the eyehole, the metal is undercut so as not to bear. If the smudge pattern indicates defective contacts, the collars should be machined, with instructions to finish the bearing surface precisely at right angles to the shaft as well as to provide uniform contact with the plate. This can be done by refacing the fixed collar when on the husk.

Closely allied with improper bearing at the collars causing a saw to run unevenly in the guides is faulty bearing that dishes the saw. A simple check is to put the saw snug against the fixed collar, place the base collar to hold but not to clamp the saw, adjust the guides within $\frac{1}{32}$ inch of each side of the plate, and tighten the nut by hand. If the rim cups to either guide, dishing is indicated. As a stopgap, paper collars are sometimes used to overcome the dishing, but it is advisable to have the collars ground to bear uniformly.

Final Check of Carriage

Assuming that the saw runs smoothly in the guides, that the teeth are sharpened (tooth-fitting details are given later), and that all parts are oiled, make sure that the dogs do not touch the saw, and then run the carriage back and forth several times. The feed mechanism must propel the carriage smoothly, not jerkily.

Log Scored on Gigback

Start sawing. If the back of the saw scores the log face on the gigback, be certain that the teeth have no high corners on the board side and have adequate swage on the log side, and that the saw is not dished toward the log. Increasing the lead will sometimes correct such scoring. If scoring continues even though the saw is properly fitted, look for side play in the carriage caused by either track irregularities or looseness in the parts holding the carriage to the guide rail.

Teeth or Holders Out of Line

Check the sawn face of the board or log for scoring. Scoring is caused by teeth or holders out of line and is more likely to occur with insert- than with solid-tooth saws. The alinement of teeth can be roughly checked by inspection, or more precisely with a side gage (fig. 3). Misalinement can usually be corrected by

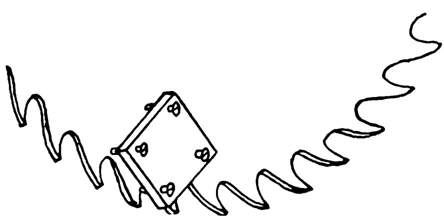

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Figure 3.—Side gage for alining saw teeth.

careful replacement of the offending teeth and holders after the contacts of the teeth, holders, and saw are cleaned with an oiled rag. In more stubborn cases the teeth and holders can sometimes be brought into line by tapping them lightly on the high side while holding a block against the opposite side.

Stretching a Loose Holder

A loose holder can be stretched by placing it on an anvil and striking a series of blows on both sides with a round-faced hammer at the points indicated in figure 4. Some sawmill operators may be unconcerned about scored lumber, but it requires excessive surfacing and adds as much as 10 percent to the power consumption of the saw.

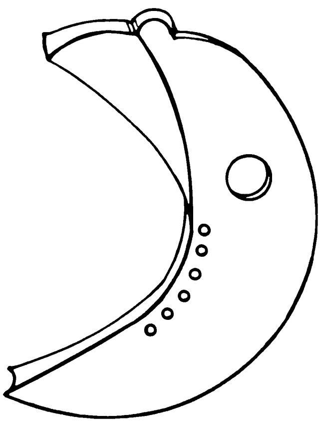

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Figure 4.—Black dots indicate where to hammer tooth holder to stretch it.

CAUSES AND CORRECTION OF FAULTY SIZING OF LUMBER

Checking the lumber for uniform sizing and correcting faulty sizing when it is detected should be done not only at the initial run but also as a day-to-day practice. Usually the pile-out man at the rear of the mill is at a good location to detect faulty sizing. With a little experience an observant man can tell at a glance if boards conform to acceptable sizing standards. He should be on the lookout for boards that vary in thickness within the individual piece and for excessively thick or thin boards. For stock thicker than boards, calipers or gages are recommended.

Dogboard as Check for Faulty Sizing

Since a dogboard ordinarily reflects better than the other boards the inaccuracies due to mechanical or human faults, pay particular attention to it in checking for faulty sizing. Ignore variations that are not consistently repeated. An occasional dogboard that is too thick or too thin, or that varies in thickness within the board is probably due to a miscalculation in setting, a chip between the cant and knee, or some other minor cause, and is normal to operations. If a particular variation shows regularly in the dogboard, however, find the cause and correct it. Some common causes of faulty sizing and the corrections for them are given in the following paragraphs.

Dogboard Thicker or Thinner at Top Than at Bottom Edge

Faulty alinement of the saw and headblocks causes one edge of a dogboard to be thicker than the other. The knee face should be at right angles to the top of the headblock base, and the saw plane should be parallel to the knee face. To check this alinement, stop the carriage so that a headblock is opposite the saw; place one leg of a carpenter's square along the top of the headblock base and the other leg first along the face of the knee and then flat against the saw. If either the saw or the knee face fails to show a right-angle relationship to the headblock base, the adjustment is faulty. Each headblock should be checked.

Correcting Faulty Saw-Headblock Alinement

The cause of misalinement can be in the track, carriage, or saw mandrel. The simplest way to correct the misalinement usually is to level the track, but if it is due to worn headblocks, they should be replaced. Headblock bases should be firmly anchored to the carriage bed, and the base of each knee should slide in its housing barely free of binding, because excess play causes lifting and tilting of the front or upright when the dogs are firmly embedded.

A board with a top edge thicker than its bottom edge may also develop when the first boards are cut from a log. The rounded face of the log rests on the headblock as the log is set to the saw, and unless it is well dogged, the log rolls slightly. The remedy is to use one or more dogs set out to clinch firmly near the top of the log.

Dogboard Thicker at One End Than at Other, or Thickness Varies Between Ends

Variation in thickness along the length of the dogboard may be due to failure to set the dogs properly to "springy" timber, to a twist or dip in the track, to side play between carriage frame and guide wheels, to misalinement of the knees, to end play in the saw mandrel, or to improper fitting, hanging, and alining of the saw.

Correct Number of Dogs

A minimum of three headblocks and three dogs is considered essential for standard-length logs (up to 16-foot length). The practice of using the front dog only and steadying the final cut with hip or hand generally causes variable thickness along the length of the dogboard. The remedy is to use three dogs when sawing the last face. Good sizing is sometimes possible with 8-foot lengths on two headblocks and a dog at the rear headblock.

"Springy" Timber

The balance of stresses within the log is usually upset in the process of sawing, so that in extreme cases the flitch tears out from one or more dogs. The correction is to saw so as to box the heart and to put this "springy" timber into framing or timbers.

Checking Track Alinement

Track alinement can be checked by stretching a fine brass wire clear of the top of the guide rail from the deck to a carriage length beyond the saw, so that any deviation or dip in this rail can be detected. Side play can be discovered by giving the carriage a vigorous sideward shove.

Correct Knee Alinement

To check on knee alinement, set the faces of the knee so that they are about 2 inches from the front of the headblock bases with the front knee opposite the saw. The exact distance from the saw plate to the knee face is then measured, and the point on the plate saw from which the measurement is taken is marked; the rack of the knee should be tight against the pinion of the shaft.

Repeat this procedure for all headblocks. All readings should be identical. Differences in readings may be due to a sprung setshaft, to a worn rack and pinion, to loose or worn keys on the pinion, or to play in the bearings holding the setshaft. Most mills provide for some adjustment, either by resetting the rack or by recoupling the segments of the setshaft, but worn parts should be replaced. For correct knee alinement, the pinions should also engage the racks snugly so that the knees cannot be pulled or pushed out of line. This is done by raising the setshaft to insure correct meshing.

End Play of Mandrel

End play of the mandrel can be detected by trying to force it toward or away from the track, using a lever on the driver pulley. The saw has a tendency to deviate when overloaded, as when using excessively fast feeds, cutting hard or frozen woods, or making deep cuts. Obviously a dull saw cuts more erratically than a sharp one.

Failure to Cut Boards of Uniform Thickness

Band and circular headrigs are not precision machines, and variation in thickness of boards is a normal condition. Inspection standards of lumber associations usually allow a spread in thickness of boards in rough lumber. In some cases this spread is from $^{28}/_{32}$ to $^{48}/_{32}$ inches for nominal 1-inch boards. Regardless of this $5/8$-inch latitude, an efficiently operated mill should not show a range beyond $3/8$ inch, and even a $3/8$-inch spread can be wasteful if more than one-half of the boards are sawed overthick in order to insure that some boards will not be too thin. If scant lumber is produced with a setting for $1\,1/8$-inch thickness in green softwood or $1\,3/16$-inch thickness in hardwood, check the mill for possible causes and correct them.

Additional Causes of Inaccurate Sizing

One source of inaccurate sizing that is inherent in the setworks mechanism on many small mills is the loose pinion-rack connection, previously discussed. With fast feeds this looseness can cause a light cant to pull toward the saw; or if unbalanced stresses are present in the cant, headblocks can be pulled toward the saw. Play in the setworks gears, or in the pawl contacts, and lack of a fixed backstop to guide in setting for the exact interval contribute to producing boards of unequal thickness. Finally, in addition to mechanical defects, miscalculations of the setter result in boards of varying thickness.

HOW TO FIT THE SAW

Servicing the saw at most small mills is limited to fitting the teeth; tensioning is ordinarily done by specialists outside the mill force. Instructions on saw tensioning are given in Small Sawmill Operator's Manual, U. S. Department of Agriculture Handbook No. 27.

Fitting Inserted-Point Teeth

Before putting the teeth in the saw, wipe free of dirt all contacts on points, holders, and saw sockets. Use an oiled cloth in wiping the contacts. Then hold the wrench in the right hand, and place the tooth holder on the wrench pin. While holding the wrench handle toward the vertical and the point in place alined with the holder, bring the point and holder to touch the "V" in the heel section of the socket. Pull the wrench handle forward and down until the top of the tooth is continuous with the rim of the saw. Check to be sure that the teeth and holders exactly center with the plate.

Holders should be tight enough so as to require considerable leverage to get them into the final position; if they slip easily they should be replaced or stretched. A holder is stretched by placing it on an anvil and striking a series of blows on both sides with a round-faced hammer at the points indicated in figure 4.

Worn Gullet Edges

If the square edges on the inside of the holder gullet become worn, square up the face with a half-round file or an emery wheel.

Swaging Inserted-Point Teeth With An Upset Swage

At many mills inserted-point teeth are not swaged; at others the points are spread with the upset swage, and at relatively few with the lever swage. The approved procedure with the upset swage is to sharpen the point, swage, sharpen again, and side dress. The first and last steps are sometimes omitted, although this reduces efficiency in sawing. To swage, place the slot having convex faces squarely over the tooth, with the central tongue of the swage above the tooth; lightly strike a single blow with a 1-pound hammer, reverse the swage so that the central tongue is still above the tooth; place the other slot squarely over the tooth, and hammer as before. Bring each corner to a uniform distance from the plate, using a side dresser (fig. 5) adjusted for the required clearance. The sharpening of teeth is described later.

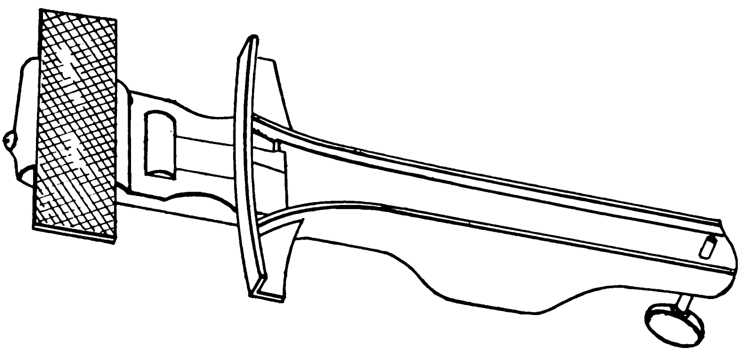

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Figure 5.—Adjustable side dresser.

Swaging Teeth With a Lever Swage

The procedure in using a lever swage (roller) consists of the same four steps listed for the upset swage. Lever swages when properly adjusted can give excellent results on insert teeth. If the edge or corners of a tooth are cracked or crumbled, it is evidence that the roller engages the underface of the tooth too far back from the edge and should be brought closer to the anvil.

Swaging High-Speed Steel Teeth

High-speed steel teeth or those made from very hard alloys are not swaged by users. High-speed steel teeth can be sharpened with an emery wheel but not with a file. Teeth made from the hard alloys require special equipment for sharpening and are normally sent to specialists.

Sharpening Saw Teeth

Whether to bench the saw for sharpening or to sharpen it on the mandrel is an individual mill problem. Of the two methods, better sharpening can normally be done on a bench. The difference in time between sharpening in place and changing saws, multiplied by the crew wages, gives a rough guide as to how much bench fitting will cost. Teeth are sharpened with a file or an emery wheel. Files may be simply guided by the user or may be mechanically supported. Mechanically supported equipment, either an emery wheel or a file, is recommended because it produces more uniform sharpening. Such machines, when properly adjusted, permit facing the tooth squarely (figs. 6, 7, 8).

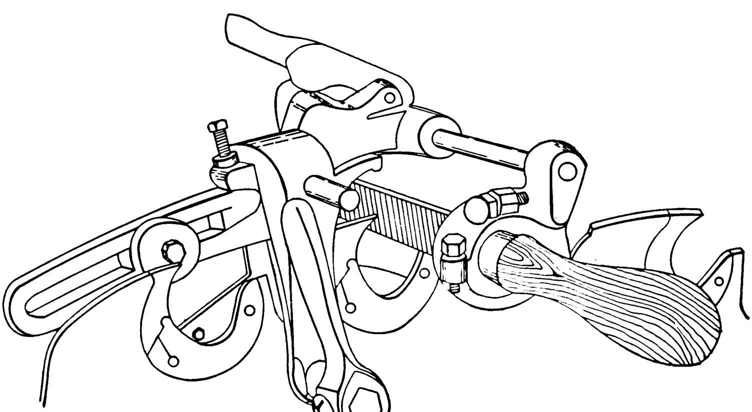

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Figure 6.—File in frame for sharpening teeth.

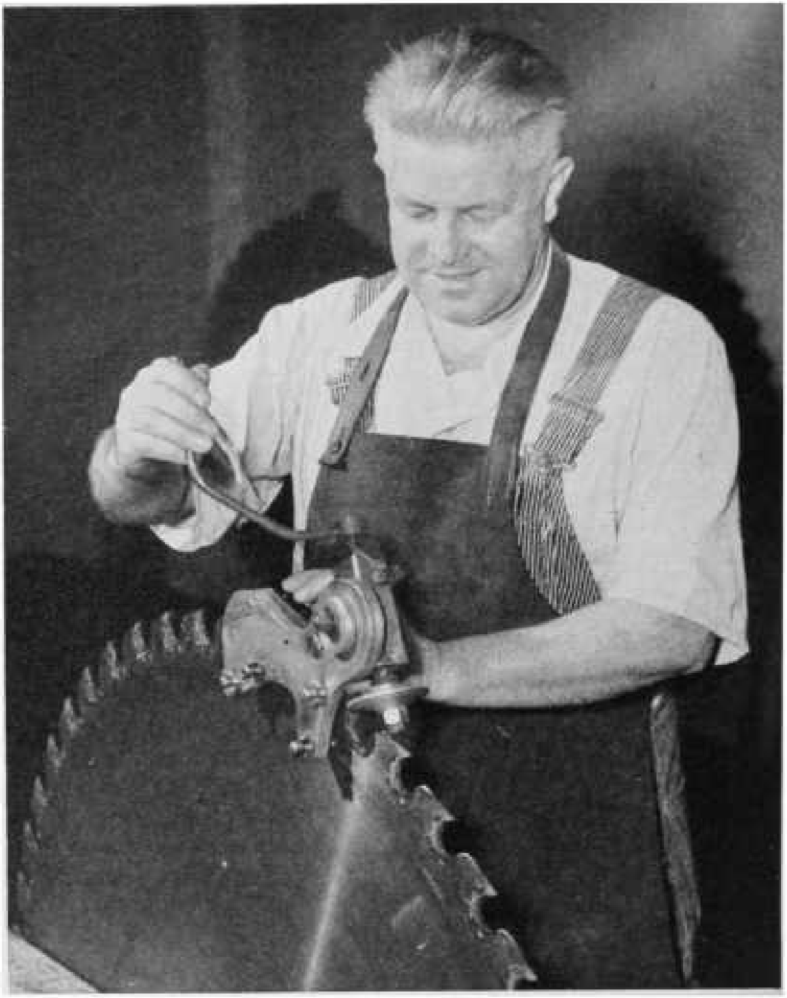

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Figure 7.—Tooth-sharpening machine using handcranked wheel faced with file segments.

Filing Teeth by Hand

In filing teeth by hand individual skill must be relied upon to surface squarely across the underface, in order to give the desired hook uniformly to each tooth. A round-edge, mill-type file 8 or 10 inches long is recommended. The filer usually sits with the saw between his knees and faces the deck when filing the saw on the mandrel. The work is done at about shirt-pocket height.

M 82121 F

Figure 8.—Tooth-sharpening machine with powered emery wheel.

The stroke is parallel with the shoulders. In actual sharpening about five strokes are taken on each tooth, but the number is varied according to the requirements of the individual tooth. Only enough metal is removed to restore the sharp cutting edges. After the face has been filed, a light stroke is sometimes made across the back, and the cutting edge is tapped with the softwood handle of the file to remove the burr.

To Check Filing Technique

To gain experience in filing it is a good plan first to place the file against the face of a tooth so that the lower edge is free of the throat and to note the zone of the file face that can be used without touching the throat. Then take about three strokes and note the results. Figure 9, *A* indicates that the strokes were straight lengthwise of the file, but they were not in the same plane as the tooth face. This gives a slanted cutting edge (high corner), as shown in figure 9, *E*. Figure 9, *B* indicates that the plane across the file was not parallel with the tooth face. This gives a decreased hook (fig. 9, *F*.) Figure 9, *C* indicates that a rolling movement accompanies the thrust of the file, aggravating the dullness of a beveled face (fig. 9, *G*). Filing should be practiced until consistency is acquired in stroking the full face, as in figure 9, *D*, and a sharp cutting edge is obtained (fig. 9, *H*).

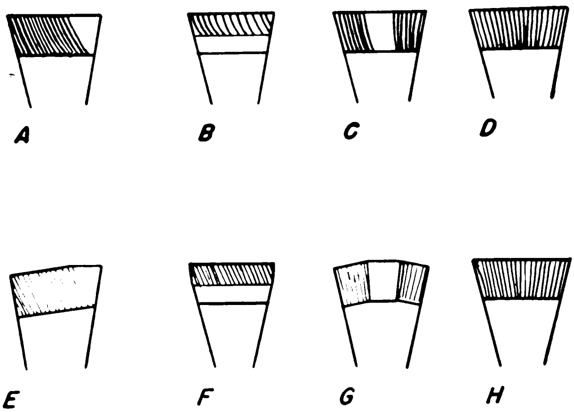

Figure 9.—Examples of correct and faulty filing. *A*, Faulty filing; stroke straight lengthwise but not in plane of tooth face; *B*, faulty filing; stroke not parallel with plane of tooth face; *C*, faulty filing; stroke made with a rolling motion; *D*, correct filing; file bears equally on all parts of tooth face. Cutting edges produced by the filing procedures *A*, *B*, *C*, and *D*, are shown in *E*, *F*, *G*, and *H*, respectively.

SAW AND FEED SPEEDS

"Coarse Sawdust" Feed Rate

Feed rates should be fast enough to produce coarse sawdust in all but the deep cuts. Given ample power, the upper limit for feed rate is determined by the capacity of the gullets to hold the sawdust. Table 1 enables you to work up standards as a check on your accustomed feed rates. Simply multiply the number of teeth in the saw by the factor given for the tooth style of the saw. The result gives the best feed rate per revolution of the saw in inches. The number of inches per revolution of the saw is shown by the scoring pattern (fig. 10) and is measured parallel with the edge of the board, near its midsection.

If the power supplied does not permit the recommended "coarse sawdust" feed rate, it will be of some benefit to reduce the saw speed (by placing a larger pulley on the mandrel) or to use a saw with fewer cutting teeth. On the other hand, if the power ap-

TABLE 1.—*Factors for determining the most efficient feed rate*[1] *for headsaws*

Style of teeth in the saw	Factor for a cutting depth of—			
	8 inches	10 inches	12 inches	16 inches
$2\frac{1}{2}$	0.075	0.060	0.050	0.038
F	.108	.086	.072	.054
B & 3	.138	.110	.092	.069
D	.147	.118	.098	.073
$3\frac{1}{2}$	.200	.160	.133	.100

[1] Feed rate is determined by multiplying the number of teeth in the saw by the factor. For example: A style $2\frac{1}{2}$ saw with 54 teeth requires a feed rate of 4.05 inches per revolution when the cutting depth is 8 inches ($0.075 \times 54 = 4.05$).

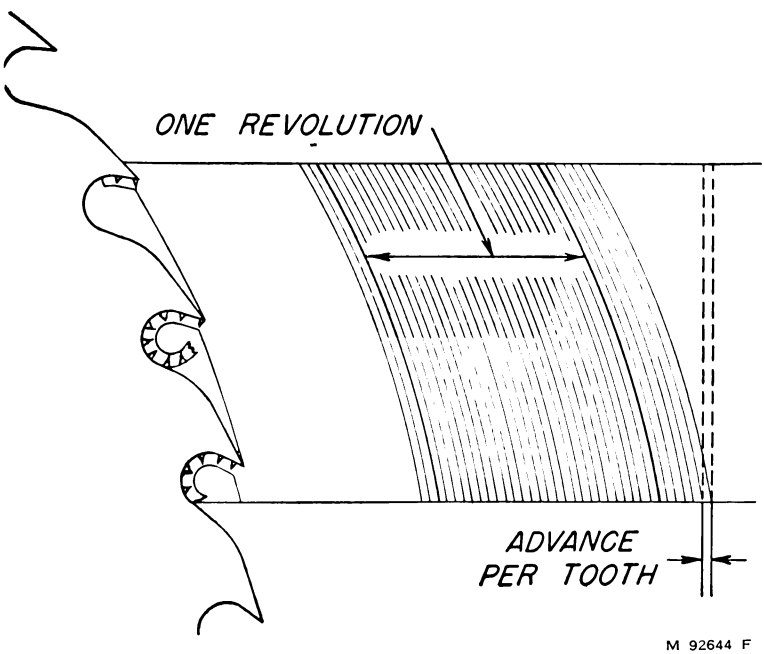

Figure 10.—Scoring pattern made by one revolution of saw.

pears to be more than enough when the feed rate produces coarse sawdust, increase the saw speed, or use saws with more teeth, and then increase the feed rate. The standards of feed rate suggested are well within the capacity of gullets to chamber the sawdust; feed rates much higher than these are likely to overload the gullets and otherwise overstrain the saw.

Power Required

The horsepower needed on the headsaw and edger in cutting small- and medium-sized logs at sample feed rates are given in table 2, with the estimated production rates when lumber is the major product.

TABLE 2.—*Horsepower required at different feed rates and lumber production rates*

Saw revolutions per minute	Approximate feed rate per minute	Horsepower required						Approximate production per hour
		Softwoods			Hardwoods			
		Steam	Electric	Internal combustion	Steam	Electric	Internal combustion	
Number	*Ft.*	*Hp.*	*Hp.*	*Hp.*	*Hp.*	*Hp.*	*Hp.*	*Bd.-ft.*
300	100	30	40	60	50	60	80	700
600	200	40	55	80	60	80	100	1, 100

Saw Speed

It is worth repeating that saw speed should be as much as the power will sustain, when making coarse sawdust. A saw having 40 teeth, each cutting 1/10 inch in a 10-inch face, should take 4 inches each revolution. It should be adjusted to do this, whether or not it is lightly powered, by reducing the revolutions per minute under light power or by increasing them with ample power, not by greatly reducing or increasing the amount cut by each tooth from the standards suggested. If each tooth takes the recommended coarse chip, power requirements will vary directly with the number of teeth in the saw. Likewise the distance cut along the log, and hence the output, will vary in the same manner.

STYLES OF SAW TEETH

Insert teeth are manufactured in over 20 styles. The 2½ style, which has the smallest gullet area, is extensively used on edgers and in some sections of the country on headsaws. On small logs the limited gullet space is not a serious limitation. In general, use as it relates to power and region is as follows: Eastern mills with high power use Styles F and 2½; those with low power use Styles B and 3. Western mills with high power use Styles B and 3½; those with low power use Styles 4½ and D, or equivalents.

GAGE OF SAWS

The extreme range in gage of circular headsaws normally used is from 7 to 10, representing a difference of about 3/64 inch in thickness. The extreme difference in kerf width between the two may be as much as ⅛ inch. A difference in kerf of ⅛ inch becomes approximately a 10 percent difference in outrun per log where the product is boards. For dimension or thick-product mills, this difference is less. The justification for using heavy-gage saws is based on the fact that less skill is required to service and use them. For inserted-point saws, 8 or 9 gage can be used for saw diameters up to 60 inches. Other choices are 9 or 10 gage for diameters of 48 inches or less, and 7 or 8 for diameters of 50 to 60 inches.

The following tabulation gives saw thicknesses corresponding to various gages.

Gage	*Thickness (Inch)*	*Gage*	*Thickness (Inch)*
5	7/32	11	⅛ scant
6	13/64	12	7/64
7	3/16 scant	13	3/32
8	5/32 full	14	5/64 full
9	5/32 scant	15	5/64 scant
10	⅛ full		

PROPER SAW DIAMETER

The diameter of the saw should be the least that is needed for the larger logs. The following shows the minimum diameter as related to the diameter of logs that can be cut by the usual "sawing around" method.

Log diameter (Inches)	*Saw diameter (Inches)*
28	48
30	52
33	56
36	60

SPECIAL SAWING PROBLEMS

Outsize Logs

No completely satisfactory method for sawing outsize logs in small mills has been found. If the slab cannot be sawed free, the delay required to chop it can be excessive. If the log is turned one-eighth of a full turn each time after slabbing, much potential lumber is wasted. The following method for sawing outsize logs wastes less lumber but requires dogs that hold firmly, adequate power to pull a saw buried in the cut, and good judgment in feeding.

Set the log so that the distance from the saw to the knee is exactly the cutting height of the saw (height of the saw above the headblock top). Saw through the log (fig. 11, *A*). Open the headblock enough to place the log as for slabbing; turn the log up until the first cut is horizontal, and saw the stock from the slab by successive cuts toward the center (fig. 11, *B*). After making stock from the first quarter, turn the log up until the original cut is vertical; then saw stock as before, completing the second quarter (fig. 11, *C*). The half log remaining can be readily sawed by putting the flat face either down or up (fig. 11, *D*, *E*).

Several measures can be taken to reduce the hazard of getting the saw stuck in the first cut. First, be sure that the dogs are well sunk into the wood. Feed slowly but steadily (stopping the feed on a buried saw causes it to heat). As soon as the saw is com-

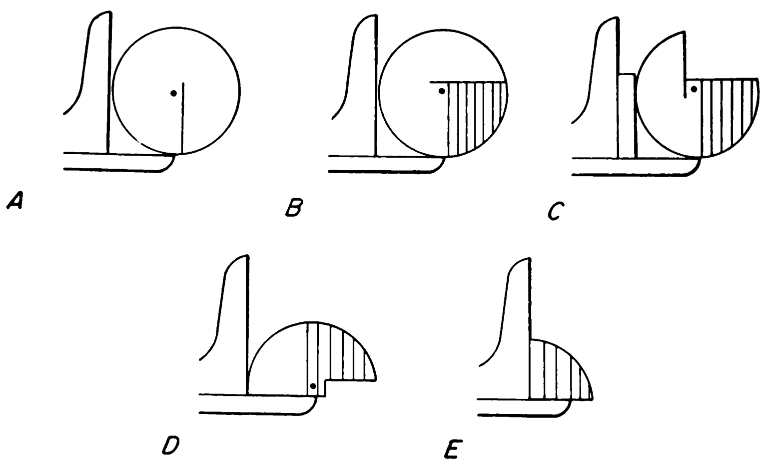

Figure 11.—Steps in sawing oversize logs: *A*, Initial cut; *B*, turned up 90° from *A*, and sawed; *C*, turned 90° from *B*, and sawed; *D*, turned down 90° from *C*, and sawed; *E*, turned down 90° from *D*, and sawed.

pletely in the log, have a helper tap a wedge into the end of the log at the lower part of the cut. The safest way is to take the saw off prior to the gigback, but this is not ordinarily done. The usual method is to cut through until only the front half of the saw is out of the log, idle the engine to slow down the saw, back the carriage slowly, and remove the wedge just before the saw reaches it. The succeeding cuts do not present a like hazard.

Logs With Stringy Bark

In sawing logs with stringy inner bark, keep the corners of the saw teeth sharp; otherwise, the bark is likely to shred in long strings, crowd between the saw and cant face, and produce miscut lumber. Willow, basswood, and cedar are some species having this type of inner bark.

Frozen Timber and Very Hard Woods

To saw frozen timber or very hard woods, such as hickory, the saw teeth must be kept sharp, the gullet face of the holder must be square across, and the feed rate must be adequate to give coarse sawdust. If miscuts result when sawing with sharp teeth and unworn holders, and at the recommended feed rate, reduce the swaged width about 2 gages, and use teeth with the corners brought out more than normal by swaging; instead of $\frac{9}{32}$-inch teeth in an 8-gage saw, try $\frac{1}{4}$-inch teeth swaged to bring out the corners, or use partly worn $\frac{9}{32}$-inch teeth so swaged.

Small, Knotty Logs

Small, low-grade logs up to about 12 inches in diameter should not normally be squared on the headsaw. Instead, saw one face nearly to the center, turn this face to the knees, and finish the log. This method speeds production by transferring work to the edger. Its disadvantage, however, is that cutting the first face deeply causes the stresses in the log to be unbalanced, and the cant springs out at the ends when the opposite face is finished, unless it is well dogged.

Low-Grade Logs

Low-grade logs over 12 inches are squared on the headsaw to produce stock 8 to 12 inches wide from the cant.

Grade Sawing

Logs having one or more good faces are sawed to recover quality stock from these faces. By placing such a log on the carriage so that a good face is either down or against the knees, the taper is taken out from the opposite face; thus, the good face is sawed parallel to the bark. This is the most important step in grade sawing and gives a higher volume of upper-grade stock than that obtained when good faces are sawed first. Grade sawing is a specialized technique. The methods used at mills differ, and few printed instructions are available. More detailed suggestions on grade sawing are given in the references listed.

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