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SMALL SAWMILL OPERATOR'S MANUAL

Small Sawmills

Agriculture Handbook No. 27

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SMALL SAWMILL OPERATOR'S MANUAL

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INTRODUCTION

Small sawmills are an integral part of our lumber-manufacturing industry. No important lumber-producing region of the United States is without them. They perform several essential functions, not the least of which is the economical production of lumber under conditions that make it impractical to operate large mills. With small capital investment and low operating costs, they can supply local needs from locally grown timber; yet they contribute importantly to the lumber supplies of metropolitan areas. They also fill an economic need in regions where large mills flourish, serving as auxiliaries that utilize timber of sizes and kinds not suitable for the large mills.

The need for improvement in small sawmill operation has long been recognized. At the request of the Chief Forester in 1926, a unit was set up at the Forest Products Laboratory to investigate means of improving the operating efficiency of small sawmills, particularly those operating on the National Forests and farm woodlands. As part of its program, this unit has assisted extension agencies in conducting schools for sawmill operators and has published recommended practices for definite phases of small-mill operation. In order to stimulate lumber production during World War II, a short bulletin (U. S. Department of Agriculture Misc. Pub. 509) was published for guidance of small-mill operators. The present manual is an amplification of that bulletin and other publications issued as a part of this program.

Many different types of sawmill equipment are described and illustrated in this manual, in order to provide operators with a reference source as an aid in selection, as well as to portray mechanical principles controlling the functioning of parts as an aid in correcting faulty mechanisms, and to provide guidance in the construction of certain items which can be made by or for the individual operator. Permission has been given by manufacturers for the use of photographs of certain sawmill features which are undoubtedly protected by patent rights. The reader should be aware that publication in this manual does not constitute a justification for copying features so as to infringe on patent rights in any manner.

There is no hard-and-fast rule differentiating "small" from "medium" and "large" mills. Sawmills of the United States range from 3,000 to 300,000 board feet in 8-hour production capacity. For purposes of this bulletin, mills producing up to 20,000 board feet per 8-hour shift have been classified as small. This dividing line is low for certain west coast mills; but elsewhere in the United States, the majority of the mills operating today fall well within this limitation.

Purpose and Scope

This publication is intended to serve as a handbook for operators of small mills. It deals mainly with the types and variations of equipment available, installation of equipment, and operational techniques, especially for mills of the circular head-saw type. The purpose is to furnish operators with a reasonably complete and detailed evaulation of various types of machinery and handling equipment, so that the general standard of operation may be raised by reducing costs, preventing wastes, and improving the quality of the lumber.

Although logging is ordinarily an inseparable part of small-mill operations, it is not covered in this handbook. Brief treatment is given such important segments of mill management policy as buying and selling; inventories of timber, logs, and lumber; selection of sales outlets, and extension of credits.

Safety Measures

Although outside the scope of this publication, reducing the hazards in sawing and machining lumber is one of the most important steps in sawmill operation. Statistics clearly show that sawmilling is one of the most hazardous occupations. Familiarity and compliance with State regulations and with responsibilities under workmen's compensation acts are essential in sawmill design and management. This publication does not attempt to deal with specific safety measures because sawmill safety is a subject in itself and requires fuller treatment than can be given here. Other publications must be relied upon for detailed information on safety measures.

Some of the literature on safety provisions in sawmill operation consists of the Logging and Sawmill Safety Code, National Bureau of Standards Handbook No. 5, and special subject matter that can be procured through the National Safety Council, Chicago, Ill.

TYPES OF SMALL SAWMILL HEADRIGS

For the purposes of this manual small sawmills are classified according to the type of headsaw employed. There are three distinct types of sawmill headsaws, circular, sash-gang, and band. Variations of the circular-headsaw type are the single-circular with or without a circular top saw; the twin-circular; and the gang-circular. All are used in small mills, but numerically the single-circular dominates almost to the exclusion of the others. Following brief descriptions of the sash-gang and band types, major emphasis will be given to circular mills. Figure 1 shows a typical circular sawmill.

Progressive operators search for methods and equipment to improve quality and lower product costs. The objectives sought for headsaw equipment may be listed as (1) maximum recovery of lumber from the log, (2) recovery of maximum qualities on a grade and thickness basis, (3) accurate sizing, and (4) minimum labor and machine costs per thousand board feet. None of the three general types of headrigs excels in attaining all four objectives.

Sash-Gang Headsaws

The sash-gang ranks high as a headsaw in the quantity of lumber recovered and in cutting accuracy, but relatively low in the grades of lumber recovered and in flexibility for cut-

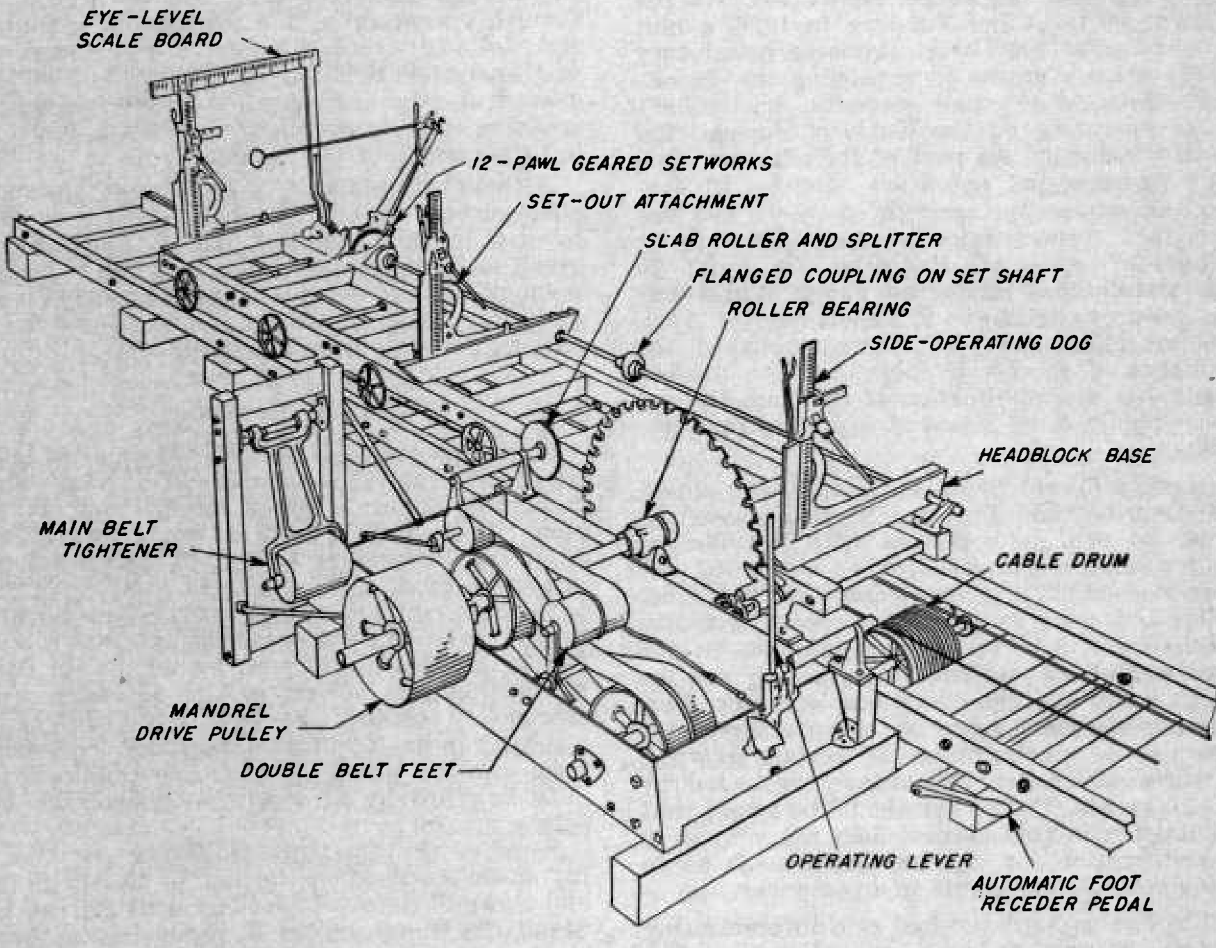

FIGURE 1.—Small circular sawmill equipped with headblock type of small-mill carriage.

ting to various thicknesses. The operating cost per thousand board feet is medium to low on properly installed and organized units. It has long been looked upon with more favor in certain foreign countries, such as Sweden, Finland, Germany, and New Zealand, than in the United States. This is due in part to the character of timber and lumber markets, and in part to the fact that foreign operations are usually planned to take maximum advantage of the characteristics of the round-log gang headrig.

By making use of the carriage mechanism, which permits sawing with the sweep of a log instead of in a straight line, the percentage of short, thick slabs cut from crooked logs can be substantially reduced. It is questionable if the round-log sash-gang mill will ever be adapted for use in the United States as widely and advantageously as in some other countries.

In the United States, the sash-gang saw is successfully used on knotty Douglas-fir and similar softwood logs up to approximately 34 inches in diameter. The saws are usually set to cut flitches 4 inches thick from the midsection and 2 inches thick from the outer faces; these flitches are edged and usually resawed to 1- and 2-inch products. Production rates up to 10,000 board feet per hour are achieved in large logs when the sash-gang headrig is combined with a heavy edger and resaw.

A second set of conditions for successful sash-gang operation prevails where small logs potentially low in grade outrun are sawed for box lumber and kindred products. One sash-gang unit slabs and saws one or more boards from two opposite faces. The cant then is reduced to lumber in passing through a second unit. Logs are sorted into groups according to their diameter. The saws of the first sash-gang are set to minimize slab waste for logs of one group and must be reset for logs of any other group. This system gives efficient quantity recovery and lowers edging costs. A variation of this system consists of a standard circular or band headrig with which the higher-quality material or random thicknesses can be recovered but which also provides slabbed cants for the sash-gang.

Sash-gang headsaw production rates on small logs approximate 6,000 board feet per hour. American practice is to use saws taking a 9/64-inch kerf; elsewhere kerfs down to 7/64 inch are taken. One requisite for successful installation is that foundations be firm enough to withstand the repeated shocks of the up-and-down thrust of the gate. Sash-gang headrigs have been used as mobile units when mounted on heavy skids or on a specially designed chassis. Those on chassis are set on firm foundations at the sawing site.

Band Headsaws

The band headrig ranks high in recovery by grades and allows ready change in thickness cut. It ranks medium in quantity of material cut and in accuracy of cut. Labor and machine costs per thousand board feet are medium to high. This machine is relatively expensive to install and maintain. Its logical field is in operations assured of timber supplies adequate to amortize the relatively high installation costs, and it is most efficient with logs in sizes and grades justifying a high-cost but flexible headrig. The small band saw is economical to operate only where production rates approach 20,000 board feet or more per shift. Band mills mounted on skids or wheels have not proved practical enough to meet competition of other types of headrigs. Production rates vary greatly with log size and supplemental equipment. A single band saw cutting medium-size logs normally produces from 3,000 to 4,000 board feet per hour.

Circular Headsaws

The circular headrig ranks high in flexibility for cutting lumber of highest grade and thickness values, but medium to low in production of all grades of lumber and in sizing accuracy. Labor and machine costs per thousand board feet are medium to high, on the other hand, installation and maintenance costs are relatively low. Circular headrigs have been successfully mounted on wheels. In combination with the lower degree of skill required to maintain and operate them, these advantages give circular headrigs a competitive advantage in operations not assured large supplies of timber.

The kerf loss due to the relatively thick saws used in America is minimized in Norwegian mills equipped with saws taking kerfs down to three thirty-seconds inch on the relatively small logs sawed. Development trends in America have been directed toward increasing output per man-hour. Mills are available on which, by use of mechanical, hydraulic, electric, or air-powered controls, the sawyer directs from a fixed position the progress of the log on the deck and to the carriage, as well as the dogging, setting, and turning operations and the movement of the log through the saw and back. This development has possibilities for producing cheaper and more accurately sized lumber on small mills. Progress in kerf reduction lags behind European standards.

Twin-circular saws are limited to cutting of relatively small logs, but the characteristic of variable spacing between saws adapts such equipment to cant or tie production. Gang-circulars, with saws fixed, are comparable to sash-gangs in that they reduce an entire log to boards in a single passage. Gang-circulars take a heavier kerf and are less accurate in sizing, but the problem of making mobile equipment is simpler with them than with sash-gang equipment. The gang-circular with saws passing through a stationary log may be developed to give better-sized products and readily lends itself to mobility because of its short over-all length.

Sizes of Headrigs

Band headsaws are classified as to size by the diameter of the wheels. Their size ranges from 3½ to 11 feet in diameter for 19- to 12-gage saws. For small mills, the wheels range from 3½ to 6 feet in diameter, and the saws from 17-gage, 8 inches wide, to 15-gage, 12 inches wide (fig. 2).

Sash-gang headsaws are classified as to size on the basis of the inside width of the gate through which the log passes. This size range is from 24 to 36 inches. The log is brought to

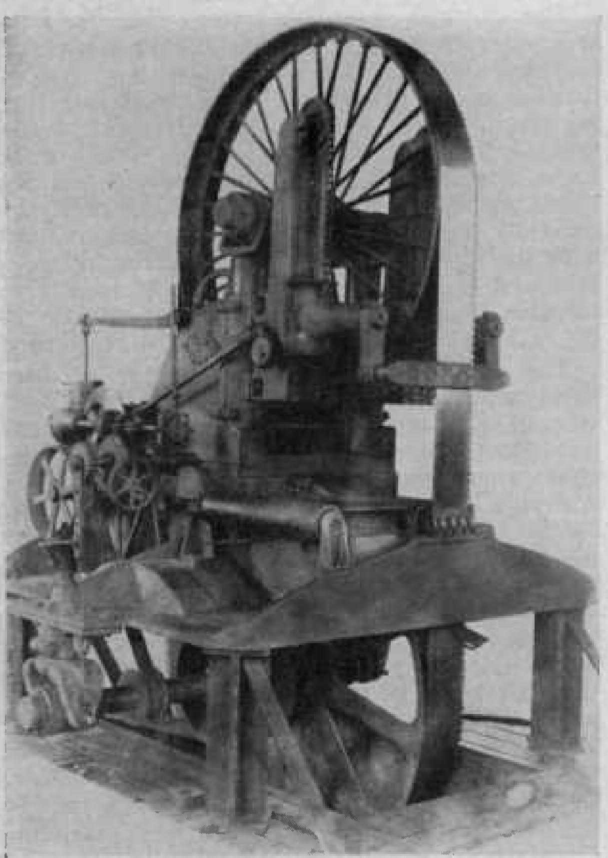

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FIGURE 2.—Six-foot band headrig.

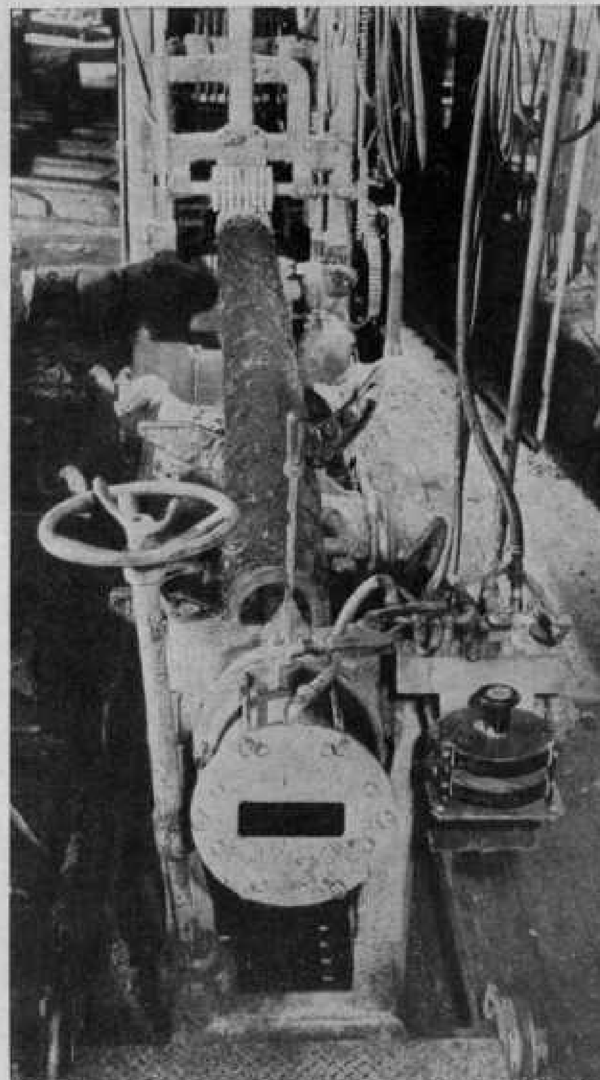

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FIGURE 3.—Round-log sash-gang headrig.

the infeed rolls on the bunks of two separate trucks running on rails (fig. 3). The rear truck has a mechanism for alining the log with the saws. To assure that the log will not twist in the rolls, either a rosser is placed slightly ahead of the bottom infeed roll to plane a flat-bearing surface, or two adjustable guide plates about 6 inches apart engage two saw lines of a series of the emerging boards. Feed rates of 6 to 20 feet per minute are controlled by means of gears. Saws are about 14-gage, with a kerf approximating five thirty-seconds inch.

The single-circular headsaws are not readily classifiable on a size basis (fig. 1). Mills using them are made by dozens of manufacturers and vary greatly in size and design. The smaller ones use saws of 36-inch diameter, and weigh from ½ to 1½ tons, including husk, track, and carriage; the largest can take a 6-foot-diameter saw, or a 66-inch main saw and a 40-inch top saw, and weigh in excess of 6 tons. The weight classification given in table 1 lists dimensions for key parts that are characteristic of, but not necessarily limited to, the particular weight class cited.

The single-circular saw has been successfully mounted on either a pneumatic-tired reinforced trailer body or special framing suspended from a single axle. Mounted on a trailer body, it is the typical small circular mill with trackway outside of the saw; if it is mounted on a single axle, the trackway passes over the mandrel. The single-axle mount is used either with the sawyer riding the carriage, which passes over small rollers fixed to the mill frame (fig. 4), or with the sawyer at the usual ground position and the carriage equipped with small wheels (fig. 5). In either case, the power unit is placed on the separate truck used to transport the equipment. Variations built by individuals have included a two-axle trailer with the power unit mounted directly over the saw. Wheel-mounted mills are relatively efficient where frequent moves are involved, as in cus-

TABLE 1.—*Size characteristics of various classes of circular-headsaw mills*

Item	Mill class (by weight)			
	3,000 pounds and less	3,100 to 4,500 pounds	4,600 to 6,000 pounds	6,100 pounds and heavier
	Inches	*Inches*	*Inches*	*Inches*
Mandrel diameter	2 3/16	2 7/16	2 11/16	2 15/16+
Width of feed belt	3	4	5	6+
Headblock openings	33	36	40	48
Maximum size of saw recommended	54	56	60	[1] 66
Maximum log diameter taken	32	33	36	55

[1]With 40-inch top saw.

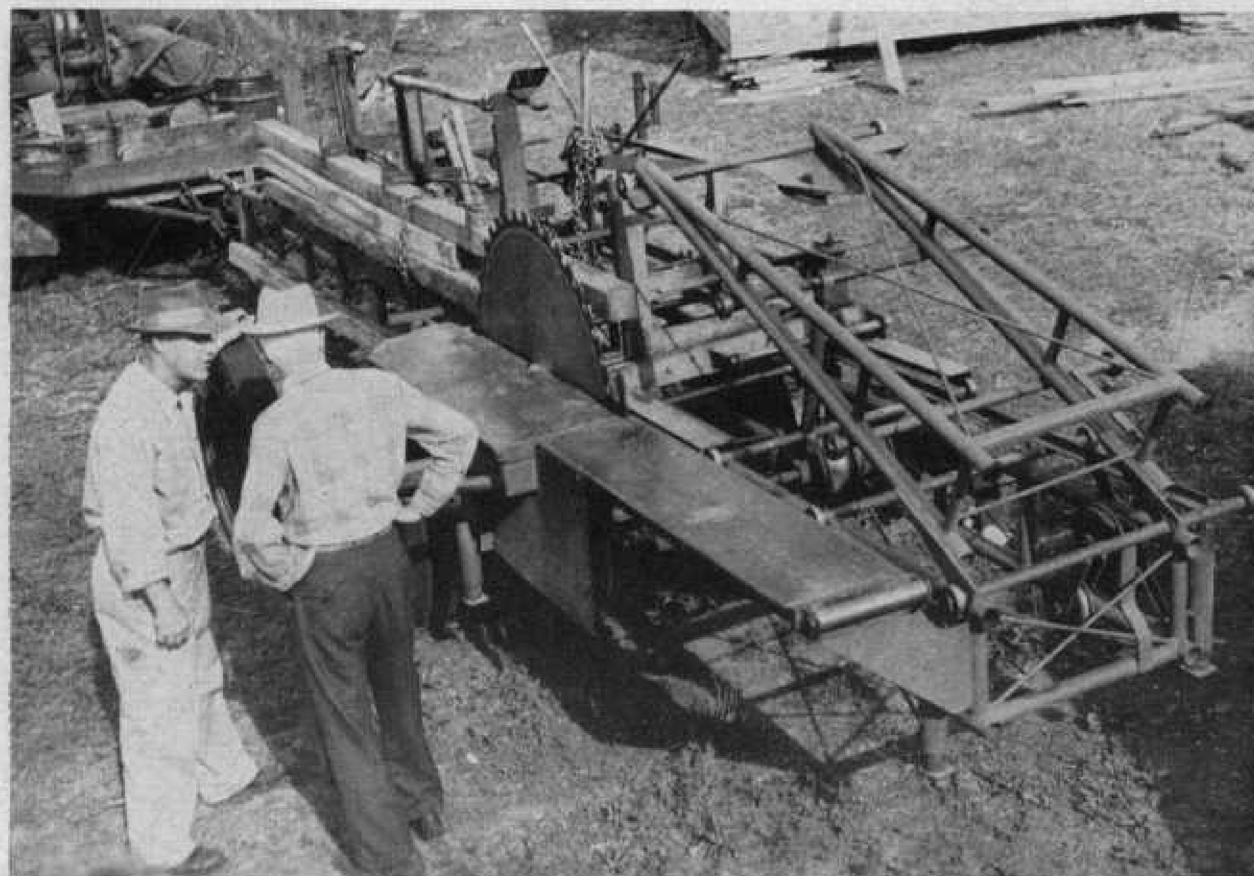

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FIGURE 4.—Single-circular mill, wheel-mounted. Sawyer rides the carriage.

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FIGURE 5.—Single-circular, wheel-mounted mill. Sawyer stands on the ground.

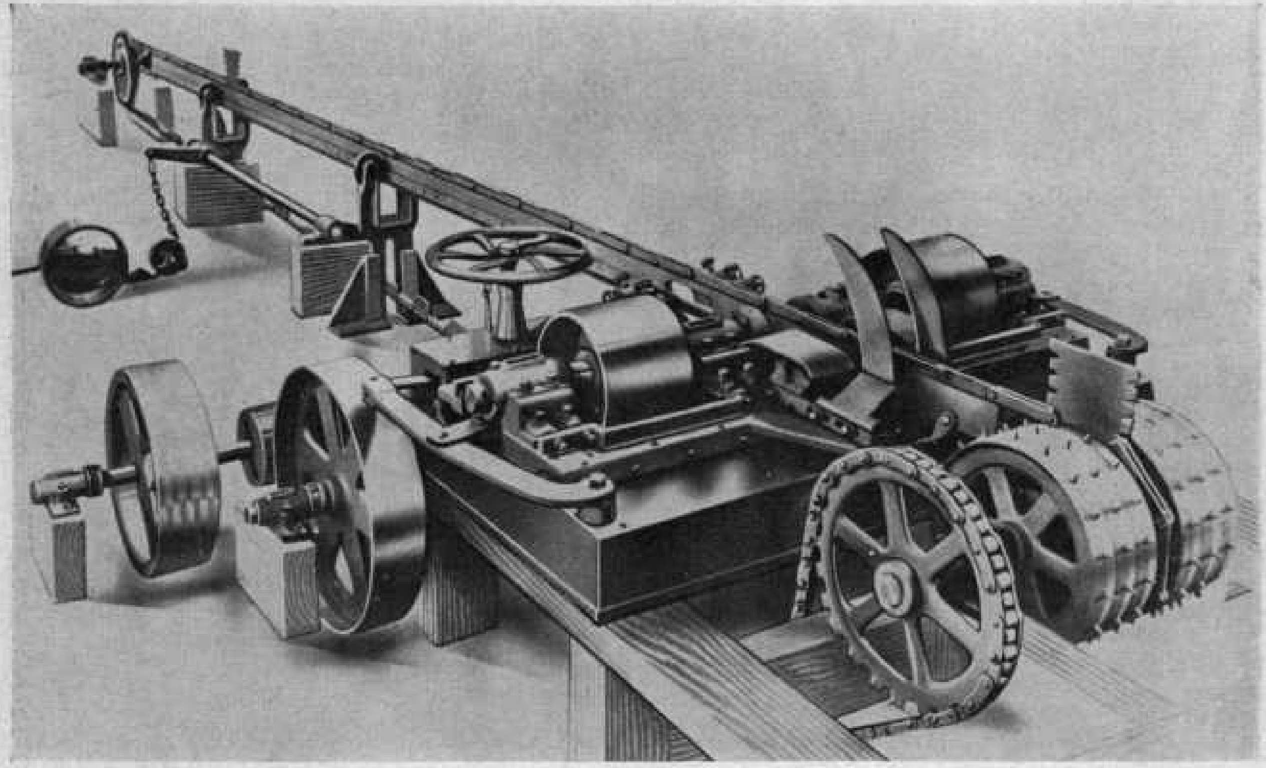

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FIGURE 6.—Twin-circular headrig. Saws not shown.

tom sawing for farmers or on commercial operations where it is feasible to bring the mill to the trees.

Twin- and gang-circular saws are used for very small logs. Twin-circulars have a separate mandrel for each saw, the saws can be given lead, and spacing between them is controlled by a sawyer-operated lever to produce stock of desired thickness (fig 6). The saws in one variant are moved along a keyway on the mandrel, in another they are fastened to the mandrel and the assembly of driven pulley, mandrel, and saw is moved by the control lever. The log may be fed to the saw by means of a continuous chain, with return ahead of the saws; or by means of a narrow, continuous chain with lugs, which may pass between the saws. A top roll, or floating block, may be employed to steady the log. Gang-circular saws are fixed to a single mandrel, the spacing between saws being controlled by means of fixed collars. Some units add a series of topsaws on a separate mandrel. In one variant (fig. 7), feed is by means of a continuous chain; in another, the log is held stationary in chucks and the saws pass through the log (fig. 8).

A special combination of circular and band saw, called a splitter-resaw, is sometimes used for making box and similar lumber from small logs. The circular saw is centered in a trough so as to split the logs as the lugged chain carries them through (fig. 9). The halved logs pass to a horizontal resaw equipped with return and outgoing conveyors. Usually three pieces can be fed to a double-bed resaw at a time (fig. 10). Production rates are relatively high in small logs, approximating 3,000 board feet an hour. The installation costs are high, man-hour requirements low, and precision of sizing medium to low.

HUSK AND MANDREL

Band mills have heavy metal frames supporting the shafts and other mechanisms. Circular mills have a box-like frame of wood or metal called a husk, that supports the mandrel and usually the feed-works mechanism. Circular-mill husks vary but slightly in the different models. Two bearings are usually provided for mandrels up to 6 feet in length, and additional ones are added for longer mandrels. With top saws, three bearings are usually used and a metal top-saw frame is added. Provision is usually made to fix the husk to sills with bolted metal brackets; in some models, brackets are also used to hold the track and husk in a fixed relationship.

Wood husks, because of their lesser weight, meet the needs of mills that are frequently moved; metal husks are more suited to semi-permanent installations. Brackets connecting the husk with the mills to maintain the proper relationship between husk and track are good features.

The mandrel, or arbor, is the expertly machined, hardened-steel shaft carrying the saw and, usually, several pulleys; sometimes it has a flywheel also. Sizes vary, the diameter of the light-duty types being as little as 2-3/16 inches and that of the heavy-duty types 4 inches or more. Standard lengths range between 4 and 10 feet; extensions can be coupled to any length. The mandrel is commonly belt-driven, but direct drives are also used. Clutches are sometimes placed in the mandrel, so that the saw can be shut down independently of other machines; or the edger-drive pulley on the mandrel may have a clutch that permits the operator to stop the edger without halting the headsaw.

The saw is clamped between a fixed saw collar sealed to the end of the mandrel and a loose collar held by lug pins and bolted on the mandrel. The standard saw has a 2-inch eye with two $\frac{5}{8}$-inch lug-pin holes equally spaced on a 3-inch circle. Mandrels have babbitt or roller bearings, and provision for adjusting the mandrel for saw lead is made with set screws that press on a pivoted bracket of the bearing nearest the saw. Roller bearings are superior to babbitt bearings. End play in the mandrel is prevented by one of three methods: (1) By means of conical roller bearings; (2) with babbitt bearings, by means of a shoulder around the mandrel that is seated in a groove in the bearing nearest the saw; or (3) by means of collars on the mandrel where it enters the bearing housing.

Requirements of a satisfactory mandrel are a diameter adequate to carry the load, enough length to place the pulleys, bearing supports to hold it in line, and saw collars that uniformly contact the saw in a plane at right angles to the mandrel axis. A space approximating three-sixteenths inch should separate the fixed collar from the first bearing box; if closer, grit is likely to collect and heat the mandrel.

In the usual arrangement of bearings and pulleys on the mandrel, a bearing is between the saw collar and the mandrel pulleys that

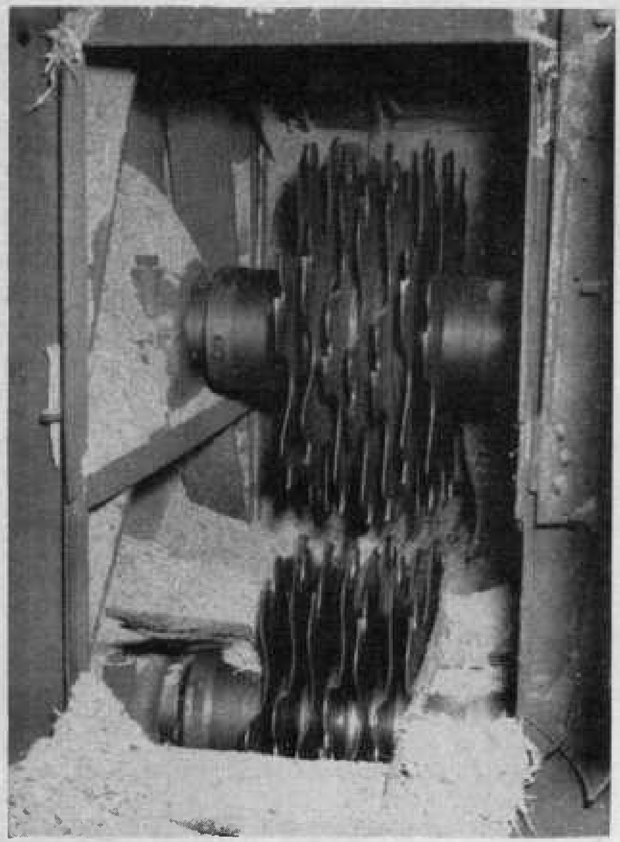

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FIGURE 7.—Gang-circular headrig with topsaws.

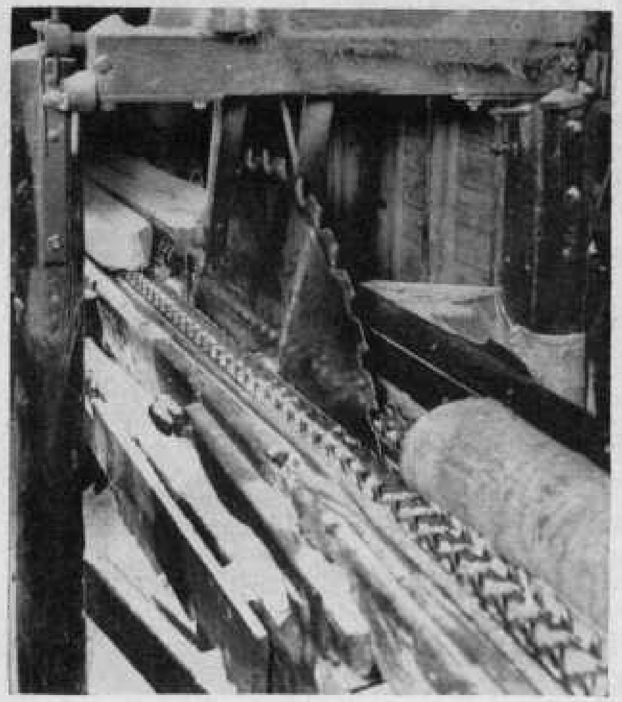

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FIGURE 9.—Circular saw of splitter-resaw combination.

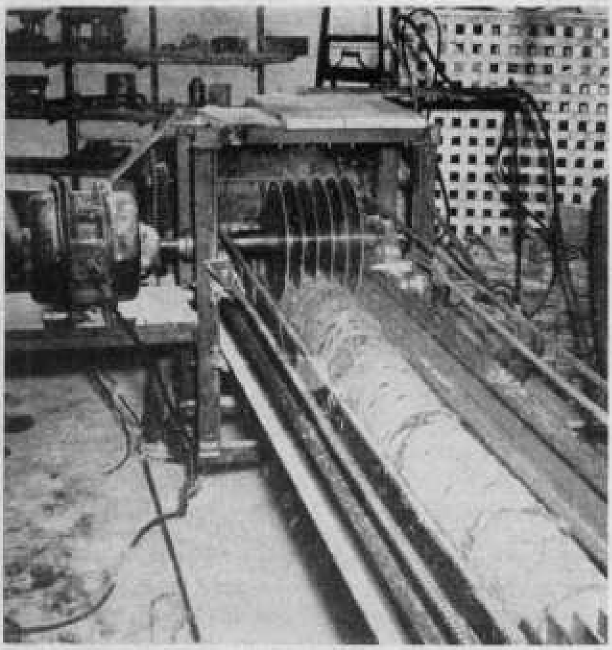

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FIGURE 8.—Gang-circular with saws feeding and log stationary.

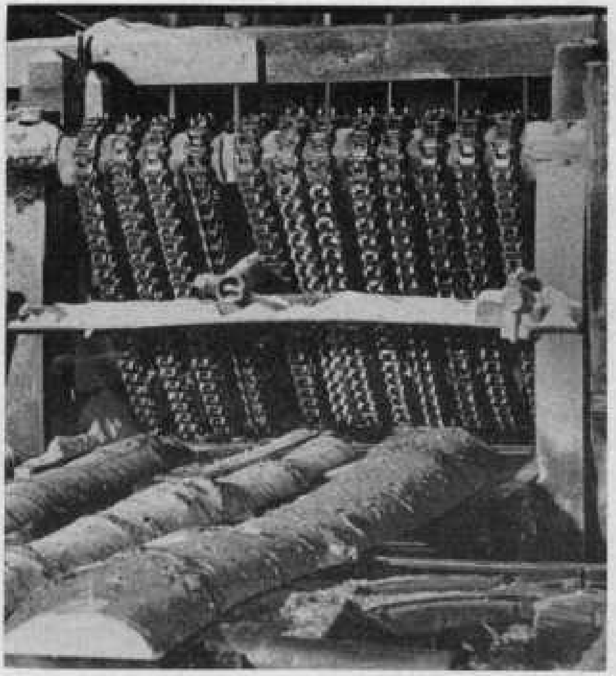

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FIGURE 10.—Horizontal band saw of splitter-resaw combination.

operate the feed mechanism (steam-piston, electric, and hydraulic feeds excepted), with a second bearing between them and the driven pulley. If the edger is driven off the mandrel, the drive pulley of the edger is beyond the second bearing and a third bearing is between the edger pulley and the driven pulley of the mandrel. Flywheels weighing up to 600 pounds can be placed between the drive pulley for the edger and the third bearing; heavier ones should have bearing supports on each side.

Direct drives are occasionally used on headsaw hookups. Usually they require a speed reducer, a flexible coupling, or a universal joint. When saws are jammed on metal or otherwise, they are likely to be severely damaged if direct-driven.

HEADSAW GUIDES

Circular-headsaw guides, which steady the saw, are placed so that the pins touch the saw about 2 inches below the level of the carriage bolsters on the front edge of the saw and one-fourth inch inside the gullet. These are sometimes supplemented with guides at the back or engaging the top of the saw. Top guides must be quickly removable in case the saw is buried in the log.

Guide pins are usually made of wood but occasionally of leather, and may have provision for self-oiling, although ordinarily they are not oiled. All models make provision for adjusting the guide pins within the frame so that they contact the saw blade, for adjusting the frame so that the gap coincides with the plane of the saw, and for readily swinging the arms out of the way when changing saws. Models may exhibit minor variations; for example, the pin-holding arms may be independently adjustable instead of in one piece (fig. 11). Guide equipment should have a deep, wide throat to insure the removal of sawdust and small particles that otherwise may give trouble if they become deflected against the sawyer or lodged in equipment.

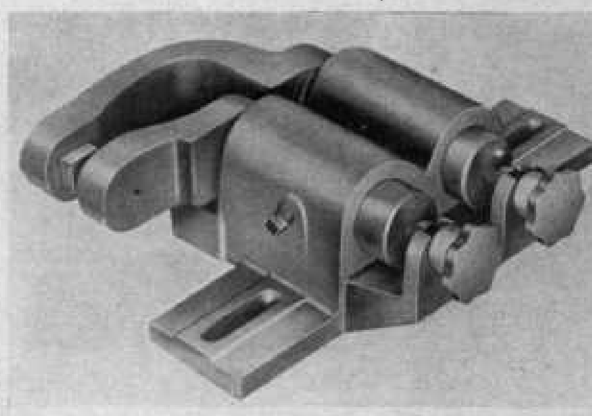

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FIGURE 11.—Saw guide with pins independently adjustable.

ROLLS AND SPREADERS

Standard equipment on most circular mills are a roll or bar attached to the husk ahead of the saw and a spreader and roller immediately back of the saw. The bar steadies the cant and expedites its passage into the saw; the spreader and roller keep the board from binding the saw and expedite its passage. Usually spreaders are disks that are flat on the log-side face and beveled to a thin edge from the board-side face. Many operators replace this disk with a spreader shaped like a scythe blade and curved to parallel the perimeter of the saw. Knife-type spreaders are required by some State safety codes.

FEED WORKS

Small-mill feed mechanisms, by which the sawyer controls the rate of log feed to the headsaw, are operated by (1) straight friction; (2) friction combined with belts and pulleys; (3) belts and pulleys; (4) belts, pulleys, and clutches; (5) gears and clutches; and (6) electric, hydraulic, or steam-piston drives. All may use the rope drive (cable over drum). The second type of mechanism sometimes substitutes the rack-and-pinion drive. One variant of the steam-piston drive transmits power through a shaft fastened to the carriage.

In straight friction types, beveled plates powered by the mandrel operate a beveled friction wheel and shaft that rotate a disk continuously. By bringing the rim of a lever-actuated friction wheel into contact with this disk, motion is transmitted through shafts and gears to turn the drum and move the carriage. Reverse motion is obtained either by crossing the disk center with the friction-wheel contact (fig. 12, *A*) or by contacting the reverse face of the disk with a second friction wheel after breaking contact with the first one (fig. 12, *B*).

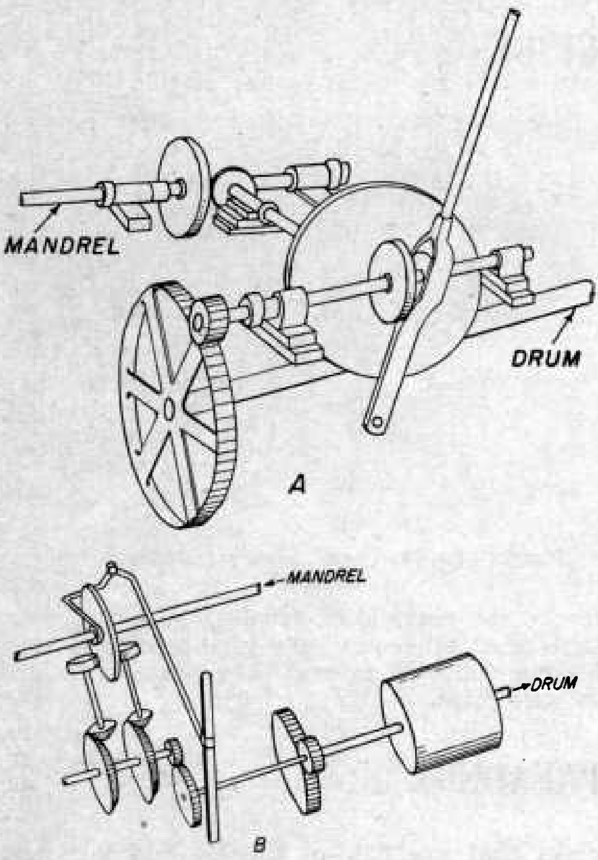

FIGURE 12.—Straight friction types of feed works *A*, Gigback obtained with lever by shifting friction wheel to opposite half of disk. *B*, Gigback obtained by disengaging one and engaging the other friction wheel with the lever-controlled mandrel disk.

In the types employing friction with belts and pulleys, power is transmitted in one of three ways: (1) From a pulley or sprocket fixed to the mandrel through a belt or chain to a pulley or sprocket shafted to a friction wheel that is lever-actuated to contact a bull pulley shafted directly to the drum (fig. 13, *A*); (2) from the drive pulley on the mandrel by belt to an intermediate pulley, which is shafted to a sprocket transmitting power through the chain to the drum shaft (fig. 13, *B*); or (3) from the drive pulley on the mandrel by belt to a second pulley equipped with an enlarged hub and wide rim (fig. 13, *C*). A friction pulley is placed between the hub and rim (fig. 13, *C*) on a movable shaft connected to the drum, and feed action results from engaging the hub face while gig action results from engaging the inside of the rim. Both feed and gigback can be obtained by the feed works shown in figure 13, *D*.

In the types employing belts and pulleys, the power for feeding the carriage is transmitted by belt from a pulley fixed to the mandrel to a lever-actuated movable pulley ahead of the mandrel, and thence through a fixed pulley behind the mandrel and the fixed pulley on the drum shaft. Power for reverse motion is transmitted by belt from a second pulley fixed to the mandrel to a second pulley fixed to the drum shaft. A lever-actuated rider is so adjusted in a rocker-arm frame that one belt can be tightened and the other loosened by moving the lever to feed or gig position, as desired (fig. 14).

The type employing belts, pulleys, and a clutch has the same hook-up as the type with belts and pulleys alone, but the belts are tight in order to rotate the two pulleys continuously on bearings about the drum shaft or a shaft geared to the drum shaft. Drive or gig is provided by contacting one disk or the other fixed to each of these pulleys with a corresponding disk fixed to lever-actuated pulleys sliding along a key seat on the drum shaft (fig. 15).

In the type operated with gears and clutch, power taken from the mandrel through chain sprockets drives a floating axle and, by means of planetary gears and a drum-brake mechanism, turns the drum shaft (fig. 16).

In electrically powered feeds, the drum is usually installed near the deck end of the track and a reversible direct-current motor is connected to it. Rod connections from the sawyer's lever to the transformer control the direction of rotation and speed attained by the motor.

Hydraulic feeds employ at least three variations in power transmissions: The turbine, the oil motor, and the single piston. In the turbine, oil under pressure from power usually taken off the mandrel is forced through the turbine blades, thus turning a shaft connected to the drum (fig. 17).

In the oil motor, a series of small pistons are radially placed on a rotating cylinder that is concentric with a fixed core that contains oil ducts (fig. 18). The piston heads are contained by an outer ring placed eccentrically to the core and free to turn on its axis. The inlet oil vents are so placed that oil under pressure is simultaneously forced into several consecutive pistons during one-half of a complete cycle of the cylinder, and withdrawn during the

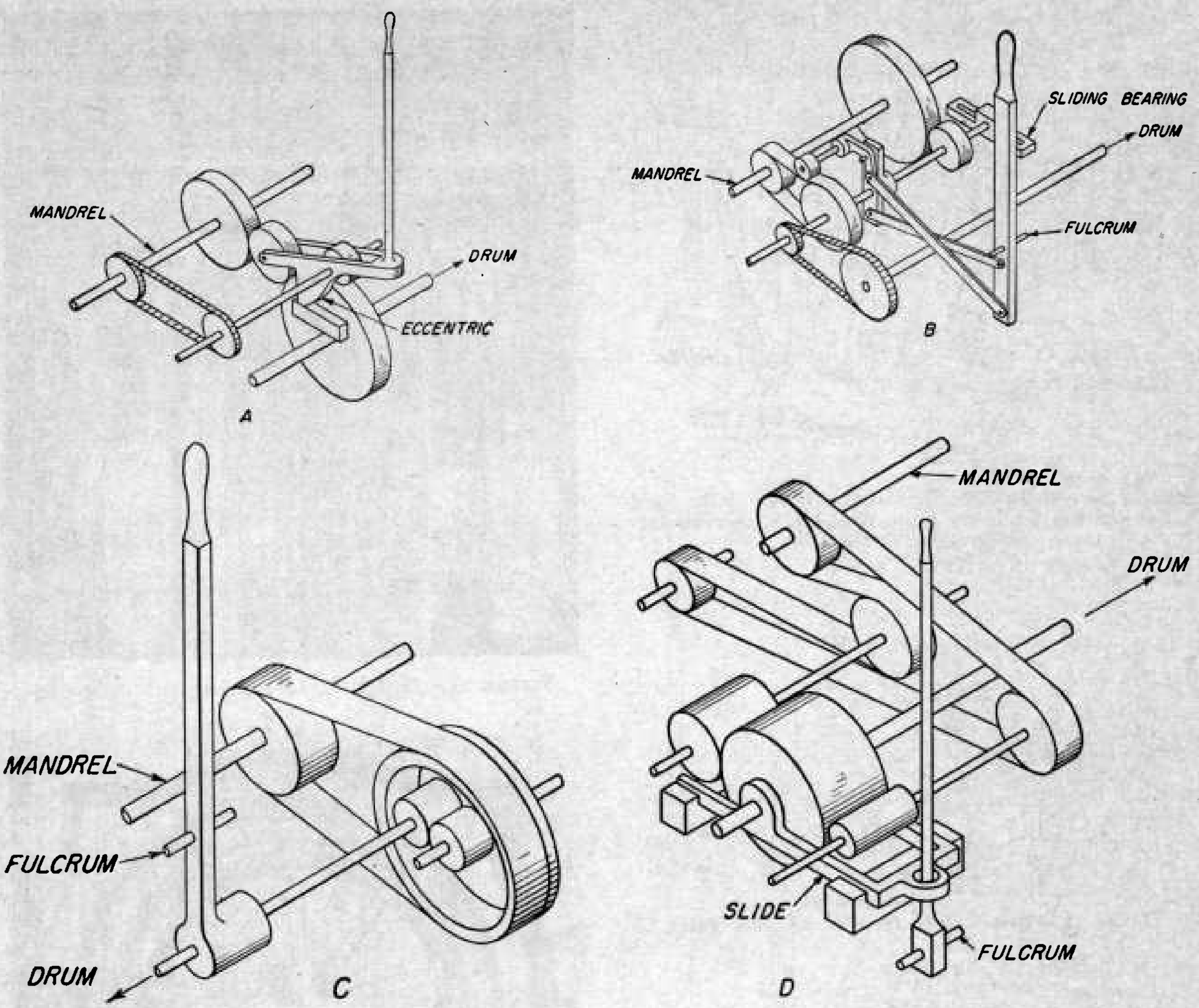

FIGURE 13.—Friction-belt-pulley feed works. *A*, Eccentric rocker lifts one friction wheel free when the other is brought in contact with friction wheel in drum shaft to reverse action. *B*, Belted mandrel pulley reverses drum shaft from direction caused by large friction pulley. *C*, Drum reversed by shifting rider pulley with lever from hub to rim of belt-driven drum pulley. *D*, Lever-controlled bull wheel reverses drum shaft as it engages one or the other of belt-driven pulleys, which turn in opposite directions.

other half of the cycle, and oil is closed from the circuit during the longest and shortest phase of the piston stroke.

To start the motor, oil under pressure enters the series of pistons, so that each piston head is thrust against the eccentric containing ring. Since the pistons are not radial to the ring, the direction of thrust is not along the radius of the outer ring; thus, one of the components of this force is tangential to the ring and acts in the direction of increasing divergence of the circumferences of the eccentric parts. This tangential force rotates the pistons about their common axis, and this rotation is transmitted to the output shaft. Reverse direction results from reversing the direction of oil under pressure; speed is controlled by varying the volume of oil supplied under pressure to the motor. Oil pressure is provided by a duplicate piece of equipment, the radial pistons of which are turned from a power source.

In the single-piston variant of the hydraulic feed, a cylinder having a length approximately one-half the distance of carriage travel is anchored between the rails. One end of a cable is attached to the cylinder mount at *a* in figure 19, and the cable is brought over one pulley of a double sheave attached to the end

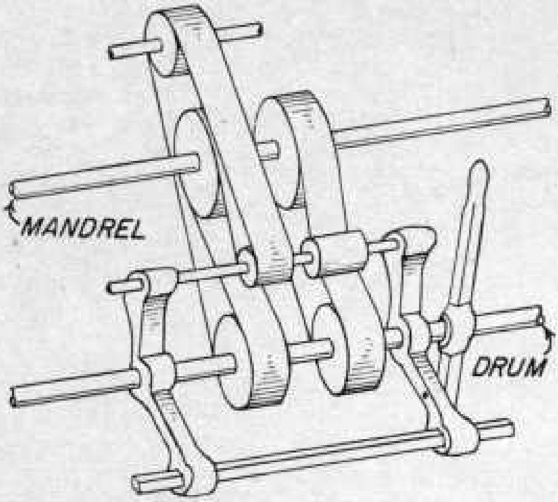

FIGURE 14.—Belt-pulley feed works. Lever action tightens one belt while the other runs slack, thereby driving drum in one direction or the other.

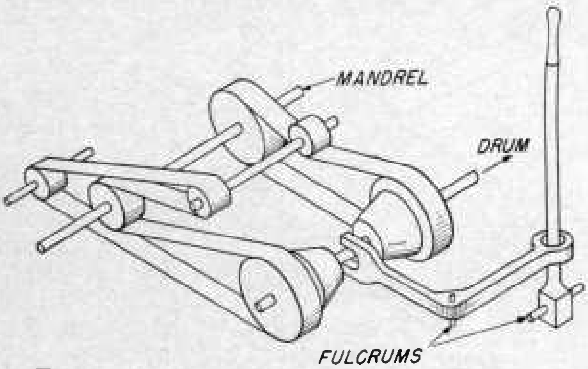

FIGURE 15.—Belts-driven feed works with clutch.

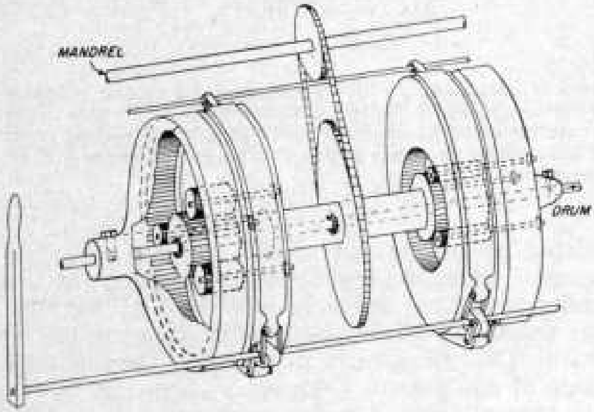

FIGURE 16.—Chain-driven feed works with lever-controlled brake bands on split housings. Chain drive rotates hollow shaft within which drum shaft floats freely. When brake band on one housing is loosened by lever, brake band on the other housing is tightened. Rotation of hollow shaft is transmitted to housings through planet gears to inner side of housing rim. Housings rotate drum shaft through pin engaging housing with shaft.

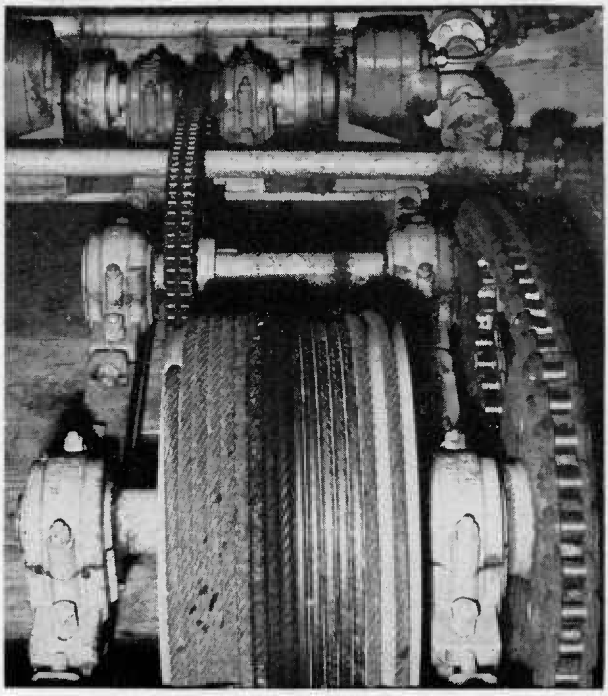

FIGURE 17.—Hydraulic feed works, turbine-driven.

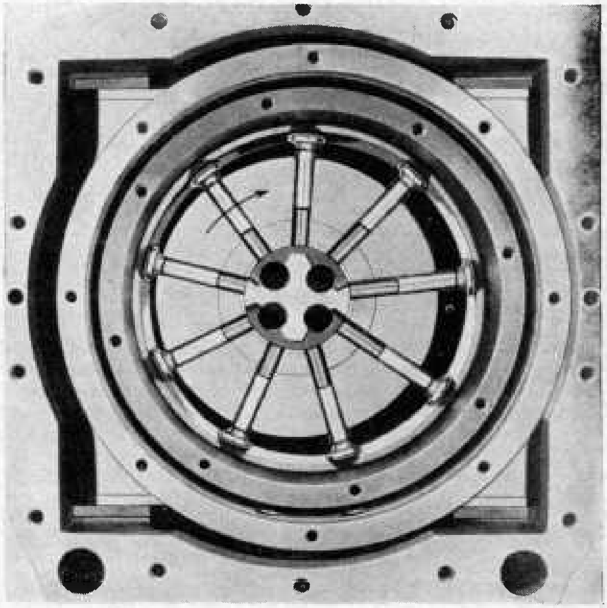

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FIGURE 18.—Oil motor used for hydraulic feed works.

of the piston rod and over a second sheave anchored at the deck end of the track and thence fixed to the front end of the carriage frame at *b* of figure 19. One end of a second cable is anchored at the opposite end of the trackway, point *e* of figure 19, passes over the other pulley of the double sheave fixed to the

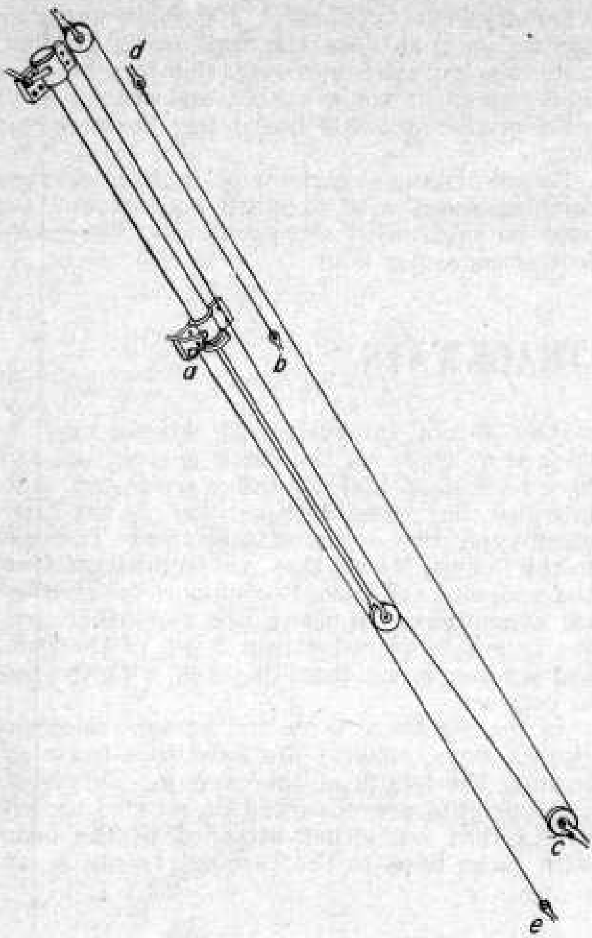

FIGURE 19.—Hydraulic feed works. Cable anchored at *a* passes over double-sheave pulley mounted on end of piston, over pulley at deck end of track, and to front end of carriage frame at *b*. Cable anchored at *e* passes over piston pulley and pulley at *c* to back end of carriage frame at *d*. Piston action thus pulls carriage back and forth twice the length of the piston stroke.

end of the piston rod, thence over a sheave anchored at the nondeck end of the trackway, and is fixed to the back end of the carriage frame (fig. 19). By this means, the carriage travels twice the distance represented by the movement of the piston.

In one feed system driven by steam pistons, the twin-engine feed, piston heads in two short cylinders deliver power through connecting rods to turn a crankshaft directly connected or geared to the drum (fig. 20). In another system, the shotgun feed, a piston head in a single cylinder that extends the full distance the carriage travels is connected by a piston rod directly to the carriage (fig. 21). In the twin-engine feed, a lever controls the direction of rotation and size of valve opening. In

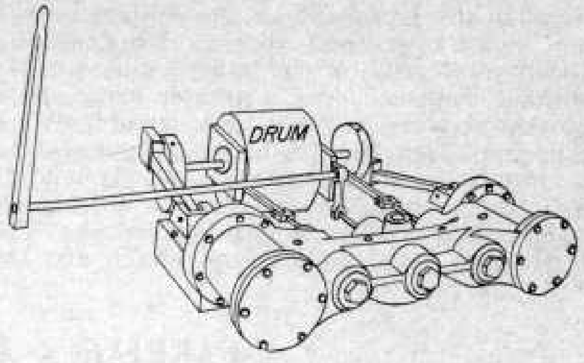

FIGURE 20.—Two-cylinder steam feed works.

the shotgun feed, the lever controls the intake and exhaust at each end of the cylinder so as to apply steam pressure to either face of the piston head and thereby advance or reverse the carriage.

In all except the steam piston, electric, and hydraulic types, the feed works is geared to recede the carriage about twice as fast as it advances it. On all types, the sawyer seeks to adjust the rate of advance to the load capacity of the saw or power source.

The rope-drive and single-cylinder feeds (hydraulic or steam) have the advantage that they can be centered on the carriage, thus minimizing strains in the frame. The rope drive can be extended more readily to saw long logs than can the single-cylinder variant. The rack-and-pinion drive, applying the propelling force along the edge of the carriage, is more subject to racking, and the carriage travel is limited by the length of the rack fixed to it. This drive therefore is less suited to cutting long logs.

In the straight friction mechanism, the braking action and power transmission are dependent upon the friction where the wheel and disk are tangent; considerable leverage must be used, and the carriage is braked into reverse by holding the friction wheel in static contact with the moving disk, thus tending to wear flat spots in the friction wheel. Carriage reverse is normally sluggish. In the belt-and-pulley type, braking action and power trans-

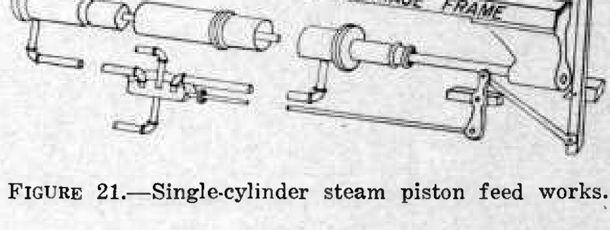

FIGURE 21.—Single-cylinder steam piston feed works.

mission are dependent on the contact of belt and pulley over areas approximating one-half the circumference of the pulley; consequently, wear is dispersed over a greater area, and a quicker response to the lever is possible. In the type employing friction, belts, and pulleys, the continuously rotating friction wheels tend to wear more uniformly and exert a quicker response than in the straight friction type. The type using belts, pulleys, and clutch and the planetary-gear type exert a quicker response and action than does the type using friction, belts, and pulleys; moreover, then can be used where steam is not available, and are suited to mills producing 2,000 board feet or more per hour.

Steam-piston, electric, and hydraulic types combine speed with excellent control, and are used on mills with a capacity of 2,000 board feet or more per hour.

CARRIAGES AND TRACKWAYS

Carriages used on band mills are usually more complex and of heavier construction than those on mills having circular headsaws. In the single-cutting type of band mill, they provide for offsetting the carriage on the gigback to clear the band saw. They are usually supplemented with power log turners, for which they must be strongly constructed. The V-track is usually farthest from the saw.

Small-mill carriages may be classified as of either the headblock (fig. 1) or log-beam type (fig. 22). Below the bolsters they are alike in that frames range in width between 2 and 4 feet and in length between 12 and 24 feet. The wheels, ranging from 6 to 14 inches in diameter, depending on the model, are outside or directly under the side members at approximately 5-foot intervals. All wheels may be flanged or those on the track nearest the saw may be flanged and the other series not. Axle bearings may be babbitt or roller. In the headblock type, two or more bolsters are fastened to the frame; if two, they are equidistant from the midpoint and spaced to support the shortest log encountered; if there are more than two, one is usually placed within 2 feet of the front and another 2 feet from the back, with the rest in between.

In the log-beam type, the upright members (knees, dogs, offsets) are fixed to a beam extending the length of the carriage. This beam and uprights are advanced or receded by setworks that are either attached to the beam with racks fixed to the carriage frame, or at-

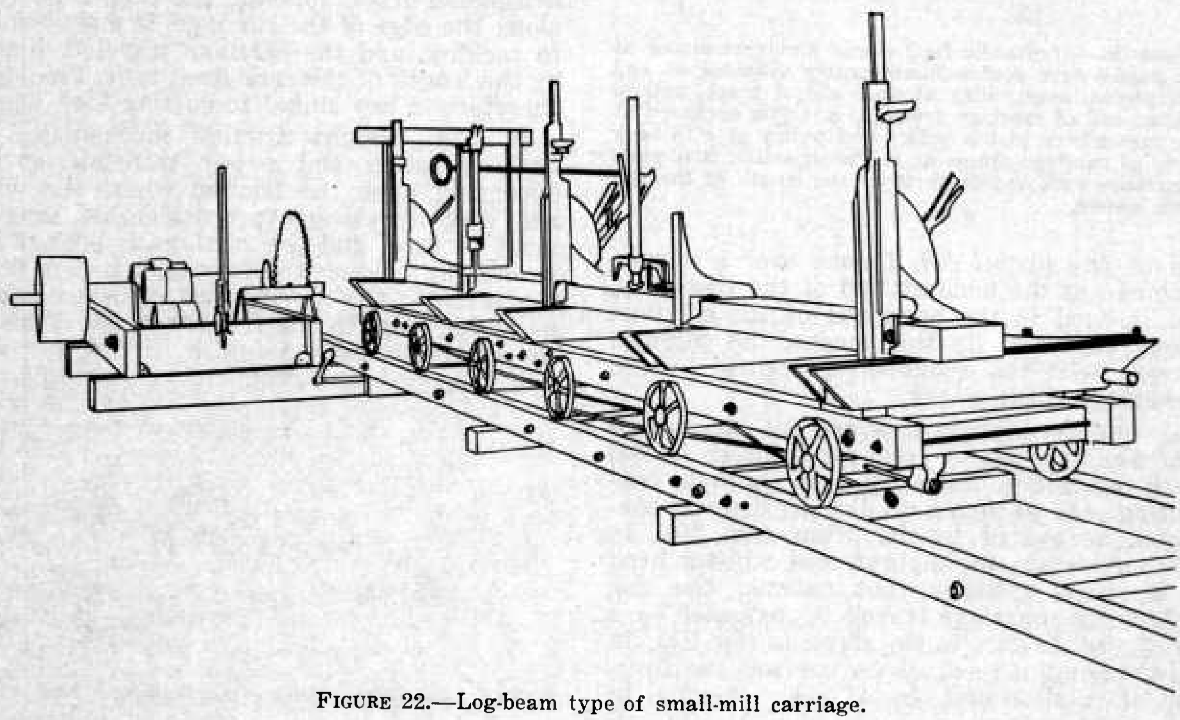

FIGURE 22.—Log-beam type of small-mill carriage.

tached to the carriage frame with the racks fixed to the beam. Two or more racks are used, and additional support is given to the beam by bolsters at 3- or 4-foot intervals. Knees and dogs can be placed at any interval along the wood beam.

The carriage should carry the log past the saw in an unvarying, straight line, should support the log against any turning or vibration, and should be sturdy enough to sustain the stresses and shocks of normal service.

Side play of the carriage is eliminated by means of flanged or grooved guide-rail wheels and by boxing the wheel bearings with axle collars. For accurate sawing, guide-rail wheels must have no lateral play on the axles; those on the nonguide rail, however, should be free in this respect. For mills using powered log turners, the guide rail is the one farthest from the saw. There is less chance that trash will collect on this rail than on the other one. The common types of guide rails are shown in figure 23.

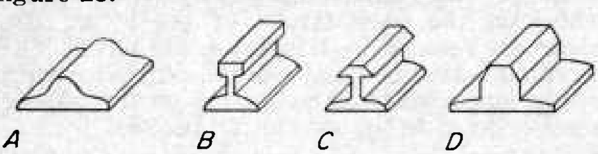

FIGURE 23.—Four variants of guide rails. *A*, Oval-head rail; *B*, T-rail; *C*, beveled T-rail; *D*, beveled bar rail.

Bolsters are usually formed from channel-iron, I-beam, or similar patterns. The base of the knee rides on the bolster, and the friction surfaces of each may be planed. The knee does not vary greatly among different makes of mills; it is essentially a sturdy upright, the base of which extends nearly across the carriage. The rack is ordinarily centered under the base of the knee, but in some models is offset outside of the bolster. In some models, the rack is adjustable. When boss dogs are used, the upright of the knee is a housing for the boss-dog mechanism and the knee face is slotted so that the dogs can function through it. Movable bars, variously known as set-out blocks, taper bars, taper knees, offsets, or false knees, are commonly bolted to the knees, so that the back supports can be advanced to conform with the taper or crook in the log. These are basically as shown in figure 24.

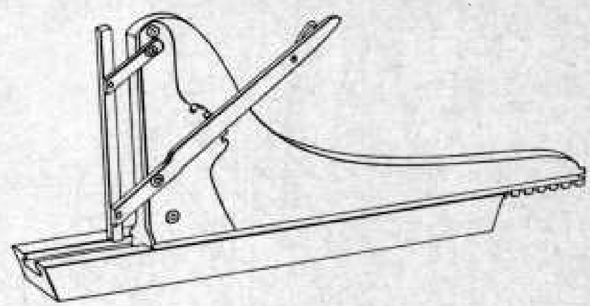

FIGURE 24.—Set-out block bolted to knee, lever-actuated.

Bolsters should support the log within 2 feet of the extremities to minimize vibration; thus, two bolsters with an over-all spacing of 8 feet are inadequate for logs longer than 12 feet, and three spaced 6 feet apart, 12 feet over-all, are inadequate for logs longer than 16 feet. As the front and rear bolsters are farther from the ends of the carriage than the trucks, the over-all length of the carriage will be approximately 4 feet in excess of the over-all spacing of the bolsters. The width of the carriage must be adequate to permit a knee opening to take and support the larger logs. For medium-size logs a carriage width of 3 feet is suggested, and for large ones a width of 44 to 48 inches. Welded metal carriages are heavier than wood ones of like size and can stand heavier shocks. The log-beam type of carriage usually has more bolsters than the headblock type, and additional dogs can be placed anywhere along the beam.

SETWORKS AND RECEDERS

The function of the setworks is to advance the log quickly toward the saw line by intervals accurately held to the thickness being cut, and to reverse the knees speedily. Precision in reversing is not vital.

The mechanism by which the knees of small mills are advanced may be lever-operated or power-operated. They may be receded by lever, by springs, or by power-actuated devices.

To advance the knees in lever-operated equipment, the toothed rim of the set wheel fixed to the set shaft is engaged by pawls attached to the lever (fig. 25). A pull on the lever is transmitted as a turn on the set shaft to the pinion wheel fixed to the shaft at each knee. The pinion turns in the rack of the fixed bolster and advances the knee. A full throw of the lever advances the knees approximately 2½ inches. With single-acting levers, the knees are advanced by forward lever movement only (fig. 25, *A*). With the double-acting type (fig. 25, *B*) knees are advanced on the back stroke as well, through a second set of pinions or pawls below the fulcrum of the lever arm.

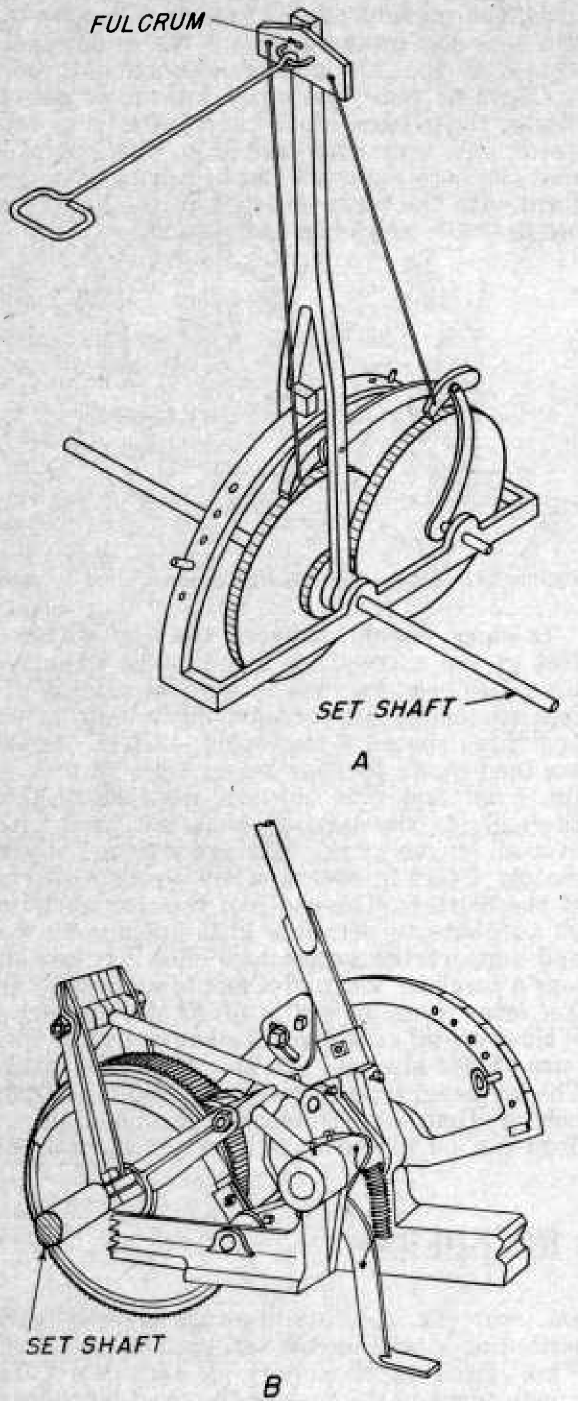

FIGURE 25.—Lever-actuated setworks. *A*, Single-acting type; twist of handle raises one pawl and lowers the other, thus permitting advance or receding of knees when lever is pulled. *B*, Double-acting type; forward motion of lever engages upper pawls, backward motion engages lower pawls which are connected to lever below fulcrum point so that gear turns set shaft in the same direction as when upper pawls are engaged.

Lever-actuated devices that recede the knees may be attached to the set shaft independently of the advancing mechanism (fig. 25), or in combination with it. The lever action may be transmitted from one geared wheel on an independent shaft to a second geared wheel fixed to the set shaft (fig. 25), or from the lever through the recede wheel attached directly to the set shaft. Provision is made to disengage the pawls on either the receding or the advancing mechanism when moving the knees.

In spring-actuated receders (fig. 26), a spring coiled about the set shaft as a core has one end anchored to a collar fixed to the set shaft and the other end anchored to the frame of the setworks. It is so oriented that, as the set shaft is turned in advancing the knees, the spring is tightened. It is usually associated with a double-acting setworks, since the continuous meshing of the alternate series of pawls insures continuous tightening of the spring; but it can also be used with single-acting setworks provided with extra pawls to hold the set wheel on the back stroke of the lever. The knees are receded by tripping these pawls. The receding action is usually brake-controlled with a lever-operated band that bears on the face of a pulley fixed to the set shaft (fig. 26).

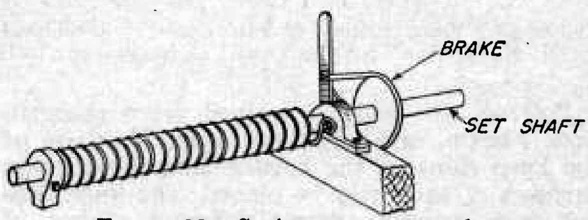

FIGURE 26.—Spring-actuated receder.

Power-actuated receders vary in design. Knees may be moved by means of power taken from movable beams, chains, ropes, drums, electric motors, or hydraulic pistons. In a common type (fig. 27, *A*) a beam alongside the track is elevated with a foot-operated lever so that it rotates a wheel fixed to a shaft having a set of bevel gears connecting with the set shaft. As the carriage is gigged back, the sawyer steps on the foot lever and the knees are receded. A variant (fig. 27, *B*) takes power from a carriage truck wheel through mitered gears to turn a shaft and friction wheel which is lever-actuated so that it can be brought to turn a bull wheel on the set shaft.

In the chain type of power setworks and receder, both setting and receding are done by meshing a sawyer-operated foot lever to a power-driven sprocket anchored inside the track. The sprocket engages a chain drive on the carriage that is connected to bevel gears that actuate the set shaft (fig. 28).

In rope-actuated types, the rope may be stationary or used as a continuously running belt. The stationary system (fig. 29) consists of a heavy manila rope extending the full track length about 5 feet above the outside trackway and passing over one and under another grooved pulley of the setworks mechanism anchored on the carriage. A friction wheel attached to the shaft of one pulley engages a disk attached to the set shaft as the rope is tightened by a sawyer-controlled lever, thus advancing the headblocks when the carriage is advanced or receding them when the carriage is gigged back. A dial-and-pointer indicator registers the set.

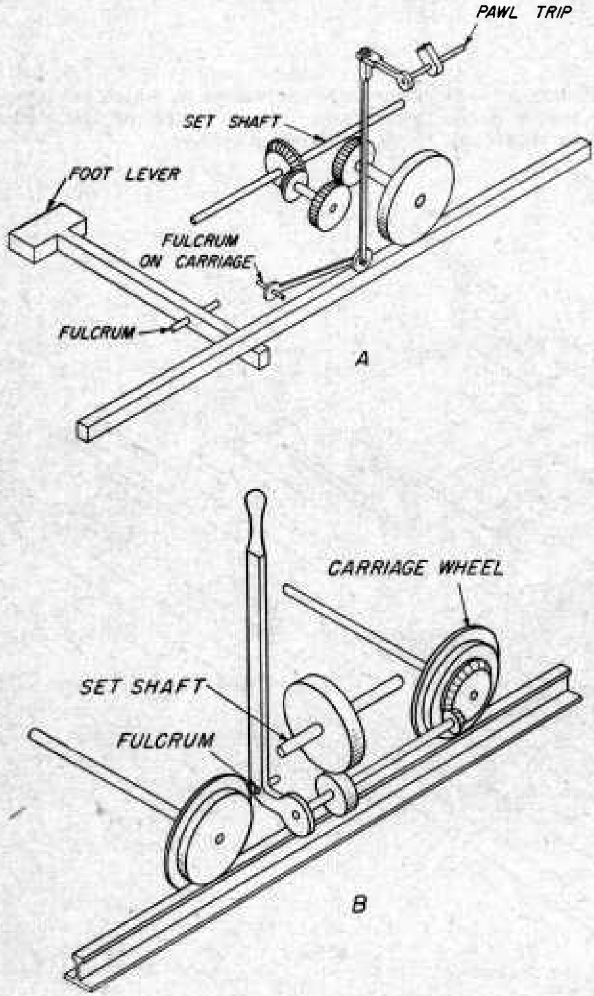

FIGURE 27.—Power receders. *A*, Movable beam, friction-wheel type actuated by carriage gigback; foot lever brings moving beam in contact with friction wheel, which operates set shaft through gears, thus receding knees. *B*, Receding action obtained through geared carriage wheel when lever brings friction wheel in contact with bull wheel on set shaft.

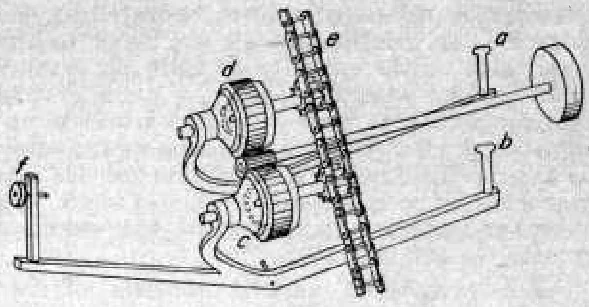

FIGURE 28.—Power-actuated setworks. Levers *a* and *b* control clutches *c* and *d*, which engage chain *e* for either advance or receding. Trip *f* releases pawls on setworks.

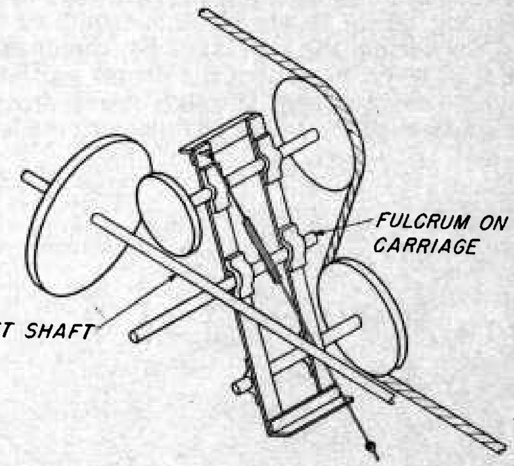

FIGURE 29.—Fixed-rope, friction-wheel type of power setworks. Mechanism is anchored to carriage, so that friction wheel actuates setworks when rope is tightened against pulleys.

With the continuously running system, the rope, powered by an electric motor, is run over a grooved pulley at each end of the carriage track and returned below these pulleys, and a friction wheel is placed on the shafts of both pulleys of the mechanism attached to the carriage. The pivoted frame is tilted so that one friction wheel will engage the disk on either face. The knees are advanced or receded when one or the other friction wheel is brought against the disk by tilting the frame with a lever.

The carriage must be in motion in order that the stationary system can function, whereas in the endless-rope system setting can also be done when the carriage is not moving.

In the drum-actuated type, a metal cylinder approximating 8 feet in length and 6 inches in diameter is placed just outside of, and parallel to, the outside track at the deck end. The cylinder is constantly revolving, and can be moved laterally by means of a lever operated by the sawyer. Two friction wheels are fixed to the under side of the carriage so that either may be in contact with the revolving cylinder, the cylinder acting as a movable bull wheel to engage one friction wheel to advance, or the other to recede the knees. The friction wheels are connected by belts or gears to the set shaft, and a dial-and-pointer indicator on the carriage records the set (fig. 30).

A drum-powered variant consists of two drums on a shaft in the carriage frame (fig. 31). One end of the cable pulling the carriage is fixed to each drum, so that the cable unwinds on one and winds on the other as the drums revolve. The sawyer, by stepping on a pedal, raises a beam alongside the trackway, thereby releasing pawls to permit the drums to turn, and anchoring the carriage. By manipulating the feed lever, he causes the drums on the carriage to revolve and, through gears, turn the set shaft until the knees advance or recede suf-

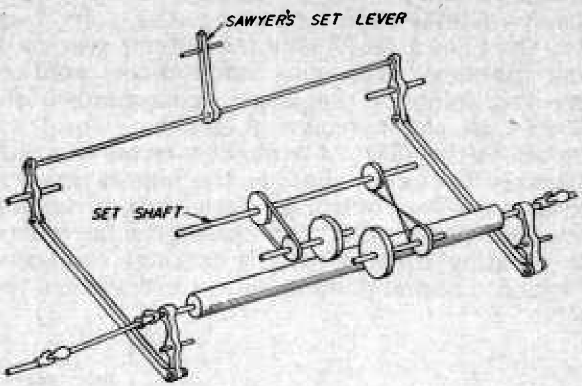

FIGURE 30.—Drum-actuated setworks in which set lever moves drum against one friction wheel or the other to rotate set shaft in either direction.

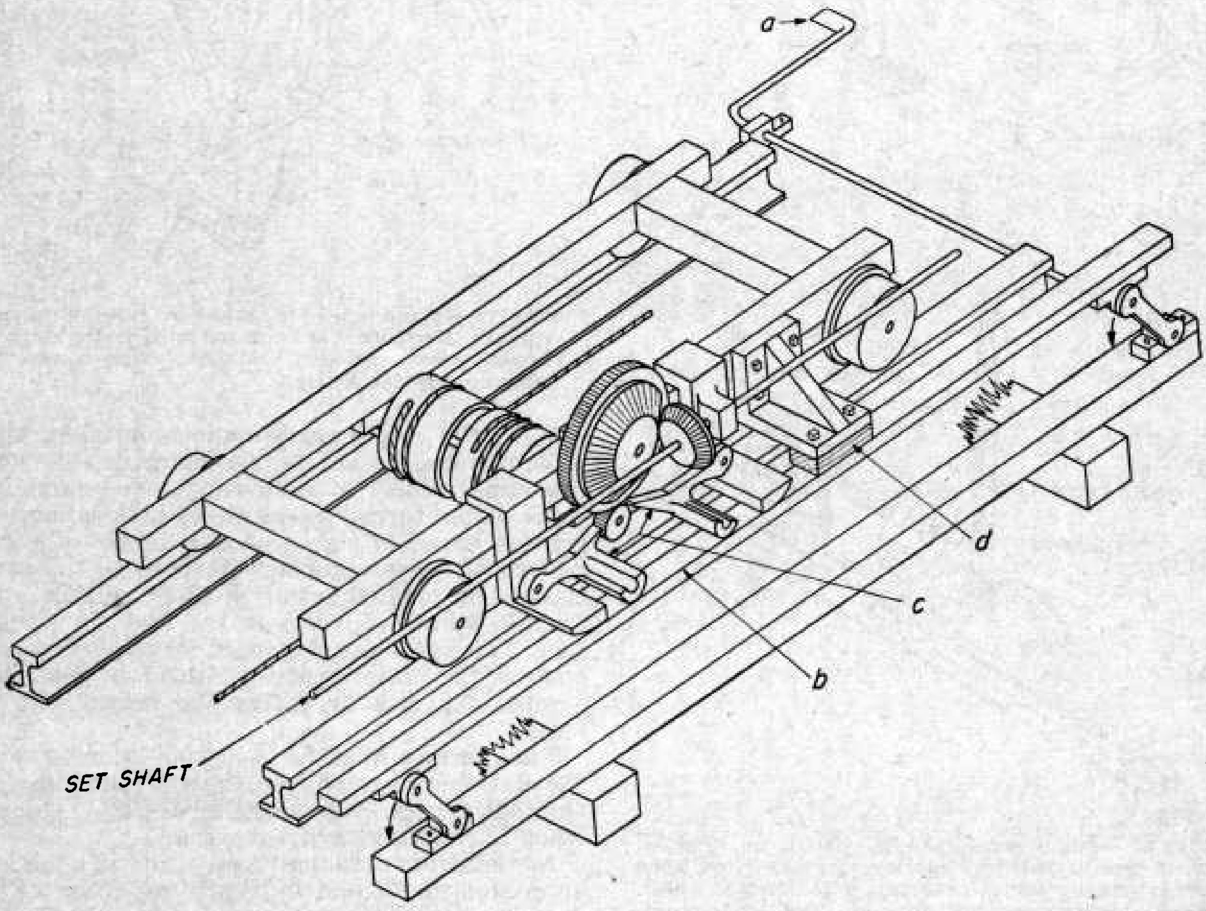

FIGURE 31.—Drum-actuated setworks in which drums are turned by carriage feed cable as sawyer steps on pedal *a* to engage set shaft and anchor carriage by raising beam *b*, which releases pawls *c* and engages brake shoe *d*.

ficiently. A lever type of set supplements this power set. A selected set can be automatically repeated and the front knee immobilized when moving the two rear ones.

In the type of setworks and receder actuated by an electric motor, a 5-horsepower reversible motor is connected by a universal joint, reducers, and gears to the set shaft. The motor control may be placed either on the carriage or at the sawyer's post. A dial-and-pointer indicator is used to record the headblock position, either the dial or the pointer being synchronized to turn with the knee; a magnetic brake is used on the motor shaft to insure a positive stop.

In one variant (fig. 32), the knee is automatically stopped at a preset position by means of a wire belt running over the dial and through small, grooved pulleys. The pulleys are arranged on the bolster as shown in figure 32. The knee

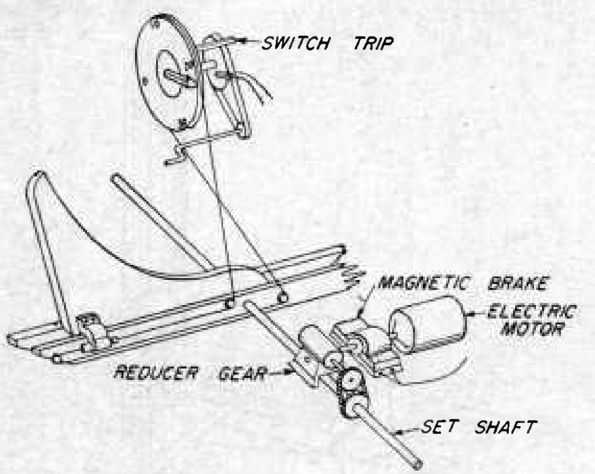

FIGURE 32.—Electrically powered setworks. Electric motor rotates set shaft, thus advancing knee, which actuates wire belt passing over dial. Pointer is preset on dial scale for distance to advance knees, thereby also setting circuit breaker. When trip on dial strikes circuit breaker, motor stops.

is automatically stopped at a preset position by a circuit breaker actuated by a trip attached to the dial. In operation, the pointer is turned to the desired setting, thus advancing the circuit breaker. As the motor is started, the advancing knee turns the dial through the wire belt until the trip on the dial opens the circuit, stopping the motor. The diameter of the pulley backing the pointer is such that the stop advances the exact distance indicated in the pointer movement. The switch is fixed to the base of the knee near the face contacting the log, and is opened when the advancing knee brings the lever in contact with the stop.

In one variant of the hydraulic type of setworks and receder, a 5-horsepower electric motor mounted on the carriage is connected through reducer and chain drives to the shaft of a hydraulic pump and oil is forced through a turbine. The device is similar in principle to the feed works shown in figure 18. The output shaft of the pump is connected by chain drive to the set shaft. The oil line connects the turbine to the sawyer's position, and the direction and magnitude of knee movement are controlled by meter valves at the sawyer's position.

In another variant (fig. 33), a hydraulic cylinder is anchored alongside the bolster of the center knee, its piston rod attached to the set shaft by a roller-bearing connection. The arrangement of pinions on the set shaft has, in addition to the racks under the knee plate, other racks fixed to the carriage frame to engage the under side of each pinion wheel. As the piston thrust pushes the entire set shaft forward, the knees are advanced a distance equal to the piston thrust; at the same time, the pinion on the set shaft rotates, thus also advancing the knee, for a total knee advance of twice the piston thrust. The sawyer controls the advance with a second hydraulic cylinder

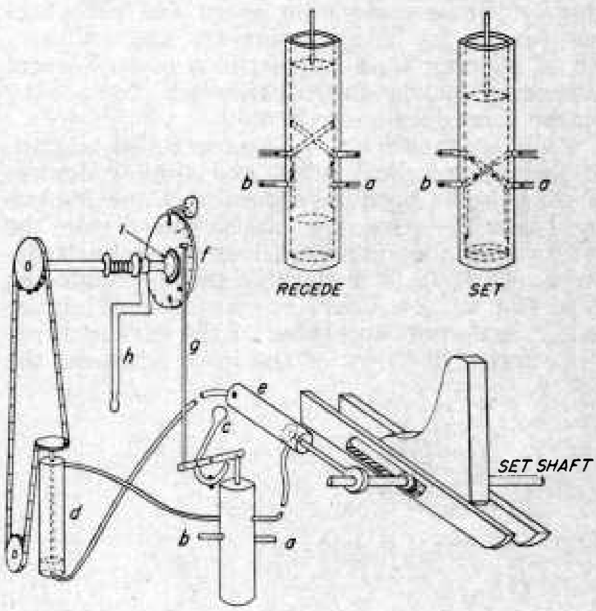

FIGURE 33.—Hydraulic setworks of the cylinder type. Oil is forced into cylinder valve at port *a*. When sawyer opens valve to "set" position with lever *c*, oil flows through ports and tube to cylinder *d*, forcing piston down. Cylinder *e* then thrusts set shaft forward, advancing knee, and oil is forced from cylinder *e* through cylinder valve and exhaust port *b* to tank. To recede, sawyer moves lever *c* to recede position of cylinder valve. Knee advance can be stopped by setting dial *f* for distance desired; pin on dial actuates lever *g*, which closes cylinder valve. Dial is rotated by chain drive off cylinder *d*. Lever *h* releases clutch *i* to set dial.

of the same size as the first one, and so connected to the first by a flexible hose that the oil expelled from the second actuates the set piston to duplicate the thrust or withdrawal of the control piston.

Control of the amount of thrust or knee advance is secured by turning a calibrated dial at the sawyer's position by means of a chain and sprockets activated by the movement of the control piston.

A clutch between the dial and transmission is disengaged and the dial turned backward by hand the amount desired for knee set as indicated on the calibration. The clutch is then engaged, and the feed valve to the cylinder base is opened by the sawyer. The thrust of the piston turns the dial forward. A peg attached to the face of the dial engages a lever to close the feed valve when the dial has turned forward the amount set.

Set accuracy is possible mechanically in the lever-actuated type of setworks only when gears of the rack and pinion, as well as the pawl-tooth contact of the set wheel, are symmetrical and uniformly spaced, with no play in them or in the bearings of the set shaft. Machine-cut rack-and-pinion gears and set-wheel teeth make for better symmetry and uniformity of spacing than do cast-iron ones. Several staggered pawls insure freedom from play better than does a single one.

Pegs, notches for a spring-controlled trigger, dial-controlled pawl trips, and similar devices save time and promote accuracy. A mechanism by which the stop shoe can be raised over the intervening pegs where a longer stroke is desired (fig. 34) is preferable to the single-peg type (fig. 26, *A*). There is very little difference in forward-operating speed of the various types —a single full throw of the lever advances the

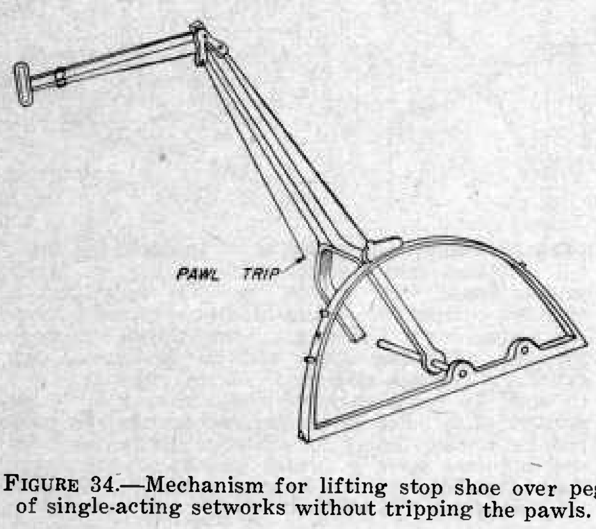

FIGURE 34.—Mechanism for lifting stop shoe over peg of single-acting setworks without tripping the pawls.

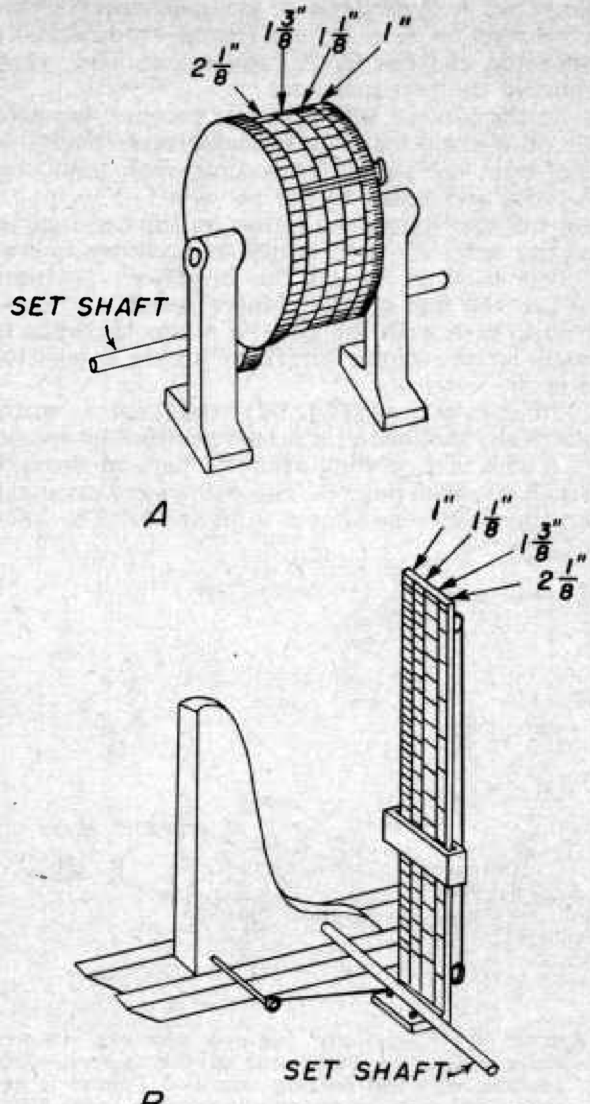

FIGURE 35.—Types of indicators showing the number of boards of a given thickness that can be taken. *A*, Cylinder type; *B*, board type.

knees from 2 to 2½ inches. A double stroke (forward and back) of the double-acting type can be set to give the same knee advance as a single stroke of the single-acting type. This setting obtains greater leverage and is often used with heavy logs.

Precision setting is possible with four of the power mechanisms described, the electric using either the switch-breaking automatic stop or the control at the sawyer's position, and the hydraulic with either metered valves or control piston and automatic valve shutoff. In other power types, the operator stops the advancing knee when the pointer on the scale indicates it has moved far enough. Perfect coordination is not possible and, though they save labor, such mechanisms are partly responsible for inaccurate sizing of the lumber cut.

The lever type of receder does not have the possibilities for fast production, particularly in sawyer-operated setworks, provided by the spring and power types. The type that is independent of the advancing mechanism requires an extra lever and has no particular merit over the combined type. Spring and power types act to recede the knees quickly. The spring type can function when the carriage is stationary as well as moving, but requires somewhat greater leverage to advance the knees. The beam-powered type is quickly operated by the sawyer while the carriage is gigging back. The chain type of power receder, while it can be foot-operated, requires extra pulleys, belts, chains, shafts, and gears. The stationary-rope type recedes only when the carriage is in motion. With moving-rope, electric, and hydraulic types, receding is independent of carriage movement.

All types of setworks have indicators to show the distance between the face of the knee and the saw line. Some, in addition, indicate the number of boards of a given thickness that can be taken by sawing through and through (fig. 35, *A*, *B*). The type having numbers and pointer on the bolster and knees (fig. 36) is least satisfactory because of poor visibility and the difficulty of quickly centering the pointer on the desired mark. A vertical gage board in sawyer-operated setworks, or a wheel gage where the sawyer rides the carriage, is easier to read and can guide the sawyer after the final turning to utilize the cant fully.

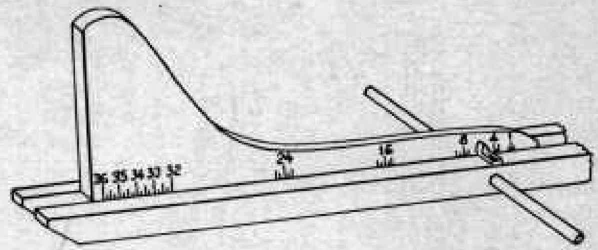

FIGURE 36.—Indicator directly on bolster and knees, where readings are difficult.

DOGS

Dogs used on small mills employ either a spike or a hook to grip the log, but in mechanical details they vary widely. The basic types are (1) those using a fixed post with the spike attached or revolving about it; (2) those with a sliding post; (3) the hammer dog with spike arm and hammer moving through a fixed arc; and (4) the "boss" dog with lever-actuated hooks thrusting out from the knees.

Included in the fixed-post, manually operated types are those shown in figure 37. The rack variation (fig. 37, *A*) consists of the spike and pinion wheel fixed to the dog housing and the rack machined or stamped into the fixed post. Pawls engaging the rack help keep the spike embedded as the pinion is turned when the lever is pulled down. The variation shown in figure 37, *B* employs an eccentric to hold the housing to the post. In one variant of the threader post or screw dog (fig. 37, *C*), the hooks are appended to a housing threaded to the post; pawls hold the housing in place or can be withdrawn to permit rapid lifting or lowering of housing. By turning the fixed post, the dog is raised or lowered as desired. The type of dog shown in figure 37, *D*, consists of a spike at each end of a lever arm that can be rotated around the post. Arms are usually of unequal length, this dog being used mainly to provide additional dogging for large logs. The weight of the dog is relied on to clinch the log properly.

Fixed-post, power-operated dogs are actuated by air or hydraulic cylinders and electric motors. The air or hydraulic dog (fig. 37, *E*) consists of the cylinder fixed to the dog housing and the piston rod anchored at the base. A bottom dog at the end of the piston rod has enough play to function. The fixed post slides laterally in guides attached to the knee and propelled by the piston of a second cylinder. A small electric motor fixed to the carriage frame runs the pump for hydraulic pressure. The shell of the hydraulic cylinder is fixed to the dog housing, and the end of the piston rod is anchored to the base of the knee. Cylinders for the air-driven dog are installed in the same way. The electric dogs have a chain attached to the top and bottom of the housing and thence over sprockets at the top and base of the fixed post and back to the sprocket propelled by the motor (fig. 37, *F*). Provision to break the current at a definite load prevents excessive strains on the assembly.

Moving-post types of dogs are shown in figure 38. A down pull on the lever gives a downward movement of the spike, and in those

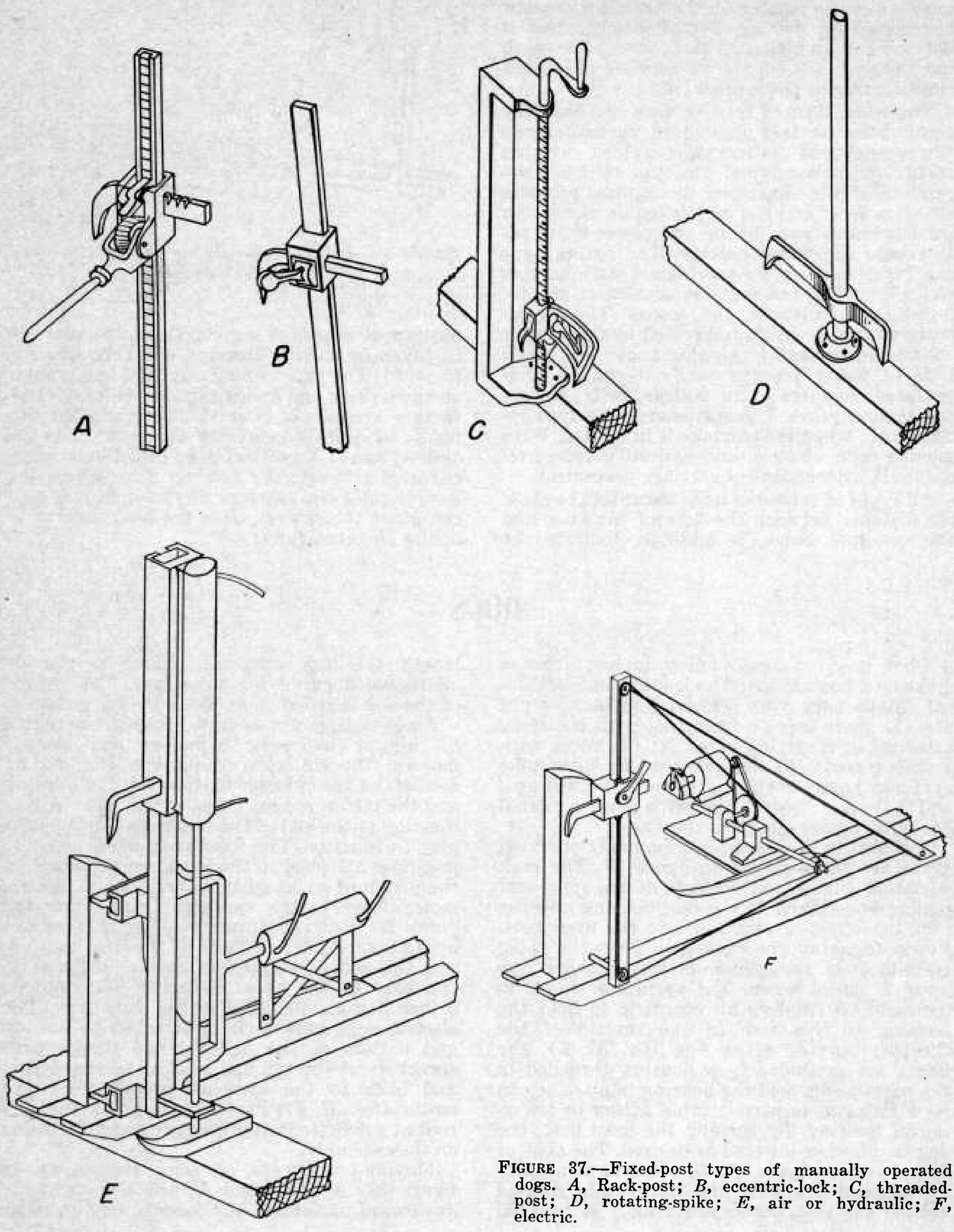

FIGURE 37.—Fixed-post types of manually operated dogs. *A*, Rack-post; *B*, eccentric-lock; *C*, threaded-post; *D*, rotating-spike; *E*, air or hydraulic; *F*, electric.

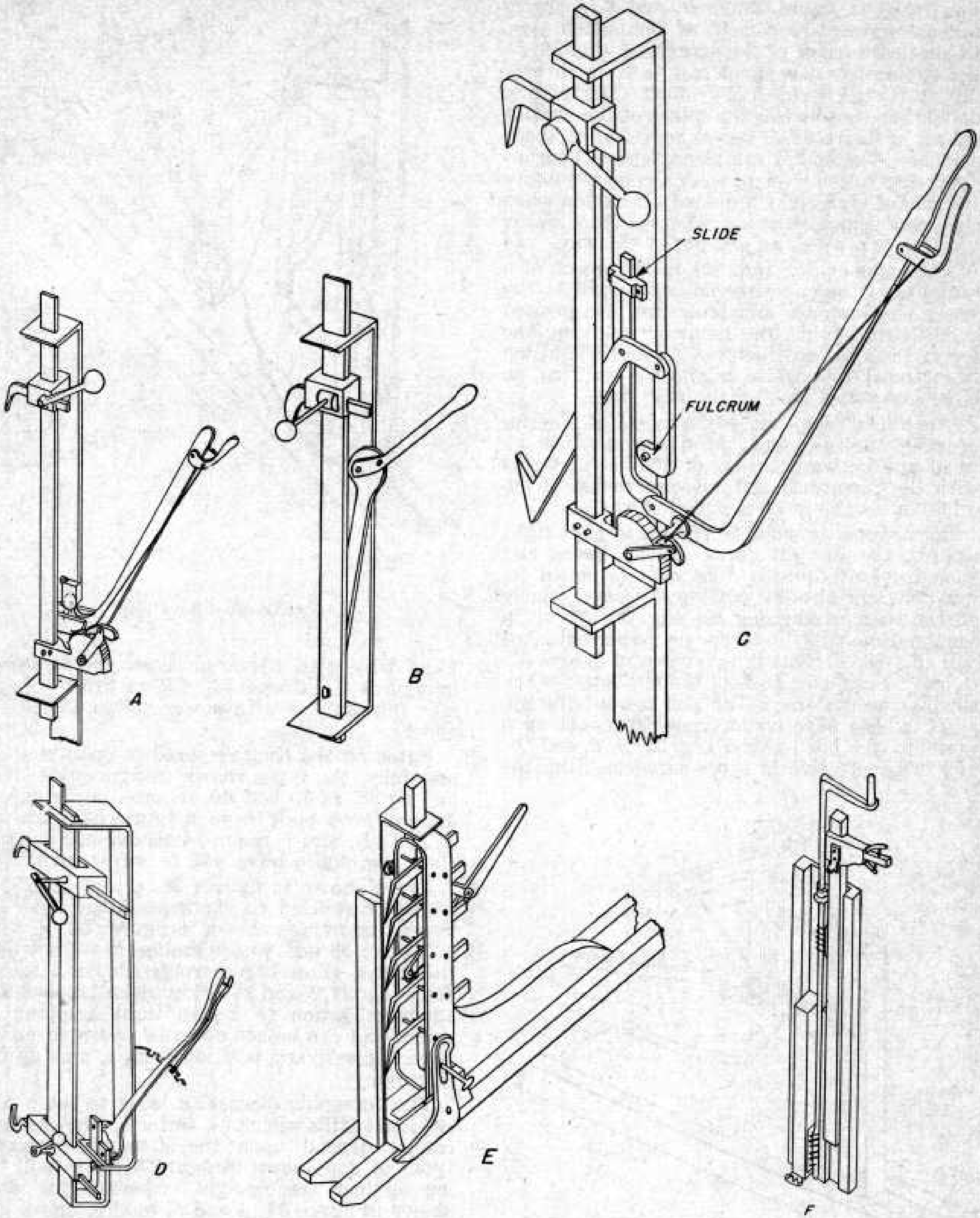

FIGURE 38.—Moving-post types of manually operated dogs. *A*, Single-bar single dog, lever at base; *B*, single-bar single dog, lever at midpoint; *C*, single-bar top and bottom dog; *D*, double-bar top and bottom dog; *E*, yoked-bar, dog with pivoted top and rotating bottom dog; *F*, double-bar threaded-post dog.

illustrated in figure 38, *C, D,* and *E,* a simultaneous upward movement of the bottom dog. In another variant of the screw dog (fig. 38, *F*) the sliding bar movement results from threading it to the fixed screw shaft. The sliding double bar that houses the spikes of the variant shown in figure 38, *E* moves up or down about 4 inches. The spikes are placed about 3 inches apart and fulcrum on a pin. A second pin under the rear of each spike provides a backstop when the spike engages the log, whereas those below are free to pivot down and out of the way.

The hammer dog (fig. 39) is at the end of a radial arm, the opposite end being fixed to the knee. The hammer and lever are also pivoted at the same point, the hammer following the arc of the spike as the lever is raised. This dog is intended to provide additional dogging on large logs when making the first cuts.

The "boss" dog (fig. 40) consists of a series of levers and fulcrums that synchronize the upward and outward thrust of one set of hooks with the downward and outward thrust of another set as the lever is pulled down.

Dogs should immobilize the log or cant tight against the upright faces of the knees and should operate quickly. The cant is pulled toward the uprights by putting the bevel wholly on the back of the dog bit (fig. 37, *D*) or in combination with a lever- or power-actuated pull (fig. 38, *A*). The types shown in figures 37, *D*, and 39 are used to hold the log better when sawing the first face. The pull toward the upright is least effective in types dependent upon jamming the bit by hand (fig. 37, *A, B*, and *D*), and more effective in types supplementing the hand drive with a lever or screw pull as shown in figures 37, *C* and 38, *A-F*, or with a hammer (fig. 39), or with power drives (fig. 37, *E* and *F*).

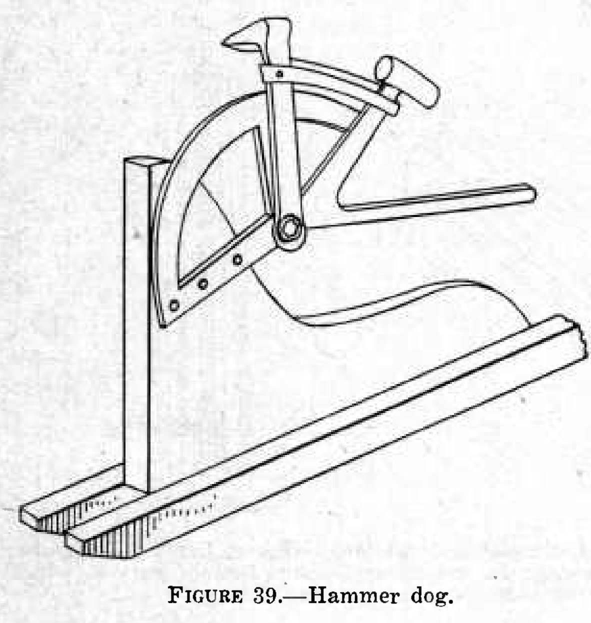

FIGURE 39.—Hammer dog.

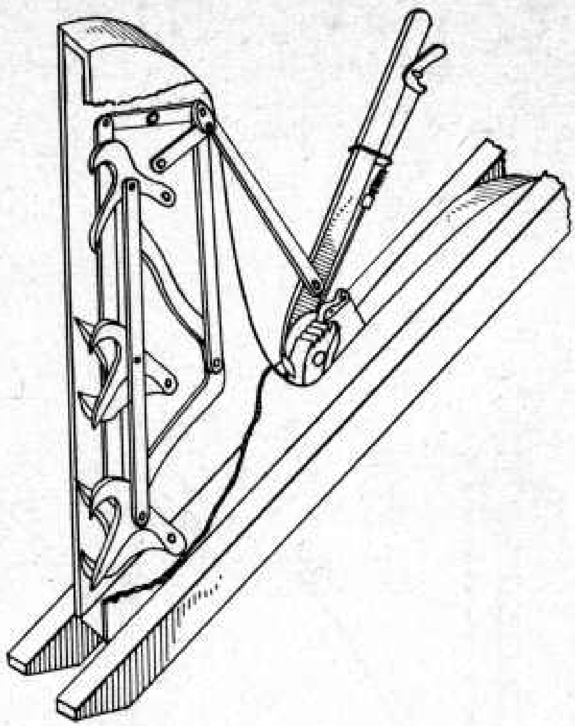

FIGURE 40.—"Boss" dog.

Rated on the time required to operate them manually, the types shown in figures 37, *A, B,* and *D*; 38, *E*; 39, and 40, require only a simple drive or lever pull; those in figures 37, *C* and 38, *A, B, C, D,* and *F* require unclamping, driving, clamping, and a lever pull or screw turn.

Types shown in figures 37, *C* and 38, *F* are usually restricted to carriages fitted with log beams; and types shown in figures 38, *A, B, C, D,* and *E,* 39 and 40 are limited to mills where the setter rides the carriage. Power-actuated dogs (fig. 37, *E* and *F*) bring instantaneous and adequate action to insure tight gripping of cants, and can be set up to be operated either from the sawyer's position or by a man on the carriage.

The foregoing discussion leads to these conclusions: Mills without a setter on the carriage cannot depend upon the manually operated types of dog shown in figure 37, *B* to pull the log against the upright, whereas the dogs shown in figure 37, *A* and *C,* tend to do so, and each requires few motions. With a setter on the carriage, the types shown in figure 38, *A* to *D* and *F* tend to hold the cant against the knees, but involve several motions; the type shown in figure 40 does this with fewer motions needed, but may score the face where the claws grip, whereas that shown in figure 38, *E* does not. Types shown in figures 37, *C* and 38, *F* hold cants against the knees, but usually a hammer or drop dog is added the better to hold the round log. The power dogs (fig. 37, *E* and *F*) hold the cant against the knees and also lend themselves to the sawyer's control.

EDGERS

Three types of edgers are used by small mills. The single-saw type (fig. 41) usually employs a light flatcar pushed along a trackway to carry the board through the saw one edge at a time. In the type having two or more saws on a single mandrel (fig. 42) the boards are fed through the saws by power rolls and one or both sides are edged or ripped for grade and size requirements. The vertical-edger type (fig. 43) with two or more saws on a vertical mandrel is installed ahead of the headsaw to edge the boards as the carriage carries the log through the saw.

The single-saw carriage edger carries a saw 14 to 16 inches in diameter running at approximately 2,000 revolutions per minute on a mandrel about 1½ inches in diameter. The carriage is a platform about 14 feet long and 2 feet wide mounted on trucks, the flanged wheels of which run over a flat-topped track.

In the multiple-saw type, all saws may be movable along the mandrel, or one may be fixed and the others movable. If a fixed saw is used, it is usually attached to the mandrel about 6 inches from one edge of the feed bed, depending on whether it is a left-hand or right-hand edger. A left-hand edger is used on a right-hand mill and a right-hand edger on a left-hand mill. Viewed from the front, a log passes to the right of the headsaw in a right-hand mill, to the left of the headsaw in a left-hand mill. A movable guide on the feed bed can be placed so that either no edging is done on this saw or the full 6-inch width is taken; with adjustable guides, any width between zero and 6 inches can be taken.

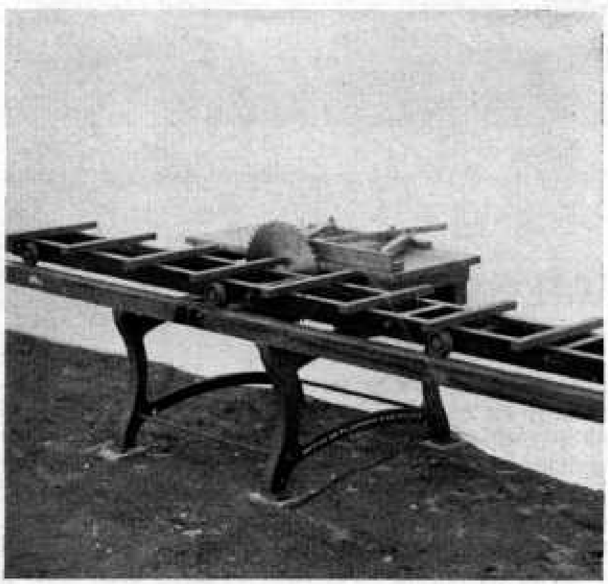

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FIGURE 41.—Single-saw type of edger.

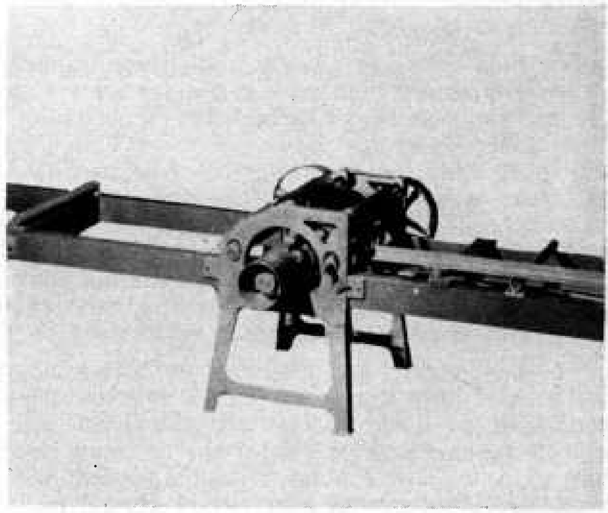

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FIGURE 42.—Multiple-saw type of edger with powered roll feed.

The movable saws slide along two keys fixed to opposite sides of the mandrel, each saw being connected, by means of a fork engaging opposite sides of the collar or guides on the saw, to a lever arm extending to the front of the machine and fulcruming at about its midpoint. The saws are normally 14 to 16 inches in diameter and are held with a 5- or 6-inch collar. An indicator fixed to the lever arm just ahead of either the saws or the feed table guides the operator in spacing the saws as it moves over a scale fixed to the machine; notches or holes in the frame, together with pawls or pegs on the lever arm, hold the saw in the position required.

The board is held in place and fed through the saws by means of a top and bottom feed roll, one pair being just ahead and another behind the saws. The bottom (feed) rolls are fluted or scored and power driven. Both top (pressure) rolls are smooth, turn by contact with the moving board, and are in a swing frame to allow them to move up or down for different thicknesses of stock. The front pressure roll is of small diameter (about 2½ inches) to obstruct the operator's view of the saws as little as possible; the rear one is usually larger, 3 to 6 inches in diameter. These pressure rolls swing away from the operator when being elevated.

The feed rolls are usually belt-driven, power ordinarily being taken off the edger mandrel at the end opposite that to which the drive pulley is attached. They are adjusted to feed at about 100 to 125 feet per minute. The feed bed also has three dead rolls, one in the center and one at each end lined up with the powered feed rolls; in one type, a chain with lugs helps propel the board to the power rolls. The rear bed may have dead rolls and a board guide lined with the fixed saw; or it may be a plane surface.

Vertical edgers are mounted on a specially built metal husk frame in such a way that the perimeter of each horizontally mounted saw exactly reaches the log side of the headsaw cutting plane at a line about 2 feet ahead of the headsaw. Thus, as the carriage is gigged back to the deck, the cant set out for the next headsaw cut, and the carriage advanced, the edger saws edge to the thickness set. The bottom saw may be fixed to the vertical shaft, or all saws may be movable up and down the shaft by means of levers or hydraulic pistons manipulated by the tail sawyer to edge or rip to required sizes.

Saws are of the inserted-point type, usually about 26 inches in diameter and with collars 9 inches in diameter. They are movable up or down along two keys fixed to opposite faces of the shaft, and rotate in a direction opposite to that of carriage feed. Vertical edgers, rarely used outside the Douglas-fir region, are found on mills with double circular headsaws operating on logs of large diameters (fig. 43).

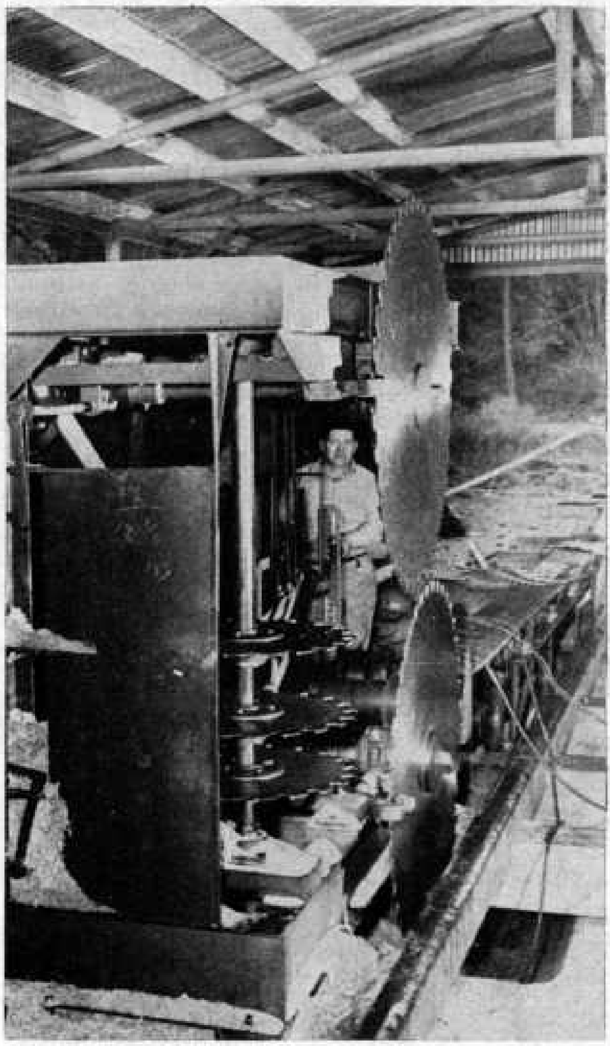

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FIGURE 43.—Vertical type of edger installed in front of headsaw.

TRIM AND CUT-OFF SAWS

Four types of trim saws used on small mills are: (1) The single cut-off, (2) the "Canadian" trim saw, (3) the two- or three-saw cut-off, and (4) the battery trimmer.

The single cut-off saw (fig. 44) consists of a swinging frame pivoted to bring the saw across the flow line of the material. The frame normally rests so that the saw is within a guard clear of the flow line. Trimming is done by pulling the saw across the material. The pivot can be above or below the flow line. If its function is mainly to make boiler-room fuel, it may be located opposite the tail sawyer-edgerman, who pulls slabs across the edger feed table and segments them with or without assistance. If its function is mainly to cut up slabs for fuel wood or to trim ties and timber, it is usually located near the back end of the edger in the rolls from the headsaw. If the main function is to trim boards, it is usually near the back end of the edger across from these rolls. The larger sizes take a saw up to 42 inches in diameter, but saw diameters normally are 24 to 30 inches.

The Canadian trimmer is used where mills and concentration yards are equipped with conveyor chains that carry the material past two fixed saws spaced about 13 feet apart along the conveyor chain and 16 feet, 1 inch, or other standard lengths, across the chain. The first saw on the line squares up one end, or the board is so placed as to trim a defective end. An operator at the opposite side of the conveyor table then places the board for accurate trim to length by the second saw, being guided by markers on the table (fig. 45).

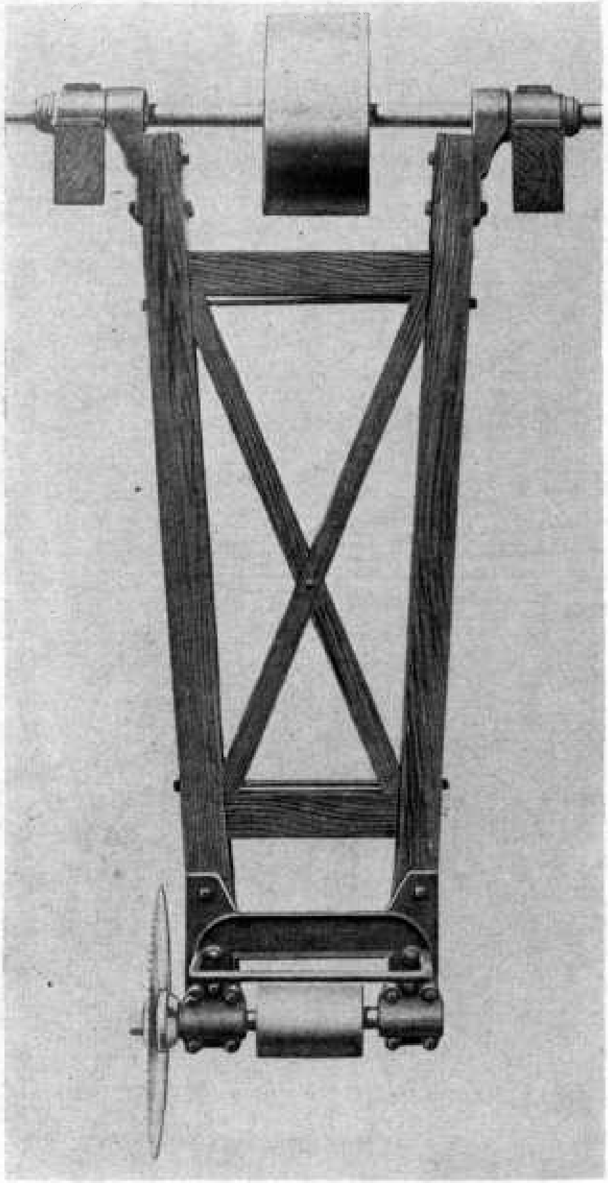

FIGURE 44.—Single cut-off trim saw.

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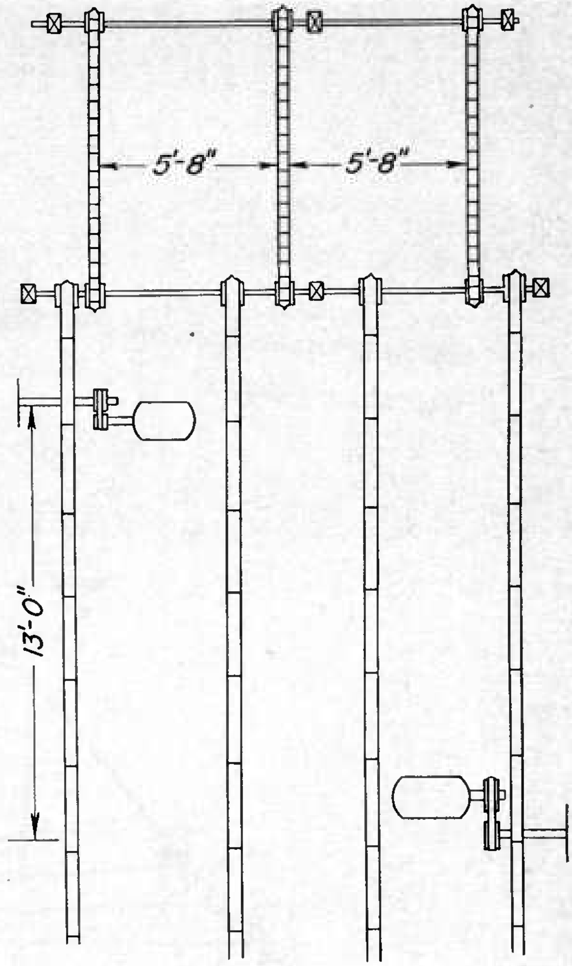

FIGURE 45.—"Canadian" trim saw.

The standard two-saw trimmer (fig. 46) consists of two (or, rarely, three) saws on a single mandrel. The saws are movable along the mandrel, their spacing being controlled with a crank or wheel to permit trimming a variety of lengths. In hand-feed trimmers the material is placed in front of a movable straight-edge guide and pushed through the trim saws. In the power-feed type, moving chains with lugs carry the boards through the trim saws. In some models the saw-spacing crank or wheel is attached to a movable transfer block; in others it is fixed to the frame. The thickness of the stock trimmed depends upon the saw diameter; 16-inch saws take 3 inches, 20-inch saws 5 inches. Saws run at a rim speed of 9,400 feet per minute, and the feed rate is gaged at 30 or 50 feet per minute.

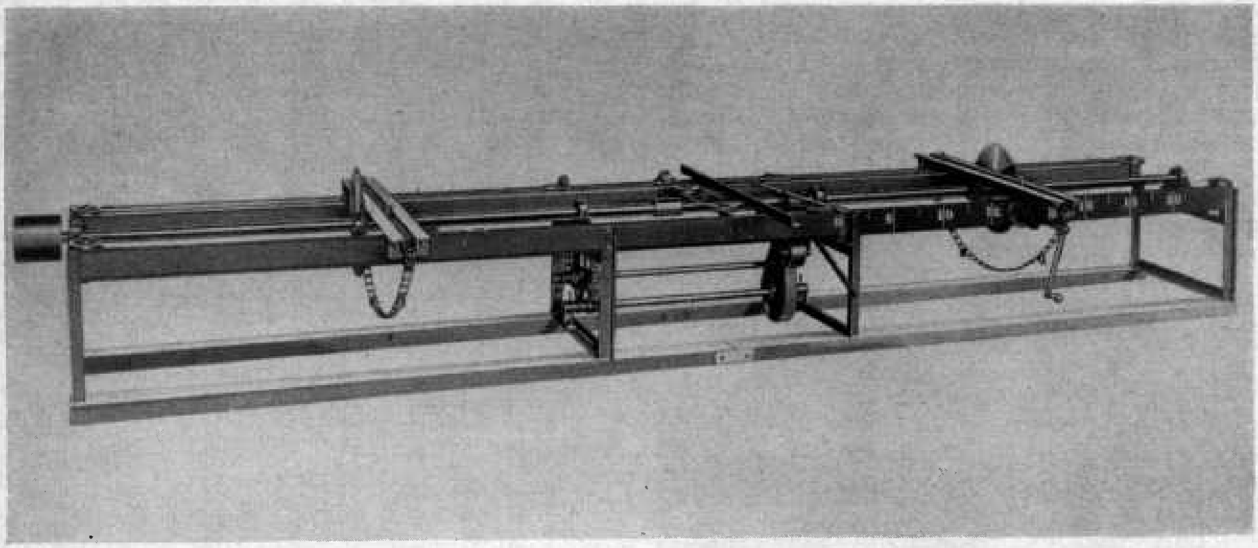

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FIGURE 46.—Two-saw trim saw.

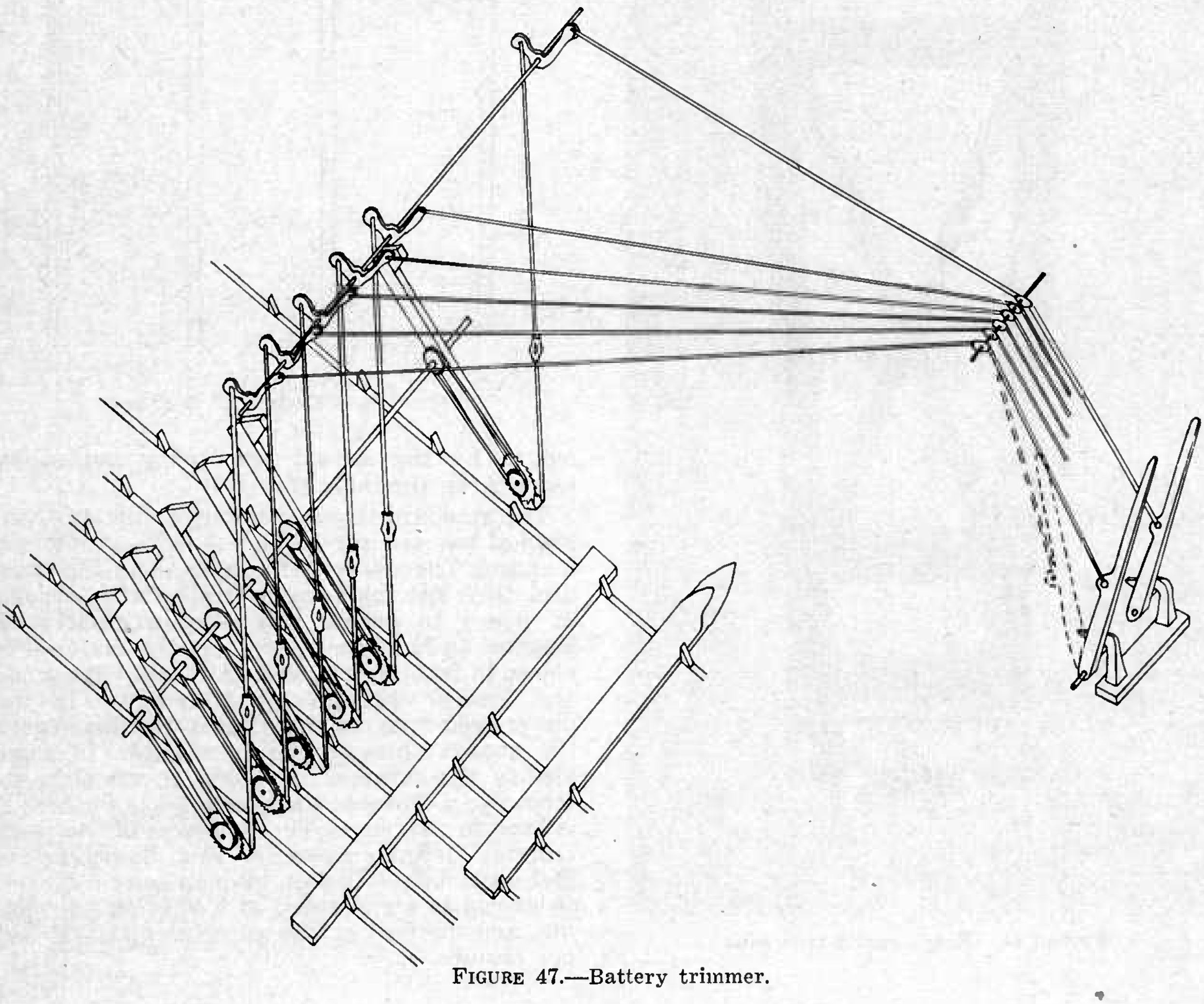

FIGURE 47.—Battery trimmer.

The battery trimmer (fig. 47) is the small-mill adaptation of the multiple-saw trimmer used on larger mills. Four or more saws, each on a separate mandrel and each in a pivoted frame comparable to that of the single cut-off saw, are placed in line across the line of flow of the material. The operator, through lever action, can extend a selected saw to cut a given length, the remaining saws being retracted either above or below the line of flow of the material.

Automatic slab cut-off saws (fig. 48) are in use. Provision is sometimes made to advance the slab when the saw is clear of the trough, and to stop its advance when the saw is passing across the trough, but equipment is often used without such controls. Usually the cut pieces drop onto a conveyor and are carried to a hopper or heap outside the mill.

A half-pinion *g* (fig. 48) fixed to the drive shaft engages the pinion, activating the slab belt for half a revolution. The pulley *n*, which

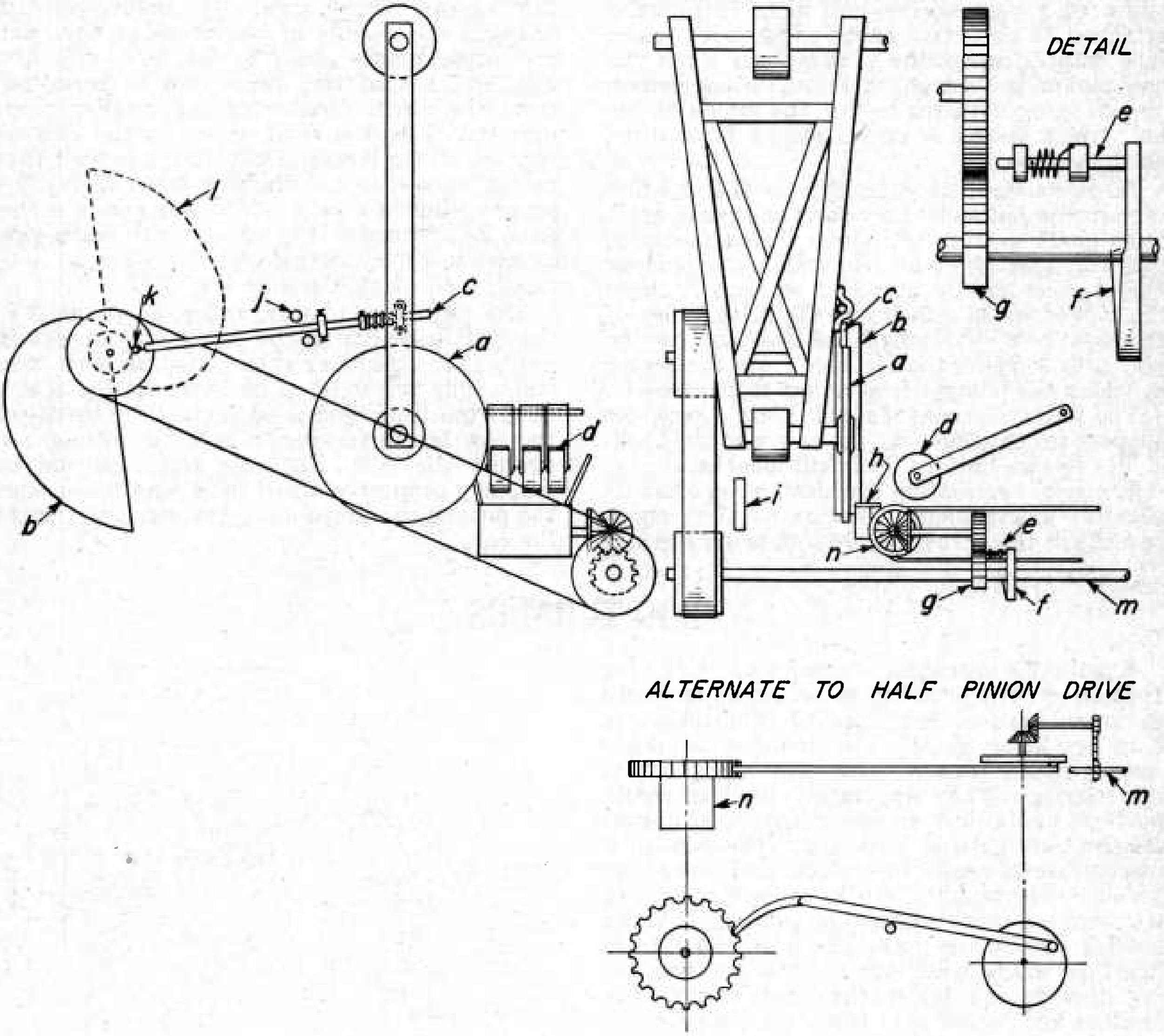

FIGURE 48.—Automatic slab cut-off saw. Saw *a* is propelled as cam *b* strikes pitman rod *c*, striking slab held under idler rollers *d*. As saw completes cut, half-pinion gear *g* engages conveyor mechanism to advance slab for next cut through pulley *n*. Plunger *e*, actuated by cam *f*, is used to realine teeth of half-pinion *g* if they fail to mesh properly with conveyor gear mechanism. Plate *h* supports short slabs and backstrip *i* controls length of cut piece. Guide rolls *j* hold shaft *c* in line. End roll *k* rotates as cam *b* strikes it. Cam *l* serves as counterweight to cam *b*. Shaft *m* coordinates conveyor belt with cams by belt. The alternate drive shown functions off shaft *m* through a rod that rotates conveyor pulley *n*.

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activates the slab belt, should have a circumference of twice the desired length of the cut piece. In order to insure that the half-pinion *g* meshes with the companion pinion wheel, the cam-plunger mechanism shown in the detail is used. The point of the plunger is conical, and the plunger entering the space between two cogs should be appreciably smaller than the opening. One-half of cam *f* is thicker than the other one-half of the circumference, the increased thickness being equal to the thrust required to bring the plunger between the cogs, and need not exceed one-half inch. This cam is attached to the drive shaft so that its raised face rotates under the plunger pin when the half-pinion is disengaged from its companion pinion, being adjusted to lock the pinion as the half-pinion clears. A strong spring is required on the plunger.

An alternate method for driving the slab belt is shown in figure 48. Sprockets and chain drive from shaft *m* transmit power through beveled gears to turn the wheel to which the plunger bar is eccentrically attached so that it turns the cogged wheel attached to the drive pulley of the slab belt. The length of slab cut can be varied by varying the distance from the center at which the plunger is attached to the wheel.

The idlers *d* are segmented. Plate *h* provides support for the slab near the saw, and the backstrip *i* fosters uniformity in cut lengths.

The cam *b* activating the pitman rod *c* has its greatest length along a radius equal to about two-thirds the thrust required to bring the saw across the trough; a 15-inch distance along the radius pushes the saw approximately 20 inches when the hook-up is proportional to that shown in figure 48. A paper outline of this cam can be made by drawing a circle with a 4-inch radius. Using the 4-inch original radius plus the required interval for saw thrust as a new radius, circumscribe a concentric circle around the one with the 4-inch radius. Divide one-half the circumference of this large circle into about eight equal parts and draw radii from the center to each point. The 4-inch radius, plus its projection for saw thrust, gives the starting point in drawing the outline of curvature of the cam. The other points are 7/8, 6/8, 5/8, 4/8, 3/8, 2/8, and 1/8 of this projection as measured from the circumference of the smaller circle outward along the radii drawn to the circumference of the larger circle, starting with that radius nearest to the starting point. Using the paper outline as a pattern, the cam can be sawed from 2-inch plank. It is advisable to make two, using one to counterbalance the other as indicated by the dotted outline (fig. 48).

The pitman rod has a roller, *k*, attached to the part contacting the cam, and moves in guide *j*. The pitman rod has a length such that, when fully retracted as in figure 48, the saw is held slightly beyond dead center, the thrust of the saw frame serving to hold the pitman rod against the cam. The saw frame should be partially counterbalanced to lessen the shock as the pitman rod drops along the straight face of the cam.

LOG TURNERS

Small mills operating in small timber find log turners of little practical value. An experienced deckman with a short-handled cant hook can turn logs under 20 inches in diameter as quickly as can power turners, and with less shock to the carriage. They are rarely used in really portable mills, but are practical in semi-permanent sets cutting large logs. The slip-block mechanism is useful in medium and large logs because it lessens the shocks to equipment and the physical work of placing the log. It turns the log toward the deck. The overhead type is practical where large logs must be handled, being durable and faster than cant hooks. The friction and rocker-arm types must be kept in accurate adjustment and be backed up by heavy carriages and trackways; they require a pit or elevated mill and a sturdy carriage.

Types of log turners used on small mills include (1) the slip-block or the hinged-block; (2) the overhead; (3) the friction; and (4) the rocker-arm type.

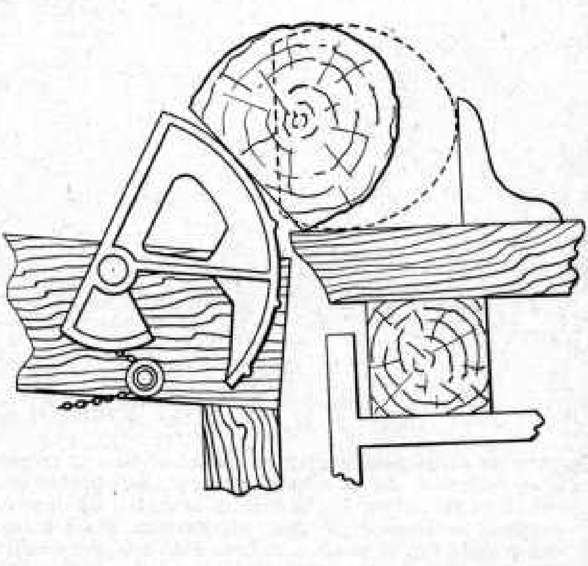

FIGURE 49.—Slip-block log turner.

The slip-block type consists of a shaft having a metal or wood arc approximating a half circle fixed to each end. The shaft is seated in two deck skids in such a way that the flat face of the turner is slightly below the skid top when not in use, and the perimeter of the arc reaches within an inch or so of the skid end when used. It is operated by means of a foot lever directly attached to the arc nearest the sawyer (fig. 49), the arcs being elevated and the log turned down against them. As the arcs turn back to their original position, the log slides back toward the knees. The hinged-block type consists of a single or double roll housed in a hinged frame that is bolted to the side of the skid to allow the rolls to be above the skid when in use and below the top of the skid at other times (fig. 50).

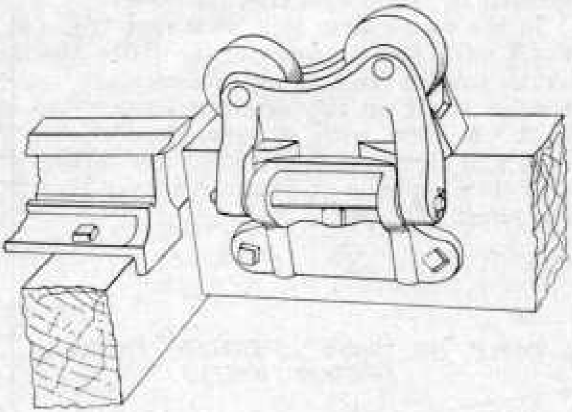

FIGURE 50.—Hinged-block log turner.

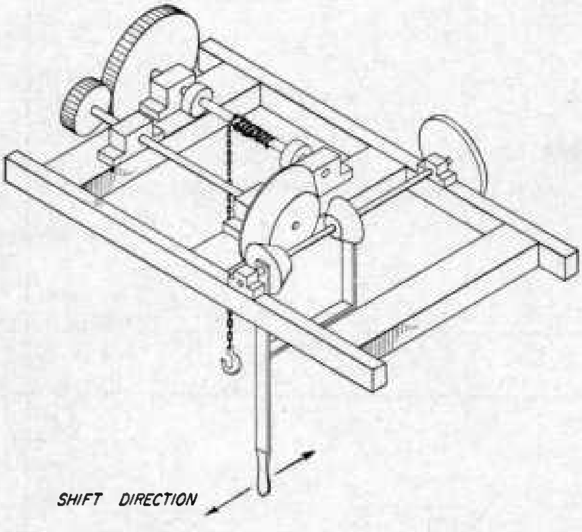

FIGURE 51.—Overhead log turner.

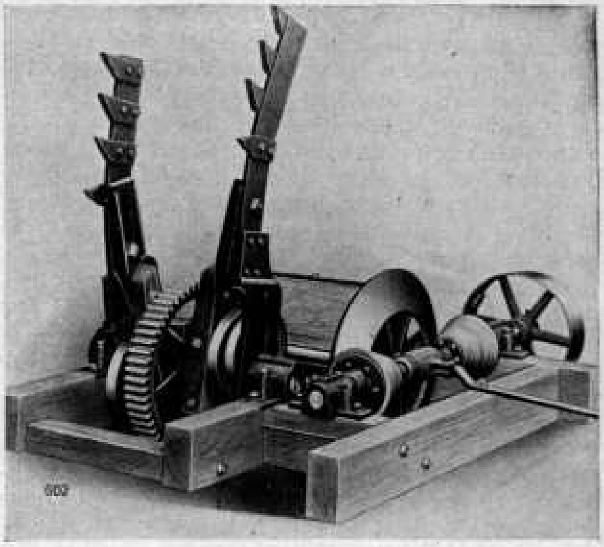

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FIGURE 52.—Double-bar friction log turner.

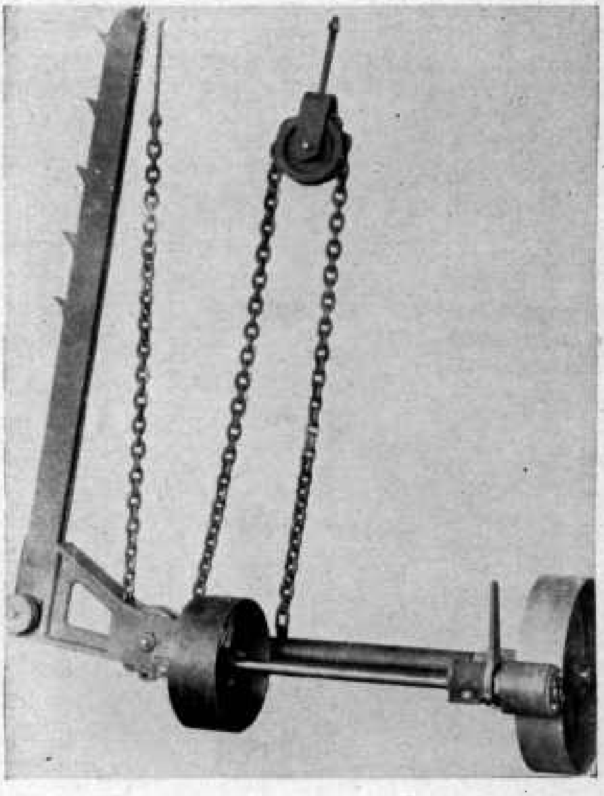

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FIGURE 53.—Single-bar friction log turner. L-shaped bar is raised at lower pulley by chain that winds on drum shaft when friction wheel is brought against drum wheel by lever. Guides (not shown) hold bar upright as it is raised through log deck. Chain is anchored at top end to deck beam.

In the overhead type of turner, two cone-type friction wheels are lever-actuated to slide along the key of a belt-driven shaft. At opposite positions one is brought in contact with a bevel-faced, driven friction wheel fixed to a shaft, thus winding or unwinding a chain having one end fixed to the shaft and a hook on the other end (fig. 51) for attachment to the perimeter of the log. A double-geared variant designed to give slower and more powerful turning has a wheel fixed to the second shaft and geared to a wheel fixed to a third, the latter carrying the chain and hook. These turners are mounted so that the winding shaft is parallel with the trackway and over the carriage at the deck.

In the friction type of log turner, two spiked lever arms fulcrum on cams so shaped as to impart an upward thrust and a backward withdrawal to the arms with each revolution; these cams are so adjusted that the upward thrust of one synchronizes with the withdrawal of the other (fig. 52). They are brought from the inoperative position below the deck skids to the operative (upright) position by friction of the wooden kicker-bar extension frame clamped to the cam shaft; by reversing the shaft they are rotated to the inoperative position. Forward or reverse drive of the cam shaft is accomplished by the friction-wheel mechanism used with the overhead type (fig. 51).

Another design of friction turner (fig. 53) has a single bar that is pulled upward between guides by a chain that winds around the drum shaft when the power-driven, lever-actuated friction wheel is brought in contact with the drum wheel. Upon release of this contact, the bar drops down. Hinged teeth on the bar engage the log as the bar is forced upward and drop back as the bar drops.

On a variant of the single-bar design, the base of the bar pivots on a bolt attached to a lever arm, one end of which pivots in turn on a bolt anchored to the foundations. The bar is moved up and down by a cable that is attached to the bar and passes under a pulley on the lever arm, as shown in figure 54. The other end of the cable is attached to the core of a shaft implemented by drum and friction wheels.

In the rocker-arm type of turner (fig. 55), a shaft with two or more arms under the deck skids pushes logs onto the carriage. and a similar shaft on the carriage throws the logs back on deck with a turn-down effect. The deck and carriage rocker arms are turned with a hydraulic piston attached to a lever arm from the shaft (fig. 55).

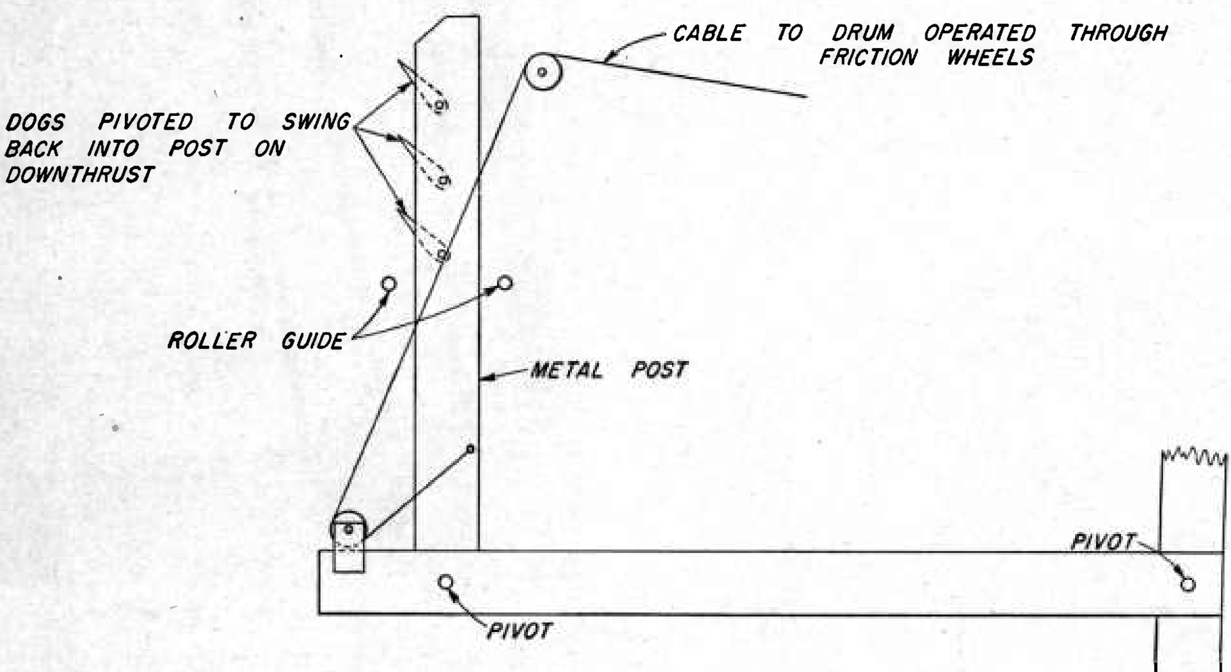

FIGURE 54.—Variant of single-bar friction log turner.

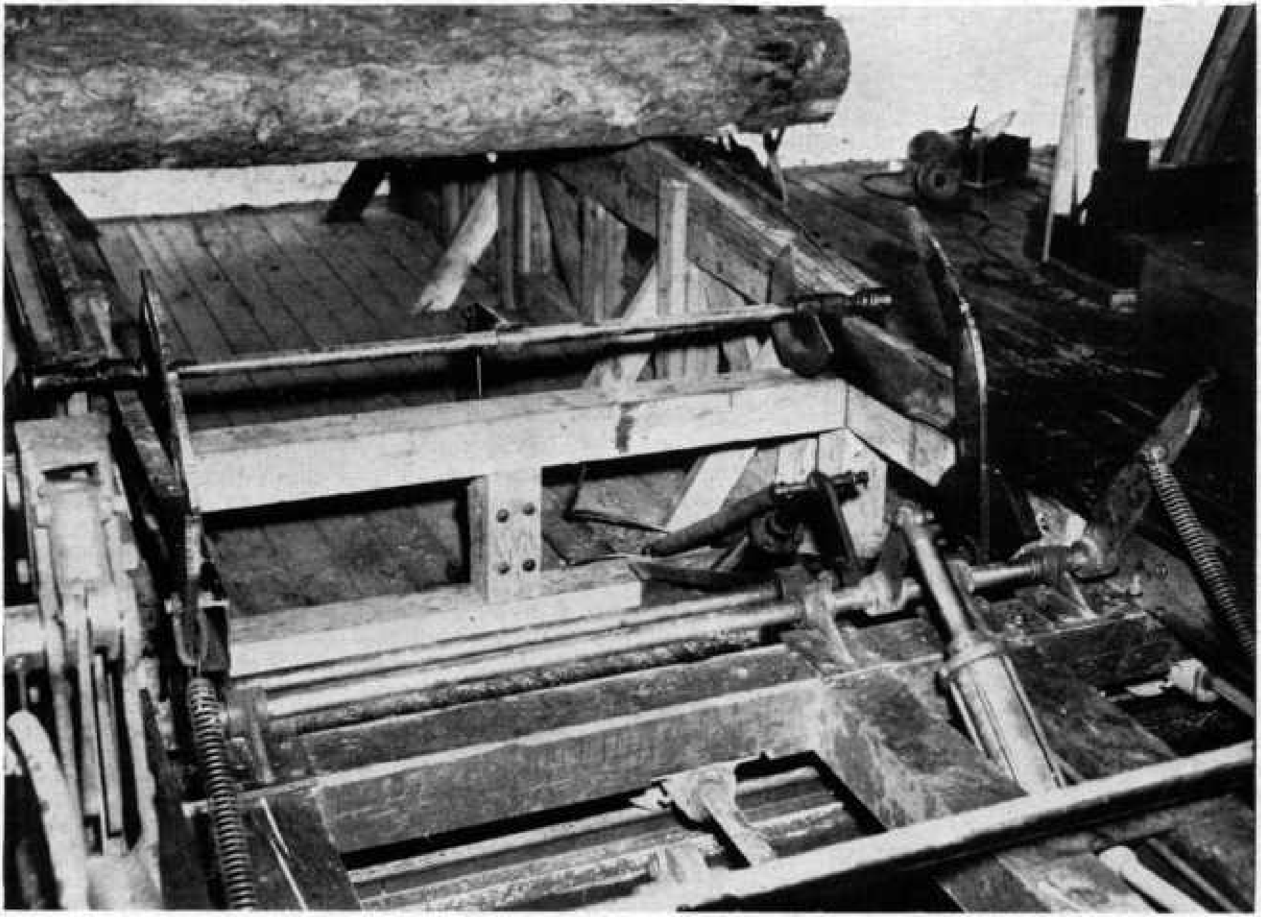

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FIGURE 55.—Rocker-arm log turner.

METAL DETECTORS

Military mine detectors (fig. 56) developed by the Army have been successfully used by mill operators to locate metal concealed in logs. The most sensitive type released as surplus by the Army, series SCR-625, requires about the same operating skills and precautions against rough usage as does a portable radio. The instrument is sensitive to metals normally embedded in logs, and the time required to examine a log is comparable to that needed to scan it with a spotlight field a foot in diameter. Usually, only logs suspected of harboring metal are examined. Nonportable instruments are available in which the log is passed through a ring, but such equipment is not ordinarily used by small mills.

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FIGURE 56.—Mine detector used for locating metal in logs.

CONVEYOR SYSTEMS

Conveyor systems find use at small sawmills both to carry lumber from the headsaw and to remove sawdust, chips, and slabs. Practically all small mills have chains or a blower to carry the sawdust from the saw pit. Those with a capacity of up to 1,000 board feet per hour usually have a line of dead rolls from the saw to the back of the mill, and perhaps a car, to remove slabs or lumber. With greater production and in semipermanent sets, live-roll, belt, and chain conveyors are used.

Sawdust Chains

To operate sawdust chains, power is taken from the mandrel through a pulley-belt or sprocket-chain device that drives a shaft and set of gears. These may turn the sprocket that drives the sawdust chain, or may turn an intermediate sprocket connected to the one on the chain. The outer end of the chain passes over an idler sprocket or pulley anchored at the apex of the pile. The chain (fig. 57) usually has lugs and commonly has a working strain rating of about 300 pounds, but chains up to 1,000 pounds in capacity are available. The return chain goes directly to the sprocket under the saw when driven from under the husk; when driven over the mandrel, it is kept high enough to clear the carriage.

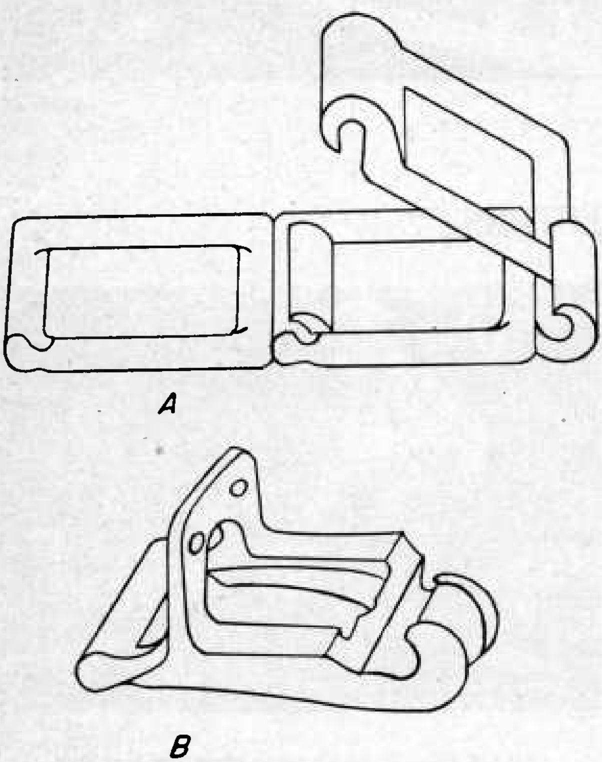

FIGURE 57.—*A*, Links and *B*, lug of sawdust chain.

Faulty functioning of sawdust chains is a common cause of delay in small-mill operations. The chain commonly used (a cast-iron, detachable type) is low in strain resistance. To lessen the chance of breakage under normal loads, the following limits of conveyor distances are suggested for various standard link sizes: Size No. 45, 40 feet; No. 55, 60 feet; No. 57, 80 feet; No. 67, 150 feet; No. 75, 200 feet.

Chains driven by a chain-and-sprocket transmission from the mandrel are more subject to breakage under abnormal loads than those driven by a belt transmission, but belts in the saw pit may be flooded in unsheltered mills. For such mills a short belt drive from the mandrel to a pulley anchored at the base of or above the husk, and a chain drive from this pulley shaft to the sprocket and gears in the saw pit can be used, both outward and return lines of the sawdust chain being under the trackway. In a variant the sprocket driving the chain is anchored about 8 feet above the husk and a pulley is anchored in the pit, the outgoing chain thus being under the trackway and the return chain overhead to clear the carriage. A belt from the mandrel through reducing transmission drives the sprocket.

Sawdust Blowers

Sawdust blowers are generally belt-driven from the mandrel and may be located at any convenient position near the saw (fig. 58). A left-hand blower is used on a right-hand mill, and vice versa. Fans have a diameter of about 24 inches, and to move the sawdust effectively they are run at speeds up to 3,500 revolutions per minute. The intake may be installed between the saw and the blower, so that the sawdust passes through the fan; but with the intake in the discharge pipe beyond the blower, damage to fan blades is avoided. A coarse screen or grate is usually placed over the hopper intake to screen out the larger chips.

Lower initial costs, together with greater convenience in moving, make sawdust chains the choice in most portable mills cutting up to 100,000 board feet at a set. Blowers are suitable in mills cutting several hundred thousand feet at a set, as the sawdust can be propelled 100 feet or more and deflected over a considerable arc. Blowers can be set up to service both the headsaw and edger.

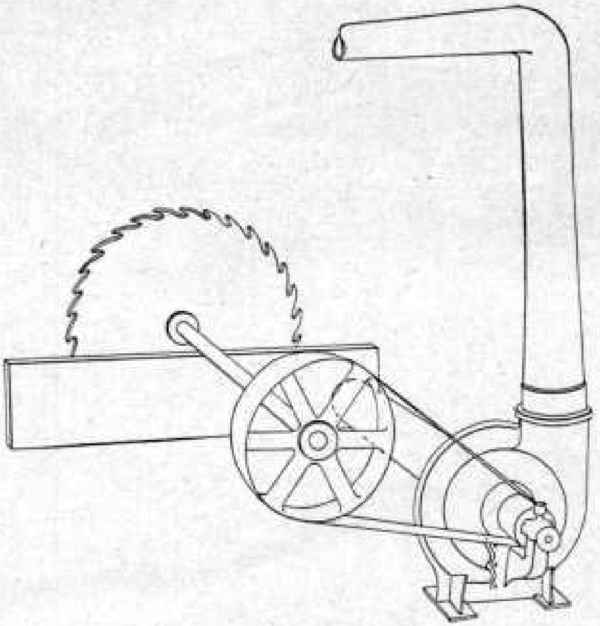

FIGURE 58.—Sawdust blower.

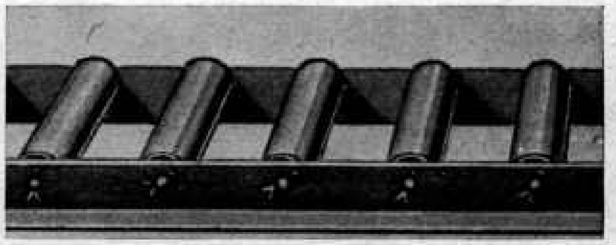

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FIGURE 60.—Series of dead rolls, used by mills with or without edgers.

Dead Rolls

In mills without edgers, a single dead roll (fig. 59) on a stand bringing the top of the roll to the level of the carriage bolsters is sometimes used behind the saw to hold material off the ground. The roll is made of wood or iron, is about 6 inches in diameter by 15 inches long, and has a shaft turning on bearings in the stand. Most small mills, however, have a series of dead rolls extending from the saw to the rear of the edger or rear of the mill (fig. 60). Some are inclined, so that gravity aids the man pushing slabs, timbers, and other material over them. The size most commonly used by board mills comes in 10-foot sections, each having seven rolls spaced about 18 inches on centers; each roll is 2 inches in diameter and 15 inches long, and is supported on an angle-iron frame by ball bearings. Heavier rolls are available for tie or timber mills.

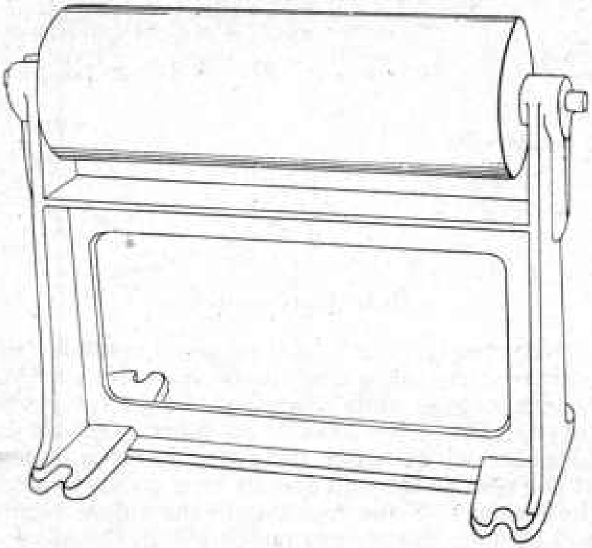

FIGURE 59.—Single dead roll used to support material when mill has no edger.

Live Rolls

Live (powered) rolls (fig. 61) manufactured for small-mill use are from 6 to 12 inches in diameter and 18 to 30 inches in length; they are made of cast-iron or steel. They are spaced about 4 feet apart in a frame that brings the top of each roll about 30 inches above the floor, and are rotated at about 300 lineal feet per minute by either beveled friction or cut gears on a shaft usually placed on the edger side of the rolls. This shaft is geared to give forward or reverse drive.

Home-made live rolls can be improvised from dead rolls by connecting them with a narrow belt, usually driven from the saw arbor. Speed reduction from mandrel to rolls is secured by connecting the arbor to a pulley approximately a foot in diameter with a 2-inch belt which is given a half twist, and connecting the shaft of this driven pulley, anchored about 3 feet behind the husk and below the rolls, to the first roll with a sprocket-and-chain drive. This chain drive is usually at the edger side of the roll. Rolls approximate 9 inches in diameter and 2 feet in length, being spaced about 44 inches. Midway between adjoining rolls a belt tightener of about 4-inch diameter is placed below the level of the top of the roll. A 2-inch belt is then threaded over each roller, usually at the end farthest from the edger, and under the tightener, thus providing a set of powered rolls.

Routing requirements vary with the particular mill set-up. All material up to 2 inches in

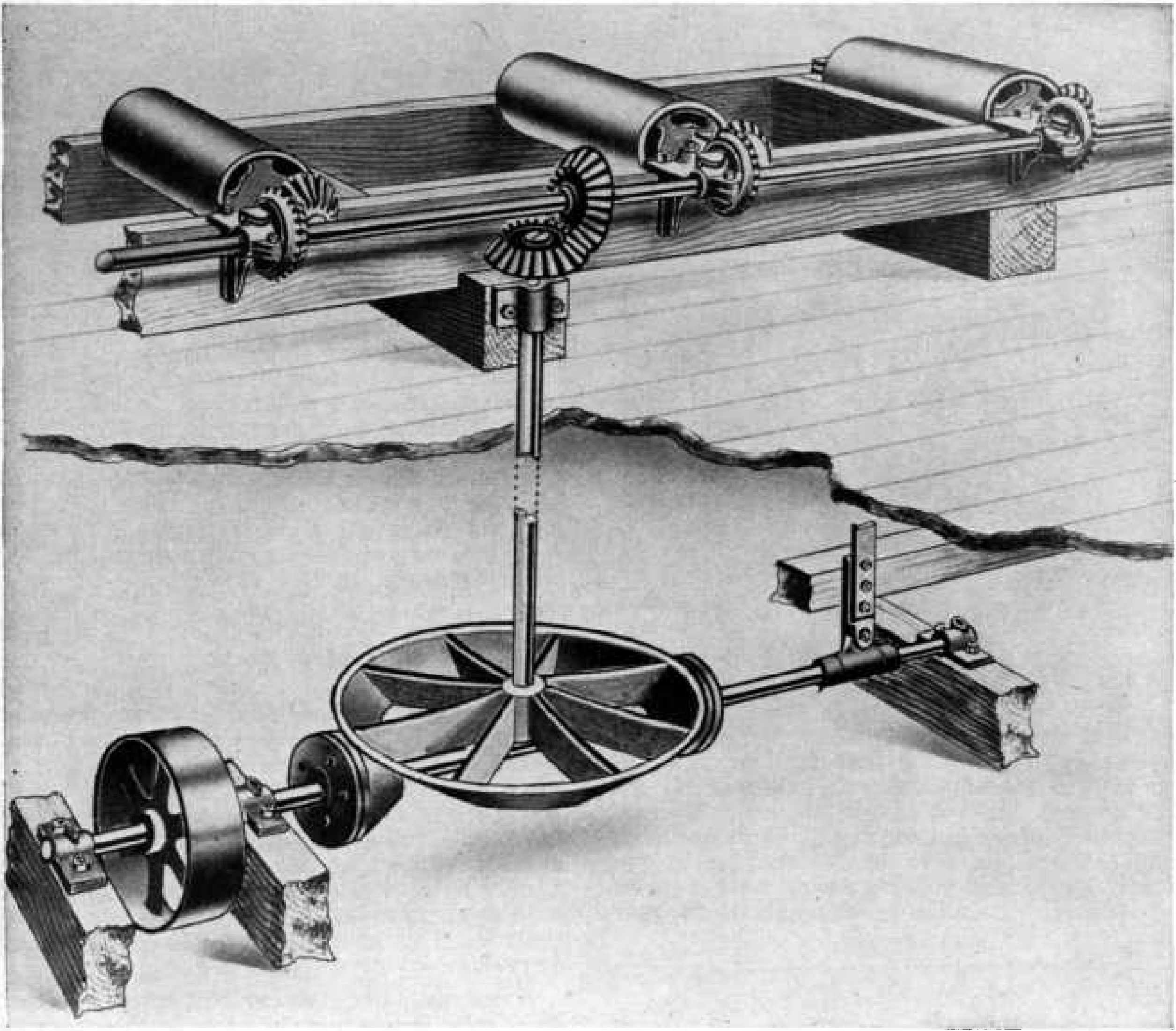

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FIGURE 61.—Live (powered) rolls.

thickness may be routed through the edger; the slabs and timbers pass down live rolls to dead rolls at the rear of the mill. A cut-off saw is often installed in the dead-roll line to trim timbers and cut up slabs and edgings. Sometimes the live rolls extend to a refuse conveyor that takes slabs and edgings to the burner; timbers are shunted to dead rolls leading to the dock. Boards generally pass through the edger and a single trimmer saw, or drop onto conveyor chains and pass through a Canadian or gang trimmer to the sorting line.

Belt Conveyors

Belt conveyors are used on some small board mills to carry slabs and boards from behind the headsaw. Idler rolls spaced at 6-foot intervals support the belt (usually of fabric and about 15 inches wide) which runs over a driven pulley at the rear of the mill and an idler pulley behind the headsaw. Slabs continue to the refuse chain and burner. Boards are pulled off by the edgerman and fed through the edger. Edgings go back onto the belt and to the burner.

Chain Conveyors

Some semipermanent small mills elevated off the ground and producing 2,000 board feet or more per hour are equipped with a conveyor-chain refuse system. The routing varies among mills. A simple routing takes sawdust from the headsaw and edger via chutes under the saws feeding onto the conveyor-chain trough below the floor. The tail edger throws the edgings into the trough through an opening in the floor between the line of rolls and the edger. About 20 feet of live rolls bring slabs onto dead rolls, where they are shunted through the hole or sawed for fuel with a swing saw in the line of rolls. The refuse from the trimmer is ordinarily shoveled into the hole at odd intervals. The chain carries the refuse to a burner.

Conveyor chains are used for lumber where production is 2,000 board feet or more per hour, mainly of boards and involving considerable sorting; or to expedite dipping. The chains provide a continuous line beyond the trim saws for the distance required by dip tanks, grading, and separations; for example, 14 feet for dipping, 10 feet for grading, and 6 feet per separation, which for a set-up with 10 separate units makes an over-all length of 84 feet. The table is about 30 inches above floor level. The usual arrangement for material up to 16 feet in length is one chain in the center and one located 5 feet 8 inches to either side of the center-line. The detachable-link chains (fig. 57) without lugs travel at a rate of about 25 feet per minute in guides. If a dip tank is in the line, the sprocket drive is on the entering side, and the section of chain for the tanks is separate from the sorter-table section. The drive for the latter preferably should be at the end farthest from the edger, but can be at the mill end. Ten horsepower will drive the loaded chain.

Trash-Disposal Systems and Methods

Mills cutting less than 150,000 board feet at a set often make no provision for trash disposal other than the chain or blower for sawdust and one or two men who carry slabs and edgings to a pile just clear of the mill or to a nearby fire. Seventy feet is about the limit; carrying slabs farther is a man-killing job. Burning close to the mill, on the other hand, is hazardous, and adds to the discomfort when smoke blows to the mill.

On some mills of this type the drudgery is lightened by the use of cars on which the slabs and edgings are loaded as they are cut. The loaded car is pushed to a dump or fire pit. If slabs can be sold, this type of mill may have a swing cut-off saw in the line of rolls beyond the rear of the edger. The operator cuts the slabs and edgings to the required lengths, and ricks them on a wagon with a platform bed or on a buggy. Usually the lumber is piled on other wagons or buggies just behind the mill and hauled to yard piles.

In more permanent types of mills, the belt conveyor emptying into a chain conveyor trough, or the under-floor chain trough system already described, effects waste disposal. Where slabs have a sale value, an automatic cut-off saw is installed and the cut stock is transported to the load-out station on a conveyor chain.

Burners for slabs and edgings ordinarily do not require forced draft, but it is necessary if sawdust is burned. A simple type of burner (fig. 62, *A*) suited to portable mills, called a pit burner, can be built by setting eight poles about 8 inches in diameter and 16 feet long firmly in the ground at equidistant points in a circle. The diameter of this circle is as little as 24 feet in some installations, but 36 feet is suggested. The ends of two 36-foot lines at right angles to each other, and intersecting at the center of the proposed "pit," give the location of four of the poles. Two 14-foot boards, if one end of each is centered on adjacent poles, will meet at points where the intervening four poles are required. For each of the eight sides, six 1- by 6-inch by 14-foot boards are nailed horizontally to adjacent poles, beginning at the ground line and spaced 2 feet apart, on the pit side of the poles. Strips of corrugated metal roofing are then nailed to the pit side of these boards to enclose the pit.

The refuse conveyor enters the burner at about the 10-foot level. If a blower is installed, the pipe enters the burner just below ground level, with the outlet directly below the end of the spillway. Old grates, bars, or even rough boulders can be put in the outlet to keep it open and diffuse the draft. The burner should be at least 75 feet from the mill, and located so that prevailing winds do not blow the smoke into the mill. A 1½-horsepower motor will run the fan. A barrel of water and a bucket are usually kept conveniently at hand in case the burner catches fire.

The two types of refuse burners shown in figure 62, *B* and *C*, have received the approval of the California State Division of Forestry because their design and construction minimize the fire hazard. More costly than the simple pit type of burner, they are perhaps best suited for use at permanent sets where their higher cost can be amortized over a long period.

The refuse burner shown in figure 62, *B*, requires the following materials: Eight pieces of 80-pound rail, each 40 feet long; eight pieces of 20-pound rail, each 12 feet long; one circular

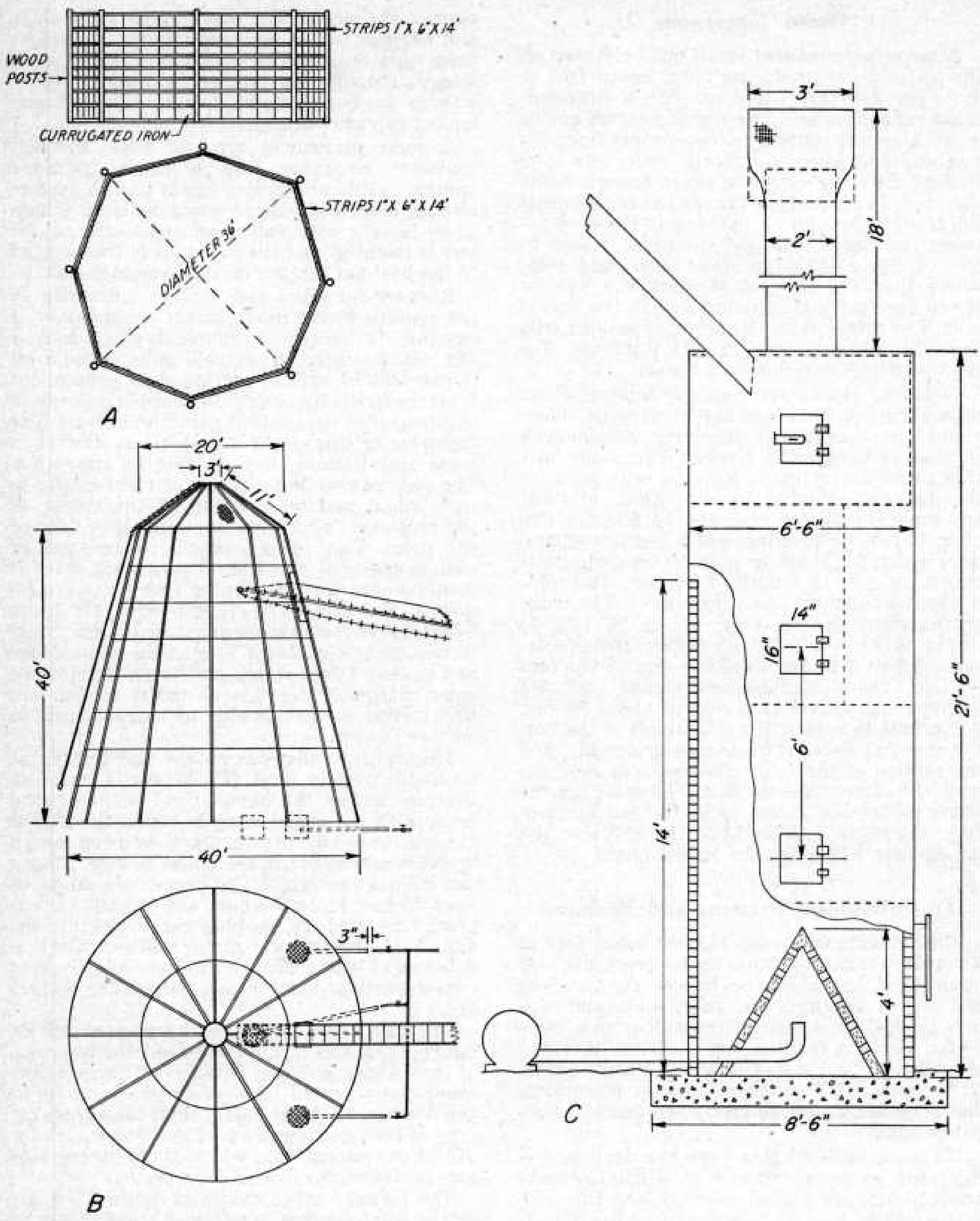

FIGURE 62.—Three types of refuse burners. *A*, Pit type for portable mills; *B*, enclosed refuse burner; *C*, enclosed sawdust burner. Types *B* and *C* approved by California State Division of Forestry on basis of safety.

iron top piece; 800 feet of 1¼-inch pipe for bands; 4,000 square feet of 18-gage flat metal; 1,200 square feet of No. 3 mesh steel screen; three steam grates; a 1½-horsepower motor with blower and pipe. The construction is such that each rail strut consists of a 20-pound rail welded to the top of the 80-pound rail. The circular iron top piece, together with the pipe rings, confines the rail struts.

The sawdust burner shown in figure 62, *C*, consists of the following materials: 2,000 fire brick; 4 bags of fire-clay mortar; 600 square feet of ⅜-inch iron boiler plate; a stack with wire-mesh vents (5 wires to the inch) and a metal cap; a 1½-horsepower motor with blower and 20 feet of galvanized 4-inch drain pipe. The burner stands on a concrete base 73 square feet in area. It has one clean-out door 2 feet square and three side doors each 14 by 16 inches in size. The pipe conveying sawdust has a swinging door fitted in it.

Burning of existing sawdust piles, especially wet ones, may be speeded up through the use of a small blower powered by any convenient unit of 5 horsepower or more. A pipe at least 25 feet long should be attached to the blower to get it away from any source of fire. A steady, diffused flow of air is effective, whereas a direct and intense draft at the zone of burning is not; hence, outlet pipes should be 8 inches in diameter or larger, the fan should be run at slow speeds, and the air stream should be directed to the ground at the base of the pile on the windward side. The blower must be moved as wind direction changes and as the sawdust pile is consumed at the point of attack. Anchoring the blower to skids provides a firm base, yet gives ready mobility.

POWER AND TRANSMISSION EQUIPMENT

Small mills expend from 50 to 95 percent of their available power on the headsaw. The amount of additional power used varies with the equipment of the individual mills, such as edgers, trimmers, cut-off saws, powered mechanical deck and carriage accessories, and transfer and conveyor systems, requiring a fairly constant amount of power regardless of operating rates. The power used at the headsaw and carriage, on the other hand, varies greatly between full loads and lesser ones.

The headsaw load is influenced chiefly by width of cutting face, thickness of chip (feed rate), and wood density. Even where power is not limited, it is possible to build up loads beyond the capacity of the saw to cut properly by combining a wide cutting face with a fast feed in a dense wood. It is also possible to overload the saw gullets in nondense woods by using excessive feed rates. Hence, the sawyer with unlimited power at his command must exercise skill to avoid overloading his saw. This is done by coordinating the rate of feed with cutting depths and densities so as to hold the load within the capacity of the saw or prime mover to function efficiently. Such coordination is gained only by testing the capacities of saw or power in an installation.

Horsepower Requirements

The horsepower required for equipment other than the headsaw is given in table 2. For headsaw requirements, small-mill manufacturers usually recommend about 3 horsepower per 100 board feet of hourly production, but this figure is too generalized to fit the variability in transmission and in logs. Tables 3, 4, and 5, based on Forest Products Laboratory tests, give the

TABLE 2.—*Power requirements for equipment other than the headsaw of a small mill*

Equipment item	Type	Horsepower required
Log haul	Car and inclined trackway, friction drive.	6
	Gear drive	15
	Chain lift from sluice opposite deck.	10
Log conveyor chains on deck.		5
Log turners	Double-bar friction kickers	3
	Overhead shaft and chain, friction drive.	6
	Single-bar type, friction drive.	6
	Rocker-arm shaft type	15
Carriage drive	Heavy type	10
	Light or medium-weight type.	5
Carriage setworks		3
Carriage dogs		1
Carriage log unloader		5
Sawdust chain		1
Sawdust blower		5
Refuse chain	Heavy type	20
Live rolls		5
Transfer and conveyor chains.		15
Sorter chains		5
Edger	Single-saw, manual type	5
	2- to 3-saw, 27-inch	15
	2- to 3-saw, 33-inch	20
	4-saw, heavy-duty	100
Two-saw trimmer		15
Cut-off saw		8
Slab cut-off saw		5

horsepower used to force a 48-inch circular saw equipped with nine-thirty-seconds-inch inserted teeth through the log.

In using these tables as a guide in choosing power requirements, reference should be made to the discussion of gullet capacity in this manual, since gullet capacity can put a ceiling on the maximum bite per tooth which can be taken, and consequently the horsepower which can be utilized. The rates of carriage feed at listed bites per tooth are given. Estimates of actual production per hour based on these feed rates are not justified. Production should, however, bear a close relation to feed rates and a power source permitting twice the feed rate of another should result in slightly less than twice the production per hour. The additional power used to run the transmission and feed equip-

TABLE 3.—*Horsepower required for various depths of cut of a 40-tooth, small-mill headsaw operated at 300 revolutions per minute, exclusive of machine-loss horsepower*[1]

Depth of bite per tooth (inches)	Carriage feed rate	Specific gravity of wood[2]	Power needed for depth of cut of—				
			10 inches	12 inches	14 inches	16 inches	18 inches
	Ft. per min.		*Hp.*	*Hp.*	*Hp.*	*Hp.*	*Hp.*
0.03	30	0.3	1.4	4.1	6.8	9.5	12.3
.04	40	.3	2.0	4.8	7.7	10.5	13.4
.06	60	.3	3.1	6.1	9.2	12.2	15.3
.08	80	.3	4.1	7.3	10.5	13.8	17.0
.10	100	.3	5.1	8.5	11.9	15.3	18.7
.12	120	.3	6.1	9.7	13.3	16.9	20.4
.13	130	.3	6.6	10.2	13.9	17.5	21.2
.03	30	.4	3.6	6.7	9.9	13.0	16.2
.04	40	.4	5.1	8.5	12.0	15.4	18.9
.06	60	.4	8.0	12.0	16.1	20.1	24.2
.08	80	.4	10.5	15.0	19.6	24.1	28.7
.10	100	.4	13.0	18.0	23.1	28.1	33.2
.12	120	.4	15.5	21.0	26.6	32.1	37.7
.13	130	.4	16.8	22.6	28.4	34.2	40.0
.03	30	.5	5.8	9.4	13.0	16.6	20.2
.04	40	.5	8.1	11.9	15.7	19.5	23.3
.06	60	.5	12.8	17.8	22.8	27.8	32.8
.08	80	.5	16.9	22.7	28.5	34.3	40.1
.10	100	.5	20.9	27.5	34.1	40.7	47.4
.12	120	.5	25.0	32.4	39.9	47.3	54.8
.13	130	.5	27.1	34.9	42.8	50.6	58.5
.03	30	.6	8.0	12.0	16.1	20.1	24.2
.04	40	.6	11.2	15.9	20.6	25.3	29.9
.06	60	.6	17.6	23.5	29.5	35.4	41.4
.08	80	.6	23.2	30.3	37.4	44.5	51.5
.10	100	.6	28.8	37.0	45.2	53.4	61.6
.12	120	.6	34.4	43.7	53.1	62.4	71.8
.13	130	.6	37.3	47.2	57.1	67.0	76.9
.03	30	.65	9.1	13.3	17.6	21.8	26.1
.04	40	.65	12.8	17.8	22.8	27.8	32.8
.06	60	.65	20.0	29.3	38.6	47.9	57.3
.08	80	.65	26.4	36.2	46.0	55.8	65.5
.10	100	.65	32.8	43.0	53.2	63.4	73.7
.12	120	.65	39.2	49.9	60.6	71.3	81.9
.13	130	.65	42.4	53.3	64.2	75.1	86.1

[1] Additional horsepower used to run transmission and feed equipment. Add 4.43 horsepower for transmission, 2 horsepower for feed equipment.

[2] Use specific gravity of individual species, as given for oven-dry material based on volume at time of test in U. S. Dept. of Agr. Tech. Bul. No. 479, "Strength and Related Properties of Woods Grown in the United States."

TABLE 4.—*Horsepower required for various depths of cut of a 40-tooth, small-mill headsaw operated at 450 revolutions per minute, exclusive of machine-loss horsepower*[1]

Depth of bite per tooth (inches)	Carriage feed rate	Specific gravity of wood[2]	Power needed for depth of cut of—				
			10 inches	12 inches	14 inches	16 inches	18 inches
	Ft. per min		*Hp.*	*Hp.*	*Hp.*	*Hp.*	*Hp.*
0.03	45	0.3	1.8	5.5	9.3	13.0	16.8
.04	60	.3	2.6	6.5	10.4	14.3	18.3
.06	90	.3	4.4	8.7	13.0	17.2	21.5
.08	120	.3	5.8	10.3	14.9	19.4	24.0
.10	150	.3	7.2	12.0	16.8	21.6	26.5
.12	180	.3	8.6	13.7	18.8	23.9	29.0
.13	195	.3	9.3	14.5	19.8	25.0	30.3
.03	45	.4	4.6	8.9	13.2	17.5	21.9
.04	60	.4	6.7	11.4	16.2	20.9	25.7
.06	90	.4	11.1	16.7	22.3	27.9	33.6
.08	120	.4	14.6	20.9	27.3	33.6	40.0
.10	150	.4	18.1	25.2	32.3	39.3	46.4
.12	180	.4	21.6	29.4	37.2	45.0	52.8
.13	195	.4	23.5	31.6	39.7	47.8	55.9
.03	45	.5	7.3	12.1	17.0	21.8	26.7
.04	60	.5	10.7	16.2	21.8	27.3	32.9
.06	90	.5	17.8	34.7	31.7	38.6	45.6
.08	120	.5	23.5	31.6	39.7	47.8	55.9
.10	150	.5	29.2	38.4	47.7	56.9	66.2
.12	180	.5	34.9	45.3	55.7	66.1	76.5
.13	195	.5	37.8	48.7	59.7	70.6	81.6
.03	45	.6	10.1	15.5	20.9	26.3	31.8
.04	60	.6	14.7	21.0	27.4	33.7	40.1
.06	90	.6	24.6	32.9	41.2	49.5	57.9
.08	120	.6	32.5	42.4	52.3	62.2	72.1
.10	150	.6	40.4	51.8	63.3	74.7	86.2
.12	180	.6	48.2	61.2	74.2	87.2	100.3
.13	195	.6	52.1	65.9	79.7	93.5	107.4
.03	45	.65	11.5	17.2	22.9	28.6	34.3
.04	60	.65	16.8	23.5	30.3	37.0	43.8
.06	90	.65	28.0	37.0	46.0	55.0	64.0
.08	120	.65	36.9	47.7	58.5	69.3	80.1
.10	150	.65	45.8	58.4	71.0	83.6	96.1
.12	180	.65	54.7	69.0	83.4	97.7	112.1
.13	195	.65	59.2	74.4	89.7	104.9	120.2

[1] Additional horsepower used to run the transmission and feed equipment. Add 6.64 horsepower for transmission, 3 horsepower for feed equipment.

[2] Use specific gravity of individual species, as given for oven-dry material based on volume at time of test in U. S. Dept. of Agr. Tech. Bul. No. 479, "Strength and Related Properties of Woods Grown in the United States."

TABLE 5.—*Horsepower required for various depths of cut of a 40-tooth, small-mill headsaw operated at 600 revolutions per minute, exclusive of machine-loss horsepower*[1]

Depth of bite per tooth (inches)	Carriage feed rate	Specific gravity of wood[2]	Power needed for depth of cut of—				
			10 inches	12 inches	14 inches	16 inches	18 inches
	Ft. per min.		*Hp.*	*Hp.*	*Hp.*	*Hp.*	*Hp.*
0.03	60	0.3	1.9	6.5	11.1	15.7	20.2
.04	80	.3	3.0	7.8	12.6	17.4	22.2
.06	120	.3	5.4	10.7	16.0	21.3	26.5
.08	160	.3	7.1	12.7	18.3	23.9	29.6
.10	200	.3	8.8	14.8	20.8	26.7	32.7
.12	240	.3	10.5	16.8	23.1	29.4	35.8
.13	260	.3	11.4	17.9	24.4	30.9	37.3
.03	60	.4	4.9	10.1	15.3	20.5	25.6
.04	80	.4	7.7	13.4	19.2	24.9	30.7
.06	120	.4	13.7	20.6	27.6	34.5	41.5
.08	160	.4	18.1	25.9	33.7	41.5	49.3
.10	200	.4	22.5	31.1	39.8	48.4	57.1
.12	240	.4	26.9	36.4	45.9	55.4	65.0
.13	260	.4	29.0	39.0	49.0	59.0	69.0
.03	60	.5	7.8	13.5	19.3	25.0	30.8
.04	80	.5	12.3	18.9	25.6	32.2	38.9
.06	120	.5	22.0	30.6	39.2	47.8	56.4
.08	160	.5	29.0	39.0	49.0	59.0	69.0
.10	200	.5	36.0	47.4	58.8	70.2	81.6
.12	240	.5	43.0	55.8	68.6	81.4	94.3
.13	260	.5	46.6	60.1	73.6	87.1	100.7
.03	60	.6	10.8	17.1	23.5	29.8	36.2
.04	80	.6	17.0	24.6	32.2	39.8	47.4
.06	120	.6	30.4	40.7	51.0	61.3	71.5
.08	160	.6	40.1	52.3	64.5	76.7	88.9
.10	200	.6	49.8	63.9	78.0	92.1	106.3
.12	240	.6	59.5	75.5	91.6	107.6	123.7
.13	260	.6	64.3	81.3	98.4	115.4	132.5
.03	60	.65	12.3	18.9	25.6	32.2	38.9
.04	80	.65	19.4	27.5	35.6	43.7	51.7
.06	120	.65	34.5	45.6	56.7	67.8	78.9
.08	160	.65	45.5	58.8	72.1	85.4	98.7
.10	200	.65	56.5	72.0	87.5	103.0	118.6
.12	240	.65	67.5	85.2	102.9	120.6	138.4
.13	260	.65	73.1	91.9	110.7	129.5	148.4

[1] Additional horsepower used to run the transmission and feed equipment. Add 8.85 horsepower for transmission, 4 horsepower as maximum for feed equipment.

[2] Use specific gravity of individual species, as given for oven-dry material based on volume at time of test in U. S. Dept. of Agr. Tech. Bul. No. 479, "Strength and Related Properties of Woods Grown in the United States."

ment of the test mill is given in footnote 1 of tables 3, 4, and 5.

Classification of Prime Movers by Types

The three types of power used in sawmills are internal combustion, steam, and electric. Each can give effective service if not overloaded, and all can be stalled by overloads. Internal-combustion (gasoline and Diesel) engines and electric motors lose speed rapidly; steam engines lose speed more slowly. If the load is not reduced to balance the reduced horsepower delivery, the motor or engine stalls. The damage caused by stalling of steam or internal-combustion units is limited to excessive belt wear and lost production. Stalling can damage electric motors by burning the insulation off the windings; for this reason, electric installations should be equipped with a circuit breaker to shut off current before the ultimate capacity is reached.

Basis of Horsepower Ratings

A motor, whether internal-combustion or electric, is given a horsepower rating by the manufacturer. For internal-combustion engines, this rating is usually the brake horsepower delivered under ideal conditions and for the engine speed at which horsepower delivery is at maximum. This rated capacity should be reduced by 20 percent when considering power capacity for sawmill operation. The rated capacity of automobile engines used as power sources on small mills should be discounted at least 50 percent, since the rating is for an engine speed greatly in excess of that at which a mill power unit is run. The manufacturer's rating of an electric motor is usually from one-half to three-fourths the maximum horsepower the unit can deliver. This rating provides a factor of safety against overheating and damage.

Steam engines and boilers may also be given a horsepower rating. The engine and boiler ratings are based upon a standard formula. The manufacturer normally rates the engine at 75 percent of its maximum output as given by the formula:

$$\text{Hp.} = \frac{PLAN}{33{,}000}$$

Where P = mean effective pressure in pounds per square inch.
L = length of piston stroke in feet.
A = area of piston head accessible to steam in square inches.
N = number of strokes per minute.

The boiler horsepower is 100 percent of the output given by the formula:

$$\text{Hp.} = \frac{\text{Total B.t.u. delivered to the water}}{33{,}479}$$

To drive the type of engine normally used, a high-speed (175 to 300 revolutions per minute), single-valve, noncondensing, simple engine, the rated boiler horsepower capacity should exceed the engine horsepower rating by approximately 50 to 75 percent.

Comparison of Types of Prime Movers

A generalized comparison of certain characteristics of the three major types of prime movers is given in the following tabulation. A rating of A is the best and C the poorest for a given characteristic. The indicated relationships do not, of course, universally apply.

	Internal-combustion engine	*Steam engine*	*Electric motor*
Initial cost	B	C	A
Cost of fuel and maintenance	C	B	A
Length of service	C	A	B
Ease of moving	A	C	B
Range of adaptability	A	B	C

Field checks indicate that approximately 65 percent of small mills are powered by internal-combustion engines, 33 percent by steam engines, and 2 percent by electric motors, but that 90 percent of the mills of highest capacity are steam-powered. The dominance of internal-combustion units in the over-all grouping is due to the preponderance of portable mills, which require the ease of moving and range of adaptability afforded by them. The high-production units are permanent mills where these two characteristics are immaterial. Electric units are preferred where high-power current is available at low rates and steam is not required for kiln drying.

Variants of Each Type of Prime Mover

Diversity exists in internal-combustion units, electric motors, and steam engines. Internal-combustion units are either spark-ignited and fueled with gasoline or compression-ignited and fueled with Diesel oil. For comparable horsepower capacities, gasoline-fueled units usually have lower initial costs and higher fuel costs than pressure-ignition Diesels. Repairs are related to running speeds in that the engine producing a given horsepower at comparatively low speed through relatively large piston displacement normally requires fewer repairs and has a longer life than one getting the same horsepower from lesser displacement and greater speed.

Electric motors are classified as constant-speed, multispeed, adjustable-speed, and variable-speed, but the class usually used at mills is constant-speed. For sawmill machines, these constant-speed motors are "squirrel-cage" wound. Servicing of a properly installed motor is simple; it consists of insuring that lubricants are available for bearings and that bearings are wholly enclosed.

The classification of steam engines is based on the number of cylinders through which steam is successively passed, but steam engines used on sawmills are usually the single-cylinder, direct-acting type, have either a simple or a balanced slide valve, and are controlled by means of a throttling or an automatic cut-off governor.

Dutch-Oven Furnaces for Burning Sawdust

Where sawdust is used for boiler-furnace fuel, an unusually long combustion chamber of the Dutch-oven type is needed. The installation is usually too costly unless the mill is operated full time at one site for at least 2 years.

A grate area of one-third to one-half square foot per required horsepower is necessary and provides a basis on which to estimate the furnace dimensions. The grate should be approximately square in order that sawdust fed to the center of it will funnel downward and cover all exposed grates. The firebox over the grates is arched (fig. 63), and the distance from the top of the grate to the center of the arch is slightly greater than the length of the grate. The distance from the bottom of the grate to the ash-pit floor should be at least 18 inches. The ash-pit floor has a slight upward slope from front to back, and the opening through the lining at the doors for furnace, ash pit, and rear increases in area from the doors inward to facilitate cleaning.

The feed tube, 6 or 8 inches in diameter, is directly over the center of the grates, and can be a piece of cast-iron pipe. It extends downward from the deck floor slightly into the chamber, and is tightly sealed with the furnace walls. A cast-iron lid is placed over the top of the feed hole when the sawdust is not being fed or when the fire is banked.

The sawdust-burning grates have openings about one-half as large as those for coal. Sizes vary, length ranging from 3 to 7 feet and width from 8 to 11 inches per bar. The grates are supported at the ends on angle-iron members, and a space of one-half inch is left at each end of the grate for expansion (fig. 63, *A*).

A recommended door arrangement for ash pit, firebox, and rear consists of a double door hung to the steel front plate, ash-pit and firebox doors fitted with wood-burning air vents, and a rear clean-out door in metal framing.

Beyond the grate area, the combustion chamber is floored to form a ridge and vertically walled at the sides. The rear is constricted inwardly back of the boiler, as indicated in figure 63, *A*. The junction of boiler and furnace walls must be tightly sealed. The furnace walls are strapped or reinforced with iron members (fig.

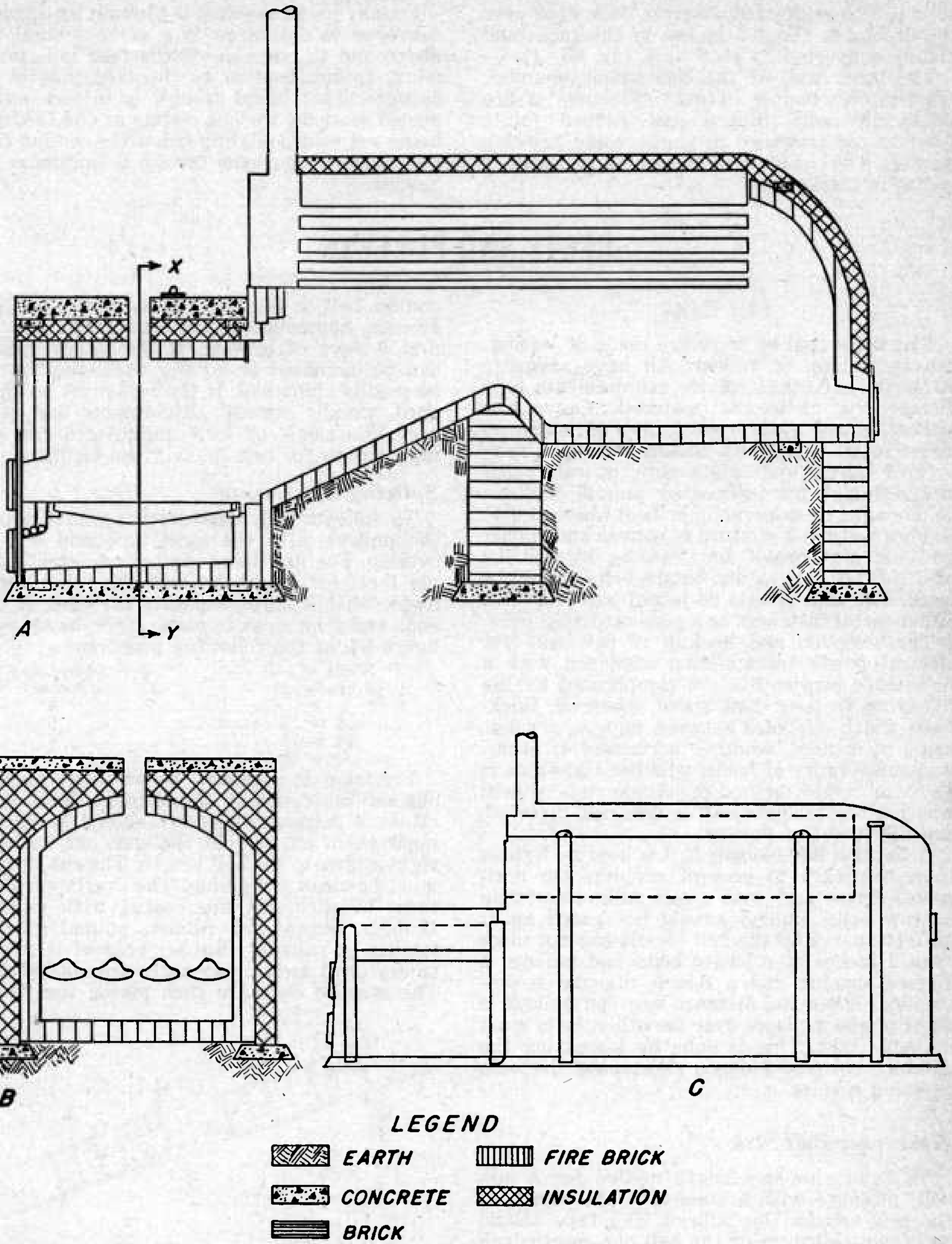

FIGURE 63.—Dutch oven. *A*, Side elevation. *B*, Section through *x–y*. *C*, Side elevation showing placement of steel strapping over insulation.

63, *C*). The reinforced-concrete deck floor over the firebox is about 4 inches in thickness and mainly supported by steel bars (fig. 63, *A*).

The inner wall of the combustion chamber consists of a double (9-inch) thickness of fire brick laid with dipped and rubbed joints (mortar not trowelled in place) using fire-clay mortar. The insulation should be at least 4 inches in thickness.

Usually green sawdust is brought by a trough conveyor to discharge at a point several feet above and to one side of the feed hole into a metal trough leading to the feed pipe in the furnace. This metal trough is in two unconnected sections, the one ending at the feed pipe being suspended slightly below the section from the sawdust conveyor trough to minimize fire hazard.

BELTS AND PULLEYS

Flat Belts

Flat belts used by mills are made of leather, canvas, balata, or rubber. All have adequate strength, but other service requirements may dictate the choice of material. Canvas or leather, unless waterproofed, does not stand up under moist conditions. Balata belting, a mixture of canvas and balata gum, is waterproof and, although not injured by animal oils, can be damaged by mineral oil or heat above 100°F. Rubber belting, a mixture of canvas and rubber gum, is waterproof but can be injured by oils. Neither canvas nor balata belts should be laced. The ends should be joined together with either metal fasteners or a cemented step joint.

The selection and hookup of flat belts for efficient power transmission combined with a reasonable service life are complicated by the following factors: Belt speed, material, thickness, width, distance between pulleys, tension, angle of contact, whether horizontal or otherwise, uniformity of loads, whether tight side is above or below, method of joining ends of belt, whether belt is kept clean or not, size, material, and alinement of pulleys.

A flat belt lasts longer if it is kept no tighter than necessary to prevent slipping. On horizontal drives and with small pulleys carrying narrow belts, pulleys should be spaced about 15 feet apart and the belt should sag not more than 2 inches; for larger belts and pulleys, a 25-foot spacing and a 3-inch sag are recommended. When the distance between pulleys is short or one is placed over the other, belts must be kept tight. This is done by increasing the distance between pulleys, shortening the belt, or using a rider.

Measuring Belt Size

To determine the length needed for a new belt, measure with a steel tape the course of the belt around the pulleys. The tape should be drawn tightly. Cut the belt one-eighth inch per foot of length short of this measured length to offset initial stretch, and splice the endless belt or lace the jointed one. New belts stretch appreciably, particularly during the first 3 days of service. If the pulley spacing can be increased or a rider used, the belt can be readily tightened. If the belt must be shortened, usually several adjustments are necessary. Catalogs of belt manufacturers give instructions for belt splicing and lacing.

Splicing and Lacing

To splice a belt, measure the course around the pulleys with the steel tape and add the overlap. For new belts, deduct one-eighth inch per foot; for used belts take the full measurement. With a knife, separate the plies at both ends and trim so as to make steps, as shown in figure 64, of the following proportions:

Width of belt (Inches)	*Size of step (Inches)*
8	4
8 to 12	5
14 to 18	6
Over 18	7

Precision is essential, because the steps of one end must exactly complement those of the other; a carpenter's square should be used to mark them off, so that the ends can be cut at right angles to the belt length. The cut surfaces must be clean for gluing. The overlapping surfaces of each end are coated with adhesive (rubber cement for rubber, animal glue for leather or canvas). Rubber cement is allowed to dry until tacky; two coats are applied thus. The stepped ends are then placed together to

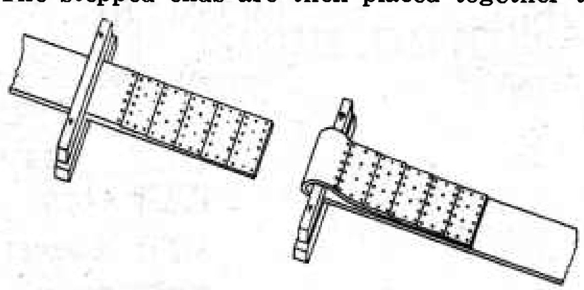

FIGURE 64.—Step-trimmed ends of composition belt ready for splicing. Dots show where rivets will be located.

form a joint. In rubber belts the cemented joint is clinched tight with 7-gage copper burr rivets. On leather or canvas belts, hot glue is applied and the joint is held under heavy weights until the glue has set before being riveted. Rivet holes are made with an awl, not with a punch.

To lace a belt with rawhide, mark off two lines parallel to each end at the distances given in table 6.

TABLE 6.—*Specifications for lacing flat belts*

Width of belt (inches)	Distance of holes from belt end		Size of lacing
	First row	Second row	
	Inches	*Inches*	*Inch*
2– 4	½	1	¼
6– 8	⅝	1¼	5/16
10–12	¾	1½	⅜
14–16	⅞	1¾	½
18–20	1	2	⅝
22–24	1¼	2½	⅝

With a belt punch, lacing holes are cut that are about three-fourths the width of the lacing used, and are alined as shown in figure 65. Lacing is threaded so that it is parallel to the belt length on the inner or pulley side of the belt and crosses on the outer side. The belt ends are held closely together while the rawhide is threaded from the outer side of the belt through the center hole, *A*, of the series (fig. 65) for about one-half the lacing length, then straight across through hole *B*. This brings the lacing end out at the nonpulley side of the belt. The lacing end is then brought across through hole *C*, and straight across on the inner side through *D*. This pattern is continued to the edge. At holes *I-J* the rawhide is threaded straight across on the inner side twice and once on the outer side, then continued back to hole *D*, the lacing end thus being on the outside of the belt.

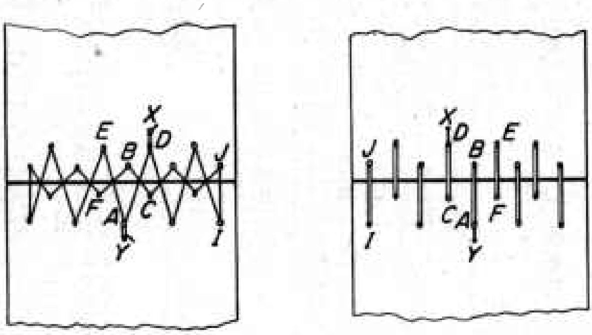

FIGURE 65.—Method of lacing a belt.

Next, the other end of the lacing is brought from hole *A* through hole *E* and straight across to hole *F*. The same procedure is then followed as for the other end, arriving finally at *A*, on the outside of the belt. Small holes *X* and *Y* are then punched three-fourths inch from holes *D* and *A* respectively; one end of the rawhide is laced twice through holes *D* and *X* and the other end twice through holes *A* and *Y*. Lacing should be pulled taut and be free from twists. The ends are trimmed close to the belt on its outer face.

Metal lacings of the hinged type are serviceable for small-mill belting. The alligator type can be put on by hammering the barbs into the belt; the clipper type is installed with a lacing machine.

V-Belts

V-belt drives are increasingly used in small mills. They require short spacing between the pulleys and a means of adjusting spacing to assure tightness. The recommended range of center-to-center pulley distances is not less than the diameter of the larger nor more than the sum of the diameters of the two pulleys. Necessary adjustments are made by providing a means of moving either the drive or the driven member. Takeups should be provided for at least 5 percent of the belt length, in addition to an allowance for putting on the belt.

To install a V-belt, the pulleys should be seated so that the sheaves are exactly alined. Either the drive or the driven machine is then moved toward the other until the belt can be put on by hand (forcing the belt on with a screw driver or lever may damage it). The movable machine is then backed until the belt is so tight that considerable effort is required to twist it a half turn when it is grasped about half way between pulleys. The mobile machine is then fixed in place.

New belts will stretch—chiefly within the first 3 days of service—and need tightening. It is not good practice to put new and used belts in the same drive. If a belt breaks, and a used one is not available, all in the set should be replaced with new ones, saving the unbroken used ones for replacement of other used belts.

Transmission Capacity of Belts

The capacity of a belt to transmit power from one pulley to another is limited by its size and that of the pulleys. Overloads result in inefficiency through excessive belt slippage, or in rapid wear of the belts. Tables 7 and 8 present manufacturers' horsepower ratings for belts of various sizes; capacity of V-belts, as shown in table 7, is rated according to the sheave diameter of the pulley as well as the belt size. V-belt sizes have been standardized among manufacturers according to cross-sectional area and identified by letters, such as A, B, C, D, and E (table 8).

The values given in tables 7 and 8 are for transmission between pulleys of equal size. If one pulley is smaller than the other, as often happens in order to step up or reduce speeds, the ratings must be multiplied by a reduction factor that, in turn, depends on the arc of contact between the belt and the smaller pulley. This arc will be less than 180°; it represents a convenient way of expressing the reduced area of surface contact between belt and pulley. Since this arc is smaller with smaller pulleys, less power will be transmitted to or from the smaller pulley.

The arc of contact of the smaller pulley can be calculated by a simple formula:

$$\text{Arc of contact} = 180° - \frac{(D-d)\ 57}{\text{Distance between pulley centers (inches)}}$$

Where D is the diameter of the larger pulley in inches, and d is that of the smaller pulley.

When the arc of contact of the smaller pulley for a given hook-up is found by this formula,

TABLE 7.—*Manufacturers' approximate horsepower rating, per inch of width, for standard flat sawmill belts subject to medium shock loads, when distance between pulleys is 15 feet or more*[1]

Belt speed (ft. per minute)	Leather belts		Rubber belts, per ply
	Single-ply	Double-ply	
	Horsepower	*Horsepower*	*Horsepower*
1,000	1.35	2.33	0.313
1,500	2.01	3.45	.474
2,000	2.62	4.50	.625
2,500	3.30	5.55	.772
3,000	3.90	6.54	.907
3,200	4.05	6.90	.945
3,400	4.27	7.26	.990
3,600	4.42	7.59	1.032
3,800	4.65	7.86	1.070
4,000	4.80	8.16	1.110
4,200	5.03	8.49	1.140
4,400	5.17	8.76	1.170
4,600	5.32	9.00	1.195
4,800	5.40	9.23	1.220
5,000	5.55	9.38	1.237

[1] Derived from data in catalogs of Chicago Belting Co. and Manhattan Rubber Co.

TABLE 8.—*Manufacturer's horsepower rating, per belt, of five types of standard sawmill V-belts under mild shock load, when arc of contact is 180°*[1]

Belt speed (ft. per min.)	V-belt type A (½ by 11/32 inch)			V-belt type B (21/32 by 11/16 inch)			V-belt type C (⅞ by 17/32 inch)			V-belt type D (1¼ by ¾ inch)			V-belt type E (1½ by 1 inch)		
	Sheave pitch diameter			Sheave pitch diameter			Sheave pitch diameter			Sheave pitch diameter			Sheave pitch diameter		
	3 inches	Change per inch diameter of pulley	5 inches	5 inches	Change per inch diameter of pulley	7 inches	9 inches	Change per inch diameter of pulley	12 inches	13 inches	Change per inch diameter of pulley	17 inches	22 inches	Change per inch diameter of pulley	28 inches
	Hp.	*Hp.*	*Hp.*	*Hp.*	*Hp.*	*Hp.*	*Hp.*	*Hp.*	*Hp.*	*Hp.*	*Hp.*	*Hp.*	*Hp.*	*Hp.*	*Hp.*
1,000	0.52	0.125	0.77	1.0	0.15	1.3	2.2	0.20	2.8	3.9	0.32	5.2	6.9	0.27	8.5
1,500	.75	.205	1.16	1.4	.25	1.9	3.2	.30	4.1	5.8	.50	7.8	10.2	.42	12.7
2,000	1.00	.27	1.54	1.8	.35	2.5	4.2	.40	5.4	7.5	.55	10.2	13.2	.57	16.6
2,500	1.16	.345	1.85	2.2	.40	3.0	5.1	.47	6.5	8.9	.85	12.3	16.0	.70	20.2
3,000	1.3	.40	2.1	2.5	.50	3.5	5.8	.57	7.5	10.2	1.02	14.3	18.5	.83	23.5
3,200	1.3	.45	2.2	2.5	.55	3.6	6.1	.60	7.9	10.7	1.07	15.0	19.3	.88	24.6
3,400	1.4	.45	2.3	2.6	.60	3.8	6.4	.67	8.5	11.1	1.12	15.6	20.1	.95	25.8
3,600	1.4	.50	2.4	2.6	.60	3.8	6.5	.70	8.6	11.4	1.20	16.2	20.8	1.00	26.8
3,800	1.4	.55	2.5	2.7	.65	4.0	6.8	.70	8.9	11.7	1.27	16.8	21.4	1.07	27.8
4,000	1.4	.55	2.5	2.7	.70	4.1	6.9	.77	9.2	11.9	1.35	17.3	21.9	1.12	28.6
4,200	1.4	.55	2.5	2.7	.75	4.2	7.1	.80	9.5	12.1	1.40	17.7	22.4	1.17	29.4
4,400	1.4	.60	2.6	2.7	.75	4.2	7.2	.83	9.7	12.2	1.47	18.1	22.7	1.23	30.1
4,600	1.3	.65	2.6	2.6	.80	4.2	7.2	.90	9.9	12.2	1.55	18.4	23.0	1.28	30.7
4,800	1.3	.65	2.6	2.6	.80	4.2	7.3	.97	10.2	12.2	1.60	18.6	23.1	1.35	31.2
5,000	1.2	.70	2.6	2.5	.85	4.2	7.3	.93	10.1	12.0	1.70	18.8	23.2	1.38	31.5

[1] Derived from data in catalog of L. H. Gilmer Co., Tacony, Philadelphia, Pa.

the reduction factor used with values in table 8 for flat belts will be:

Arc of contact	*Reduction factor*
170°	0.95
160°	.90
150°	.85
140°	.80

Similarly, the reduction factors used with values in table 8 for V-belts on pulleys of dissimilar sizes are:

Arc of contact	*Reduction factor*
170°	0.98
160°	.95
150°	.92
140°	.89
130°	.86
120°	.82
110°	.77
100°	.72

The values for V-belts in table 8 must also be corrected when this type of belt is run over a flat pulley—as, for example, when transmitting power from an electric motor with a V-pulley to a flat pulley. If the V-pulley is smaller than the flat pulley, its arc of contact will be less than 180°. Reduction factors are necessary, therefore, to determine the transmission capacity of the V-pulley. For various arcs of contact, these are:

Arc of contact	*Reduction factor*
170°	0.64
160°	.67
150°	.69
140°	.71
130°	.73
120°	.75
110°	.77
100°	.72

Although V-belts can be and are used in hook-ups of sheaved pulleys and flat ones, such hook-ups normally are not so efficient as those with all pulleys sheaved. In a hook-up of a V- to a flat pulley, the speed of the grooved pulley must be at least three times that of the flat one. The flat pulley should not be crowned, nor should the center distance between pulleys be more than the diameter of the flat pulley.

Pulleys

Pulleys are made of iron, steel, wood, or fiber. The transmitting capacity of a wood pulley is about 10 percent, and that of a fiber one 20 percent, more than that of metal pulleys at maximum limits, because they slip less. Wood and fiber pulleys do not, however, hold up as well at high speeds. Cast-iron pulleys can be used at rim speeds up to 5,000 feet per minute, which is the maximum recommended for small sawmills.

The face of a flat pulley should be wide enough to allow about 1 inch of clearance on each side of the belt. Crowning the face so as to raise the center by about 1/8 inch per foot of face width helps to keep the belt centered. The vital point about installing pulleys is to fix them in perfect alinement. The diameter must be that necessary to maintain the speed relationship required, but very small pulleys subject belts to excessive wear. Diameters less than 6 inches should not be used with thick belts (five-ply composition or two-ply leather) running at 4,000 feet per minute or more.

The rule used to determine pulley size or speed relationships is that the revolutions per minute of the drive pulley, multiplied by its diameter, equals the revolutions per minute of the driven pulley multiplied by its diameter. Given values for any three, the value of the fourth can be calculated. To determine the diameter of a driven pulley when the diameter and speed of the drive pulley and the speed required for the driven pulley are known, the formula is:

$$\text{Diam. of driven pulley} = \frac{\text{diam. of drive pulley x its r.p.m.}}{\text{r.p.m. of driven pulley}}$$

When the unknown value is the revolutions per minute of the driven pulley, the formula is:

$$\text{R.p.m. of driven pulley} = \frac{\text{diam. of drive pulley x its r.p.m.}}{\text{diam. of driven pulley}}$$

When the unknown value is the diameter of the drive pulley, the formula is:

$$\text{Diam. of drive} = \frac{\text{diam. of driven pulley x its r.p.m.}}{\text{r.p.m. of drive}}$$

When the unknown value is the revolutions per minute of the drive pulley, the formula is:

$$\text{R.p.m. of drive} = \frac{\text{diam. of driven pulley x its r.p.m.}}{\text{diam. of drive pulley}}$$

Power ratings are given in table 8 for two sizes of pulleys for each class of V-belt. To get ratings for pulleys of intermediate size, allow for each inch of pulley diameter the amount shown in columns between those giving ratings. When the diameter of the smaller pulley exceeds the larger diameter given for a belt type, use the rating given for the larger diameter.

The following are the smallest pulley diameters (in inches) that should be used with each type of V-belt listed in table 8: A, 3.0; B, 5.4; C, 9.0; D, 13.0; E, 21.6. All values given for diameters of V-belt pulleys are expressed as pitch or diameter outside the belt minus the belt thickness.

Pulleys for V-belt drives are relatively heavy and therefore act as flywheels, hence must be expertly balanced.

Shafts and Bearings

Shafting for small mills is usually of cold-rolled steel. Table 9 gives essential data related to shaft size, distance between bearings, and maximum load limits.

TABLE 9.—*Maximum recommended distances between bearings for various sizes of cold-rolled steel shafting, and maximum power transmitted* [1]

Diameter of shaft (inches)	Maximum distances between bearings [2]		Maximum power transmitted at—		
	No pulleys	With pulleys	100 r.p.m.	300 r.p.m.	600 r.p.m.
	Feet	*Feet*	*Hp.*	*Hp.*	*Hp.*
1 7/16	11.3	6.6	4.1	12.3	24.6
1 1/2	11.7	6.8	4.8	14.4	29.0
1 11/16	12.7	7.3	6.9	20.7	40.5
1 15/16	13.9	8.0	10.4	31.0	62.0
2 3/16	15.1	8.8	15.0	45.0	90.0
2 7/16	16.3	9.4	20.0	61.0	122.0
2 15/16	18.3	10.6	36.0	108.0	217.0
3 7/16	20.3	11.8	58.0	174.0	348.0
3 15/16	22.3	13.0	86.0	258.0	516.0

[1] Data derived, by permission, from Machinery's Handbook, Fifth edition, New York, N. Y. 1,400 pp. Illus. 1920.

[2] For shaft speeds not exceeding 3,000 r.p.m.

Bearings are usually babbitt metal, but saw mandrels, carriage wheels, and edgers may have roller bearings and the trimmer ball bearings.

Making Babbitt Bearings

Bearings are either solid or split. To make a solid babbitt bearing, cut or melt out the old babbitt metal cleanly, being careful to free the retaining grooves or holes of the old babbitt. The shaft must not only be clean but freed from cuts or scratches by dressing it with emery cloth or in a lathe if necessary. Block it in the position it is to run, centering the box. Cut pasteboard collars and place them tight against the shaft at each end of the box, puttying any small opening. Place the shell, and, if necessary, build a clay crater around the oil hole to aid in pouring the babbitt. Melt the babbitt until it flows freely and chars a pine stick; heating beyond this point may damage the babbitt.

To avoid excessive tightness, smoke the shaft until a layer of carbon smudge covers it. Heat the shaft and box with a blowtorch or otherwise, but avoid burning out the pasteboard collars. Stir the melted babbitt to get a uniform mix, and pour it through the oil hole until the box is full. When the babbitt has set, work the box off the shaft, drill out the oil hole, and cut two oil grooves that cross each other under the oil hole of the box and extend diagonally to within one-fourth inch of either end of the bearing. Try out the bearing. If it heats, remove the box and scrape the bearing until trial indicates the proper fit.

To babbitt a split bearing, clean the shaft and box as for a solid bearing and fix the bottom half of the box in position on the shaft. Put shims across the junction of the bottom and top halves of the box. These shims extend to the shaft the full length of the box, and each has two or three notches next to the shaft to permit filling the bottom half with melted babbitt. Bolt the top half of the box in position and enclose the ends. Heat the box and shaft and pour the metal through the oil hole. When the metal has set, unbolt the upper half of the box and separate the two halves by driving a chisel between them to break the babbitt in the shim notches. Scrape off uneven spots in the bearing, put in the oil grooves, and bevel the edges of the babbitt slightly where the top and bottom halves of the box meet. In fitting the box, bolt it in place, using shims to separate the halves enough to give a cool box.

CARE AND MAINTENANCE OF SAWS

The common types of saws found in the sawmill are the headsaw, the edger, the trimmer, the cut-off, and the slasher saw. At small mills, these types are used according to the size of the mill and the permanence of the set-up. The headsaw, of course, is indispensable. Edger saws are quite commonly used at all but the smallest portable mills, which frequently use the headsaw for this purpose. At all but the smallest mills, likewise, trimmer and cut-off saws are quite generally used. Slasher saws are in use at fairly permanent mills which must have a means of cutting up waste for boiler fuel or for salable firewood.

In the care and maintenance of saws, an understanding of the types of sawteeth, how they perform in the cutting operation, and how they are kept in proper condition for sawing, is essential. These aspects of saw use and care are described in the following sections. While headsaws are considered primarily, the statements are generally applicable to the other types of saws as well.

Sawteeth

In order that a saw may function effectively, the sawteeth must be spread so as to make a channel that is wider than the thickness, or gage, of the saw plate. Two types of teeth are in common use to meet this requirement. In the spring-set type, the teeth are bent outward, alternate teeth in the same direction and adjacent ones in opposite directions. In the swage-set type, the plate is spread at the cutting zone of each tooth.

Spring-set saws are normally used for cross cutting and swage-set saws for ripping. Spring-set teeth tend to cut fine sawdust, while swage-set teeth, if properly fitted, cut out small chips rather than sawdust.

In all three classes of headsaw (gang, band, and circular) the rip tooth is given hook; that is, the front outline of the tooth, from its point to the throat of the gullet, lies behind a perpendicular extending from the point to the saw back in band and gang saws, or behind the radius to the tooth point in circular saws. Cross-cut bands with a spring-set, rip type of tooth are rarely used for cross cutting logs on deck. In circular cross-cut saws, the outline has no hook or a negative one; that is, the radius from the point coincides with or is behind the cutting edge of the tooth.

Swage-set teeth may be "solid"—that is, cut from the plate—or "inserted," fixed to the plate with special holders. Normally such teeth approximate the degree of hardness of the plate, but harder teeth or cutting parts are available. Inserted points of high-speed steel normally cut several times as much between sharpenings as do standard teeth. Still harder alloys, usually shaped to form cutting parts welded or brazed to solid or inserted teeth, are coming into use. These normally function for several days or weeks between sharpenings, but are brittle and subject to damage from metal or rock, and special equipment is required for sharpening them.

Complete uniformity is lacking for a given style of inserted point and holder as made by different manufacturers. In table 10 are listed the style symbols used by specified manufacturers for a given style. All symbols vertically in a given column identify interchangeable products. The difference in styles includes not only the shape of the gullet, as shown in figure 66, but differences in the holder and tooth, as shown in the three major variants (fig. 67).

Resistance to cutting increases with chip thickness and saw speed, with a change from species of low to those of high density, with knotty material, with progressive dulling of the teeth, and with increasing depth of the sawed face. The effect of these conditions has been tested (tables 3, 4, and 5, pp. 40, 41). Given adequate power and gullet capacity, sufficient resistance can be built up to cause the saw to deflect under extremes in any of these condi-

TABLE 10.—*Extent to which inserted-point sawteeth and tooth holders produced by various manufacturers of sawmill saws can be interchanged. Tooth and holder numbers in the same column vertically are interchangeable. Based on data furnished by manufacturers listed*

Manufacturer	Saw part	Manufacturer's part number																				
Atkins	Teeth	2	2½	3	3½	4	4½	5	B	[1] C	[1] 33											
	Holders	2	2½	3	3½	4	4½	5	B.D.F.	[1] C	[1] 33											
Corley	Teeth		2½	3						[1] 3D	[1] 33									22		
	Holders		2½	3					B.F.													
Disston	Teeth	4½D	2½	3	3½	8	4½	9		[1] 3D	[1] 33	ABC	ABC	ABC	I[3]	I[3]	I[3]				44	
	Holders	4½D	2½	3	3½	8	4½	9		[1] 3D	[1] 33	A	B	C	50	55	66				44	
Hoe	Teeth	2	2½	3	3½	4	4½	5	B	[1] 6	[1] 33										44	25
	Holders	2	2½	3	3½	4	4½	5	B.D.F.	[1] 6	[1] 33										44	25
Lippert	Teeth	2	2½	3																		
	Holders	2	2½	3																		
Ohlen-Bishop	Teeth		2½	3														1	2P	22		
	Holders		2½	3														1	2P	22		
Simonds	Teeth	2	2½	3	3½	4	4½	5	B.D.F.[2]													
	Holders	2	2½	3	3½	4	4½	5	B.D.F.[2]													
Southern	Teeth	2	2½	3		4			B.F.	[1] 3D	[1] 33							1	2P		44	
	Holders	2	2½	3		4			B.D.F.	[1] 3D	[1] 33							1	2P		44	
Spear and Jackson	Teeth		2½	3	3½		4½		B													
	Holders		2½	3	3½		4½		B.D.F.													

[1] Atkins No. C and Disston No. 3D saws will take No. 33 teeth and holders, but neither Atkins No. C nor Disston No. 3D teeth can be used with No. 33 holders.

[2] B, D, or F teeth will fit either B, D, or F holders, but a saw milled for a given holder by the manufacturer must be fitted with that holder (holders not interchangeable).

[3] Disston "Single Ball Invincible" tooth.

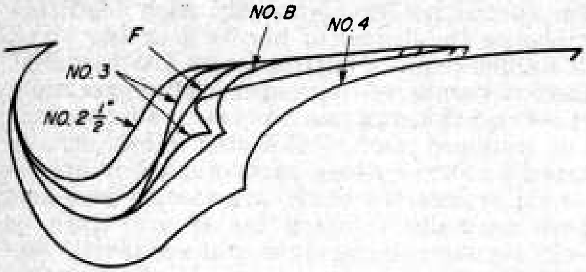

FIGURE 66.—Outline of gullet for common styles of inserted teeth.

tions. Lacking a knowledge of the force required to deflect a saw under given conditions, however, guidance on what the saw will take can be gained only by using the saw.

Factors Affecting Selection and Operation of Saws

Many factors affect the selection and use of saws. Among these are saw diameter, which largely determines the size of log a mill can handle; saw gage, which varies with diameter but also to some extent with the density of the timber being handled; tooth pattern, including shape of gullets as well as points; and saw speed. For particular purposes, the buyer should consult some competent authority on suitable saw characteristics for his job.

Diameter

The diameter of the saw should be the least needed to break down the larger logs sawed. The relationship between saw diameter and the diameter of the log that can be sawed by the standard method of "sawing around" the log is as follows:

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

Gage

The extreme range in gage of circular headsaws used under normal conditions lies between 7 and 10, a difference of about one twenty-second inch. Circular saws are usually beveled from near the collar to the rim, so that the rim is 1 or more gages thinner than the center section. For solid-tooth saws, an 8–9 gage (8-gage center, 9-gage rim) is recommended for average conditions, with the alternative of a 9–10 gage for saws 48 inches or less in diameter or for saws 50 to 60 inches in diameter when run at high rim speed (10,000 or more feet per minute). A 7–8 gage is generally used for 50- to 60-inch saws subjected to heavy loads, as with heavy hardwoods, or for feeds exceeding 1/12 inch per tooth. For inserted-point saws, the 8–9 gage can be used on all diameters up to 60 inches, with the alternative of the 9–10 for saws 48 inches or less in diameter and the 7–8 for saws 50 to 60 inches in diameter.

Teeth and Gullets

Ripping is most efficiently done by a chisel action and crosscutting by a knife action. Chisel action is easiest if the tooth tapers gradually from the cutting edge to the shank. In designing the headsaw tooth, the top face is carried back from the cutting edge so as to give a clearance angle of about 12° (fig. 68). The tapered, or cutting, face is carried back from the cutting edge to make as sharp an angle with the top face as possible and yet give enough body to the tooth to prevent noticeable vibra-

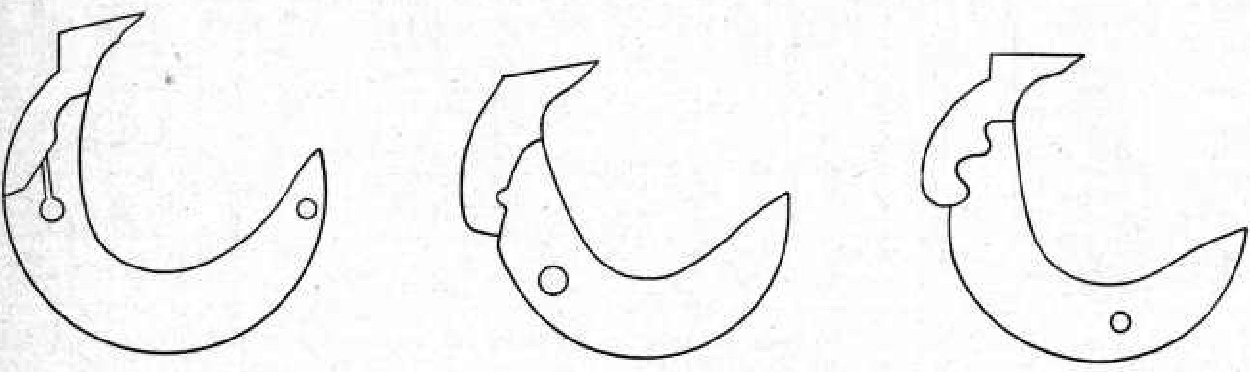

FIGURE 67.—Major variants of style in holders and inserted teeth.

tion when cutting. In solid-tooth saws this cutting face normally makes an angle of 30° to the radius from the tooth point, although where heavy loads require a stronger tooth this hook angle may be as little as 15°. Inserted points are given more hook, approximately 41°. The rest of the tooth is shaped to provide the maximum gullet space consistent with an adequately supported point.

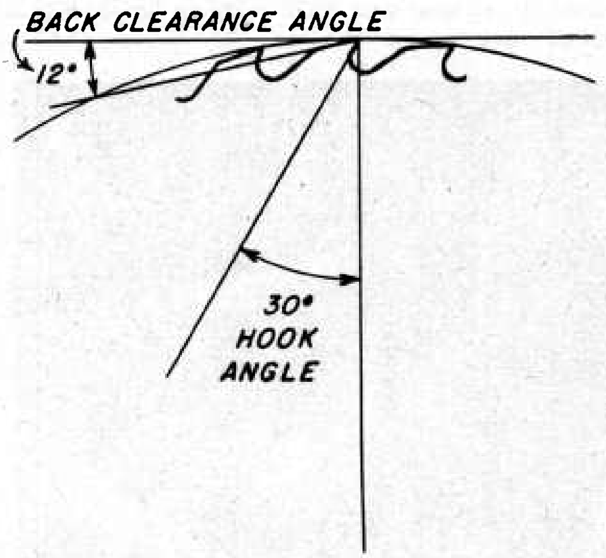

FIGURE 68.—Design of tooth and gullet, showing proper clearance and hook angles.

The tooth should be only wide enough to assure clearance for the blade. Wider teeth put unnecessary strain on the saw, increase the chance that sawdust will work out of the gullet, take more power, and waste more material. In saws of 7- to 10-gage, at least 3/32 inch in addition to the blade thickness should be allowed; 4/32 inch is commonly used on the solid-tooth type for softwoods. For hardwoods or frozen timber, 1/64 inch less than the above-stated allowances is recommended.

Inserted points, which are narrowed back from the cutting edge, are not commonly swaged beyond what is given them by the manufacturer. Repeated sharpening shortens the inserted tooth, thus continually narrowing the cutting edge. The new tooth, therefore, has excessive clearance (5/32 inch) in order to lengthen its service life. Cutting takes place not only along the cutting edge but back along the edges of the lower face for a distance usually between 3/32 inch and 6/32 inch, depending upon the size of chip taken. Hence these edges must be carefully machined and dressed for the job.

Spacing of Teeth

The gullets of sawteeth must have a curved outline (angles or corners in the gullet foster cracks) with an area ample to carry the sawdust, yet with a strong backing to the tooth proper. The gullet space required to carry the sawdust limits the number of teeth that can be put in the saw.

As has been pointed out in this manual, the capacity of the gullet to carry sawdust may be a limiting factor in determining power requirements for a saw. A feed rate in excess of gullet capacity results in miscut lumber and a jammed saw. Calculations of gullet capacity are based on the relationship of the cross-sectional area of wood as a solid and that as sawdust when packed up to a condition where additional sawdust adds undue load to the saw. It is assumed the gullet area must be twice that of the wood removed. This is an approximation which does not allow for the variation in packing quality of sawdust as related to its density. The cross-sectional area of the gullet can be measured by outlining the gullet profile (fig. 66) included under a straight line from point to point of consecutive teeth on a paper having lines making one-fourth-inch squares. Each square thus equals one-sixteenth square inch. The cross section of the amount of wood is the bite per tooth multiplied by the cutting depth.

The bite per tooth for a stated cutting depth which fills the gullet under the 2 to 1 assumption is found by the formula

$$2 \text{ bites} \times \text{cutting depth} = \text{gullet area}$$

Thus, for a cutting depth of 20 inches and a gullet area of 2.5 square inches, the bite is 0.0625 inch, which equals 16 teeth per inch of feed.

The feed rate up to overloading, in terms of feet per minute, is:

$$\frac{\text{Number of teeth in saw x saw r.p.m.}}{\text{Number of teeth per inch of feed x 12}}$$

For a bite taking 16 teeth per inch on a saw with 48 teeth running at 550 revolutions per minute, the feed rate thus is:

$$\frac{48 \times 550}{16 \times 12} = 137\tfrac{1}{2} \text{ feet per minute}$$

For normal work, inserted-point saws have approximately one tooth for each 3¼ inches of rim, solid-tooth saws one for each 2½ inches. With fast feeds, gullet requirements raise the limit for solid-tooth saws to about 3 inches.

Saw Speed and Chip Thickness

The usual instructions that saw speed should be no greater out of the cut than can be maintained in the cut are inadequate without consideration of feed rate. Output hinges on feed rate—the thickness of the chip taken per tooth—and on saw speed. In small mills, the feed rate ranges between 1/24 and ⅛ inch per tooth. A relatively thick chip is obviously desirable; it gives greater production with less wear on the cutting edge and corners of the tooth, and makes coarse sawdust that is less prone to crowd out of the gullet. At most mill set-ups, a thick chip also results in more efficient use of horsepower, as indicated by Forest Products Laboratory test results shown in table 11.

TABLE 11.—*Horsepower required to cut a 10-inch depth at similar carriage feed rates but different saw speeds*[1] *and chip thicknesses*

Carriage feed (ft. per min.)	Chip thickness at—		Total horsepower at—	
	300 r.p.m.	600 r.p.m.	300 r.p.m.	600 r.p.m.
	Inch	*Inch*	*Hp.*	*Hp.*
60	0.06	0.03	19.1	20.6
80	.08	.04	23.4	25.1
120	.12	.06	31.9	34.0

[1] Saw diameter 50 inches.

A thicker chip results when the number of teeth in the saw is reduced, when the carriage feed rate is increased, or when the saw speed is reduced. In underpowered mills, the carriage feed rate usually cannot be increased; for such conditions, a saw with fewer teeth or one run at a reduced speed should prove more efficient. Given plenty of power, the carriage feed rate can be increased to the capacity of the gullets to carry sawdust; for additional increased production, both the carriage feed rate and saw speed can be increased. The increased loads resulting from higher saw speeds and feed rates, however, require heavier small-mill equipment in carriage and saw mechanism.

Tensioning the Saw

Forces acting to stretch the rim of a circular saw are (1) centrifugal force, or the outward pull of the revolving plate; (2) resistance to cutting; and (3) heating of the saw when gumming it. These are enough to expand the rim so that the saw will fail to hold to a true line, dodging or otherwise deviating, unless it is properly treated. By stretching the midradial area uniformly—that is, "tensioning" it—the rim is steadied, so that the saw holds a true line.

The amount of tension given this midradial zone is governed by certain considerations. A large saw requires more tension than a small one; a thin saw more than a thicker one; a high-speed saw more than a low-speed one; and a heavily loaded saw more than one under light load. The measure of tension is the extent to which the midradial zone sags below a straightedge held on the radius when the saw is supported as shown in figure 69. This sag may be as little as 1/75 inch on small, slow-speed headsaws, or as much as 1/12 inch on large, high-speed ones.

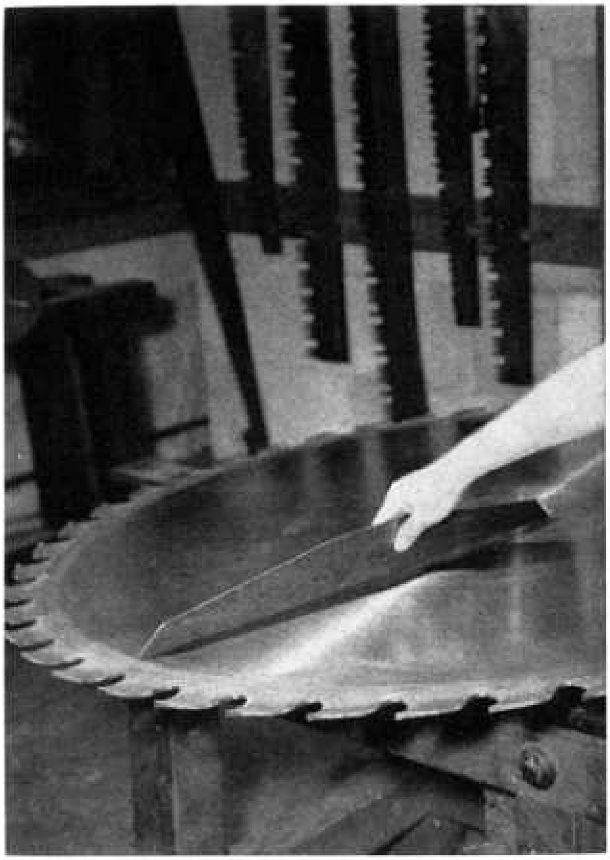

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FIGURE 69.—Method of measuring tension in a circular saw.

Tension is commonly put into circular saws by hammering[1] the midradial area with a special type of hammer. As tension is gradually dissipated or the rim stretch gets out of balance, the saw must be retensioned.

A competent man can acquire the skills of leveling and tensioning saws. Where and how much to hammer must always be a matter of judgment for each tensioning. This can only be acquired by experience.

[1] Tension can also be given by heating localized areas of each tooth.

The tools suggested are a trial mandrel (fig. 70), a hammer bench with running board or back rest, a 150-pound anvil with crowned face, a 4- or 5-pound square-faced hammer, a 4- or 5-pound round-faced hammer, straightedges 10 and 60 inches in length, and a tension gage (fig. 71). The tension gage is a straightedge altered to conform to the arc of curvature when the properly tensioned saw is tested for "drop." A headsaw gage can be made by dressing the edge of a thin strip of steel to fit exactly the arc of curvature of the correctly tensioned saw when the saw is given the tension test, one end of the gage being placed about 4 inches from the bottom of a gullet and the other end about 4 inches from the eye (center hole) of the saw. Mark one end of the gage so that the same end can be placed at the rim in all tests. Do not allow either the gage or the straightedge to lean from the upright position; press it gently against the plate.

To put a saw in condition (1) check for twists, lumps, and other high spots; (2) level these; and (3) put in the correct tension. The gage will indicate where to hammer for tension and when to quit. To get background experience on the degree of uniformity sought in a properly leveled saw, put a correctly leveled and tensioned one on the trial mandrel, fix the pointer so that it barely clears the plate about 1 inch below the base of the gullet, and then slowly turn the saw, noting the degree of variation in the gap between the plate and the pointer. Uniformity should be checked at 2-inch intervals along a radius from the rim to the collar line.

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FIGURE 71.—Equipment for tensioning a saw. Bench, anvil, square-faced hammer, round-faced hammer, straightedge, and tension gage.

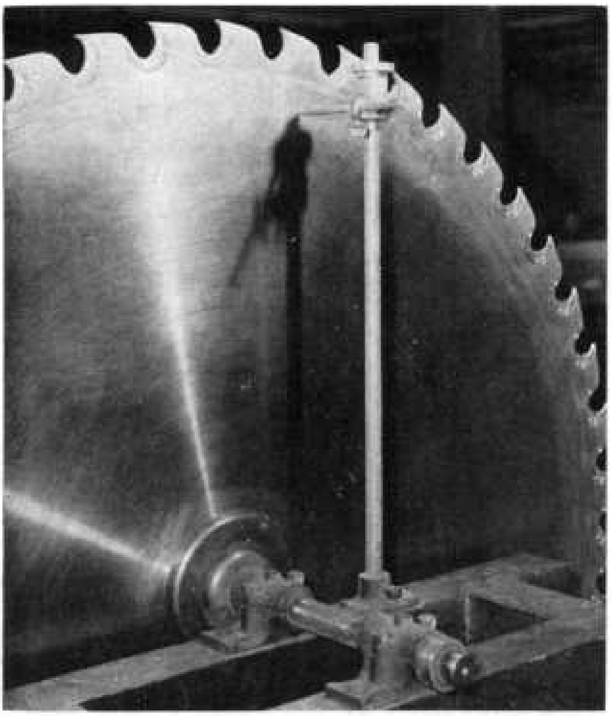

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FIGURE 70.—Trial mandrel. Pointer indicates whether saw is properly tensioned when saw is rotated. Pointer can be raised or lowered with set screw.

The trial mandrel must be flawlessly straight and held true in the bearings; saw collars must be perfectly fitted and planed. The rod to which the pointer is attached should be parallel to the planed faces of the collars.

To learn how hard to strike a saw for tensioning purposes, spread a film of oil over an area of a discarded saw and place the saw on the anvil. Practice striking it until the face mark left by the round-faced hammer is maintained at a 7/16-inch diameter. This diameter should never be greatly exceeded; one of 5/8 inch indicates excessively heavy blows. In leveling, blows are ordinarily less severe than in tensioning.

Put the saw requiring fitting on the trial mandrel. Turn the saw slowly and, where the gap between pointer and plate diminishes beyond the standards set up previously, draw a short chalk line on the plate. Repeat for each of the concentric circles 2 inches apart. The result should be a series of marks indicating areas of high spots. In some cases, high spots are indicated by particularly bright metal; in extreme instances the metal may be blued by heat generated in sawing.

These marked areas result from lumps and twists in the saw and must be hammered out. Before the saw is taken from the trial mandrel, the extent and direction of these high spots should be confirmed by placing a 6-inch straightedge against the plate in such a way that it is centered on a marked high area. By sliding the straightedge in different directions over it, the size and shape of the high area can be correctly delineated and marked.

Put a double sheet of wrapping paper over the anvil, place the eye of the saw in the socket with the marked side of the saw up, and center one of the spots on the anvil. In all hammering, whether for leveling or tensioning, move the saw as needed to bring the anvil squarely under the blow. Circular high spots can be taken down with either the round- or the square-faced hammer; linear areas (twists) can be properly leveled only with the square-faced hammer. To level a circular area with the round-faced hammer, strike blows beginning at the center of the area and following a line to the margin. Space the blows about an inch apart, and taper off on the force of the blows in progressing to the margin. Place succeeding series of blows on lines from center to margin, as in the first case. Exercise care that the blows are no harder than needed—too heavy pounding drives the high spot beyond the level condition and complicates later tensioning. Do not expect to level the lump completely the first time over the saw. In using the square-faced hammer, a second blow is always struck directly over and at right angles to the first.

For linear areas (twists), center the area over the anvil and hammer it so that the long axis of the square-faced hammer is along, rather than across, the twist. Blows are spaced about an inch apart. The first line hammered should conform to the axis of the twist. Follow up by hammering a series of lines on each side if the width of the raised area indicates the need. Do not hammer the area inside the collar line or the 4-inch zone next to the base of the gullets at this stage, but level completely the midzone area.

Having gone over the areas indicated to be in need of hammering, put the saw on the trial mandrel with the other face to the pointer, and mark the high spots as before. Those requiring leveling are hammered out. Chalk marks are cleaned from the saw, and the process of remarking and hammering is repeated until the saw is properly leveled.

The saw is now ready to be checked for tension. With the saw on the trial mandrel, place the long straightedge firmly across the plate as close to the diameter as permitted by the collar. This diameter-wise application of the straightedge is repeated on six diameters equally spaced to divide the circumference into twelfths. The saw is evenly tensioned when the straightedge contacts it over its entire length at all checks. The initial checks will usually disclose high and low areas.

Low areas indicate relatively great tension, and they should be outlined and skipped when hammering. The rest of the plate may contact the straightedge throughout the diameter, or unleveled lumps or twists may show as localized high spots. Mark and level these twists. Eventually the straightedge will be completely in contact except at the low areas.

Inscribe a series of concentric circles centered at the eye, the outer one about 4 inches from the base of the gullets and the others at 3-inch intervals until within about 2 inches of the collar line. For saws run at less than 700 revolutions per minute, draw radii to alternate tooth points; for saws run at higher speed, draw them to each tooth point. The intersections of the radii and the circles are the spots to hammer.

Place the saw on the anvil as for leveling, but without the paper cushion. With the round-faced hammer, strike a single blow at each intersection, starting near the collar line and progressing along the radius toward the rim. Then follow the next marked radius from the rim toward the center. Continue this until all intersections to be hammered have been treated.

Uniformity of blows is attained by detailing to the tensioner the single job of hammering the plate. A helper at the bench side pulls or slides the saw between blows, so as to bring consecutive marked intersections over the center of the anvil. The saw is moved at a uniform rate in order not to interrupt the steady, even tempo required for uniformity in hammering. The tensioner stands across from the bench in the position best suited to the individual for accurate hammering over the center of the anvil.

The saw is next marked on the opposite face with the identical pattern of radii and circles, so that hammering is done directly over targets on the reverse side. A single blow of like magnitude is given at each marked intersection. The saw is then placed on the bench and checked with the gage for uniform tension; areas in need of further hammering are marked. This gage check is done by supporting one edge of the saw on the bench and, with the right hip and left hand, raising the opposite edge so that the saw is supported only by the hip and bench (fig. 69) and steadied by the left hand. With the right hand, the gage is placed on a radius exactly halfway between the bench and hand supports, and the degree of conformity between the gage edge and the saw plate under it is noted. If the gage touches at the midzone but not toward the ends, further tension is required for that area. If the end zones touch but light shows under the midzone, this area should not be hammered. Blows are struck at the intersections of radii and circles as before, but only in those areas showing need of additional tension. These blows usually are lighter. It is good practice to stagger the second series of blows from the original ones by placing circles and radii midway between those marked for the first treatment.

When the plate fits the gage on all radii, put the saw on the trial mandrel and again check the plate for uniformity of flatness by placing the long straightedge as close to a diameter as the mandrel nut allows. The plate should touch the straightedge throughout. If high or low spots show up, they are usually due to lumps. If in the rim or collar zone, these can be located by using a 6-inch straightedge while the saw rests flat on the anvil. Hammering inside the collar line or at the rim zone must be done very carefully and only after thorough checks indicate that other zones are properly leveled and tensioned.

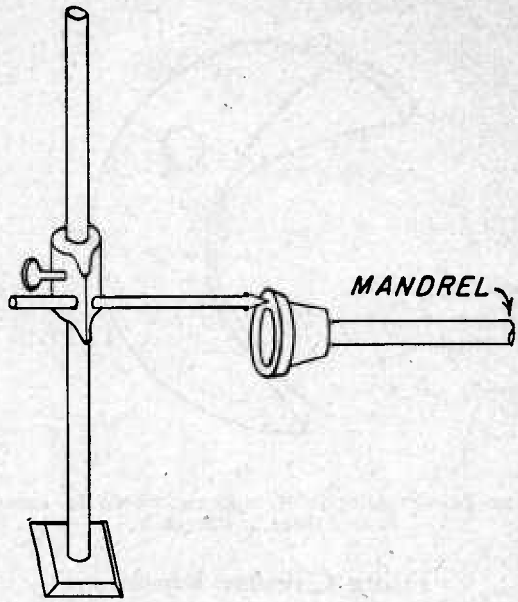

FIGURE 72.—Fixed pointer for checking alinement of mandrel collar.

Alinement of Saw and Teeth

A saw that is properly alined and tensioned cuts faces without visible scorings. Scoring wastes both material and power. Tests at the Forest Products Laboratory indicate that approximately 10 percent more power is used in cutting scored faces than clean ones. Scoring results either from a flutter in the rim of the revolving saw or because holders or teeth are out of line. The rim flutter may be due to faulty tension or to faulty alinement of the mandrel or collars. If the source of flutter is in the saw, a properly fitted one shows none; if it is in the mandrel or collar, all saws will flutter. If the flutter persists, even though the mandrel is held in place by its bearings, check the fixed-collar alinement. The plane of the shoulder that bears on the saw plate should maintain, when the mandrel is turned, a uniform spacing with reference to a pointer that almost touches the collar (fig. 72). If necessary, the collar should be ground.

The alinement of holders and teeth can be roughly checked by inspection, or more precisely with a side gage (fig. 73). Misalinement due to inaccurate placement of tooth or holder can usually be corrected by careful replacement after the contacts of tooth, holder, and saw are cleaned with an oiled rag; in more stubborn cases, they can sometimes be brought into line by tapping them lightly on the bulge side while holding a block against the opposite side. Misalinement due to sprung parts can be determined by inserting a tooth and holder that is in line with its own setting. If it is out of line, the tooth can be brought in line by putting a saw set on the plate just back of the heel of the tooth and pulling the tooth.

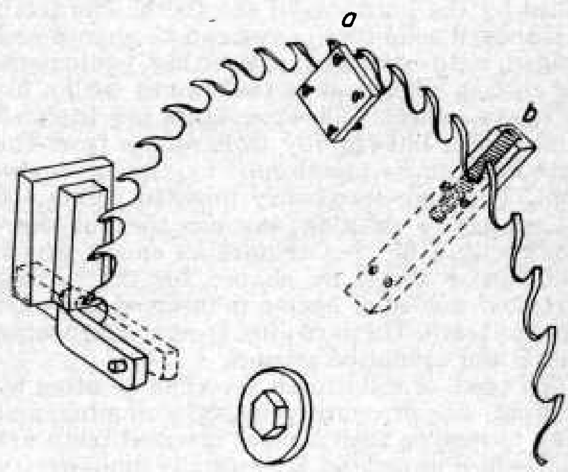

FIGURE 73.—Tools for alining a saw, including, *a*, side gage; *b*, side dresser; and *c*, jointer.

A loose holder can be stretched by placing it on an anvil and striking a series of blows with the round-faced hammer at points indicated in figure 74, repeating this procedure on the opposite face.

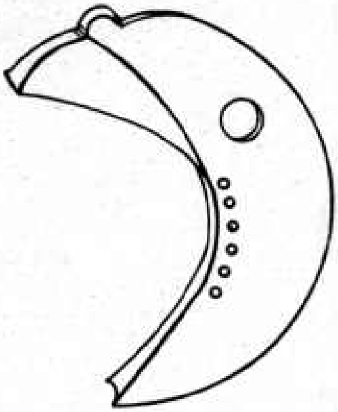

FIGURE 74.—Small circles indicate where to hammer tooth holder to stretch it.

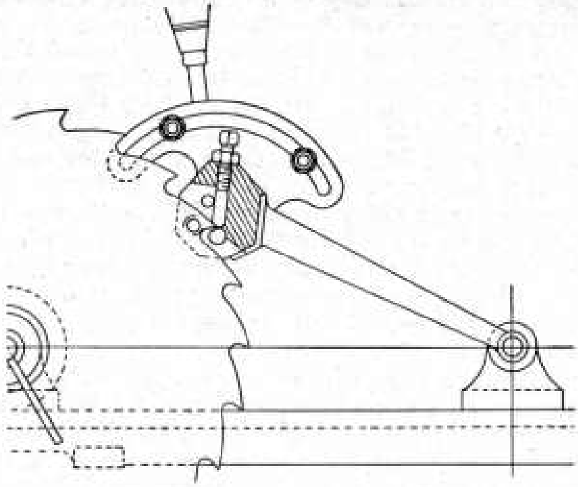

FIGURE 75.—Lever type of swage.

Filing Circular Ripsaws

Filing, as an operation, includes sharpening, swaging, side-dressing, jointing, and gumming. The method of filing circular ripsaws is determined by the hardness of the teeth. The teeth of standard solid-tooth saws can be shaped and swaged with standard saw-fitting equipment, and cutting edges can be maintained with a file or emery wheel. Likewise, standard inserted points differ but slightly in hardness from the plate and can be maintained by similar equipment. The high-speed-steel inserted points are not subject to swaging; nor can they be sharpened with a file, but require an emery wheel. Still harder alloys are shaped for the cutting parts and welded or brazed to inserted and solid types of teeth. These require special sharpening wheels and cannot be swaged.

The teeth of solid-tooth saws can be fitted by swaging, side dressing, jointing, gumming, and filing to restore their shape; inserted teeth are chiefly filed or ground. It is usually unnecessary to swage inserted points, as the design assures adequate clearance for the useful life of the tooth.[2]

Solid teeth are swaged and usually filed two or three times, after which their shape is restored by swaging, side dressing, jointing, and gumming. For swaging, either a lever type of swage or an upset type is used. The lever type (fig. 75) draws the front of the tooth out and flattens it between an anvil and die. The anvil is adjusted to bear squarely on the top of the tooth, and the die contacts the under face back of the cutting edge. The die is slightly eccentric, so that, when turned with the hand lever, it flattens the metal at the end of the tooth. This swage is usually fixed to a bench for shop service or, with a slightly different frame, can be used when the saw is on the mandrel. The upset swage (fig. 76), battens the point. If the upset is used, the central tongue should be above the point and the point inserted in the slot having convex faces, with the back of the swage held on a line with the back of the tooth. A single blow is struck lightly with a 1-pound hammer. Then, reversing the swage so that the central tongue is still above the point, the tooth is inserted in the slot with straight faces and hammered as before.

After the tooth has been swaged, its sides may be given uniformity by side dressing them with a file mounted on a block (fig. 73). Blunt-end screws that can be adjusted pass through this block to keep the file the required distance from the saw plate; or uniformity can be obtained by using a shaper (fig. 77) to pattern the sides of the swaged area by compressing the sides of the tooth between dies.

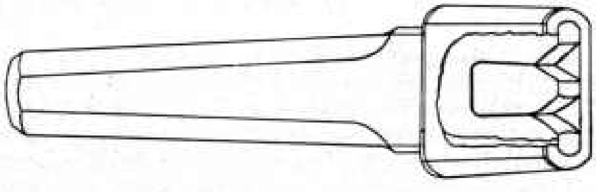

FIGURE 76.—Upset type of swage.

[2] If swaging of inserted points is attempted with the upset swage, the teeth should be held in a discarded plate or section in order to avoid damaging the milled juncture of the plate with the tooth and holder. If the lever type of swage is used, the anvil must be carefully adjusted to avoid gripping the tooth too far back, as the hard points crumble or crack under excessive spreading.

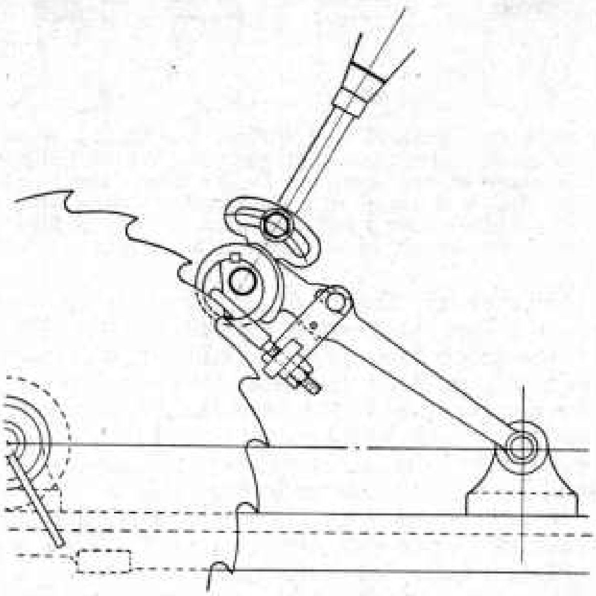

FIGURE 77.—Tooth shaper.

Jointing, which usually follows swaging, is done only to bring all teeth to a true peripheral circle. Before inserted points are jointed, holders and teeth must be tight and in the true plane of the saw. Jointing is done by bringing an emery stone or file against the cutting edge of the revolving saw. The stone, or file, is fixed to a block or base (fig. 73) and is supported by the saw-guide bracket. At first it should engage only the highest teeth; then it is advanced very slowly, until all teeth finally engage.

Gumming is done with a power-driven emery wheel. Usually, provision is made for automatically grinding the desired tooth and gullet shapes progressively around the saw. Instructions as to proper operation and emery-wheel patterns are provided by manufacturers.

In using such an emery wheel, burning of the saw metal must be avoided; that is, the wheel must not be forced against the metal so hard that the metal shows a blue tint. This is avoided by adjusting the emery wheel to grind the gullet lightly at first and not at all directly under the cutting edge; each gullet should be ground this way before proceeding. Then the emery wheel is readjusted to deepen the gullet, and each gullet is ground until the wheel grinds the cutting edge of the tooth and completely around the gullet. Cutting parts of teeth that have been distorted by filing, wear, and swaging should be touched up with a properly adjusted wheel only after the throat and bottom of the gullet have been ground.

Gumming with a round file is not usually practical on headsaws because of the labor involved and the difficulty of maintaining uniformity of tooth shape and spacing.

Inserted points are usually sharpened with a file or emery wheel without removing the saw from the mandrel. Three machines are available for sharpening the saw on the mandrel. One consists of a frame supporting a standard file in a position as in hand filing, uniform surface contact being assured by means of frame supports as the file is pushed across the under face of the tooth (fig. 78). The second consists of a frame that supports a hand-cranked wheel faced with file segments, which can be adjusted to surface the face of the tooth (fig. 79). The third consists of a frame supporting an adjustable emery wheel to surface the face of the teeth. Power is supplied through a flexible shaft, either by hand-cranked gears or a motor (fig. 80). All three machines, when properly adjusted, permit facing the tooth squarely; the emery wheel can be set to grind to a definite tooth spacing.

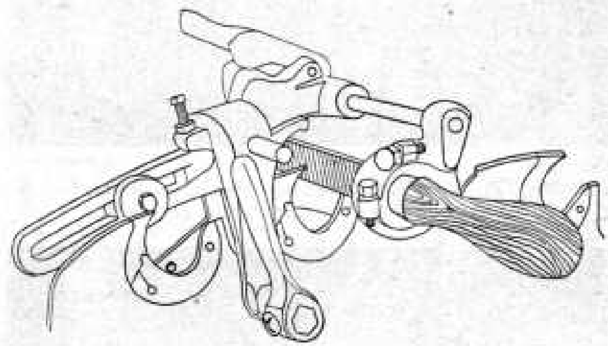

FIGURE 78.—File in frame for sharpening teeth.

In filing by hand, individual skill instead of mechanical guides must be relied on to surface squarely across the underface on the plane, in order to give the desired hook uniformly to each tooth. A round-edge, mill type of file 8 or 10 inches long is recommended. The filer can work at the top of the saw or somewhat back of the top. When filing at the top, he stands on the track side, facing the saw with his shoulders at about 45 degrees to the saw plane. The file is pushed full length straight from the shoulder without dropping the elbows, being held firmly against the face of the tooth by gripping the handle with one hand and the point with the other.

In gaining experience 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, noting the zone of the file face that can be used without touching the throat. Then take about three

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FIGURE 79.—Tooth-sharpening machine using hand-cranked wheel faced with file segments.

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FIGURE 80.—Tooth-sharpening machine with powered emery wheel.

strokes and note results. Figure 81, *A* indicates that the stroke was straight lengthwise of the file but it was not in the same plane as the tooth face. This results in a slanting cutting edge

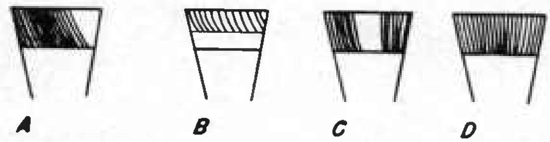

FIGURE 81.—Examples of correct and faulty filing. *A*, Faulty filing; stroke straight lengthwise, but not in plane of saw tooth. *B*, Faulty filing; stroke not parallel with plane of tooth face. *C*, Faulty filing; stroke made with a rolling motion. *D*, Correct filing; file bears equally on all parts of tooth face.

(high corner). Figure 81, *B* indicates that the plane across the file was not parallel with that of the tooth face, which results in decreased hook. Figure 81, *C* indicates that a rolling motion accompanied the trust of the file, aggravating the dullness of a beveled face. Filing should be practiced until consistency is acquired in stroking the full face, as in figure 81, *D*.

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

When filing the back of the saw, the filer usually sits back of the saw and facing the deck, the saw being between the knees. The work is done at about shirt-pocket height. The stroke is parallel with the shoulders and more difficult to hold true than the straight thrust used in filing at the top of the saw.

Filing Circular Crosscut Saws

Trimmer, straight-line cut-off, and slasher saws function by cutting across the grain. Teeth are spring-set except that, in hollow-ground saws occasionally installed for smooth end trimming, no set is used.

Tooth Patterns and Spacing

To maintain teeth of uniform length, spacing (point-to-point distance), and shape, the saw should be jointed, the teeth spring-set and sharpened, and the gullets gummed. Figure 82 illustrates the tooth forms used when cutting is done below or above the mandrel. Tooth spacing is $1\frac{1}{4}$ to $1\frac{3}{4}$ inches. Tooth form *a* shown in figure 82 is developed by dividing the rim into intervals equal to the desired tooth spacing and using each interval as the apex of a triangle having all sides equal. The base of the gullet is rounded out so that the tooth depth is two-thirds the point-to-point distance, and a bevel is given as shown in figure 82.

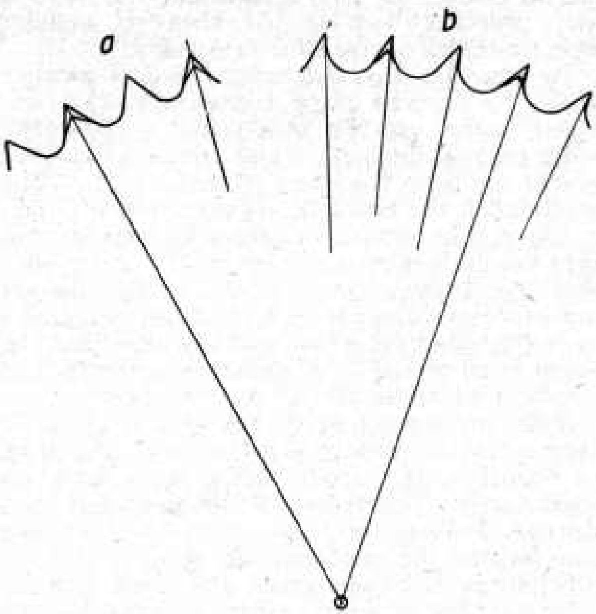

FIGURE 82.—Tooth forms of crosscut saws. Form *a* is used if cutting is done below the mandrel. Form *b* is used if cutting is done above the mandrel.

Crosscut saws are often sharpened, set, and gummed with a power-driven automatic sharpener to insure that the correct shape and spacing of teeth are maintained. Many small mills lack such equipment, however, using files to sharpen and gum teeth. In filing, the guiding considerations are to keep the teeth of uniform length, shape, and spacing. The base of the gullet must be rounded and the face and back of the tooth beveled.

Several varieties of setting equipment are on the market that combine either a hammer-and-anvil or a vise-and-lever action. For straight-line cut-off and trimmer saws, a set of 0.02 or 0.025 inch, and for slab saws 0.03 inch on each side, is suggested. The set should be started not more than 0.2 inch below the point. Uniformity in this point of departure and in amount of set is usually provided for by the mechanism employed.

To sharpen the saw, first file the bevel, preferably with a round-edge file, taking equal amounts from the front and back in order to maintain the correct shape, and height, as well as uniform spacing, of the teeth. The knife edge extends down from the point one-fourth to one-third inch. For slab and straight-line cut-off saws, a bevel of 15° on the front and 10° on the back of the tooth is suggested; for trimmer saws it should be 25° to 30° on the front and 10° to 15° on the back. The guesswork can be eliminated by using a gage cut from heavy tin plate, as shown in figure 83. Between the knife edge and the base of the gullet, the tooth is filed straight across sufficiently to maintain the correct outline, and the base of the gullet is deepened and rounded with a round file. Guidance for uniformity of gullet depth is gained by drawing a circle centered on the eye, with a radius not quite to the base of the gullets.

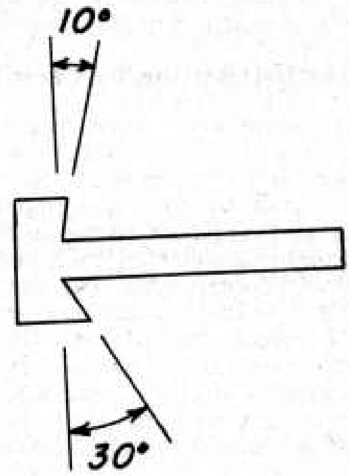

FIGURE 83.—Gage for checking front and back bevel on trimmer saws.

LABOR REQUIREMENTS FOR SMALL SAWMILLS

For any given tree species, the number of man-hours required per thousand board feet of lumber produced generally increases with mill capacity. Table 12, based on detailed Forest Products Laboratory studies of several operations involving small mills of varying size, shows the variation in the man-hours per thousand board feet and in working force from pond or log yard through the back of the mill.

The relatively low number of man-hours per thousand board feet given in table 12 for western species is largely due to the larger log sizes and greater mill power which are prevalent in the West, that for the eastern white pine to less complete manufacture (round-edged lumber).

The usual positions for members of crews of various sizes for circular-headsaw mills is

TABLE 12.—*Mill labor required to produce 1,000 board feet of lumber*

Species	Labor per thousand board feet		Number of mill employees [1]
	Range	Average	
	Man-hours	*Man-hours*	
Ponderosa pine, redwood, Douglas-fir	2.4 to 5.2	3.9	6 to 26
Eastern white pine	3.5 to 5.5	4.5	2 to 8
Eastern hardwoods	3.3 to 11.7	6.8	4 to 10
Southern pine	5.2 to 10.3	7.5	6 to 10

[1] Includes pond men and stackers.

shown in table 13. The fireman of a steam mill is not included. Variations from this general scheme of manpower placement are common. Where logs are delivered directly to the deck, the manpower for log yard or pond is not needed. Mills using the horizontal edger dispense with the edgerman and tail edger but use a tail sawyer. Mills with deck and carriage controls handled by the sawyer dispense with dogger and setter. If band headsaws are used, a saw filer becomes essential for any size of crew.

Work Distribution by Crew Size

On the two-man crew units, the sawyer and tail sawyer fill the deck with logs, then saw them. If edging is done on the headsaw, the tail sawyer lays aside boards to be edged and piles edged ones and slabs on racks or dollies. Unedged stock can be collected back of the saw on about 30 feet of dead rolls, and accumulations can be loaded onto the carriage and brought back to the deck for edging. By a second method, the tail sawyer pushes the unedged boards toward the deck, making a pile supported by a fence over the husk. By a third method, the stock is not sawed completely free from the log but is returned to the deck in reversing the carriage and then pulled from the log. This is poor practice, because the shearing usually leaves a faulty surface for reworking.

To edge on the headsaw, the tail sawyer helps the sawyer place the accumulated unedged boards on the headblocks, placing the wider ones on the bottom and setting successive boards out from the knees, so that the saw line will take off the required edging. After one side is edged, the bundle of boards is flopped over onto the deck skids and repiled, the wider ones again being placed on the bottom. This second saw line determines the width of the board, and for softwoods a ruler is useful to insure that the board is so placed as to result in a product of standard width as well as square edges.

If the mill has an edger, unedged stock is set aside until the deck of logs is sawed. For such an operation the edger should be spaced approximately 6 feet from the rolls to permit such storage. The sawyer helps the tail sawyer, one man feeding the edger and the other piling out.

On three-man crew units, the third man divides his time between yarding logs to the deck and taking lumber and slabs from the back of the mill to the yard. Edging is usually done on the headsaw. In operations delivering logs directly to the deck, however, an edger can be used to advantage, the third man acting as a tail edgerman and piling lumber and slabs onto racks or trams.

On four-man crew units, the log yarder can usually also transport lumber and slabs to the yard.

With a five-man crew, the fifth man helps the tail edgerman pile out lumber and slabs. He may also operate a cut-off saw on either lumber or slabs.

With a six-man crew, the sixth man is the decker, rolling and turning logs and dogging all but the front dog, this being done by the sawyer.

TABLE 13.—*General assignment of positions for crews of various sizes at a circular-headsaw mill*

Number of workmen	Log yard or pond	Decker	Setter	Sawyer	Tail sawyer	Edgerman	Tail edgerman	Cut-off sawyer	Trimmer	Pile-out men	Saw filer	Night watch	Millwright
2				1	1								
3	1			1	1								
4	1			1		1	1						
5	1			1		1	1			1			
6	1	1		1		1	1			1			
7	1	1	1	1		1	1			1			
8	1	1	1	1		1	1		1	1			
9	2	1	1	1		1	1		1	1			
10	2	1	1	1		1	1		1	2			
11	2	1	1	1		1	1		1	2	1		
16	2	1	1	1		1	1	1	1	3	1	1	1

With a seven-man crew, the seventh man is usually placed as setter on the carriage. He may also operate one or more dogs. The sawyer does not operate the dogs, but the decker may help the setter.

With an eight-man crew, the eighth man operates the trimmer, usually a two-saw machine.

With crews larger than eight men, the additional members are needed to provide logs to the deck or pile out lumber at the rear of the mill. Special service men—filers, millwrights, night watchmen—are added about as indicated in table 13, and in the larger small-mill units the edgerman is relieved of taking boards behind the headsaw by a tail sawyer, and a cut-off saw operator is used together with the trim-saw operator.

MILL LAYOUT

Efficient mill layout has much to do with successful sawmill operation. It has a direct bearing on such time-consuming jobs as the handling and piling of logs and lumber and the disposal of refuse. Basic to a well-laid-out mill is the choice of mill site. This, in turn, is governed largely by the size and type of mill.

When small portable mills are moved to the timber, the mill site is preferably located where the logs can be brought to it most cheaply. Usually this will be where the log haul is shortest and uphill hauling is at a minimum. A further requirement is that the lumber outhaul be feasible. Within this frame the site is chosen with an eye toward minimizing the work of leveling up the mill and providing a suitable log and lumber yard. Beyond avoidance of rocky, stumpy, wet, hummocky, or very steep sites, local conditions may be advantageously utilized to varying degrees. Steam-powered mills must tap water supplies. Those using hand-pushed trams to the lumber yard should be so located as to permit a level or slightly down-grade tram line; a slightly down-grade slope from log dump to track is also favored. A steep down slope on the track side of the mill aids in slab and sawdust disposal.

Permanent and semipermanent small mills are usually located at points where favorable living conditions for labor are combined with good shipping facilities or local outlets for the products, including so-called wastes. Local considerations may be the relative cost of the site, taxes, convenience to labor supply, access to a railroad siding, public roads, or water transportation, and ample space for log and lumber yards.

Log Yards and Ponds

Small mills try to balance log deliveries in such a way that the highest possible proportion will be unloaded directly on deck, in order to save pick-up costs. The deck skids extend back from the carriage tracks about 20 feet to a gap for the delivery road, then continue for another 20 feet.

If logs must be yarded, the simplest way is to unload them directly on the ground, rarely piling them higher than the bunk of the transporting vehicle. Logs are seldom segregated by species or other characteristic. A space approximately 3 feet is allowed between the ends of the longer logs of adjoining piles, and the unloading faces of a series of piles are kept abreast, so as to be accessible for subsequent loads. Poles supporting the logs hinder the movement of vehicles bringing logs to the dumping point or subsequently transporting them to the mill deck, and are not normally used.

Equipment of the types shown in figures 84 and 85 is often used to pick logs off the ground. Mill operators and loggers have developed various other machines for this general purpose.[3] Where the truck derrick (fig. 86) is used, poles expedite the loading of logs, the vehicle backing between the poles. They are placed about 7 feet apart and are sunk into the ground to elevate the bottom logs about 6 inches off the ground.

About 300,000 board feet per acre can be stored in piles averaging 5 feet in height.

At permanent mills these and other methods are used. A system of skids that spills logs onto a tram car can be installed (fig. 87), a derrick can be erected for bunching the logs in high piles (fig. 88), or the logs can be stored in water.

Streams, lakes, and ponds can be used for logs that float, and large quantities may thus be held for a year or more without serious degrade. About 150,000 board feet can be floated per acre.

Relatively small ponds holding but a few hours' supply are used for species that sink as well as for floaters. The purposes of this ponding are to wash grit and abrasives from the logs, thaw frozen logs, and provide a practical means of separating and feeding logs to the

[3] Results of a continuing survey of woods and mill handling equipment by the Forest Products Laboratory are available to mill operators as published in the Laboratory's Equipment Survey Notes, which are issued from time to time.

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FIGURE 84.—Tractor with rack for yarding logs.

mill. Such ponds are either blocked off from larger water bodies or are constructed at the mill site. The conditions sought, in addition to stable water levels, are a pond width permitting all logs to be reached from the margin with long pike poles, a depth limited to adequate log floatage, and a length to contain the required log volume. For logs not more than 16 feet in length, a 20-foot width, a 5-foot depth, and a length of between 50 and 150 feet are suggested. The sides are vertical and are stabilized by cribbing, planking, or concrete. A spillway that safely carries off excess water can be built of timbers or concrete, and gates or outlet pipes are provided for draining when cleaning is required. In the northern States, ponds are maintained above freezing temperatures by diverting exhaust steam into them; or cold water is pumped from the pond over pipes or tanks heated by the refuse burner, and then returned to the pond.

The dump ramp extends along one side of the pond, and a dry-storage ramp can be built at the opposite side. The storage ramp is a duplicate of that shown for use with a track and tram car (fig. 87). Capacity is increased if the road along the outer edge of the ramp is elevated.

Logs are conveyed from pond to deck by means of trams, conveyor chains, or sling chains. Cable-pulled trams operate on inclined tracks that are extended under the surface of the pond, so that logs can be floated onto the car bunks. Conveyor chains transporting the log lengthwise consist of heavy links 8 inches long, made of iron 1 inch thick, to which are attached log dogs at intervals of 4 feet. The chain runs in a trough and extends from slightly below the surface of the pond to the back end of the deck. A less expensive device suited to small-mill production rates employs a jackladder to hoist logs sidewise (fig. 89).

Another device employs sling chains about 8 feet apart having links about 4 inches long. The pond slip is extended opposite and parallel to the deck. One end of each chain is anchored to the deck and the other is fastened to a shaft above deck level. Chains of ample length are used to provide a sling reaching below water level. The shaft is powered by a friction wheel (fig. 90). A log is floated endwise over the slings and hoisted to the deck when the shaft is rotated. When the friction wheel is disengaged, the sling drops back to receive another log.

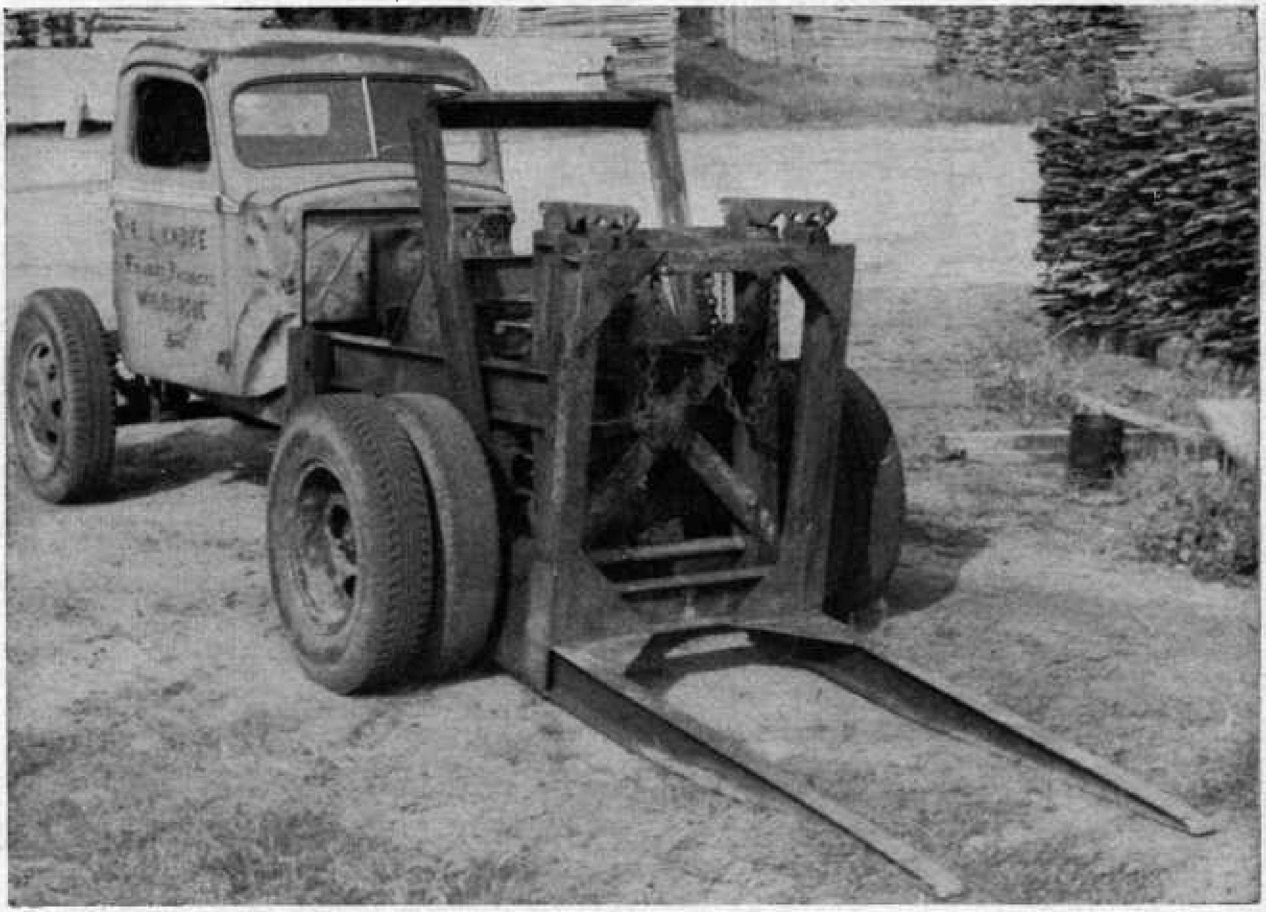

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FIGURE 85.—Truck with lift arms for yarding logs.

Lumber Yard Layout

Green lumber, unless treated with chemical fungicides and insecticides, cannot be kept long without seriously deteriorating, principally in the sapwood. The speed and extent of deterioration depend largely on temperature, because fungi and insects are active during warm weather, less active during cool weather, and dormant in extreme cold. When wood falls below 20 percent in moisture content, fungi cannot develop, and it is less attractive to most insects. Consequently one way to avoid fungus and insect attack is to dry the lumber quickly, particularly the surfaces, to a moisture content below 20 percent.

The product of small sawmills is seldom kiln dried; seasoning is done, if at all, in an air-drying yard. The yard should be easily accessible from the mill, on ground suitable for hauling and pile foundations, and open to air currents for lumber drying. Good air circulation and soil drainage, a soil that drains quickly, and a level or slightly rolling surface are essential to meet these needs. Uneven or steeply sloping surfaces require excessive cribbing for pile foundations and grading for roads.

The ground should be kept free from debris and vegetation. Debris harbors fungi and insects and interferes with air movement. Vegetation restricts air movement over the ground surface and from beneath the lumber piles. When the vegetation becomes dry it creates a fire hazard. Vegetation can be kept in check by cutting, or can be killed with chemical weed killers.

A road or an 8-foot fire line around the margin of the yard is kept cleared of vegetation as a check against encroaching fires. Where organized fire protection is not available, water barrels and buckets should be placed according to a planned pattern; for example, at the beginning and end of every fourth row. Adding 3 2/5 pounds of calcium chloride per gallon

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FIGURE 86.—Truck derrick for yarding logs.

will prevent freezing of water at temperatures down to -20°F.

In general, yard layout should provide for wide alleys and ample space between piles to insure good air circulation and adequate room for handling and hauling lumber. Main alleys should be 16 feet wide for motor truck or dolly hauling and hand stacking, or 30 feet wide for fork-lift truck hauling and piling. The spacing between main alleys for hand-stacked piles is twice the length of a pile plus a rear alley of 6 feet or so, making a total of about 38 feet. With unit-package piles, stacked by fork-lift truck, the space between main alleys is optional, depending on the number and width of the piles in the rows and the space between them. Cross alleys should be 16 feet wide for motor truck or dolly hauling, or 30 feet wide for fork-lift truck hauling, and spaced about 100 feet apart to give ready access to main alleys leading to all points in the yard.

For hand stacking, it is suggested that the piles be 6 feet wide and about 10 feet high, with a space of about 2½ feet between the piles. Unit packages for yard drying are generally about 4 feet wide, and are stacked three to five units high. A space of about 2 feet should be left between the piles of unit packages in a row, and 3 to 4 feet between rows.

Piling and Sorting Lumber for Air Drying

The degree to which it is practical to improve air-drying practice varies from mill to mill. In general, the larger the mill, the more exacting its practices, such as piling of stock according to species, grade, thickness, length, and width. Permanent mills can also do more in the way of improving drainage, grading, and pile foundations.[4]

The total number of piles necessary for a given operation depends, of course, on production rates and seasoning time allowed, as well as on sales. The total number of piles open, or in the process of building, at one time depends mainly on how closely the lumber is segregated

[4] Mathewson, J. S. The Air Seasoning of Wood. U. S. Dept. Agr. Tech. Bul. No. 174, 56 pp., illus. 1930.

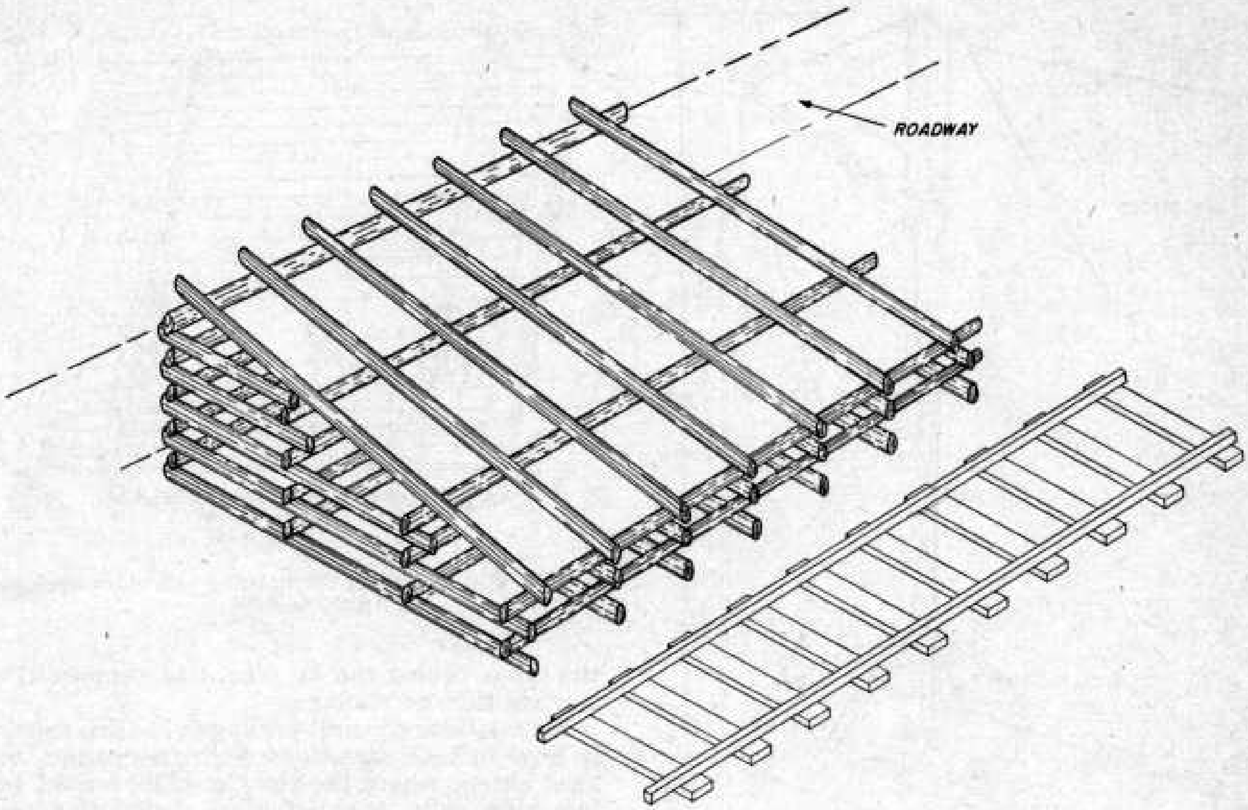

FIGURE 87.—Skids and trackway for yarding logs.

according to species, size, and grade. Inventory and shipping are benefited by putting in a separate pile each item that has a different market rating, but piling costs and exposure degrade are thereby increased.

Each operator must determine the degree of segregation he can afford to follow. Different thicknesses are, in general, separately piled. Different species are separately piled if sold on a species basis. Hardwoods of different lengths and widths are usually placed in the same pile and may be separated according to grade. A common practice at small hardwood mills is to pile No. 1 Common and better separately from No. 2 Common and poorer.

Small mills cutting softwoods often separate stock by width, except that the 3–, 4–, and 5–inch stock is piled together; and at least partially according to length and thickness. Rarely is softwood lumber piled according to grade. One practical method for softwoods is to place the 8–, 14–, and 16–foot lengths in one pile, and the 10– and 12–foot lengths in another, thus making so-called "sorted-length" piles. Grade separation can be practiced to some extent for softwood yarding at small mills by box piling the high-grade items, putting all lengths and widths of a given upper grade group in one pile, and piling the lower-grade material separately according to width and length.

Labeling of piles as to contents helps in identification and inventories. It can be done by surfacing a sticker edge with a knife and writing with a soft crayon the pile number, species, item (width, thickness, and grade), piling data, and footage, thus: No. 65 ash – 4/4 No. 2 Common – 3/5/50 – 3,240. The footage is an estimate made either when the pile is completed or at the first inventory afterward.

Pile Foundations

The foundations should be mechanically strong, and sufficient to raise the first course of lumber at least 18 inches from the ground. Piers, posts, or blocks make a more satisfactory foundation support than cribbing, because the foundation is more open for air movement beneath the pile. For permanent yards, piers of concrete, masonry, or posts that are of a decay-resistant species or pressure-treated with a

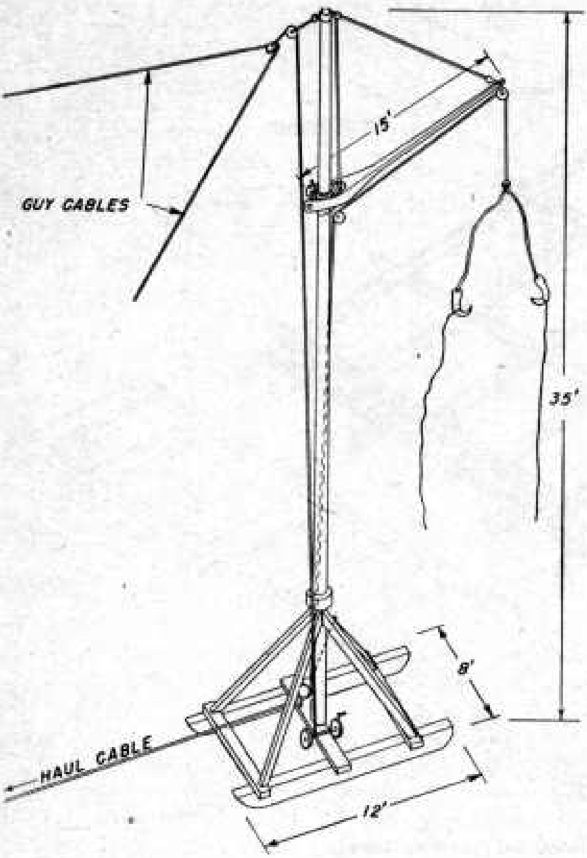

FIGURE 88.—Derrick or jammer for high-piling logs.

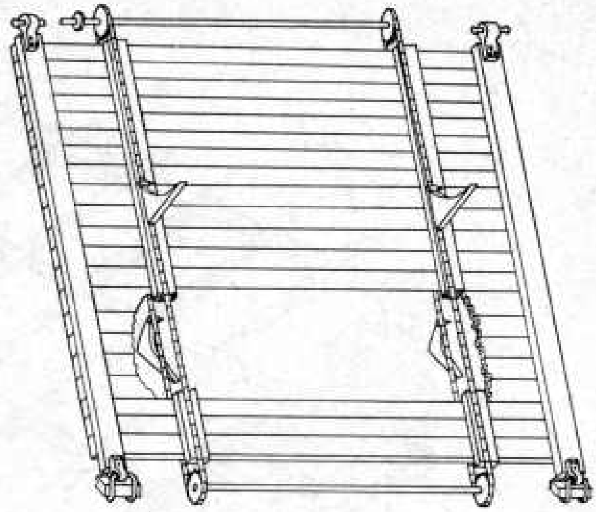

FIGURE 89.—Jackladder for hoisting logs sidewise from pond to deck.

preservative, make excellent supports. Piers or posts set into the ground should extend below the frost line. Posts or blocks may rest on sleepers or mud sills placed on the ground surface. At portable operations a reasonably sound log of low value can be cut into sections to provide posts or blocks. The tops of each pair of supports should be surfaced or cut so that they are on a level, and are on a slope of 1 inch to the foot or on a level in a lengthwise direction.

The rest of the foundation consists of stringers and cross beams, or of cross beams only (fig. 91). Stringers, generally 6 by 8 inches in dimension laid on edge, are placed on the tops of the piers, posts, or blocks (See fig. 93, *A*). The stringers run lengthwise of the pile and follow the slope. Cross beams, generally 4 by 4 or 4 by 6 inches in dimension, are laid on the stringers, or on the top of the piers, posts, or blocks, where stringers are absent. Where stringers are used the number of piers, posts, or blocks can be reduced. Stringers also permit more flexibility in the positioning of the cross beams, so that with piles of different lengths, the cross beams can be placed to support the vertical tiers of stickers.

Foundations for unit-package piles are usually level in both directions. Stringers cannot be used except where the rows of piles consist of two piles only. A satisfactory foundation for unit-package piles consists of cross beams, 4 feet apart, supported by piers, posts, or blocks; a central 8-foot space is left clear for the entrance and exit of the fork-lift truck by omitting the central cross beam. A removable and replaceable device carrying a cross beam or its equivalent should be used to support the center of the pile (fig. 92). This support is put in place when the particular pile is made, but is removed to allow the fork-lift truck to approach piles nearer the center of the row. Such a support may be a sawhorse or a cross beam with legs.

Pile Construction

For air drying, it is almost universal practice to pile stock flat, so that most of the weight bears on the wide faces, not on the edges or ends. A flat pile may be level both crosswise and lengthwise, or level crosswise and sloped lengthwise. With this method of piling the drying rate is relatively slow, but the weight of the pile tends to keep the stock from warping. It is therefore suited to species that are likely to check or warp, and less suited to species that are likely to suffer from sap stain. Flat piles may be hand stacked, in a continuous pile, from bottom to top, or may be made up of several unit packages separated by bolsters. Hand-

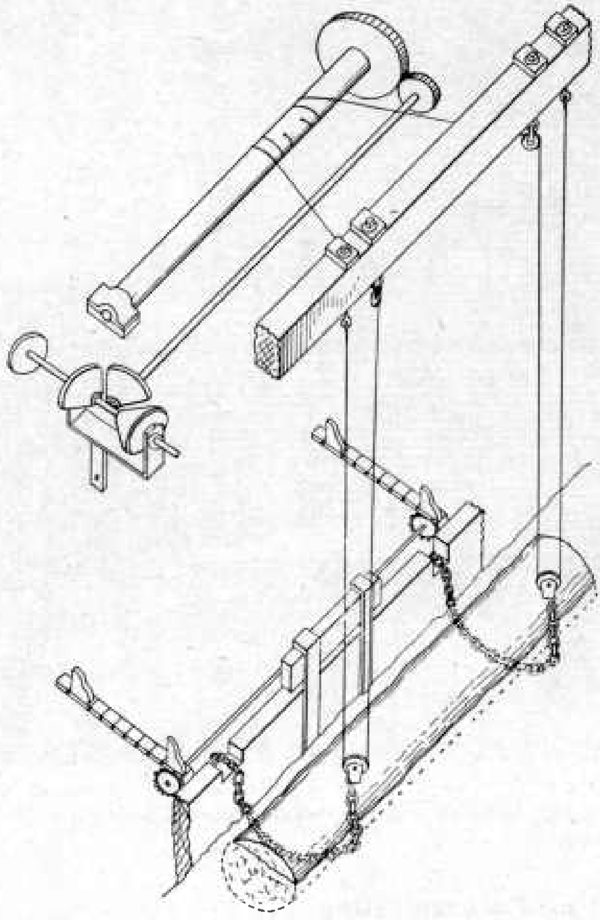

FIGURE 90.—Sling-chain log hoist from pond to deck.

FIGURE 91.—Box pile of random-length hardwoods, supported on sections of logs and cross beams.

stacked piles may be square at both ends, such as a box or sorted-length pile, or the board ends may project or overhang at the rear or at both ends. To prevent excessive warp, it is desirable either to sort for length or to box pile so as to eliminate overhanging ends.

For lumber that is susceptible to sap stain, special piling methods that promote rapid partial drying are sometimes used. These are known as end piling, end racking, and crib piling. Each of the methods is described in a later section of this manual.

To obtain rapid drying with end piling, wide spaces should be left between boards. End piling, though easily done by one man, causes nonuniform drying from top to bottom, and severe end checking and surface checking in the upper parts of the boards, particularly in thick stock. End racking causes rapid drying, with excessive checking and warping if the drying is allowed to progress very far, but is suitable for fast partial drying for such purposes as getting the stock dry enough to prevent blue stain; thereafter the stock should be flat piled to minimize checking and warping. End-racked boards, however, are likely to blue stain where they cross. Crib piling also induces fast drying, and is therefore useful for partial drying but may result in excessive stain where the boards cross, as well as warping.

Sorted-Length Piling

Sorted-length piling, which closely resembles box piling, is suggested for softwoods. To make such a pile, lay a sticker over each cross beam and place the first course of boards so that the front end of each board is flush with the front edge of this sticker. Space the boards in this course 2 to 3 inches apart; if two or more lengths are included in the same pile, place the longest ones in the outside tiers, and interspace other long ones regularly in the course to give a well-supported pile. Succeeding courses duplicate the first, or base course.

The front of the pile should pitch toward the main alley, 1 inch to the foot of height. Each tier of stickers should be alined parallel to the front one. Stickers within a tier should be directly above one another except for the slight progressive offset required to follow the pitch of the pile. The front of the pile should be free of projecting ends that would catch water and cause it to flow into the pile. If the boards are

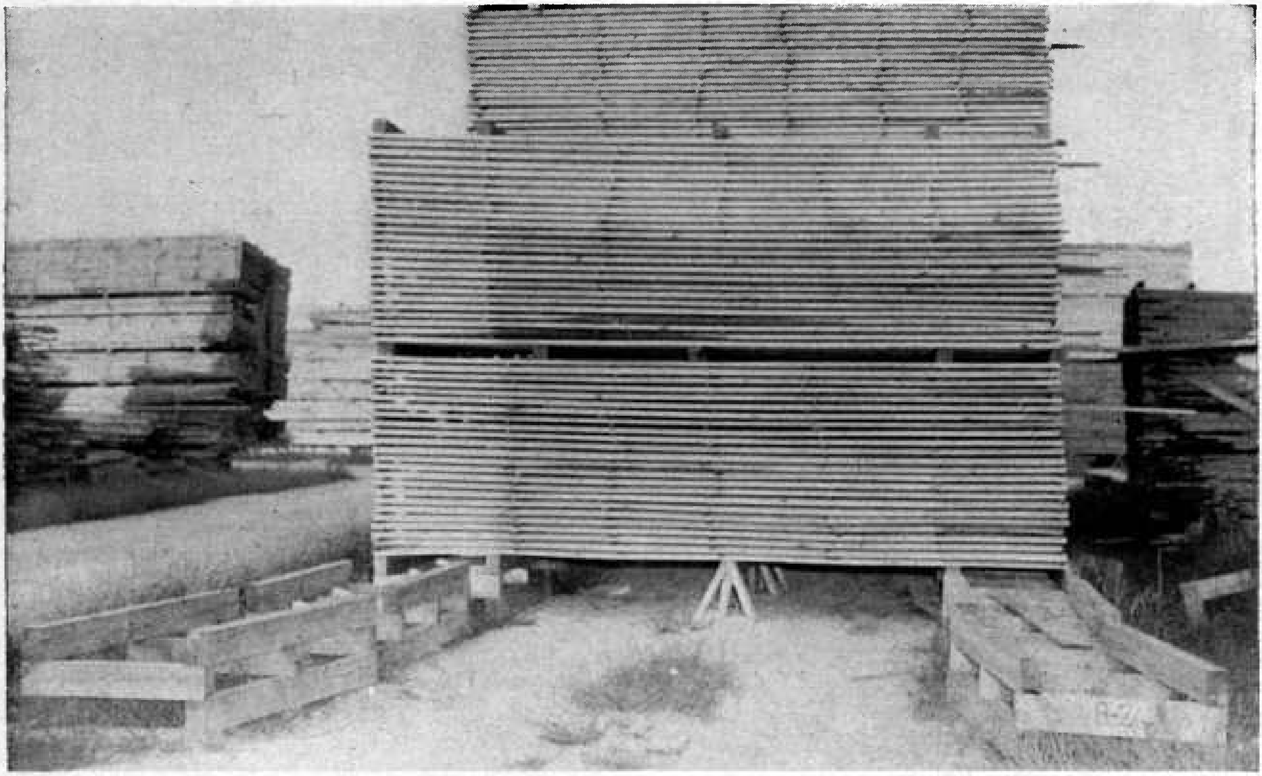

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FIGURE 92.—Unit-package pile foundation, consisting of a central support and two benches across which are laid cross beams.

of uniform lengths and the piling has been well done, the rear of the pile will also be free of projecting ends.

Box Piling

Box piling is suggested for hardwoods. To make a box pile, lay a sticker over each foundation cross beam and place a full-length board in each of the outside tiers. If enough stock is available for more than two full-length boards to the course, intersperse long boards regularly in the course. Place shorter boards in the inside tiers, with their ends alternately flush with the front and back of the pile. Each tier is approximately 12 inches in width; thus it can contain an 8- and a 4-inch board, or two 6-inch boards. One end of each board can rest on the sticker at either end of the pile (fig. 93). Tiers should be truly vertical, 4 to 6 inches apart. The front of the pile should be given a pitch of 1 inch per foot of height. This method of piling results in vertical flues that allow a free downward air flow from the top to the bottom of the pile. Both ends of the pile should be square, with no projecting board ends.

Unit-Package Piling

Unit-package piles are composed of 3 to 5 unit packages, placed by fork-lift truck. The unit packages are made up at the rear of the mill, using methods similar to those recommended for flat piling. They are hauled to the yard by fork-lift truck and built into piles (fig. 94). Good sticker alinement and uniform spacing are essential in unit packages of lumber, in order that good alinement of cross beams, bolsters, and tiers of stickers can be attained in the yard pile of unit packages. Piles of unit packages do not ordinarily have either slope or pitch.

Stickers

Stickers are used to separate the courses of lumber in piles. "Stock" stickers are narrow boards of the same lumber as the pile. Such piles are commonly called "self-stickered." Self stickering may be justified with low-value lumber, where degrade suffered through staining and checking is not important. "Special" stickers for lumber up to 8/4 in thickness are gen-

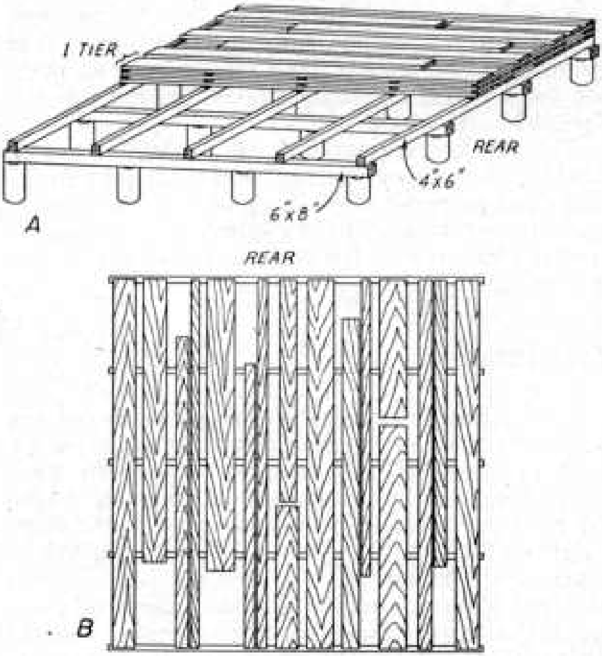

FIGURE 93.—Method of placing boards in box piling. *A*, Method of laying up on foundation; *B*, top view showing board placement according to length.

FIGURE 94.—Building a unit-package pile with a fork-lift truck.

erally made of nominal 1-inch stock, rough or dressed. Stickers for thicker lumber may be about 1½ inches thick. Special stickers for hardwoods are generally about 1 inch thick by 1½ to 2 inches wide, and for softwoods 1 by 2 or more inches. Special stickers should preferably be of air-dry heartwood. At small portable mills, edgings that have been air dried provide relatively cheap and satisfactory stickers. Stickering of unit packages of lumber follows the same rules as stickering of hand-stacked piles, except that the narrow width of the packages rules out the use of stock for stickers.

Pile Roofs

If yard piles are not roofed the upper courses of lumber are likely to deteriorate enough to cause a drop in grade and hence value. The roof should protect the pile from sunshine and precipitation and should be reasonably tight. A common type of pile roof is one composed of a double layer of low-grade boards. The roof should be pitched so that most of the water will run to the rear end and drip off. If the lumber pile slopes 1 inch per foot from front to rear, the pitch of the roof can follow the slope of the pile. If the pile is not sloped, the roof should be supported so as to obtain the required pitch.

For a sloped pile the front roof support can be made by placing three 2 by 4's laid flatwise, with the center and rear supports made up of two 2 by 4's. A double layer of boards is laid on the center and rear supports, with the boards of the upper layer overlapping those in the lower layer. This procedure is repeated for the front part, allowing this part of the roof to overlap the rear portion. The roof should project beyond the pile, about 1 foot at the front and 2½ feet at the rear. In windy regions, tie pieces wired to the pile should be placed at the front, center, and rear, to keep the roof boards from blowing off.

End Piling

Lumber piled on end is equivalent to an up-ended flat pile. Boards for end piling should be grouped according to length. With random-width stock, like widths should be placed in the same row, or up-ended tier. In its simplest form, end piling requires a floor, a central rack, and strips or some other device to support the stickers (fig. 95, *A*).

The stickers must be placed and held until the two outer boards of a course are placed. Strips for supporting stickers can be dispensed with if the piler is provided with a sticker holder, consisting of a handle adequate to reach the height desired for placing the sticker, and one or more cross arms each approximately 3 feet long. The sticker resting on the cross arm as easily boosted into place. Then, while the handle end of the tool is supported on the base, the piler places the outside boards of the next course against the sticker, thus permitting removal of the holder.

The floors should be of latticed construction and should support the lumber at least a foot above the ground. The central rack should be sturdy. Piles are generally built up in two directions from the rack, but occasionally in one direction only. The piles are usually about 10 feet wide, 75 to 100 feet long, with an 8-inch space between the rows of boards.

End Racking

In end racking, two rows of boards placed on end are crossed like an X, or preferably form an inverted V (fig. 95, *B*). The boards are supported by a ridge pole, and the lower ends should be supported about a foot above the ground. If the boards are to be crossed at their top ends, different racks will be needed for different length stock.

The stock dries rapidly, and 3 to 15 days of drying, depending on the weather, should be sufficient to prevent staining. After this period the lumber should be flat-piled or shipped, to prevent excessive checking and warping in the end-racked pile.

Crib Piling

Crib piling, used by some small mills cutting southern pine, eliminates foundations, stickers, and pile roofs, but requires excessive yard space. Separate piles are made for each length by cribbing three tiers in the form of a triangle (fig. 96). The first plank rests on supports at each end; one end of the second plank crosses the first above a support and the other end rests upon the third support of the triangle; and the third plank closes the triangle. In succeeding

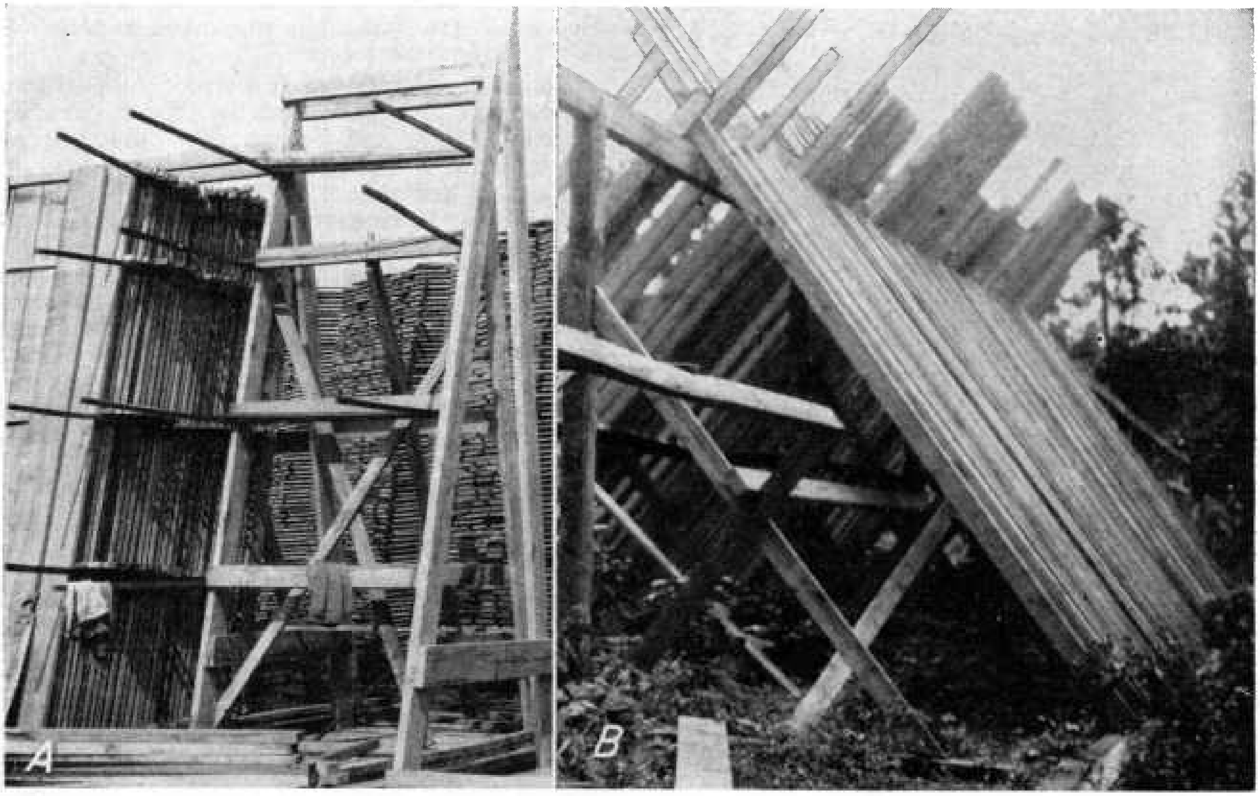

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FIGURE 95.—Supports for *A*, end piling and *B*, end racking.

courses this crib rack is carried to a height convenient for one-man stacking. The drying rate is like that of end-racked lumber, and if excessive checking and warping are to be avoided the cribbed lumber should be taken down and flat-piled after 3 to 15 days.

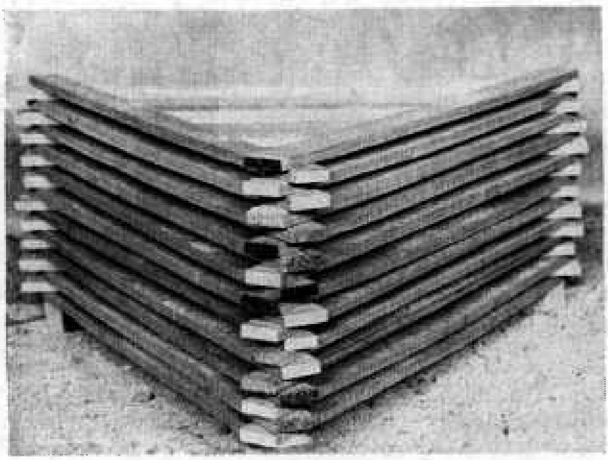

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FIGURE 96.—Crib piling.

Refinements in Flat-Piling Practice

In flat piles the drying rate and consequent degrade by blue stain, decay, checking, and warping are likely to vary with the location of the pile, the species of wood, and the season. Therefore, where there is need to reduce checking, warping, blue stain, or decay, the following refinements in piling practice may profitably be considered.

To reduce checking—
- Lower the foundations; decrease the spacing between boards and between piles.
- Use thinner, narrow stickers. Place end stickers so that they project beyond ends of pile.
- Use end coatings.
- Use sun and wind shield.

To reduce warping—
- Use a sufficient number of stickers, of uniform thickness, properly alined and supported.

To reduce blue stain and decay—
- Occurring throughout the pile:
  - Raise the foundations; increase the spacing between boards and between piles.
  - Provide one central flared chimney or a series of narrow chimneys.[1]
  - Narrow the piles.[1]
- Occurring in lower part of pile only:
  - Provide short chimneys 1/3 or 1/2 height of pile.[1]
  - Use thicker stickers in lower part of pile only.

[1] Does not apply to piles less than 6 feet wide.

Dipping Tanks

Treatment of green lumber against blue, or sap, stain sometimes includes passing the material through a spray of the chemical solution, but the usual method is to dip the stock in the solution. Figures 97 and 98 show details of two kinds of dipping tanks.

The gravity dip tank shown in figure 97 is placed alongside the rolls and immediately beyond the swing-trim saw. Boards to be dipped are started down the inclined skids by the trim-saw operator. The slope and length of the skids are such that the boards being tipped off the rolls push the boards farther along through the liquid and up the discharging side. Excess liquid drains off the board and into the tank as the board emerges and before it drops to the skids at the discharging side.

The conveyor-chain type (fig. 98) is usually so placed that the lumber is conveyed through the tank and to the sorter chain. Power for driving the conveyor lugged chains, when applied to the sprockets on the shaft at the entering side of the tank, insures, together with the rider wheels, that the chain and conveyed material will be submerged.

Strap iron 3 inches wide is fastened to the tank under the chains to prevent excessive wear. The tank is floored with a double layer of 1 by 6 tongued-and-grooved material staggered so that the tongue and groove of one layer centers the board of the other layer. The rider wheels (iron pulleys) are on a hinged frame supported above the tank (fig. 98).

Least waste of liquid results when the speed of the chain is the minimum required to move the stock; 30 feet per minute is suggested for mills with a capacity up to 2,000 board feet per hour. Approximately 130 gallons of liquid will suffice to keep the dip to the level shown, and the tank should have outlets permitting draining and cleaning. A mixing tank of at least 50-gallon capacity and a shelter complete the equipment.

End Coatings

Since wood dries faster from the end grain than from the side grain, some kinds of wood, especially in thick sizes, may check and split at the ends during air seasoning. For this reason

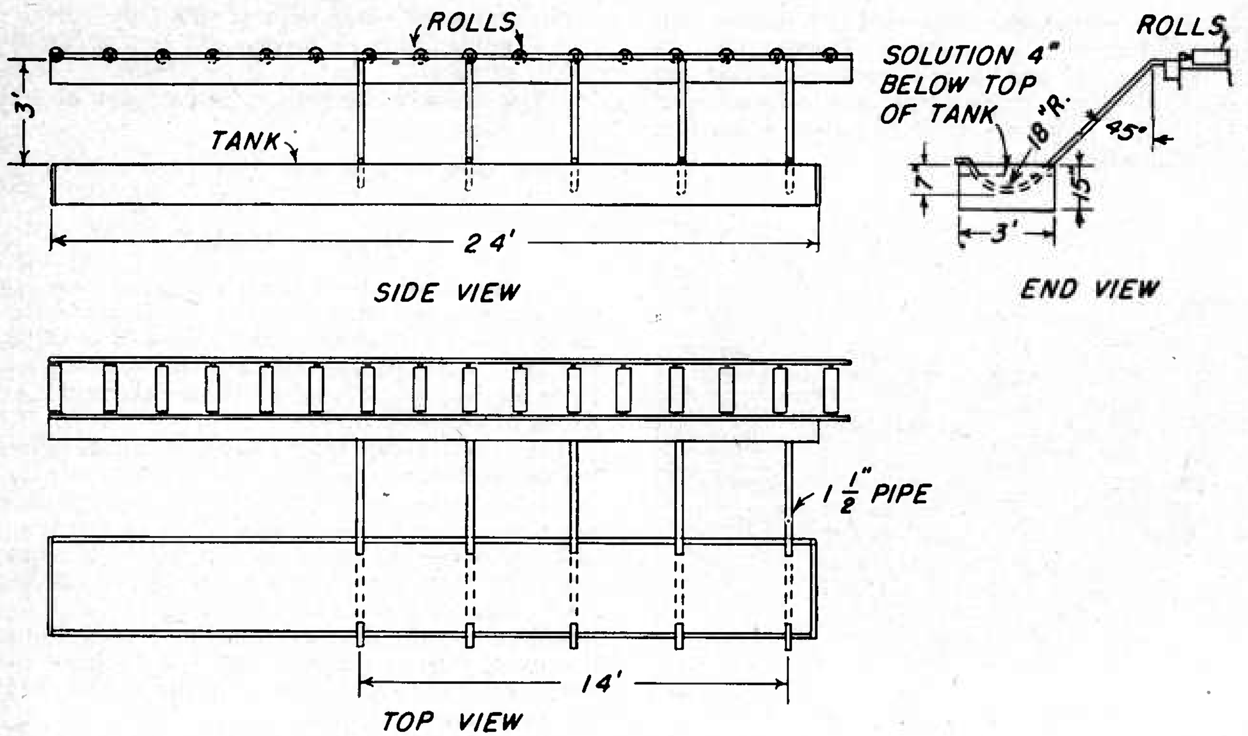

FIGURE 97.—Gravity dip tank.

it is often advisable to coat the ends with a moisture-resistant end coating when wood is being seasoned.

Some coatings are liquid at ordinary air temperatures and can be applied cold. Others are solid at ordinary temperatures and must be heated before being applied. Either hot or cold coatings are effective for drying temperatures up to 140°F., but for temperatures between 140° and 170°F. hot coatings should be used.

Two good cold coatings are hardened gloss oil thickened with barium sulfate and magnesium silicate (very cheap), and high-grade spar varnish and barium sulfate (expensive).

The gloss oil should be of a thick grade, made up (by a paint manufacturer) of about 8 parts by weight of quick lime, 100 parts of rosin, and 57.5 parts of mineral spirits. To 100 parts of the gloss oil, 25 parts barium sulfate and 25 parts of magnesium silicate are added. One or two parts of lampblack can be added if a black coating is desired. Any paint manufacturer can make this coating, or the user can mix it as needed, if the proper grade of gloss oil is at hand. Some gloss oils have little moisture resistance, and it is therefore necessary that the coating be made up according to the formula given above.

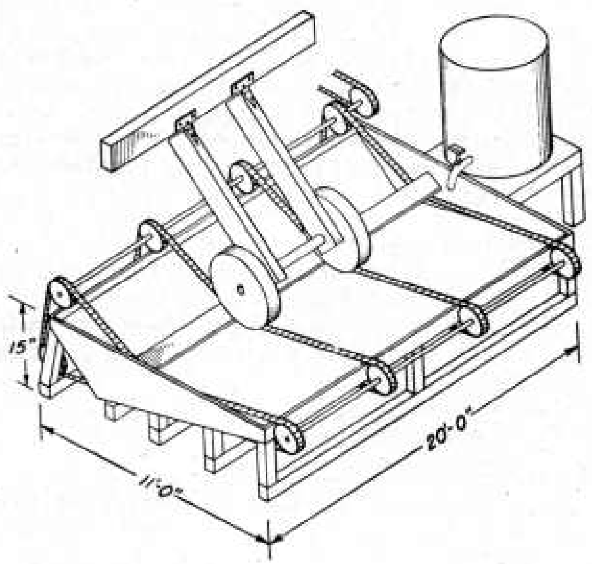

FIGURE 98.—Conveyor-chain dip tank.

Paraffin, at 150°F., is a satisfactory hot coating for use on material that is to be air seasoned, but its melting point is too low for use on stock to be kiln-dried. Other hot coatings are:

60 parts by weight of 213°F. coal-tar pitch mixed with 25 parts of 155°F. coal-tar pitch and 15 parts of 225°–235°F. asphalt; or 7 parts of lampblack mixed with 100 parts of rosin. Hot coatings can be applied by dipping the ends of the stock ½ inch into the hot material or by holding the ends against a power-driven roller party submerged in the coating.

SAMPLE PLANS OF MILL LAYOUTS

In the following sections sample mill layouts are presented for circular headsaw mills of unsheltered, temporarily sheltered, semi-permanent types. The smaller band mills may be housed in a one-story structure based at ground level by using a pit, but preferred practice calls for a rigidly supported structure well above ground level.

Wheel-mounted mills require so little site preparation that they usually can be economically operated for as little as 5,000 board feet at a set. The problem is less one of mill setting than of slab, sawdust, and lumber disposal. Some types of such mills are stabilized in working position by means of jacks; others require no supports other than for the truck wheels.

Detailed instructions on fixing parts together for efficient operation are outlined in the discussion of plan 1 that follows, and can be followed in using the layouts described for plans 2 through 5. Obviously, modification of such instructions or of plan details will be required to meet special needs or conditions.

Setting Up an Unsheltered Ground Mill According to Plan 1

Operators cutting up to 200,000 board feet at a set customarily put the mill directly on the ground and provide little or no shelter. This type of mill is shown in plan 1 (fig. 99).

The three essentials in setting up a ground mill are:

1. The mandrel must be level.
2. Log-carriage track must be at right angles to the mandrel, leveled so that the tops of carriage bunks are horizontal, and so bedded that carriage headblocks clear the saw by ½ to ¾ inch at a line approximately 1 inch above the saw collar.
3. Track and husk must be well bedded and bolted in order to remain truly alined under the shocks and stresses of sawing.

The procedure of setting up a ground mill begins by marking on the ground the outline of sills and saw pit. Sills are bedded firmly in the ground to about one-half their depth. The sills must be solidly supported their entire length, with the ends under the outside track, each resting on a post bedded solidly in the ground. Earth is tamped firmly against the sides. A saw pit is dug that will be ample to provide for the type of dust removal and feed works employed.

The husk is placed at the desired location with a sill under each end, to which it is accurately bolted. Sills should extend parallel from beyond the outside track to the pulley end of the mandrel. Sills should be at least 10 by 10 inches in size and made of well-dried heartwood of durable species. Mills differ as to methods of locking the husk to the sills. In some, metal plates or angle irons are used; in others, the husk is bolted directly to the sills. Husk and sills should remain rigidly fixed under the heavy stresses of operation; mortising of plates into sills and dressing the sill face where it contacts the husk contribute to stability.

After the husk is firmly bolted to the sills, the mandrel and feed works are set in place.

Portable mills are usually provided with light metal carriage tracks fastened to light wood stringers, and correct track width is maintained by cross pieces between the stringers. These stringers rest on ties, which in turn may rest on sills bedded in the earth. The gap in the sill-tie foundation at the saw pit should be reinforced with 6- by 8-inch cross pieces saddled between the husk sills directly under each track. Good foundations for the track beyond the saw pit are assured by bedding under each rail a 4- by 6-inch sill leveled with the top of the husk sills.

The mill manufacturer patterns the drum shaft and track stringers to insure that the headblocks clear the saw by ½ to ¾ inch at a line about 1 inch above the saw collar. In some mills this ½- to ¾-inch clearance is fixed by metal plates between husk and track. Lacking these, two blocks are fitted between the husk and rail stringer, one being bolted to each sill. The track stringers are bolted tightly to the husk sills and ties, and the track is checked to make certain that it is at absolutely right angles to the mandrel and level both ways throughout its length. Other track sections are then laid and leveled.

Next, the carriage is placed on the track and run its full length, and the accuracy of leveling is checked with a level lengthwise and across the bolster tops. If inaccuracies occur, they are corrected by raising or lowering the sills under the ties.

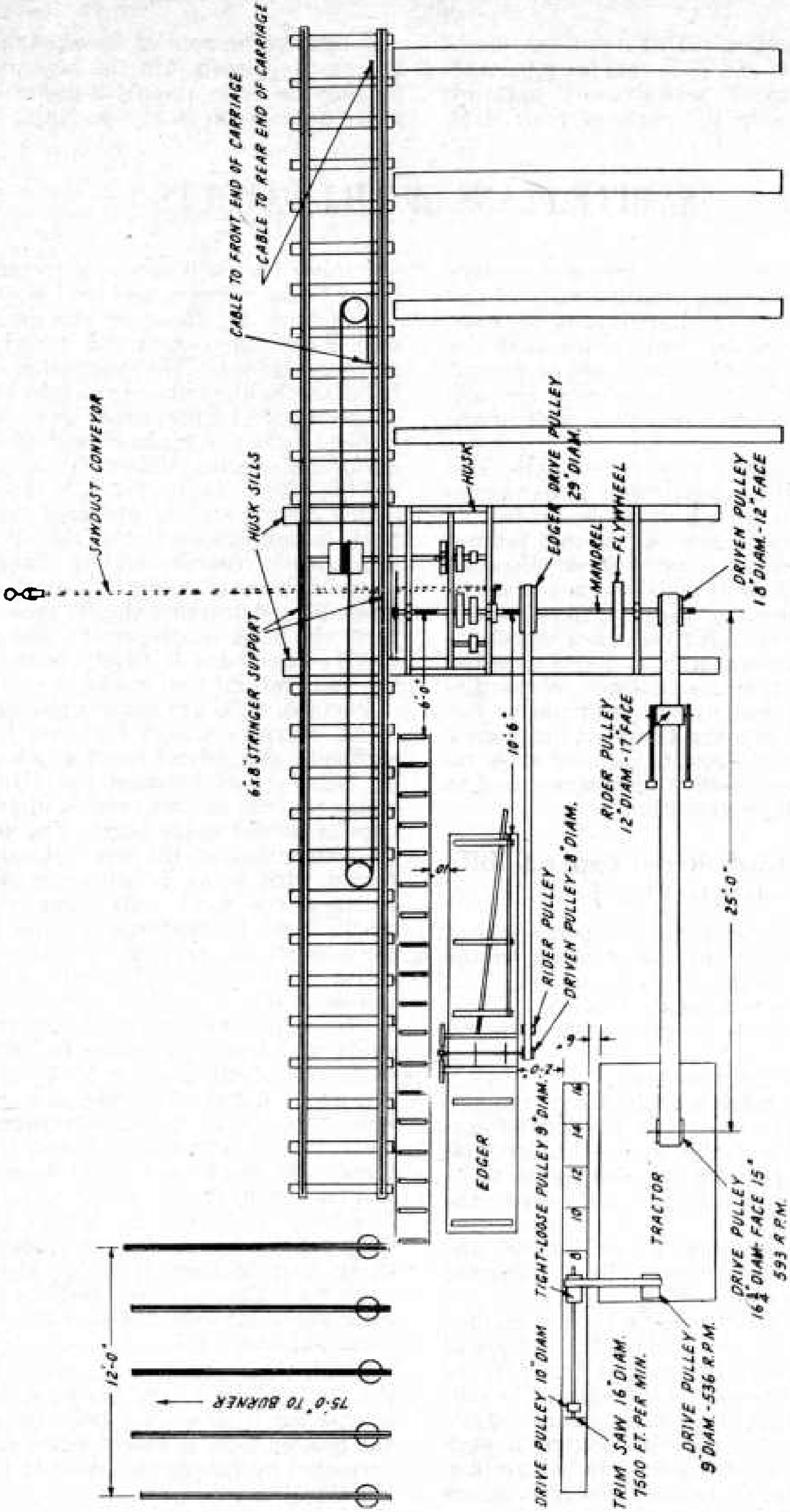

FIGURE 99.—Mill layout for unsheltered mill directly on the ground.

One end of the cable is fastened to the cable eye on the front of the carriage, and the cable is run through the deck-end pulley and back over the drum. Usually the first strand is carried over the top of the drum and wrapped three to five times around it, leaving the drum at the top. These wrappings should occupy the mid-portion of the drum. Then the cable is threaded through the other pulley and fastened to the eye at the rear of the carriage. The cable should be tight when fastened.

Mills worn by long service may give poor performance even when carefully set up. For this reason, mandrel bearings, carriage wheels, setworks, and headblocks should be checked. The mandrel should run level and without end play, which calls for good bearings. The same is true of carriage wheels on the guide rail. Provision is usually made for taking up play developing in the carriage wheels. They should be kept adjusted just short of binding or sticking. Worn setworks parts prevent accurate cutting, as do worn bolsters on headblocks.

With the guide blocks fastened to the husk the next step is to hang the saw. It must fit the mandrel perfectly, neither so tightly that it must be forced on nor so loosely that there is perceptible play. Place the loose collar and tighten the nut hard against the collar. Check with a plumb line to make sure that the saw is vertical and not seriously dished. Minor dishing can be corrected by inserting paper shims. This is done by cutting two paper rings, one with a rim one-half inch wide and of the full diameter of the collar, the other with a rim one-half inch wide and of a diameter to fit inside the hole in the first; ordinary kraft wrapping paper is suitable. Both paper rings are oiled, and the larger one is put on the fast collar and the smaller on the loose collar if the saw dishes away from the log; if it dishes toward the log, the two rings are reversed. Additional rings may be used if required. The operator should be on guard against reversing the dish.

The next step is to put the lead in the saw. This is done by slewing the mandrel slightly in a horizontal plane by means of set screws controlling this adjustment, so as to bring the front edge of the saw slightly into the log. Be sure the mandrel does not bind in the bearings after adjustment. Try a ⅛-inch lead in 20 feet. If the saw heats at the rim reduce this; if it heats at the center, increase the lead. A simple means of getting a 1/8-inch lead in 20 feet is to bring the carriage up so that the rear bolster is opposite the saw center; then fasten a strip along the top of the bolster to project within ⅛ inch of the saw. Run the carriage 20 feet away from the saw center toward the deck, and stretch a line from the end of the strip across the face of the saw. Adjust the mandrel until the string, drawn taut, touches both edges of the saw along the log-side face. Set the board-side guide pin to the saw in the new position and, when the saw is running, set the log-side pin close enough to steady but not bind the saw. Attach the spreader wheel behind the saw to clear the teeth about ½ inch and in the same plane as the saw, but not so that it rubs the log.

The guide blocks should be adjusted so that the guide pins clear the bit holders and touch the saw about ¼ inch outside them and 2 inches below the level of the carriage bolsters on the front edge of the saw. After placing the correct lead in the saw, the board-side pin should be set to leave a gap about 1/50 inch to the saw plate. The log-side pin is set to provide a like gap after the saw is brought up to operating speed.

There remains the installation of log deck, power unit, and possibly lumber rolls, edger, cut-off saw, dust conveyor, dip tanks, shelter, and yards. A simple log deck can consist of skids to facilitate easy approach of log to the carriage and spaced as in figure 99. A gentle downslope to the carriage is helpful but not essential.

The power unit, if hooked up by means of a flat-belt drive, should be so placed that the driver wheel and driven wheel are about 25 feet apart, their mandrels truly parallel and the pulleys in line, the belt centering on the pulleys. Guides are not used to keep the belt centered. Units are spaced so that the belt has about a 3-inch sag on the slack, or top, side. Place the belt rider on top of the slack belt. For an edger that is driven from the headsaw mandrel, the lower belt is slack, the rider being on the under side of the lower belt and close to the small driven pulley on the edger.

Building Plan and Machine Location for Sheltered Portable Mill According to Plan 2

With a cut of 200,000 to 1,000,000 board feet at one site, the operator often will erect a simple shelter. The equipment is usually on the ground or on a floor at ground level. Housing a mill of this size in a simple shelter according to plan 2 (fig. 100) will insure more sawing days, fewer delays, greater comfort to workmen, and longer life of equipment. The plan applies to either tractor-driven or steam-powered mills.

Plan 2 differs from plan 1 chiefly in that a shelter is provided for the machinery. This shed (fig. 100) requires about 4,000 board feet of lumber, exclusive of trestle, and 1,650 square feet of corrugated roofing. If wood is substi-

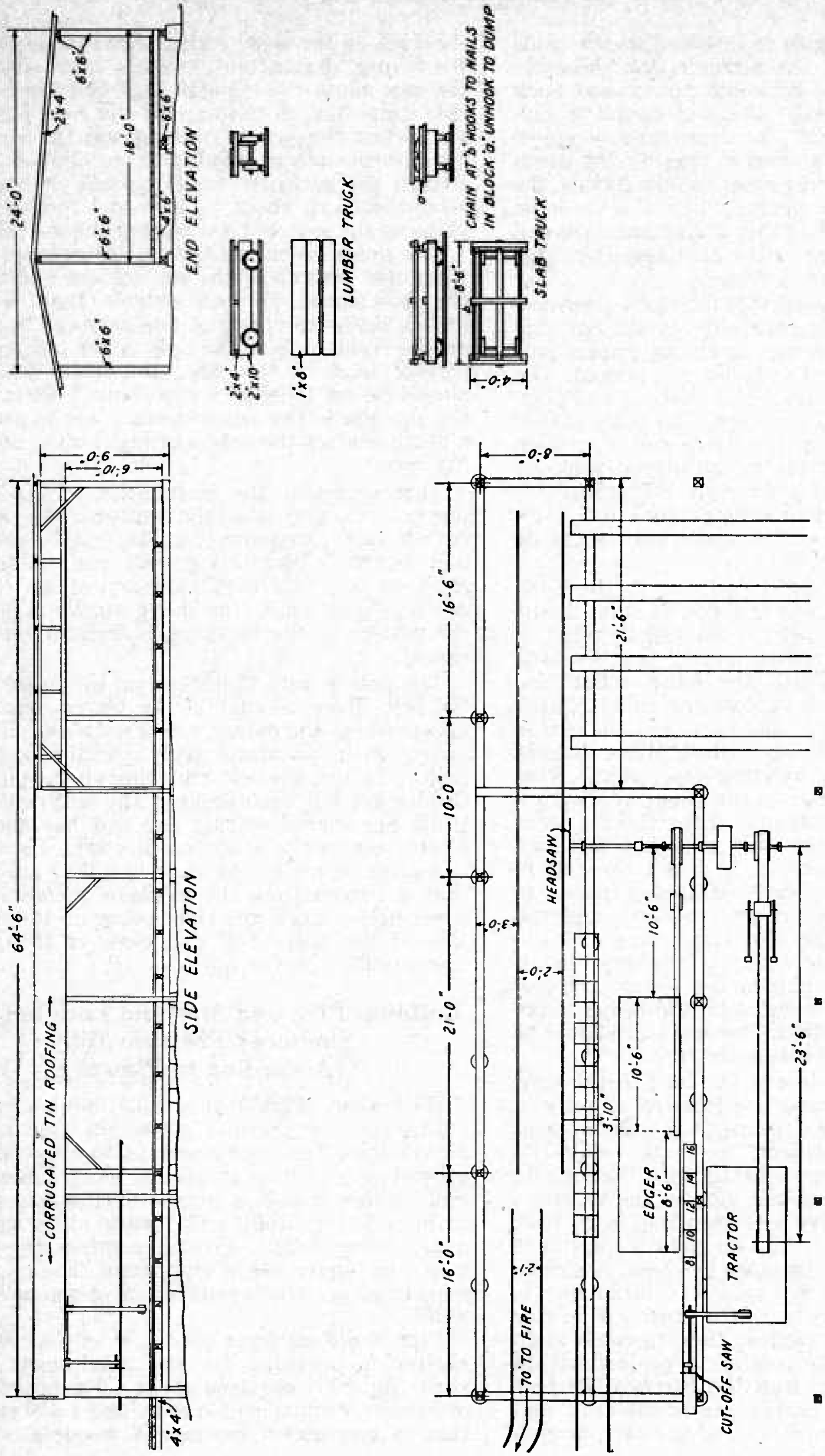

FIGURE 100.—Plan for a temporarily sheltered mill.

tuted for corrugated roofing, a higher pitch and some 2,000 board feet more lumber will be needed.

In this layout, slabs passing over dead rolls are loaded on a small car, together with edgings, are run out about 75 feet from the mill and dumped so as to slide 20 feet down five inclined rails to the fire. Lumber loaded on another car is run out to piles over a separate track. The columns supporting the trestles are placed in pairs at 8-foot intervals and are joined with 2- by 6-inch caps.

Where rolls are installed, the top of the roll should be level with the bed of the edger. The simplest means is to lower the floor supporting the edger; otherwise, the husk and track must be elevated so that the tops of the carriage bolsters are level with the edger table.

In the event that a relatively small portion of the material goes through the edger, the rolls are omitted and the lumber car brought within 6 feet of the headsaw, in line, so that sawed boards and slabs fall to the car, the slabs being carried across the carriage tracks and loaded on a slab car outside the mill. The floor of the slab car is supported by a single beam lengthwise along the middle. The beam has beveled ends resting in notches, so that it pivots as the load is dumped. One end of a chain is permanently fastened to the car floor and the other temporarily to the truck body to prevent accidental pivoting. A comparable slab car is shown in figure 101.

In plan 2, the 4- by 6-inch joists supporting the mill floor are spaced about 3 feet apart, but care should be taken to have a joist directly under the breaks in the carriage track. It is advisable to provide for a roomy sawdust pit under the headsaw (at least 3½ feet from the saw rim to the bottom of the pit) and one under the edger large enough (6 feet deep by 4 feet wide) to permit a wheelbarrow to catch sawdust directly. For steam-powered mills, the engine would be mounted in the space labeled "tractor" and the boiler set up so that it is conveniently near the slabs at the rear of the mill.

Building Plan and Machine Location for Semipermanent Tie Mill According to Plan 3

With a prospective cut of more than 1,000,000 board feet, a reasonably permanent building and other facilities are justified. Such mills are equipped to produce between 1,000 and 2,000 board feet per hour with a minimum of labor. For capacities in this range, the layout of a tie mill is shown in plan 3 (fig. 102), and that of a lumber mill in plan 4 (fig. 103).

A plan for a building with sides and ends boarded up but unfloored is presented in plan 3 for a semipermanent tie mill. It requires approximately 10,000 board feet of lumber. A rather large crew is needed, consisting of two deckers, one setter, one sawyer, one tail sawyer, one tail edger-slab off-bearer, one trim-saw

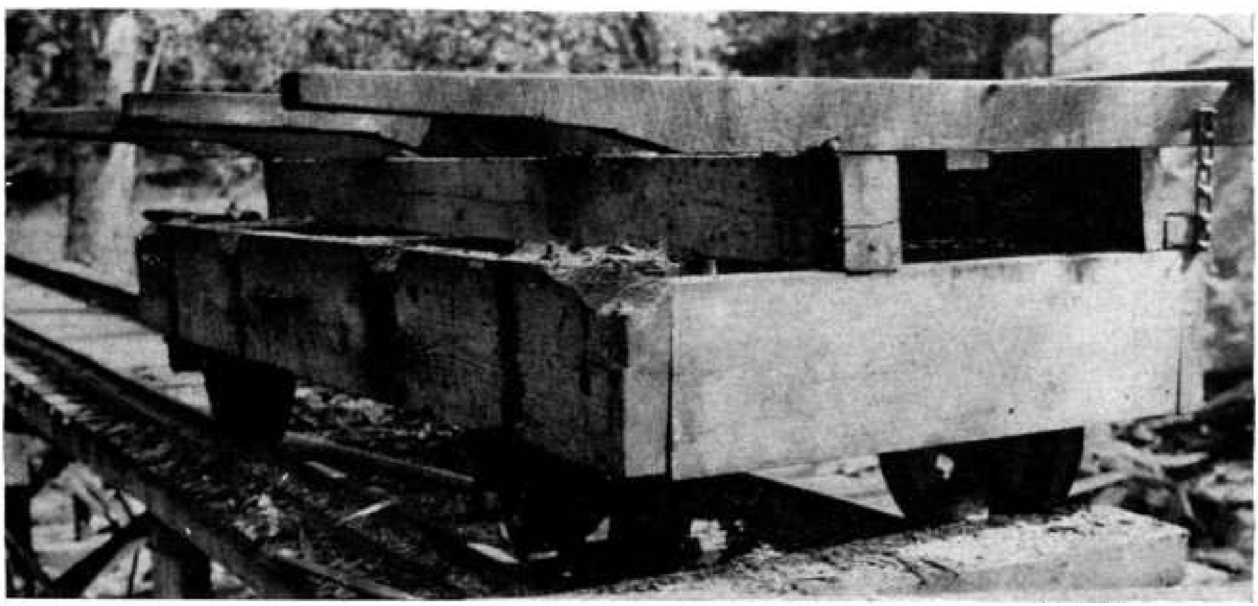

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FIGURE 101.—Slab car. Bed pivots on two hinges attached to longitudinal beam near middle of car.

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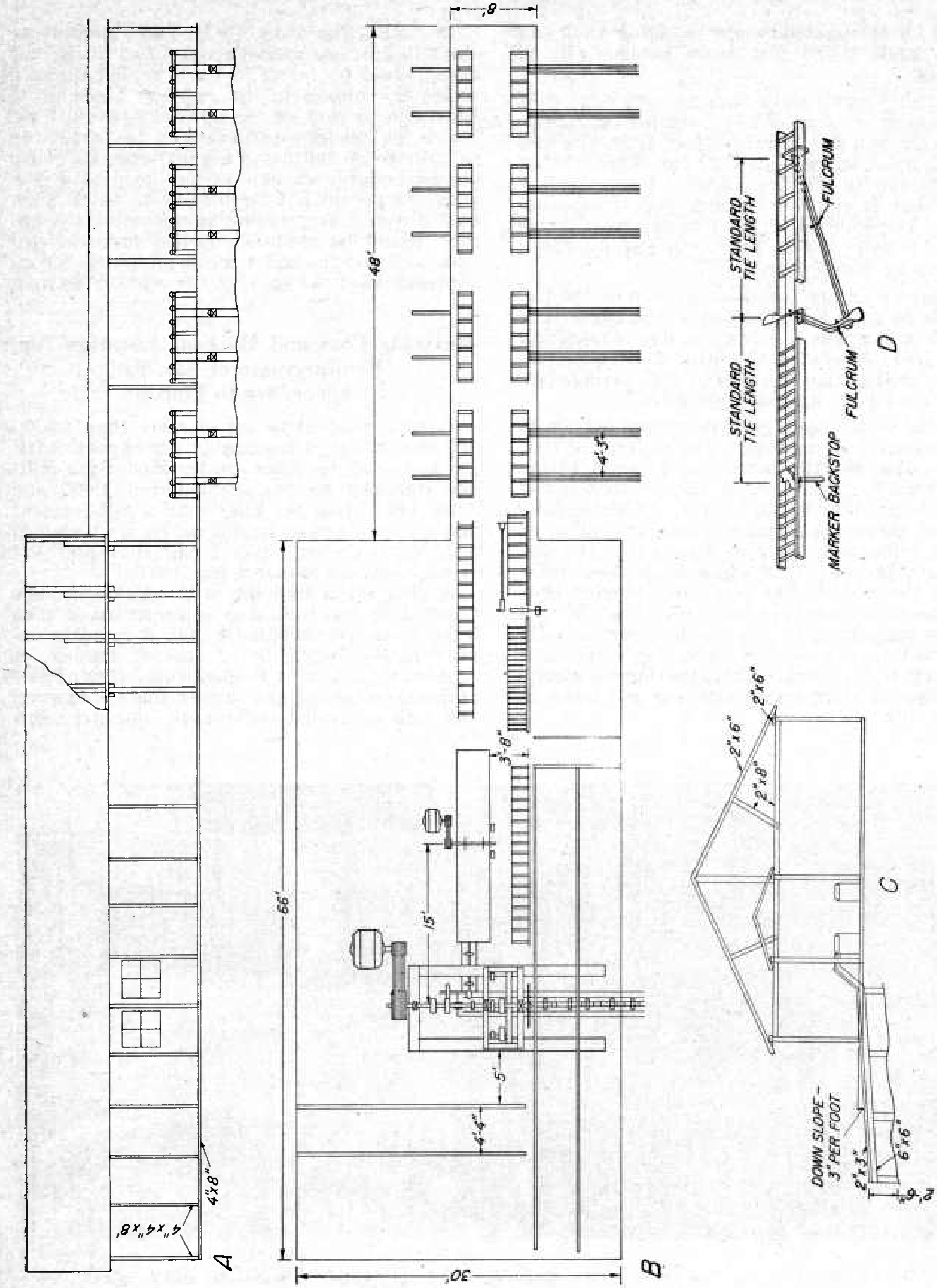


FIGURE 102.—Plan for semipermanent tie mill. *A*, Side; *B*, floor plan; *C*, end; *D*, device for measuring tie lengths.

operator, one pile-out man, one bark-peeler-clincher, one truck-mounted derrick operator, and two lumber-tie stackers. Production for a 9-hour shift is 450 ties and 3,600 board feet of side lumber. The headsaw motor has a rating of 100 horsepower, that for the edger 25 horsepower, and that for the cut-off saw 8 horsepower.

Logs can be delivered directly to the deck or dumped in the log yard as reserves.

Slabs and edgings are pushed down the inclined rails and drop outside the mill onto two skids. A truck equipped with a derrick slings a bundle of this refuse on a chain and hauls it to a nearby pile for conversion to fuel wood; or slabs may be thus disposed of and edgings bundled and tied by the trim-saw operator. Ties and boards go out the rear of the mill, the ties to the tie dock and the boards onto skids to be picked up by the derrick-truck and hauled to the pile.

The convenient device shown in the plan (fig. 102, *D*) for measuring standard tie lengths at the cut-off saw consists of infeed rolls 2 inches in diameter, spaced 4 inches center to center, a central dead spot 3 feet long with the spiked device for holding the tie while it is being cross cut, then a section of rolls. Rolls are equipped with ball bearings. The marker operates just before the tie reaches the cut-off saw. It is free to rotate, forcing the stop down as the incoming material reaches it, but the counterweight brings the plate up between the rolls when the tie has cleared. The trim-saw operator pushes the tie back until the end engages the plate. To operate the marker beyond the cut-off saw, the operator steps on the pedal, thus raising the plate across the line of travel. With the same motion, the spikes in the member under the saw table are raised and, as the pedal is pushed completely down, the spikes are raised above the table top to engage the tie. They are located about 8 inches from the guide rail, which is across the rolls from the operator (fig. 102).

Building Plan and Machine Location for Semipermanent Lumber Mill According to Plan 4

The semipermanent mill shown in figure 103 is supported at least 4 feet off the ground by a series of piers. These are spaced 6 feet apart along the length of the mill and 8 feet apart across the mill, except that those in the five series at the front of the mill up to the saw are spaced 4 feet apart. The plank floor is continuous, except that the power-unit base rests on the ground and the space over the unit and drive belt and extending to the log haul-up mechanism is unfloored and may serve as a saw-filing space. The track and husk are raised so that the tops of the carriage bunks are level with the edger bed. Approximately 11,000 board feet of sawed material are required, together with 2,500 board feet of piers and 2,400 square feet of roofing.

A blower delivers sawdust from the headsaw and edger. A conveyor belt delivers slabs and edgings to the refuse chain at the rear of the mill and thence to the burner, placed at least 75 feet from the mill. The lumber, after passing through the gravity dip tank, is piled for transportation to the yard or elsewhere.

The crew consists of at least seven men: One man to haul up logs, a deck man, a sawyer, a tail sawyer, a tail edgerman, a trim-saw operator, and a pile-out man. The equivalent of a 100-horsepower Diesel engine should be used for power.

Figure 103 is drawn to scale. Pulley sizes are based on the assumption that the drive pulley to the headsaw has a diameter of 17½ inches and that to the intermediate shaft 20 inches, each turning at 1,000 revolutions a minute. The suggested speeds for various pieces of equipment are: Headsaw, 650 revolutions a minute; log haul, 100 lineal feet a minute; edger saws, 2,000 revolutions a minute; blower, 2,800 revolutions a minute; trim saws, 1,720 revolutions a minute; and slab-conveyor belt and refuse chain, 200 lineal feet a minute.

The drive shaft on the power unit is 3½ inches in diameter, the intermediate shaft is 3 inches, the blower shaft 1-7/8 inches, and the trim saw shaft and conveyors are 2 inches in diameter.

Widths of the various drive belts should be as follows: To the headsaw, at least 12 inches wide; to the intermediate shaft, 10 inches; from the intermediate shaft to the trim-saw shaft, 8 inches; from the trim-saw shaft to the drive pulley, 6 inches; from the intermediate shaft to the second intermediate and all belts beyond for conveyor transmission, 6 inches; from the intermediate shaft to the edger, 8 inches; and from the intermediate shaft to the blower, 5 inches. The belt conveying slabs is 15 inches wide. The lugs in the trash-conveyor chain are spaced 8 feet apart.

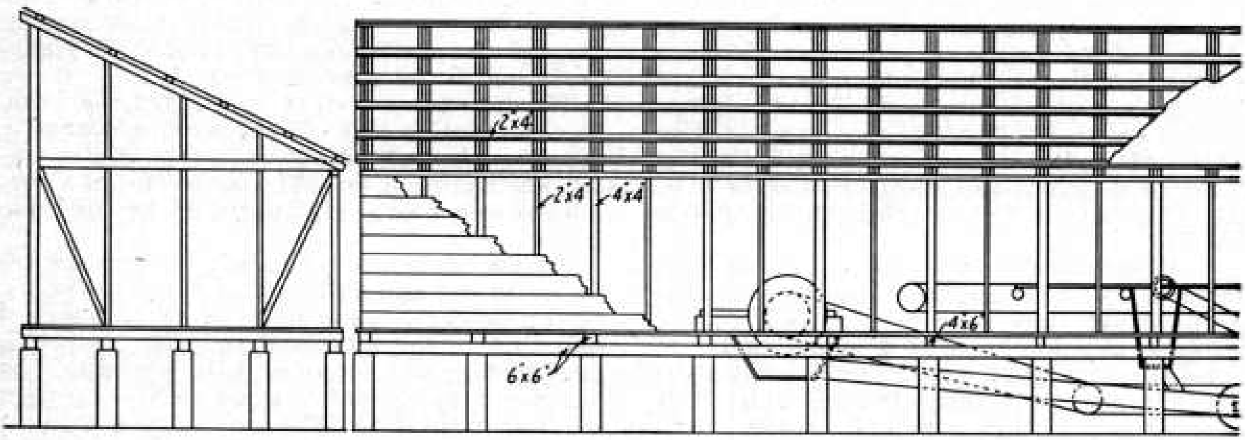
Building Plan and Machine Location for Permanent Heavy Mill According to Plan 5

A plan for a heavy type of small but permanent Douglas-fir mill is given in figure 104. This mill, producing from 3,000 to 5,000 board feet per hour from logs with a diameter inside bark of between 20 and 40 inches, is a "small" mill only on the west coast. Production is predominantly of stock at least 2 inches thick and includes timbers sold green from the mill. The mill building requires about 55,000 board feet of timbers and lumber and 1,400 lineal feet of piling.

Substituting a band headsaw would require no change in layout if timbers and ties are not to be cut. If timbers and ties are cut, substitution of a band headsaw would require a swing cut-off and docks.

The list of materials needed for building and equipping this permanent heavy mill includes:

1 gas drag saw for the pond.
1 10-horsepower electric motor, with gears, shaft, and chain, for the log slip.
1 10-horsepower electric motor, with winch and chain, for the overhead log turner.



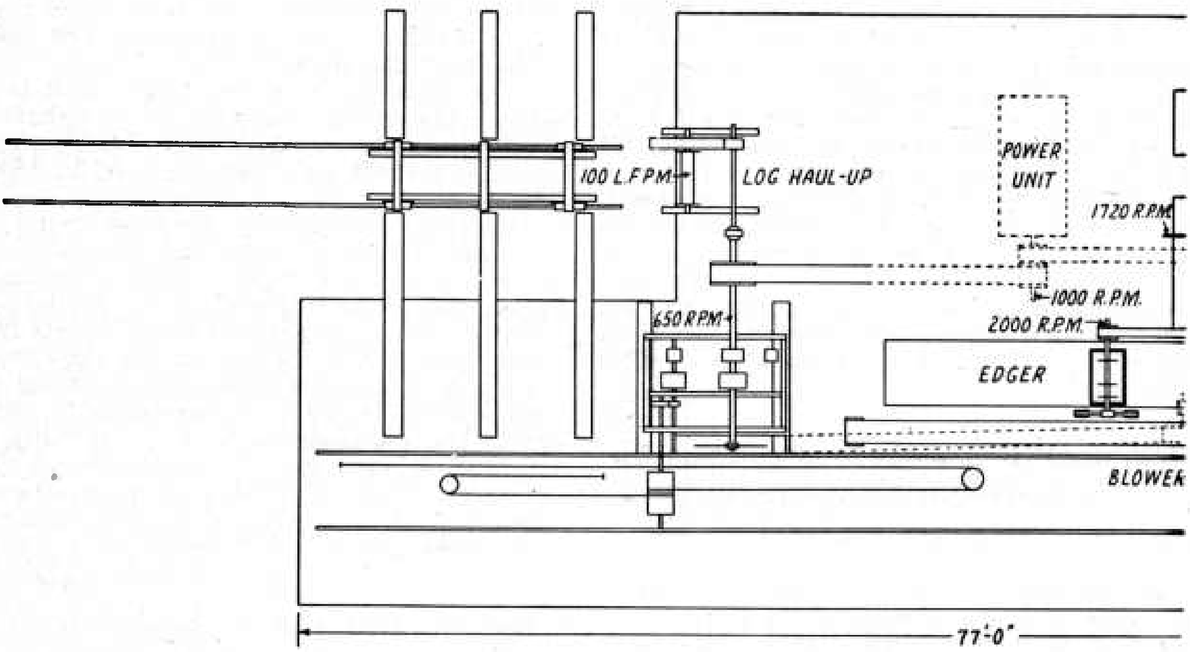
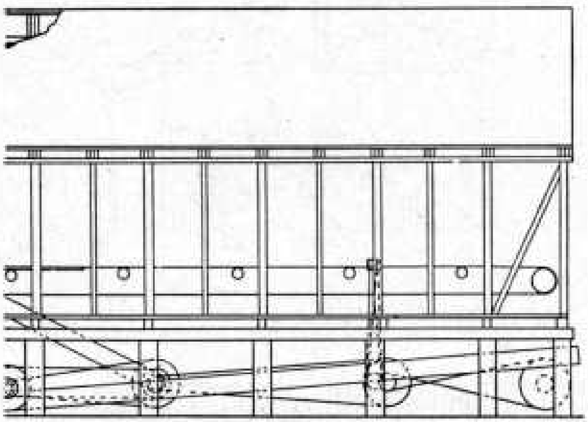
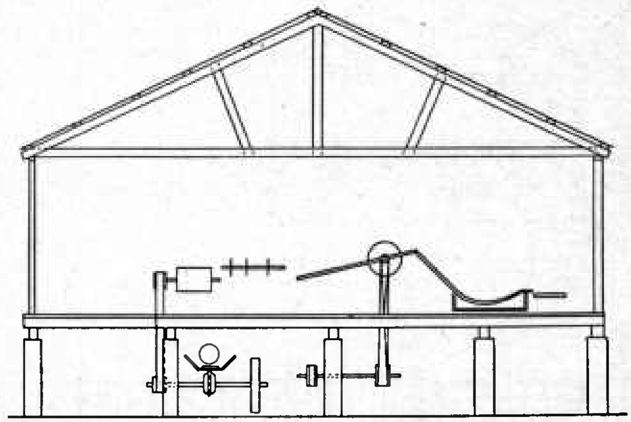
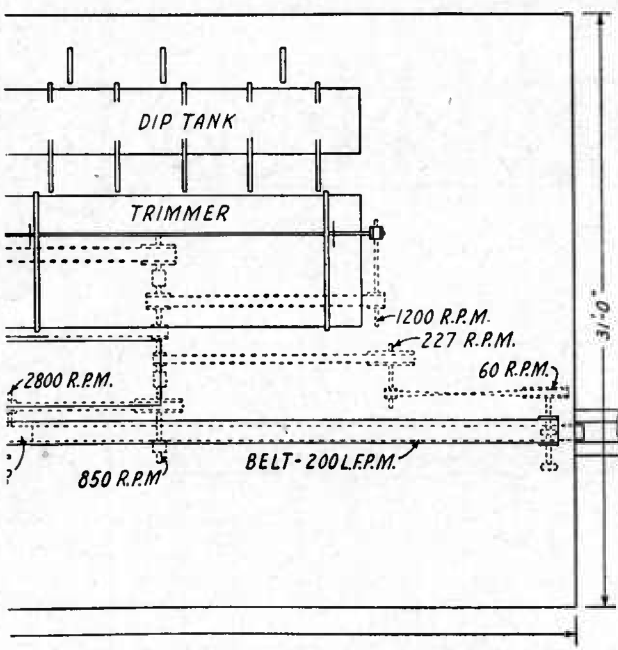


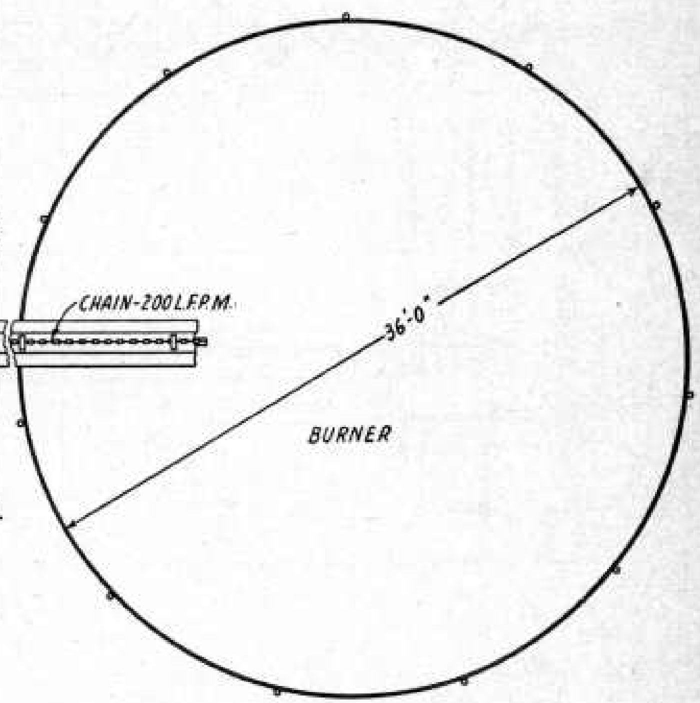
FIGURE 103.—Plan for

1 10-horsepower electric motor for the carriage set-works.
1 200-horsepower electric motor for the headsaws.
1 7½-horsepower electric motor for the live rolls.
1 100-horsepower electric motor for the edger.
1 20-horsepower electric motor for the refuse chain to the burner.
1 15-horsepower electric motor for the lumber conveyor chain.
1 15-horsepower electric motor for the trim saws.
1 5-horsepower electric motor for the burner blower.
1 carriage, 7 by 20 feet, to include three headblocks; two knees; a screw shaft; drop dogs on a perforated movable-arc post; motor-driven friction wheels to activate the setworks; and a feed friction-bull-wheel, cable driven.
1 husk, carpenter built, supporting a 7-gage, 60-inch headsaw and a 7-gage, 60-inch topsaw, with 42 insert-type, No. 4 style teeth per saw.
1 set of 20-inch live rolls.
1 72-inch, four-saw edger.
1 set of transfer chains with live rolls to the edger bed.









semipermanent lumber mill.

1 refuse chain from the headsaw to the rear of the mill.
1 refuse chain from the rear of the mill to the burner 100 feet distant.
1 set of lumber conveyor chain (70-foot table).
1 set of trim saws (four).
1 blower for the burner.
1 burner.
1 pond 200 by 250 feet in area by 5 feet deep.

The crew consists of two pond men, one operating the drag saw and the other feeding logs to the slip; one decker operating the pull-up, rolling logs and helping turn them; one setter-dogger; one sawyer; one tail sawyer; two edgermen; one trim-saw operator; four sorters; one boss; one night watchman; and one filer-mechanic, making a total of 16 men. This excludes the load-out force in mills loading directly from dock to railroad car.

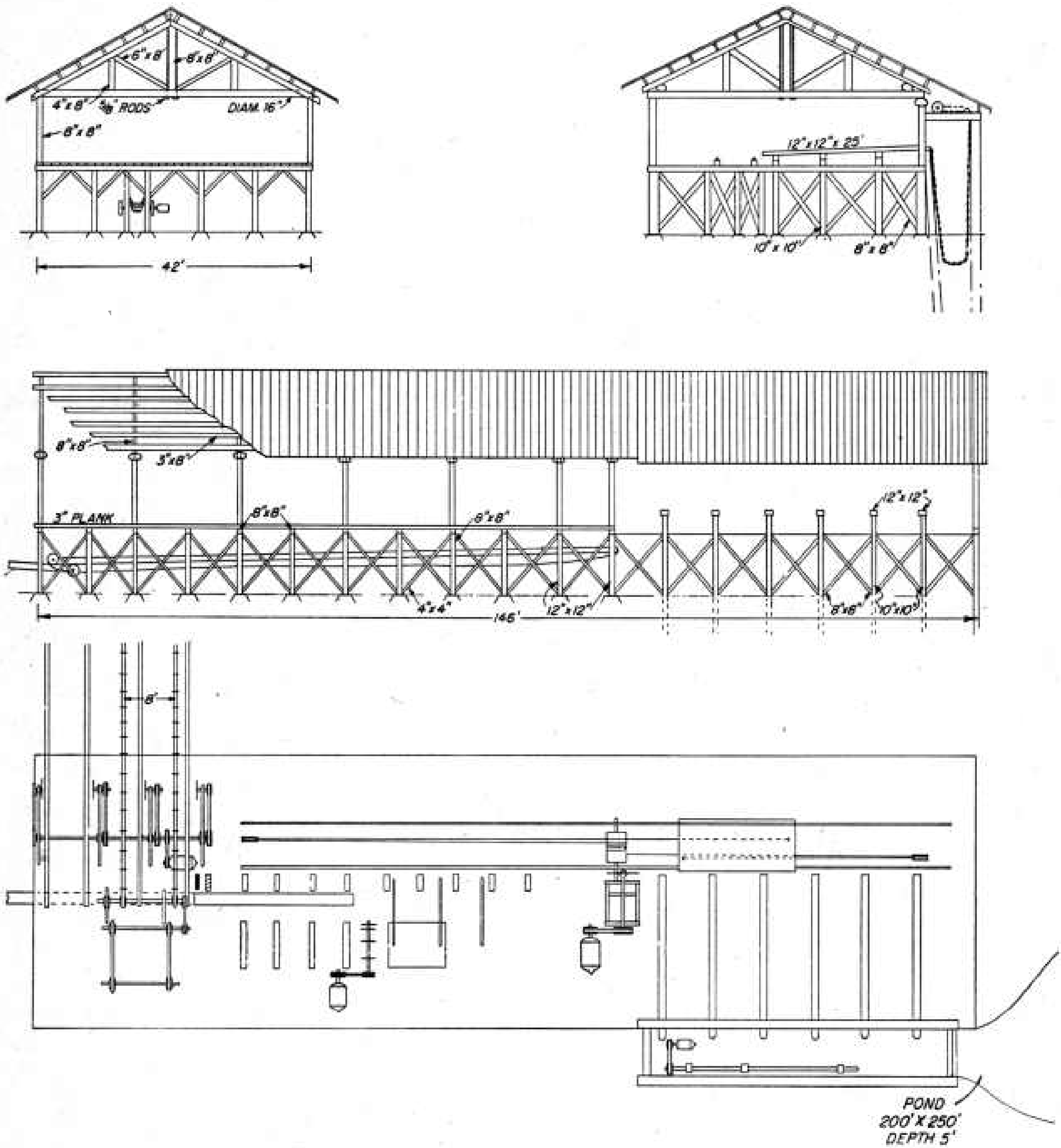


FIGURE 104.—Plan for permanent lumber mill, heavy type.

LOAD-OUT EQUIPMENT

Several methods permit orderly handing of lumber at the rear of the small sawmill. Depending upon production volume, one or another of these methods appears well suited to various types of small mills.

Car and Trackway

One means of handling of lumber at the rear of the mill is to load it on a car and transport it over a trackway to piles along each side (fig. 105). Trackways are level or with a down slope toward the yard of up to 1 foot in a run of 50. By making the car frame detachable from the axles, several cars can be used on one track, the empty car being brought from the yard and set off the track to give right-of-way to the one being loaded.

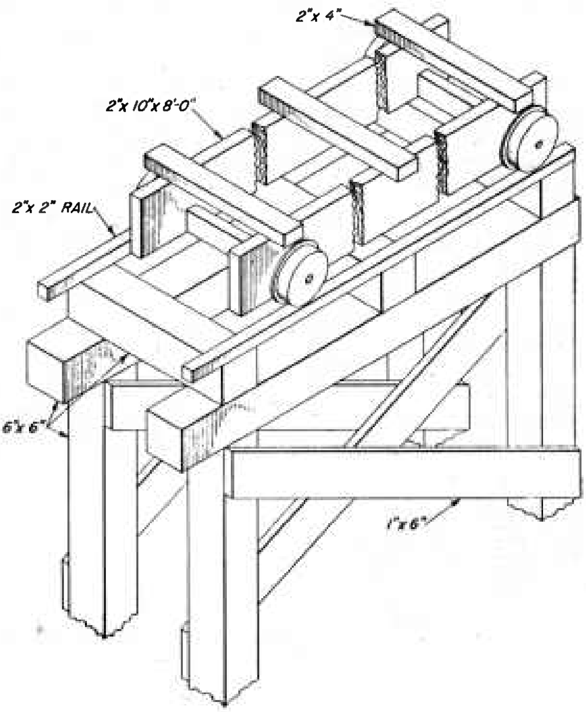


FIGURE 105.—Car and trackway for transporting lumber from mill to pile.

Lumber Props

Mills built directly on the ground can use the lumber-prop method (fig. 106), which permits grouping of items by species, thickness, width, length, or grade at the mill instead of at the pile. A series of rolls carries the lumber out the

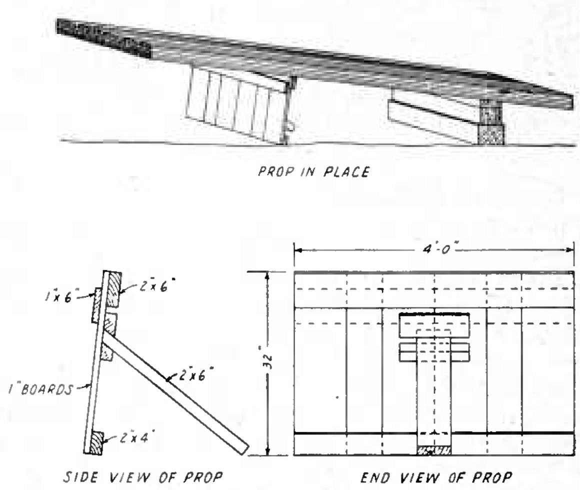


FIGURE 106.—Lumber-prop load-out device.

rear of the mill, and one man piles it, by required items, on special props. Spacing between props should be adequate to permit backing the wagon, truck, or bummer under the load; the prop is just high enough so that the vehicle's bunk contacts the load about an inch ahead of the prop, the prop itself being placed about one-third the length of the load from the front end. About 500 board feet makes a load.

The bummer or other two-wheeled vehicle is backed under the load so as to engage it just ahead of the prop. The load is chained to the bunk and, with the driver standing on the front end to minimize drag, the bummer is started, causing the prop to fall forward. The back of the load drags on the ground. One man driving a single horse can usually move production from mill to pile where the yard is within a quarter mile of the mill.

Rolls

For mills built off the ground, a simple yet effective method of handling loads of up to 1,000 board feet utilizes an inclined platform and rollers (fig. 107). The platform's incline from mill to truck is $1\frac{1}{2}$ inches in 10 feet, with the rear about 2 inches above the truck bed. Three wood rollers, each 6 inches in diameter and 7 feet long, are blocked on the skids 5 feet apart. If separations are required, the platform is made wider so as to carry several loads at a time, each provided with a set of rollers.

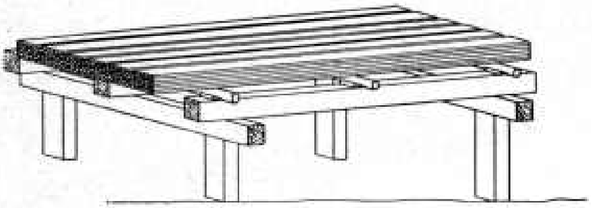


FIGURE 107.—Inclined platform and rolls for loading out lumber.

To transfer the load to the truck, the vehicle is placed opposite the load so that the longest boards will clear the platform when the lumber has been shifted to the truck. A 4- by 6-inch by 7-foot timber is placed with 6-inch face downward on the truck bed about a foot from its rear. A 6-inch roller is placed just ahead on the truck bed, the blocks are taken from under the rollers supporting the load, and gravity moves the load onto the truck. As it engages the roller on the truck, and before the rear of the load drops off the platform, the 4- by 6-inch timber is turned with a 4-inch face against the truck bed to minimize the shock of the drop.

Loading Scaffolds

Variations of devices to support loads clear of the ground, so that a vehicle can be backed under and the load picked up as a unit (figs. 108 and 109) are suitable for mills built off the ground.

The type shown in figure 108 is used for loads of about 1,000 board feet moved by a truck or wagon relatively short distances to the yard. No grouping is usually made at the mill, other than some sorting of like items within the load. Usually two men transport and pile the production directly from the vehicle. Supports *a* are hinged. The ground line of the roadbed is so inclined that, in backing between supports *a*, the rear end of the truck bed—or, if bunks are used, the rear bunk—engages the load of lumber just ahead of support *b*. As the truck continues to back, the load is lifted clear of support *b*, and supports *a* fall back, pivoting on the hinges. If a truck bed is used, cross members must be placed so as to support the load more than 6 inches off the bed, to allow support *c* to be taken from under the load. The distance between supports *a* and *b* will depend upon the truck bed length or distance between bunks. The length to which the lumber extends beyond support *c* is regulated to clear the cab. The width of the pile is that readily taken on the truck.

The type shown in figure 109 is used for truck-trailer loads of 4,000 board feet and relatively long hauls. The load is supported just high enough to clear the bolsters as the trailer and trucks are backed under it. The driveway is planked under the load, and with enough incline so that the trailer bunk engages the load at the moment the bunk of the truck is behind support *a*. The jack is placed on support *b* and one end of support *a* is lifted, the blocks removed, and the end of the support lowered until it rests on the post. The jack is taken to the other end of support *a*, and the process repeated until the support can be removed. The load is chained to the vehicle and is then ready to move. The specifications in figure 109 are for bunks 8 feet wide on dual-drive, dual-wheel trailers.

Sliding Skids

The specifications for sliding skids shown in figure 110, *A* are for truck-trailer loads of 4,000 board feet and relatively long hauls. The lumber is piled across skids *a* to a load width suited

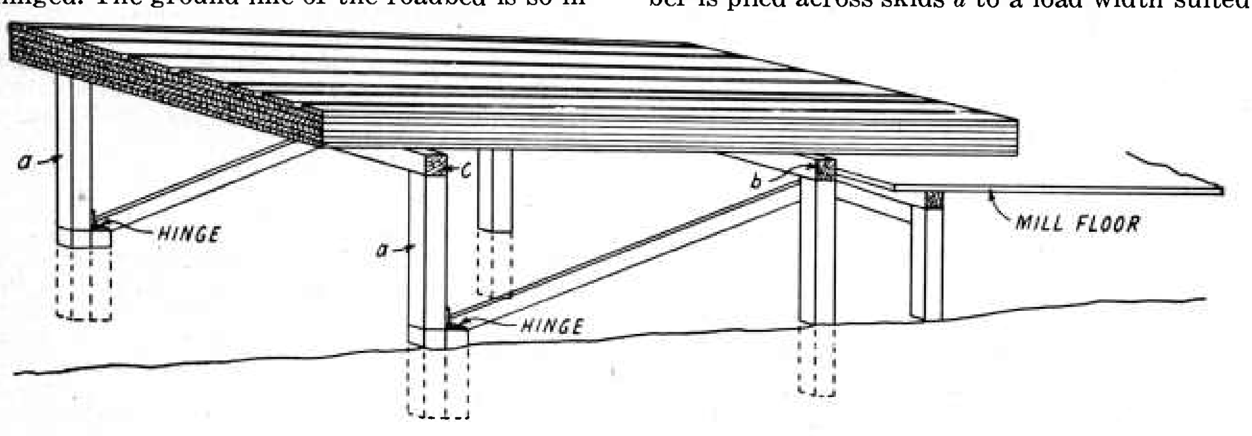


FIG. 3
LOADING SCAFFOLD FOR 1M BD. FT.

FIGURE 108.—Hinged-post loading scaffold. Truck is backed between hinged supports *a*, lifting load off support *b*. Supports *a* fold back and support *c* is removed.

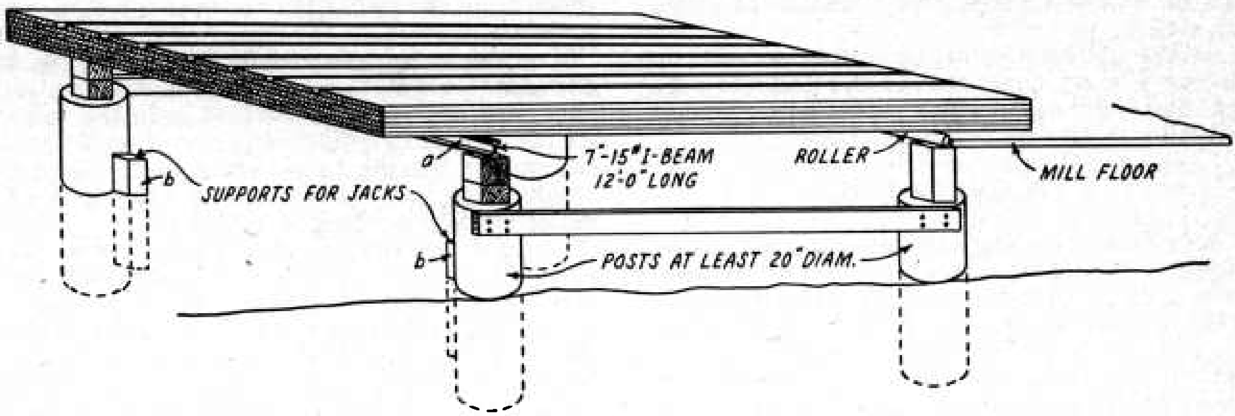
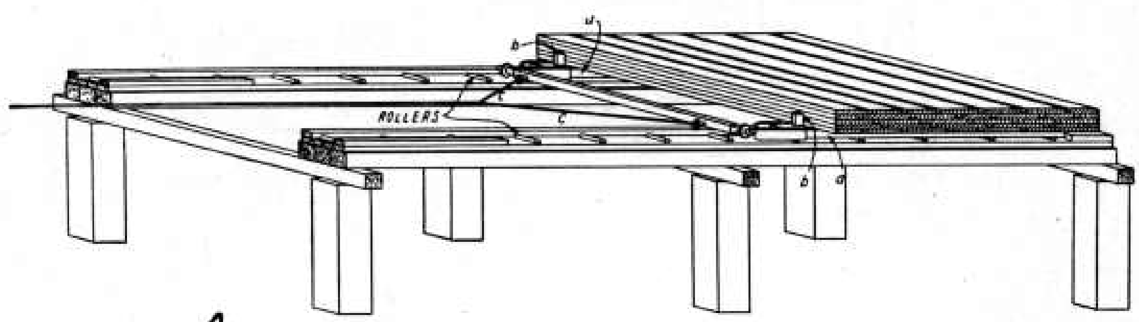


FIGURE 109.—Jack-lowered lumber scaffold. Support *a* is raised by jack on support *b*, one end at a time, blocks under support *a* are removed, and it is lowered to posts so that load rests on truck bunk backed underneath.

to the bunks of the carrier, as indicated by angle-iron guides *b*. Loading and unloading are facilitated if truck and trailer bunks are provided with 4-inch channel-iron bolsters with rollers inset to clear the bolster by about ½ inch (fig. 110, *B*).

To move the load, a cable from a hand winch anchored bunk-high across the truck road is connected to chains *c* (fig. 110, *A*) and, when operated, pulls the loaded skids over the rolls. The truck is placed so that the skids will be ahead of the bolsters rather than opposite them and the skids are removed when the load is placed on the bolsters. If a truck with a solid bed is used, the skids are pulled directly onto the truck bed and remain under the load. The truck driver or helper operates the hand winch.

If the skidway is lengthened, several loads



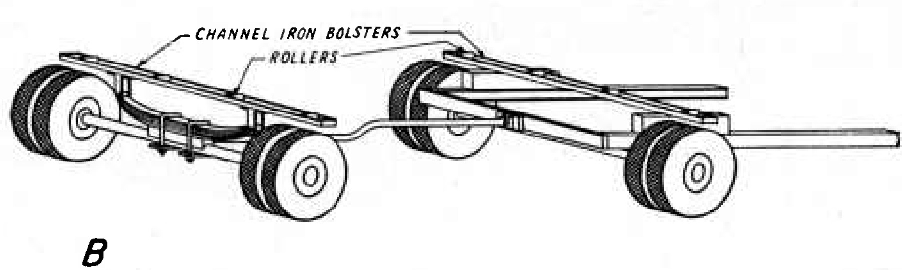


FIGURE 110.—Loading devices using sliding skids. *A*, Platform showing skids *a*, angle-iron guides *b*, and chains *c*. *B*, Truck, showing channel-iron bolsters and rollers.

can be stored against irregularities of truck schedules.

At the delivery point, unloading consists in placing a heavy chain around the load and pulling it laterally on the skids with a power device, or lifting it with an overhead crane.

Trucks and Rails

A method of loading out suited to heavy loads requires two firmly fixed sections of railroad rails, each of a length equal to the over-all load width (7 feet) across the truck frame (fig. 111, *A*). One rail is about 30 inches behind the rear axle of the truck and the other about 7 feet ahead of this rail. Kiln trucks with a welded extension (fig. 111, *B* and *C*) can be placed on rails at the back of the mill, spaced exactly as the rails on the truck (fig. 111, *A*). The truck is spotted so that its rails are an extension of those from the mill, with not over a 3-inch gap. A jack is used under the end of each rail nearest the mill to bring to and hold the truck rails at the same level as those of the mill. A winch and cable are used to pull the load onto the truck. At the unloading point, rails are provided with the proper spacing to permit running the kiln trucks with the lumber off the hauling truck, using jacks and winch as outlined.

Several variants of this method are used normally for loads of 4,000 or 5,000 board feet of stock, mainly 16 feet in length. Jacks housed in portable standards can be used either to ease the load onto the truck or to take it off (fig. 112). A set of two jacks supports a small log or metal beam at a height adequate for bunk clearance as the truck is backed under it. The roadbed is inclined downward at the front of the load so that, in backing between the supporting jacks, the rear bunk engages the load and

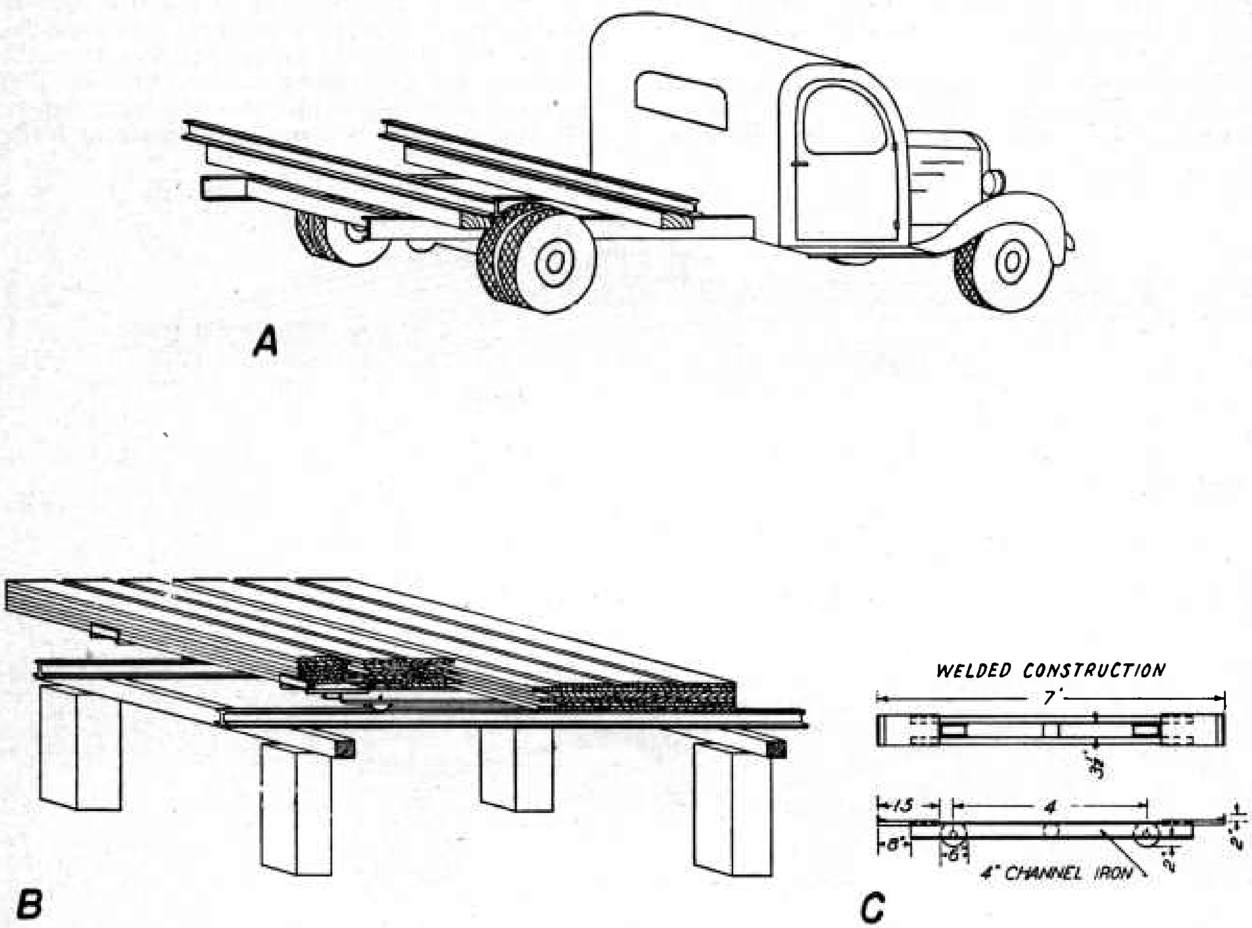


FIGURE 111.—Kiln-car method of loading lumber. *A*, Truck with rails on bunks; *B*, kiln car on rails of load-out platform; *C*, details of skid.

positions it properly with relation to the cab and bunks. The truck is stopped at this point, the front support is jacked down, and the load is settled on the truck without shock. Where this equipment is used to remove a load from the truck, four jacks are used, two elevating the front support and two the rear one.

In a lever-arm support, the end of the log cross piece is supported by the end of a plank which can be used as a lever to raise or lower the cross piece slightly (fig. 113). To load, the truck is positioned as with portable jacks, the key bolt at *a* (fig. 113) is removed, and restraining force is applied to the plank to steady the descent of the front corner as the plank pivots under the weight of the load. The stop at *b* is about 5 feet above pin *a*. The let-down of the front corner resulting from the plank end traveling from *a* to *b* is not enough to bring the load down onto the bunks, but after the other front corner is lowered in a similar manner, the supporting log can be easily turned down with a cant hook toward the front end of the load until the load rests on the bunks.

In another variant, a rectangular frame (fig. 114) adequate to support one end of the load at the required height is placed about 10 feet from the mill platform. It may be tilted with the top slightly toward the mill, and propped with a plank, or it may be supported by a notched 2 by 4 (fig. 114, *A*) with the other end of the 2 by 4 nailed to the load-out platform; or it may be tilted with the top slightly ahead of center and supported by a small chain (fig. 114, *B*). It may be set up directly on the roadbed (fig. 114, *A*) or be anchored and turned on a pipe (fig. 114, *B*) or hinge. If it is anchored, a portion of the planked roadbed is cut out so that the frame is countersunk when flat, to provide a roadbed for the truck wheels at the same level as the adjoining roadbed. The height of the gate should be adequate to keep the front end of the pile above the end on the load-out platform, so that the truck roller engages the load about a foot back from the front of the load and lifts the load off the support as the truck continues to back under the load. The mill platform has a step to provide a backstop as the truck continues back in placing the load.

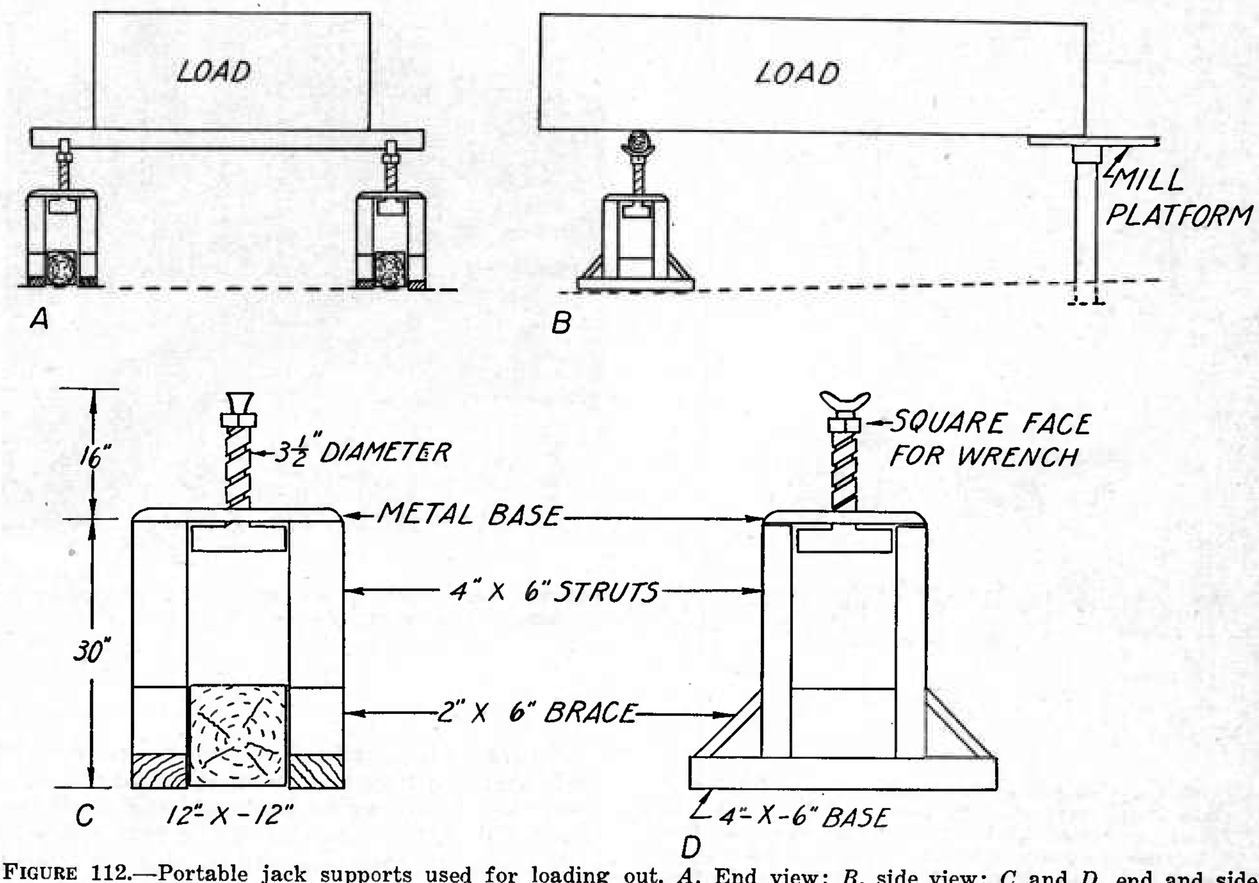


FIGURE 112.—Portable jack supports used for loading out. *A*, End view; *B*, side view; *C* and *D*, end and side views of support.

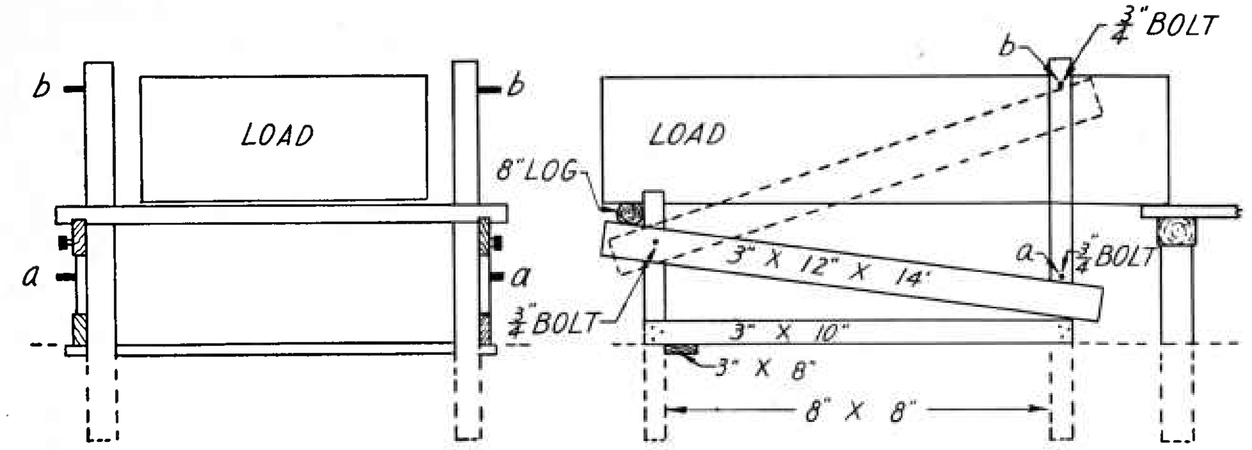
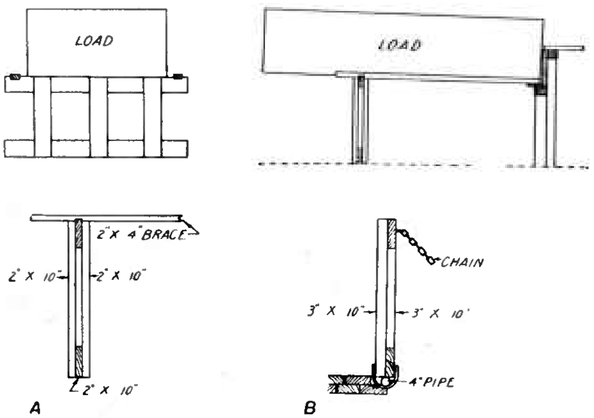


FIGURE 113.—Lever-arm support for load. Left, front view; right, side view. Bolt *a*, when removed, causes plank to pivot upward to bolt *b*, thus lowering opposite end of load. Removal of log brings end of load to truck bunks.



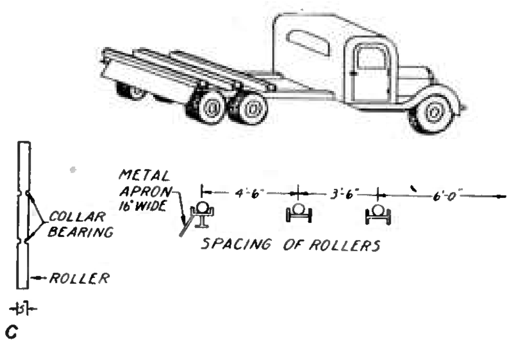


FIGURE 114.—Details of two types of gate frames. *A*, Gate frame supported by notched 2 by 4; *B*, gate frame supported by chain and hinged on a pipe; *C*, truck equipped with rollers for ease in loading and unloading, with details of truck roller and roller spacing.

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FIGURE 115.—Stacking lumber in unit packages by means of tram car running from rear of mill.

Figure 114, *C* indicates the truck features and roller spacing. The metal apron at the rear minimizes breakage as loads are rolled off the truck. By cutting the end of the rear roller to take a wrench, provision can be made to unload the entire package in one operation.

Fork-Lift Trucks

Lumber can be taken from the rear end of a mill with fork-lift trucks. The lumber must be assembled in units that can be handled and carried by the forks, and the unit must be placed so that the forks can be inserted beneath the load. The lumber can be handled in bulk-piled units or in sticker-piled packages prepared for seasoning in the yard. The bulk packages can be taken to the yard or loaded onto motor trucks for shipping in the green condition. The same fork-lift truck used to take lumber from the rear end of the mill can be used in log yarding, and various miscellaneous handling and transporting operations.

Where stickered packages are picked up, space for stacking bays should be provided. An arrangement consisting of a tram car running on a track can be used (fig. 115). The lumber is unloaded directly from the tram car to stickered packages placed on bolsters.

MILL OPERATION

The most advantageous method of sawing logs on any operation depends upon market demands and price difference between different grades and between thicknesses within a grade. Thick stock of the better grades normally brings a better price than inch lumber. In hardwoods (graded from the poor face) the likelihood that the grade on the inside face will hold up to that on the outside decreases as thickness increases; hence, to capitalize on thick stock requires expert knowledge by the sawyer. Thicknesses most commonly produced by small mills are shown for several hardwood species in table 14.

TABLE 14.—*Thickness of hardwood stock of various species commonly produced on small sawmills*

Species	Thickness in inches					
	4/4	5/4	6/4	8/4	10/4	12/4
Ash	x			x		x
Basswood	x	x		x		
Beech	x		x			
Birch, yellow	x		x	x		
Cherry, black	x					
Cottonwood	x			x	x	
Elm	x		x			
Maple, soft	x		x			
Maple, sugar	x		x	x		
Oak, black	x		x	x		
Oak, chestnut	x			x		
Oak, upland red [1]	x		x	x		
Oak, lowland red [1]	x			x		
Oak, upland white [1]	x		x			
Oak, lowland white [1]	x	x				
Yellow-poplar	x	x		x		

[1] Includes all commercial species.

The sawyer must know the following details of lumber grading: (1) The minimum width and length provisions of each grade, to guide himself when slabbing; (2) the defect allowance or clear-face requirements of the grade, as a guide in log turning; and (3) the grade provisions applying to the lowest merchantable grade, in order to avoid wasting time or making unmerchantable stock.

The edgerman must know (1) the minimum width-length provisions of each grade; (2) the amount of permissible wane; and (3) the provisions covering standards of manufacture, particularly that applying to crook.

Both the sawyer and edgerman should note that minimum thickness, width, and length provisions of the grade rules usually apply to dry lumber and must allow for shrinkage in thickness and width. Hardwoods are edged to give the widest possible board in any fraction of inches above the minimum required. Softwoods are sized to give widths in inch or 2-inch intervals.

Recommendations applicable to milling both softwood and hardwood logs are:

1. Clear faces should be taper sawed in order to get the maximum possible footage in upper grades.
2. Thin stock should be taken next to the slab to minimize edging waste.
3. The pith should be enclosed within a boxed-heart item where splits and checks are not considered a degrade.

Milling Softwood Logs

The major markets of small mills cutting softwood lumber are those taking standard retail-yard items, box lumber, and railroad ties. Production, except in the Douglas-fir region, is rarely geared to the special size and finance requirements of industrial, export, and bill-timber (large-sized timbers) markets. To minimize waste, products of different sizes should be made, the particular sizes being varied according to the log. In this way complete utilization is most nearly attained. It is also desirable to saw the log in such a way as to produce lumber of maximum grade values.

The size and grade standards for merchantable items are given in grading rules sponsored by lumbermen's associations, and a sawyer should master these provisions for the species sawed. Normally, however, there is a greater demand for certain sizes or grades than for others. The effect of this is to limit the size combination that can be used. For instance, the nominal widths specified under softwood rules include each inch class from 3 to 12 inches, but a market rarely exists for widths of 7, 9, and 11 inches. Likewise, for some softwood species, No. 1 Common boards are in little demand, whereas No. 1 Common dimension is readily sold. Since softwood is graded from the best face, usually the sawyer can estimate the approximate grade before setting is done and readily substitute dimension for boards.

The several methods of sawing softwood logs differ mainly in the sequence used in turning. The two objectives of a sawyer are to recover maximum grade values and get maximum volume production per hour. It is not possible to get both by any one method: either the frequent turning required to recover the maximum grade values reduces volume, or the minimum turning necessary to get maximum production sacrifices grades. In order to get a balance between grade values and production volume, turning procedure must be varied in accordance with log qualities, sizes, and mill facilities. No rigid set of instructions can be universally applied. The ones suggested are commonly used and provide the beginner with a definite starting point.

The turning sequence is easily identified by terming the first log face to be sawed, face 1, after which faces 2, 3, and 4 will be turned in a sequence starting from the top and ending with the bottom, face 3 being opposite face 1. Greater production volumes are possible by using the 1–3 sequence; better grades usually result from some combination of 1–2–3–4.

In sawing logs, the sequence in which faces can be sawed is limited by the requirement that adjoining sawed faces must be at right angles. To insure this, the first face sawed must be turned to the bolsters or to the knees. On mills equipped with dogs incapable of preventing the log from turning while face 1 is sawed, a slab is taken from face 4 and the log turned so that face 4 rests on the bolsters. In the following instructions it is assumed that the dogs will hold the log firmly; otherwise, the outlined procedure must be changed so that face 4 is slabbed and turned to the bolsters before face 1 is worked.

For logs 12 inches or less in diameter and promising only common grades, the 1–3 sequence is used, sawing nearly to the center from face 1 and then turning the log 180° and finishing it. The dog board is usually cut to dimension size. If the first face is not worked to near the center of the log, most types of dogs will fail to hold the piece as the opposite face is worked beyond the center.

The first slab should give a face of a minimum merchantable width. In slabbing the opposite face, the sawyer adds the thicknesses and saw kerfs remaining to be cut and so slabs the piece as to end up with a dog board (the final board) of proper size. In practice the second face to be cut is brought to the saw line to give a tentative face of minimum width, and the sawyer then decides whether a thicker slab is required in order to have a dog board of proper size at the finish.

For logs of common-grade quality exceeding 12 inches in diameter, the 1–3 sequence has disadvantages. The edgerman is prone to lose potential footage in the wide center boards through improper ripping. Lumber from rip lines along or near the pith tends to crook in drying. For such logs, a 1–2–3 sequence is recommended if turning is done with cant hooks, or a 1–3–2–4 sequence if powered equipment is used that turns the log up and over. In using the 1–2–3 sequence, faces 1 and 2 are slabbed to give boards of minimum width, and face 3 to end with a dog board of proper size. In the 1–3–2–4 sequence, face 1 is slabbed to give boards of minimum width, face 3 to end with a cant thickness of 6, 8, 10, or 12 inches instead of a dog board, face 2 to give a face of minimum width, and face 4 to give a dog board of proper size as sawing is completed.

A secondary refinement in sawing of common grades is that knots should be toward the center and away from the edges of sawed stock. Thus, insofar as is possible, the log should be placed on the carriage so that the visible knots will be toward the center of the face rather than at the margin.

The recommended practice for logs promising a portion of their lumber in grades above common is to place the high-grade faces to the saw and taper-saw them (parallel to the bark). If all but one of the faces is clear, the log is placed with the poor face to the saw, slabbed, and turned to face 2 on mills employing turn-down equipment. Before face 2 is sawed, the small end of the log is set out to get a slabbed face of uniform width the length of the log. After slabbing to a face of minimum width, this face is sawed until the grade drops to common.

The log is next turned to bring face 3 to the saw, which is slabbed and sawed as was face 2. By slabbing face 1 as instructed, face 3 will be taper-sawed without setting out the small end. Next the log is turned to face 4, the small end set out as for face 2, and this face is sawed until common lumber develops. Before turning to another face the taper is taken out by retracting the taper blocks, bringing the cant against the knees, and sawing the wedge so as to have a cant thickness of 6, 8, 10, or 12 inches. If short pieces are merchantable, one or more short boards are taken in straightening the cant. In order to end up with a dog board of proper size, the sawyer adds the thicknesses and saw kerfs remaining to be cut and slabs accordingly on the third and fourth faces of the log.

If two adjoining faces are clear, the log is placed so that one poor face is to the saw and the other is up. Face 1 is slabbed and may be sawed lightly, then face 2 is brought to the saw and treated likewise. Faces 3 and 4 are successively taper-sawed deeply without use of taper blocks.

If two opposite faces are clear, the log is placed with a clear face on top. After face 1 is worked as described above, face 2 is brought to the saw, the small end of the log is set out, and this face is worked until common lumber develops. Next, face 3 is sawed as described for face 1. Face 4 is taper-sawed after the small end is set out, and before the cant is turned to another face it is straightened as previously described.

A log with a single clear face is placed on the carriage with this face against the knees, thus permitting this face to be taper-sawed without use of taper blocks. These instructions are for mills employing equipment which turns down logs. For mills turning up, the log is turned either 180° or 270° after face 1 is worked and the procedure modified to conform to this different turning system. Small mills deriving no premium from upper grades "saw around" large logs as described, except that the small end is not set out.

Rough softwood lumber that is later to be surfaced, or surfaced and patterned, must be edged and trimmed to widths and lengths that allow for the manufacture of finished lumber of definite size standards. Usually nominal widths are 3, 4, 5, 6, 8, 10, and 12 inches with even-foot lengths. A flitch that can be edged and trimmed to produce a board of 9-inch nominal width and 11-foot length, but cannot be made 10 inches wide by 12 feet long, should normally be sized to 8-inch nominal width and 10-foot length. Since wane is excluded from surfaced or patterned material for most items, edging and trimming should remove wane that will not be surfaced out.

A simple rule to guide the edgerman is that normally material should be edged to get the widest merchantable stock possible and in the maximum even-foot length, but that the width should be reduced by 2 inches wherever 4 feet or more can be gained in length. The edgerman thus tentatively estimates the even-foot length for a board of a given maximum merchantable width and decides if a width reduction of 2 inches allows for a length extension of 4 or more feet.

The edgerman should have definite instructions on the green width required for each width class manufactured in the mill. Basically these widths depend upon an allowance for shrinkage in drying, usually 1/16 inch per inch of width, and an allowance for planing, usually 1/16 inch per face planed. These allowances are added to the actual width standards set up for yard items in the published grading rules of the association and species concerned.

Wide pieces should be ripped into any series of widths that will raise the grade of one board above that of the wide piece. If no grade rise is possible, the piece should be ripped to produce a board 12 inches wide and the others as wide as possible, but normally avoiding 7-, 9-, and 11-inch widths. Where possible, wide pieces should be ripped so as not to intersect a knot that may fall out during seasoning, nor should material be ripped so that the pith is at the edge.

The trimmer operator trims to produce a merchantable board of the maximum even-foot length possible. Usually a 2-inch allowance in excess of the even-foot length is made when trimming.

Milling Hardwood Logs

Sawed hardwood is mainly channeled to two outlets, (1) factories using material of random width and length, or (2) construction fields using material of specified sizes. The basis for grading for the factory outlet is the degree to which the material can be worked into relatively clear cuttings. Specifications for construction material are designed mainly to assure that strength properties will be adequate. Usually material dominantly free of defects commands a higher price in factory outlets, whereas the construction fields can use to better advantage material containing defects but otherwise fulfilling strength requirements. If the mill can sell construction material, the lower-grade logs or lower-grade sections of quality logs are usually sawed to such items. The change from factory material to construction items varies with local conditions, but operators normally try to saw material grading below No. 2 Common into construction items.

The market price per thousand board feet for upper grades of factory lumber usually increases with stock thickness. Recommendations cannot be made that all small mills should cut thick stock, because the limited production at a small mill can result in excessive handling costs. The cutting policy with respect to the type of products from the lower-grade portions and the thick stock from the higher-grade portions should be determined for each individual mill.

The price structure for the standard grades for the factory outlet is such that No. 3 Common usually fails to return production costs, No. 2 Common approximates costs, No. 1 Common yields a moderate profit, and Firsts-and-Seconds returns a large one. For Firsts-and-Seconds and No. 1 Common the market price increases appreciably with thickness; for No. 2 and No. 3 Common in factory outlets the price advantage for thick stock is inappreciable. For this reason the higher-quality material is sawed into items of random width and length, and the lower-quality material into items of specified widths, thicknesses, and lengths.

The actual sawing practice for grade-sawing factory lumber should be to work the high-grade material from the better faces by taper sawing and then to turn to a different face as the grade drops below that promised by adjoining faces. This process of working around the log is usually profitable if it results in raising the grade from No. 3 Common to No. 2 Common.

As the log is transferred to the carriage, the sawyer should decide on how to divide it into four cutting faces and on the probable sequence to be followed in sawing them. Deciding on one face automatically fixes the other three. A mirror at the deck end of the track reflecting a view of the end farthest from the sawyer as the log is against the knees is helpful in judging the influence of end defects in determining faces and probable sawing sequence. In the following description, face 1 is to the saw, face 2 on top, face 3 against the knees, and face 4 on the bolster for initial sawing.

For clear, straight, sound logs with the pith at the approximate center it makes no difference how the log is divided into faces, and the cutting sequence from one face to the next is that involving the least delay. Thus, at mills turning down, the cant is turned down 90°. At mills turning up, the cant is turned at least 180° from the first face. If the pith is off center, the log should be placed so that one face is perpendicular to the longest radius.

Logs with straight cracks are placed so that the crack is at the board edge that is to be taken out in edging (fig. 116, *A*). The log is placed so that the crack coincides with the radius that is 45° to the bolster and toward the saw. If, however, face 2 promises high-quality material and hence should be taper-sawed, a slab is taken from face 4 before turning to face 1. At right-hand mills turning down, the cutting sequence usually is face 1, 2, 3, and 4. At right-hand mills turning up, the sequence is usually face 1, 3, 4, and 2.

Logs with spiral cracks (fig. 116, *B*) are placed so that one end of the crack is as for logs with straight cracks and the damaged zone is downward and back toward the knees. At mills turning down, the first face is usually sawed until the crack appears on a board edge, after which the other faces are successively worked; but where spiral cracks extend for one-third or more of the circumference, the unaffected faces are sawed deeply before short pieces are cut from affected faces. At mills turning down, face 1 is worked lightly, face 2 deeply, and the cant finished on face 3. At mills turning up, face 1 is worked lightly, face 3 is slabbed, face 2 is worked deeply, face 1 is worked nearly to the pith, and then face 3 is finished.

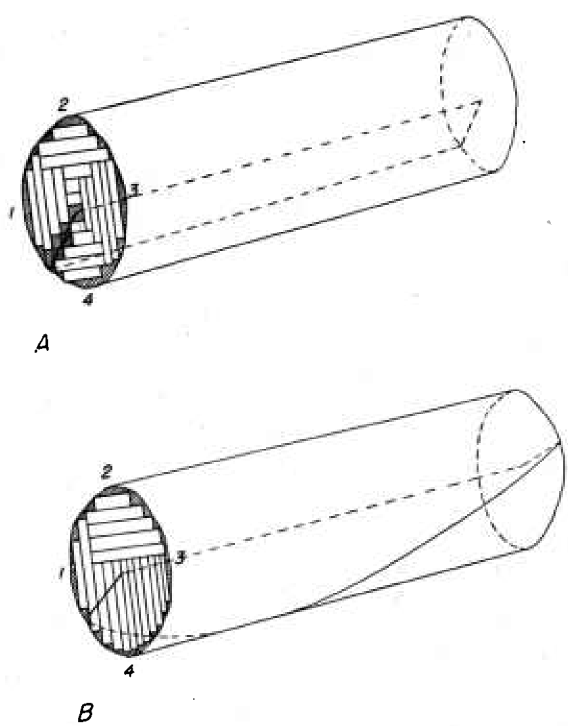

FIGURE 116.—Sawing procedures for cracked logs. *A*, For log with straight crack; *B*, for log with spiral crack.

Shake, rot, or spider heart (several splits radiating from the pith) that is restricted to the center does not influence the manner of dividing the log to faces or sawing sequence. The unmerchantable core is boxed and discarded. Logs with shake or rot in the outer zone are placed on the carriage in such a way that a cutting face is parallel to the straight line connecting the ends of the arc of shake or the long axis of the rot area, and the face affected is sawed last.

Logs with worm holes (grub, shot, or pin) should be placed on the carriage so that faces visibly free from holes are sawed before the log is turned to the affected areas.

Indicators of degrading defects listed up to this point usually are detected from the ends of the log. Indicators detected from surface inspection, such as adventitious bud clusters, bird pecks, bulges, bumps, burls, butt scars, cankers, conks, holes, knots, overgrowth, and wounds, can be treated as a group insofar as they influence the manner of dividing the log into faces and the sawing sequence. Logs will include the full range between those with few indicators affecting a localized area and those with many that are dispersed over the entire surface. Surfaces free of indicators are determined as the basis for initially placing the log, and it is then successively turned so as to cut the high-grade material from these faces before deep cuts are made into the defective ones. Thus, for a log with three high-grade faces, the defective one should be slabbed and turned down 90° or up 180°, depending on mill practice, the defective face being sawed last.

Logs with two adjoining high-grade faces are slabbed on each of the low-grade faces. On mills turning down, they are then placed with one high-grade face up and the other to the saw. After the first high-grade face is sawed the log is turned down 90°. Where turning up is practiced, the log is placed with one high-grade face to the saw and the other down, and after the first face is sawed, the log is turned up 90° and successively worked around.

Logs with two opposite high-grade faces are placed with one to the saw regardless of the turning method. After the high-grade material is sawed from this face, the log is turned down 90° at mills having turn-down equipment, slabbed, and turned down 90° to saw the high-grade material from the other good face. At mills having turn-up equipment, the first face is sawed, the log is turned 180°, and the other good face is sawed.

A log having a single high-grade face is placed with this face against the knees. At mills turning down, a 90° turn is used for successive faces. At mills turning up, the turning sequence after the first face is sawed is 180°, 90°, and 180°.

Where a clear face adjoins one having one or more defects that seem likely to be removed in edging, the log is placed so that these defects will be near the edge of the defective face. Cankers, conks, holes, and large dead knots, however, are indicative of extensive defects not likely to be removed by edging, and the sawyer should center them on the poor face (fig. 117).

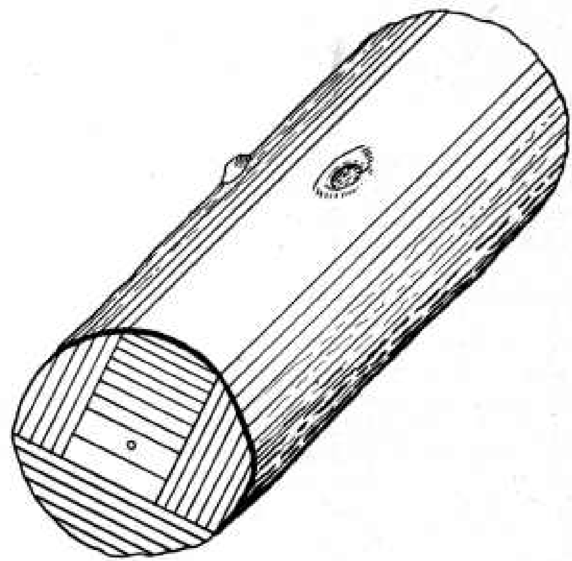

FIGURE 117.—Method of sawing log with small sound knot and large dead knot.

Logs with sweep should be placed on the carriage with the crook out, and the four faces should be successively worked in the sequence dictated by turning equipment. Better grade recovery usually results when the widest boards are cut from the faces that are at the top and bottom with reference to the first face sawed.

It is important that the location of faces be fixed in accordance with the factors outlined. The high-grade faces are usually sawed parallel to the bark and the low-grade ones in the most convenient way to speed up the work. If a high-grade face is opposite a low-grade one, the good one should be sawed parallel to the bark. This can be done either by placing the poor one against the knees and setting out the small end of the log, or simply by placing the good face against the knees and slabbing the poor face first.

If the high-grade faces are opposite each other and the log is characteristically free of defects nearly to the pith (as with red oak, ash, and yellow-poplar), one good face is placed against the knees and the other is partially sawed without regard to parallelism. If the log is characterized by interior defects that extend beyond the pith zone (as with sugar maple and birch), the small end is set out enough to permit cutting a slab of uniform width the full length of the log. When the opposite good face is turned to the saw, this process is repeated; but after this face is cut and before the log is turned to another, the cut is "straightened" by retracting the taper levers, setting the small end back against the knees, and sawing the face to produce a cant with opposite faces parallel. The purpose of this is to take out the taper from the low-grade material in the core instead of from high-grade material in the outer zone.

When slabbing parallel to the bark, the face of the slab should be the minimum width required by the prospective board grade—6½ inches for grades above No. 1 Common and 3½ inches for No. 1 Common or lower. With any face, a 4/4 cut is usually taken next to the slab in order to minimize edging waste, but if the face is opposite a previously sawed one, the sawyer slabs so that the final piece will conform to the size requirements, thicknesses, or widths of the intended item. Faces indicative of high-grade material are sawed deeply, those indicative of low-grade lightly. The usual practice is to continue sawing a face until the grade drops to that promised by the adjoining faces. This progressive turning continues until either the central portion is sized to meet construction item specifications or until the grade improvement fails to pay. For small mills that specialize in cutting factory lumber, such turning is justified as long as lumber better than No. 3 Common can be cut.

Procedure for Edging

Material for factory outlets is normally edged to get the maximum width possible in inches and fractions; for construction item outlets, it is edged to conform to definite width specifications.

The minimum width for dry factory lumber is 6 inches for Firsts-and-Seconds and 3 inches for Common. Normally, a shrinkage allowance of $\frac{1}{16}$ inch per inch of width is made, so that green Firsts-and-Seconds should be at least 6⅜ inches and green Common at least 3 3/16 inches in width. Boards are usually edged with the narrower (bark) face up.

Boards below Firsts-and-Seconds are edged so that the surface area of the wane or rot left on the board is approximately equal to the area of sawed, sound face of the edging (fig. 118). For Firsts-and-Seconds, wane and rot cannot exceed one-twelfth the surface measure nor aggregate more than one-half the length of the piece. Shakes and splits in Firsts-and-Seconds cannot aggregate in inches more than twice the surface measure of the piece in feet nor diverge more than 1 inch per foot of length unless they aggregate 1 foot or less in length. They should be removed by ripping or trimming if they violate this requirement in Firsts-and-Seconds or extend more than one-third the length of the piece in Common grades.

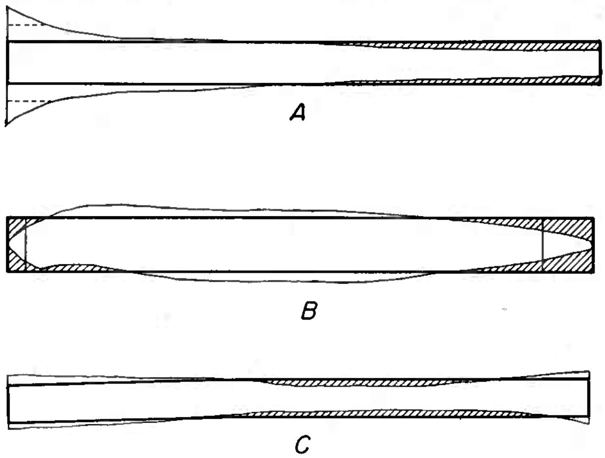

FIGURE 118.—Examples of first boards under slabs requiring edging and trimming in grades below Firsts-and-Seconds. *A*, From butt log, edged; *B*, from convex face of crooked log, edged and trimmed; *C*, from concave face of crooked log, edged.

All pieces exceeding 16 inches in width should be ripped if the grade of the resulting two boards does not fall below that of the wide piece.

Boards are ripped to raise the grade when one-half or more of the original surface measure is raised at least one grade.

Material for construction outlets is edged to conform to definite width requirements. Items may be made from a limited number of species and sized to a restricted series of widths, thicknesses, and lengths—as for car stock and construction boards. The sawyer, edgerman, and trimmer must know the size, species, and allowable-defect provisions of grading rules for such items. The $\frac{1}{16}$-inch allowance per inch of width should be made to take care of shrinkage from the green to the dry condition. Material in thicknesses exceeding 3 inches is normally edged on the headsaw. A high percentage of all construction items is produced by the headsaw from squared cants and requires no edging. The small amount requiring it is edged according to the size and quality specifications for the particular product. These products are usually so diverse that general edging instructions cannot be set down.

Procedure for Trimming

Each piece should be trimmed 2 inches over the nominal foot, and boards below Firsts-and-Seconds should be trimmed so that the surface area of the wane or rot left on the board is approximately equal to the area of the sawed, sound face of the trim (fig. 118). Where the sawed face does not reach the board end (feather ends) (fig. 118, *B*), the termination of the sawed face is regarded as the board end. For Firsts-and-Seconds, wane or rot in excess of one-fourth the affected area within 1 foot of the end must be trimmed, and at least one-half the area of this last foot must have clear face. The rule for edging boards with splits in Firsts-and-Seconds also applies to trimming them; they are trimmed so that splits aggregate no more in length in inches than twice the surface measure in feet, nor diverge more than 1 inch to the foot in length, except when 1 foot or shorter.

For construction outlets, each item is trimmed to conform with specific length requirements and with wane, shake, or crack provisions for the item as listed in the applicable grading rules.

Green Firsts-and-Seconds should be cut at least 6½ inches wide and green Common at least 3¼ inches wide.

Green stock coming from the saw should be of the following minimum thicknesses: 4/4, 1$\frac{1}{16}$ inches; 5/4, 1 5/16 inches; 6/4, 1 10/16 inches; 8/4, 2 2/16 inches. To insure this, the setworks should be accurately adjusted to permit advance at 1/16-inch intervals, and proper allowance made for saw kerf and machine variation. Few small mills can produce lumber within $\frac{1}{16}$ inch of the desired thickness.

Digest of Rough Hardwood Lumber Grades for Factory Outlets

Maximum grade recovery involves a series of operations. The tree length must be properly subdivided into logs; the logs must be properly placed on the carriage and turned to a new face as required; edging and trimming must be carefully done; and proper drying methods must be used. A knowledge of grade rules is the basis for decisions governing most of these operations.

Special rules apply to particular species, but only the most essential requirements of the three grade segregations, First-and-Seconds and No. 1 and No. 2 Common, are discussed here as a first step in understanding hardwood grade rules. With this as a framework, the special rules that apply to certain species can be obtained from rule books published by the National Hardwood Lumber Association, 59 E. Van Buren Street, Chicago 5, Ill.

Actually the sawyer, edgerman, or trimmerman will not have time to do any close grading, but must depend on his own mental picture of the grade classification gained by practice grading as described below.

With a lumber-scale rule and crayon, examine any hardwood board in the yard to determine whether it is properly manufactured and which side is the poor face. To decide if the board has been properly manufactured, note whether the cutting areas are full thickness when "shipping dry." Nominal inch lumber must be at least 1 inch thick in the thinnest part of the cutting area, 5/4 lumber at least 1¼ inches thick, and so on. Lumber 1 to 2 inches thick that varies more than ¼ inch in thickness is rejected as miscut.

Hardwoods, with minor exceptions not considered here, are graded from the poor face—the side that will grade the lowest.

From table 15, the requirements for a given grade are readily determined. It is suggested that the sample board be checked against the grading rules, starting with those for the top grade and progressing through those for the lower grades until the rule is found that fits the board and thus fixes its grade.

The detailed steps necessary in determining grade are:

1. Get the surface measure (SM) of the board with the lumber-scale rule.
2. Assume an estimated grade for the board.
3. Determine whether the board meets the size requirements (cols. 2 and 3, table 15).
4. Mark off, on the poor face, all clear-face cuttings that equal or exceed the size requirements of the estimated grade (cols. 4 and 5, table 17), drawing straight lines as would result from ripping or crosscutting or both (fig. 119).
5. Determine the number of cuttings conforming with requirements for the surface measure taken and estimated grade (col. 6, table 15), dropping any fractions.
6. Measure, for not more than the allowable number of cuttings, the width in inches and length in feet of each cutting, making no allowance for saw cuts.
7. Multiply the width (inches and fractions) by length (feet and fractions) of each cutting.
8. Add all results obtained under step 7.
9. Determine the number of units required for the surface measure and estimated grade (col. 7, table 15).
10. If the total obtained by step 8 equals or exceeds the number of units determined in step 9, the board is at least as good as the estimated grade. Examples of this procedure are given in table 16.

In addition to the requirements listed in table 16, there are limitations of defects on the piece outside of the cuttings. For Firsts-and-Seconds these limits are: (1) For wane, 1/12 of surface measure (9-foot scale x 12 = 108 square inches); (2) for pith, when the length

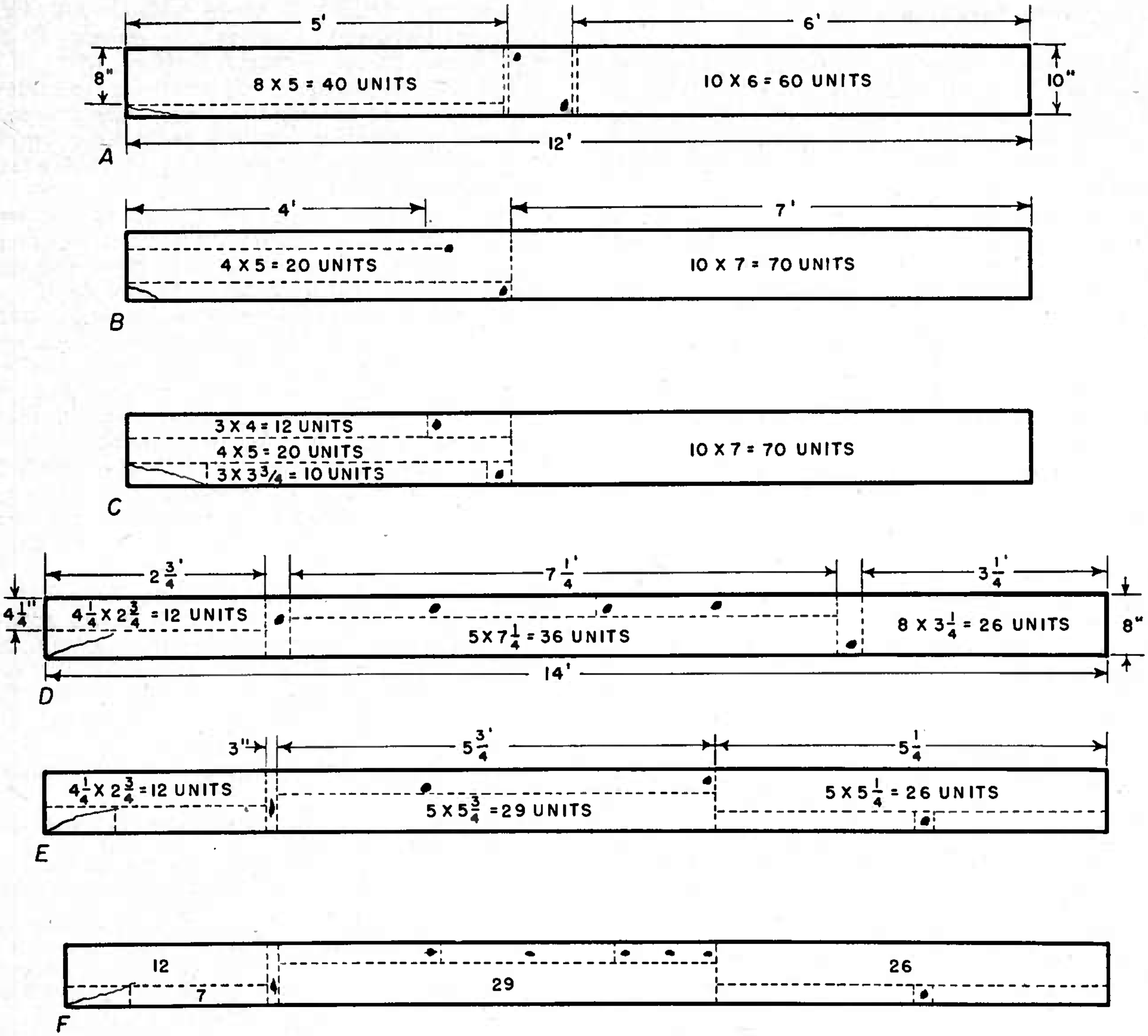

FIGURE 119.—Examples of how to delineate cuttings and compute areas for hardwood grade classification. *A*, *B*, and *C*, pieces with knots in center; *D*, *E*, and *F*, pieces with knots along edges.

of pith in inches equals the scale in feet (9-foot scale = 9 inches); (3) for a knot or hole, when its size in inches equals 1/3 the scale in feet (9-foot scale x 1/3 = 3 inches), the boundary of a sound knot being taken where the trunk wood and branch wood meet, as in figure 120; for a split, when its length in inches equals twice the scale in feet (9-foot scale x 2 = 18 inches). For No. 1 Common, pith is limited to ½ the length, and for No. 2 Common, it is limited to ¾ the length of the board.

A cutting is a portion made by imaginary ripping, by cross-cutting, or by both. In measuring the dimensions of cuttings, no allowance is made for saw cuts. Clear-face cuttings are free of defects other than sound burls, permissible streaks, and similar acceptable blemishes on the grading face of the board; the other side may have sound defects, but rot, pith, shake, and wane are excluded. Sound cuttings are free of rot, pith, shake, and wane on the face or back.

There is no difference in grading because of thickness, ½, 1, 2 inches, and all other thicknesses being graded on the surface-measure scale.

Lengths are measured back to the full foot. A piece 11 feet, 11 inches long is counted as 11 feet. Only 50 percent of odd-length pieces are

TABLE 15.—*Summary of hardwood board and cutting requirements for three key standard grades* [1]

Grade	Smallest board permitted		Smallest cutting permitted [2]		Maximum number of cuttings [3]	Least number of units required [3]
	Width	Length	Width	Length		
(1)	(2)	(3)	(4)	(5)	(6)	(7)
First and Seconds (FAS)	*In.* 6	*Ft.* 8	*In.* 4 or 3	*Ft.* 5 or 7	$\frac{SM}{4}$ and not more than 4	SM x 10
					Alternate for boards 6- to 15-foot SM: $\frac{SM}{4}+1$	SM x 11
No. 1 Common	3	4	4 or 3	2 or 3	Boards 1 foot SM, 1	SM x 12
					Boards 2 feet SM, 1	SM x 9
					Boards 3 to 4 feet SM, 1	SM x 8
					2	SM x 9
					Boards 5 to 7 feet SM, 2	SM x 8
					3	SM x 9
					Boards 8 feet SM and over: $\frac{SM+1}{3}$ and not more than 5	SM x 8
No. 2 Common	3	4	3	2	$\frac{SM}{2}$	SM x 6
					Alternate for boards 2 to 7 feet SM: $\frac{SM}{2}+1$	SM x 8

[1] Digest from National Hardwood Lumber Manufacturers Association Rule Book.
[2] The smaller of the two widths given, or the smaller of the two lengths, governs FAS and No. 1 Common. Example: Cutting may be 4 in. by 5 ft., or 3 in. by 7 ft., for FAS.
[3] SM=surface measure.

admitted, those in excess being taken as the next lower even foot.

All thicknesses of random-width lumber are scaled surface measure with a lumber-scale rule[5] (fig. 121). They are tallied as the full-foot figure between the vertical lines. If two read exactly on the half-foot mark, one is counted at the lower and the other at the upper even foot. Surface measure is determined by estimating or measuring the length of the piece, then laying the lumber rule across it so that the metal end plate touches the board edge. The rule gives the surface measure directly in board feet according to the length of the piece.

These condensed specifications and interpretations apply to "shipping-dry" lumber. In actual manufacture, it is necessary to remember that shrinkage must be allowed for when cutting green lumber to meet the minimum size requirements of "shipping-dry" materials. A general rule is to allow about $\frac{1}{16}$ inch of shrinkage for each inch of width or thickness. For example, the minimum width for "shipping-dry" Seconds is 6 inches; a green board sawed less than $6\frac{3}{8}$ inches wide is, therefore, likely to be less than 6 inches wide when "shipping-dry."

[5] Lumber-scale rules are manufactured by: American Rule Co., Nashville, Tenn.; Frank R. Buck and Co., 2133 Touhy Ave., Chicago, Ill.; Cleveland Rule Co., 2190 W. 59th St., Cleveland, Ohio; Lufkin Rule Co., Saginaw, Mich.; American Sawmill Machinery Co., Hackettstown, N. J.

Sawing Oversized Logs

There is no efficient method of cutting, by the "sawing-around" procedure, logs that are too large for the headsaw. The relation between saw diameter and maximum log diameter is as follows:

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

Logs having diameters slightly larger than those tabulated may be sawed by using approximately a one-eighth turn instead of the one-fourth turn common with the "turning-around" method, after as much is taken as can be sawed

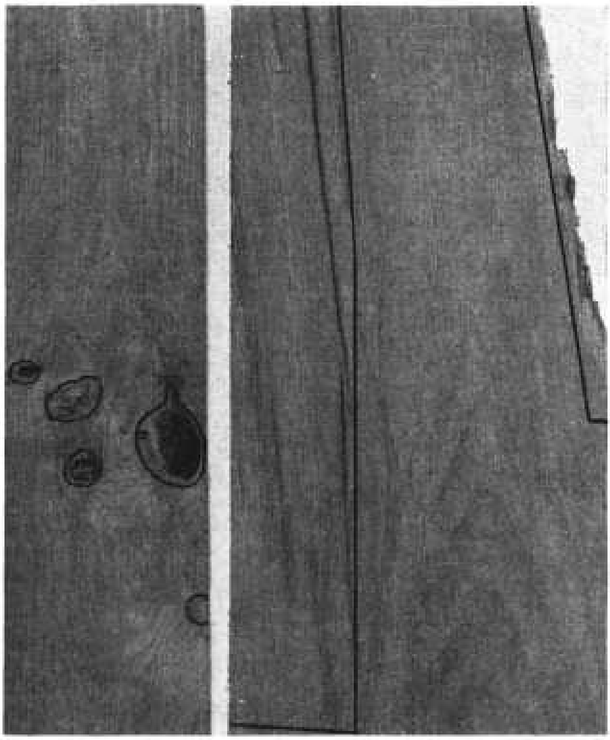

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FIGURE 120.—Defective areas of a hardwood board marked off. Left, knots; right, splits and rot.

from one face. Ultimately the many-sided piece thus formed can be squared and sawed as in normal procedure. This method is wasteful of material and time.

Logs with diameters nearly twice the height of the portion of the saw above the bolsters can be reduced as follows:

Set the log to the saw so that the saw line will be a distance from the face of the knee equal to the height of the saw above the bolsters, and cut a line (fig. 122, *A*).

Dogs must be fixed to hold the log firmly, and feed must be slow. Turn the log up exactly 90° and saw stock items, discontinuing before reaching the log pith or center (fig. 122, *B*). This series of cuts should extend exactly to the first saw line. Turn up 90° and set out the small

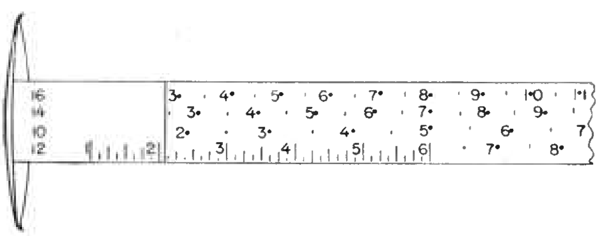

FIGURE 121.—Lumber-scale rule used in measuring lumber.

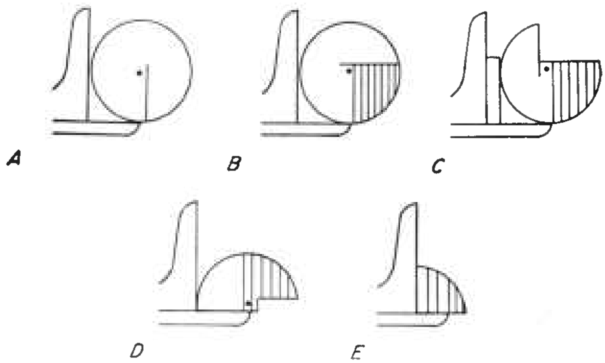

FIGURE 122.—Successive steps in sawing oversized logs. *A*, Initial cut; *B*, turned up 90° from *A* and sawed; *C*, turned 90° from *B* and sawed; *D*, turned down 90° from *C* and sawed; *E*, turned down 90° from *D* and sawed.

end, so that the ensuing saw lines will follow planes parallel to the first saw line taken. Saw stock items, discontinuing before reaching the center (fig. 122, *C*). Turn the log down 90° and saw stock items until beyond the center (fig. 122, *D*), then turn down 90° and finish (fig. 122, *E*).

Powered drag saws and chain saws are sometimes used to reduce oversized logs to segments that can be cut on the headrig.

Size Standards

Lumber, timbers, and ties must meet the precise size standards given in the official grading-rule books of the lumber associations concerned with the species in question. With timbers and ties, the sizing problem concerns allowance for sawing inaccuracies; with lumber and light framing, it concerns allowance for sawing inaccuracies and, in addition, a green-to-dry shrinkage allowance.

For most species an allowance of $\frac{1}{16}$ inch for each inch of width or thickness is adequate to offset shrinkage from the green to the air-dry condition. Thus, green lumber 34/32 inch thick should meet the requirement for 1-inch. air-dry, rough stock. Softwood yard items of lumber and light framing are usually surfaced, and may be patterned. The rules establish standard dressed dimensions for such material, and the actual minimum sizes required from rough lumber before dressing can be found by adding a $\frac{1}{8}$-inch dressing allowance to the required dressed dimensions. A nominal 1- by 8-inch S4S yard item is actually $\frac{25}{32}$ by $7\frac{1}{2}$ inches and can be made from rough, dry lumber $\frac{29}{32}$ by $7\frac{5}{8}$ inches in section, which when green is $\frac{31}{32}$ by $8\frac{1}{8}$ inches.

TABLE 16.—*Tabular method of analyzing hardwood lumber for grade*

Case No.	Figure No.	Surface measure	Estimated grade	Does board meet size requirements?	Minimum size of clear-face cuttings allowed: Width	Minimum size of clear-face cuttings allowed: Length	Clear-faced cuttings: In board	Clear-faced cuttings: Allowed	Actual dimensions of cuttings: Width	Actual dimensions of cuttings: Length	Units per cutting	Total units in allowable number of cuttings	Required units	Is board as good as estimated grade?
					In.	*Ft.*	*No.*	*No.*	*In.*	*Ft.*	*No.*	*No.*	*No.*	
1	119A	10	FAS	Yes	4	5	2	2	8	5	40	100	100	Yes
					3	7			10	6	60			
2	119B	10	FAS	Yes	4	5	2	2	4	5	20	90	100	No
					3	7			10	7	70			
3[1]	119C	10	No. 1 Common	Yes	4	2	4	3	3	4	12	102	80	Yes
					3	3			4	5	20			
									3	3¾				
									10	7	70			
4	119D	9	FAS	Yes	4	5	2	2	5	7¼	36	62	90	No
					3	7			8	3¼	26			
5	119D	9	No. 1 Common	Yes	4	2	3	3	8	3¼	26	74	72	Yes
					3	3			5	7¼	36			
									4¼	2¾	12			
6	119E	9	No. 1 Common	Yes	4	2	3	3	5	5¼	26	67	72	No
					3	3			5	5¾	29			
									4¼	2¾	12			
7	119F	9	No. 2 Common	Yes	3	2	6	4	4¼	2¾	12	74	54	Yes
									3¾	2	7			
									5	5¾	29			
									5	5¼	26			
									3	2¼				
									3	2¼				

[1] A board failing to qualify in a higher grade may be classed in the next lower grade without further checking if the total number of grade units found in testing for the higher grade equals or exceeds the total required for the next lower grade.

Circular and band headrigs are not precision machines. As much as 75 percent of the production will be $\frac{1}{32}$ inch or more outside in interval intended. If no allowances were made for such variability, as much as 30 percent of the cut would be below the size standards required. The allowance necessary to counteract this variability may be as little as $\frac{1}{32}$ inch or more than $\frac{5}{32}$ inch. The majority of sawyers allow 2/32 inch, or set for 1⅛ inch thickness when sawing inch lumber. If any scant lumber is produced by a mill set to cut 1⅛-inch stock, the owner needs to check the machine causes and correct them.

It is a widely held belief that a saving in saw kerf or precision will not be had unless an extra board results. The rationalization follows the pattern that nine boards must be taken with a ⅛-inch kerf before any saving results over the ¼-inch kerf. It can be demonstrated diagrammatically that an increase of approximately 2½ percent in softwood footage results from each $\frac{1}{32}$-inch decrease in saw kerf, and a comparable saving results from improved precision in sizing.

Under normal conditions, buyers pass up small-mill lumber in favor of that from larger mills. This is only partly due to factors beyond the control of the individual operator. The small-mill operator can size his product as accurately as does the big mill (fig. 123) but better sizing is the reason most commonly advanced for purchaser preference for the product of larger mills. By correcting the causes of inaccurate sizing, the small-mill operator can gain perhaps more benefit than by almost any other improvement in efficiency. Besides the decreased sales resistance, a greater recovery of salable products accrues because less allowance must be made for thickness variation; hence the average of all boards can be thinner. As shown by figure 123, most mills cut lumber excessively thick because they cannot be set closer to the required thickness without cutting an important percentage of stock under minimum thickness.

The causes of inaccurately cut lumber are (1) faulty condition of the saw, which may be due to teeth that are out of line with the perimeter, holders or teeth out of line with the saw

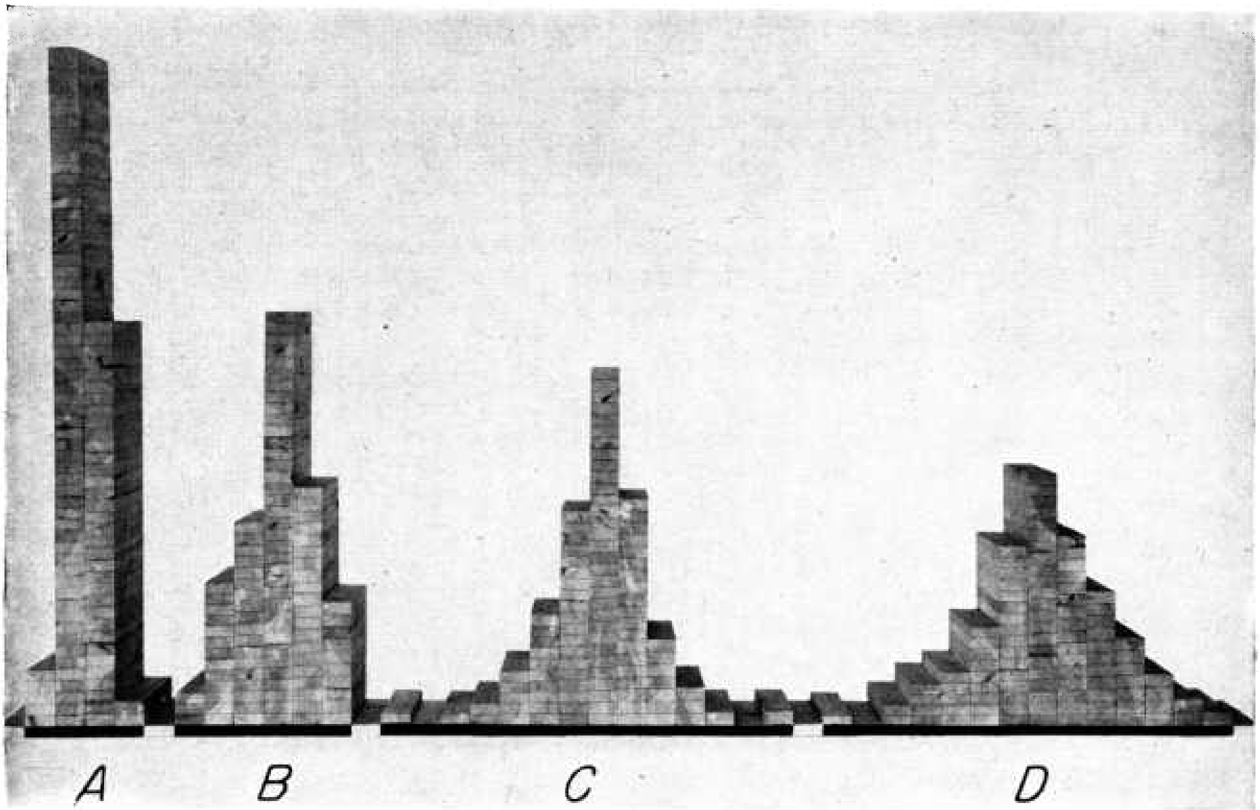

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FIGURE 123.—Thickness variation in inch lumber produced by *A*, a sash gang saw; *B*, a good circular saw; *C*, average of eleven band saws; *D*, average of six circular headsaws. Each pile has 100 blocks. The blocks in each vertical tier for each pile are uniformly thick but differ one thirty-second inch in thickness from those adjacent. Tallest tier in each represents the thickness set for. Comparative range of thickness in each pile indicates sash gang to be most accurate and average circular least accurate.

plane, excessive or uneven swage, teeth that are dull on one side, or incorrect tension; (2) worn bearings in the mandrel, the carriage wheels, or the setwork; (3) poor installation of the carriage and saw; (4) lodging of chips between the log and headblock or on the tracks; (5) careless setting or miscalculation; (6) inaccurate manipulation of the dogs, or use of types of dogs mechanically unfit to hold the log firmly; and (7) frozen timber or unequal stresses in the wood.

Common Causes, Results of Faulty Sizing

1. *Dog board thicker or thinner at top than at bottom edge.*—Faulty alinement of the saw and headblocks will cause unequal thickness of the dog board. The knee face should be at right angles to the top of the bolster, and the saw plane should be parallel to the knee face. The specific cause of this type of inaccurate sizing can be in the track, carriage, or saw mandrel.

The cause of the misalinement can be checked by stopping the carriage so that the headblock is opposite the saw, placing one leg of a carpenter's square along the top of the bolster 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 bolster top, the adjustment is faulty. Each headblock should be checked. The simplest way to correct this difficulty usually consists of leveling the track, but where faulty alinement is due to worn headblocks, they should be replaced. Bolsters should be firmly anchored to the carriage bed.

2. *Dog board thicker at one end than other, or varies in thickness between ends.*—Variations in thickness along the length of the dog board may be due to a twist or dip in the track, to side play between carriage frame and wheels, to misalinement of knees, or to end play in the saw mandrel. Track alinement can be checked by stretching a fine brass wire just clear of the top of the guide rail from the deck to a distance of a carriage length beyond the saw, so that any deviation or dip of this rail can be detected. Side play can be detected by giving

the carriage frame a vigorous sideward shove.

The check on knee alinement consists of setting the faces of the knee so that they are about 2 inches from the front of the bolsters. To do this, the carriage is stopped so that the front knee is opposite the saw. The exact distance from saw blade to knee face is then measured, the place on the saw where measurement is taken being marked; the rack of the knee should be tight against the pinion of the set shaft. Next, the carriage is moved to bring the next headblock opposite the mark on the saw and measurement is taken as for the first block as before. This procedure is repeated for all headblocks. All readings should be identical. Differences in readings may be due to a sprung set shaft, to a worn rack and pinion, or to loose or worn keys on the pinion. Most mills provide for some adjustment, either by resetting the rack or by recoupling the segments of the set shaft, but worn parts call for replacements.

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.

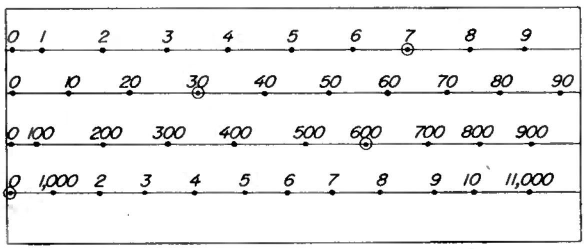

FIGURE 124.—Board-peg lumber tally board.

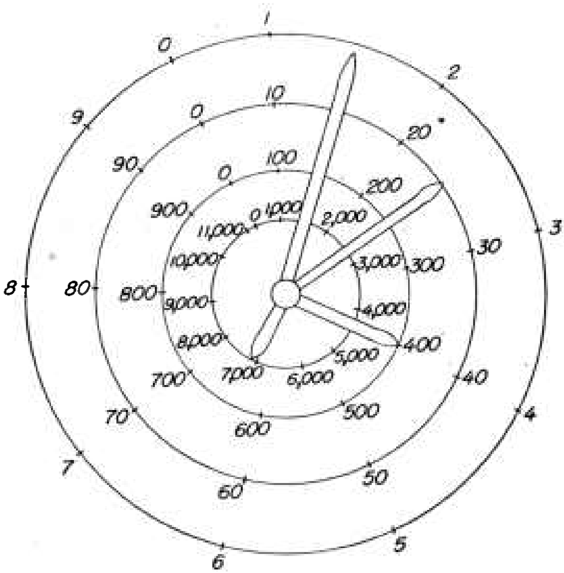

FIGURE 125.—Dial-pointer lumber tally board.

3. *Failure consistently to cut boards of similar thickness.*—Inconsistent thickness may be due to causes already listed or to the dogs, setworks, or saw. One source of inaccurate sizing is inherent in the setworks mechanism of many small mills, the pinion-rack connection being so loose that the knee can be moved backward or forward as much as one-half inch without recourse to the set lever. Such looseness also results from worn gears. With fast feeds this looseness can cause a light cant to pull toward the saw; or, if unbalanced stresses are present in the cant, one or more headblocks can be pulled toward the saw. Faulty sizing also results from play in the setwork gears, or in the pawl contacts. Either is usually traceable to worn keys, cogs, or pawls. Faulty sizing may also be due to miscalculation by the setter or to lack of a fixed backstop, which makes it difficult to set the exact interval desired in setworks.

TABLE 17.—*Lumber tally footage by lengths, widths, and thicknesses*

Nominal cross section (inches)	Footage tally for length of—					
	8 feet	10 feet	12 feet	14 feet	16 feet	18 feet
	Board feet	*Board feet*	*Board feet*	*Board feet*	*Board feet*	*Board feet*
1 x 3	2	2½	3	3½	4	4½
1 x 4	2⅔	3⅓	4	4⅔	5⅓	6
1 x 6	4	5	6	7	8	9
1 x 8	5⅓	6⅔	8	9⅓	10⅔	12
1 x 10	6⅔	8⅓	10	11⅔	13⅓	15
1 x 12	8	10	12	14	16	18
1½ x 4	4	5	6	7	8	9
1½ x 6	6	7½	9	10½	12	13½
1½ x 8	8	10	12	14	16	18
1½ x 10	10	12½	15	17½	20	22½
1½ x 12	12	15	18	21	24	27
2 x 4	5⅓	6⅔	8	9⅓	10⅔	12
2 x 6	8	10	12	14	16	18
2 x 8	10⅔	13⅓	16	18⅔	21⅓	24
2 x 10	13⅓	16⅔	20	23⅓	26⅔	30
2 x 12	16	20	24	28	32	36
3 x 4	8	10	12	14	16	18
3 x 6	12	15	18	21	24	27
3 x 8	16	20	24	28	32	36
3 x 10	20	25	30	35	40	45
3 x 12	24	30	36	42	48	54
4 x 4	10⅔	13⅓	16	18⅔	21⅓	24
4 x 6	16	20	24	28	32	36
4 x 8	21⅓	26⅔	32	37⅓	42⅔	48
4 x 10	26⅔	33⅓	40	46⅔	53⅓	60
4 x 12	32	40	48	56	64	72
6 x 6	24	30	36	42	48	54
6 x 7	28	35	42	49	56	63
6 x 8	32	40	48	56	64	72
6 x 10	40	50	60	70	80	90
6 x 12	48	60	72	84	96	108
7 x 9	42	52½	63	73½	84	94½
8 x 8	42⅔	53⅓	64	74⅔	85⅓	96
8 x 10	53⅓	66⅔	80	93⅓	106⅔	120
8 x 12	64	80	96	112	128	144

Faulty sizing from slack dogging shows up in fast feeds or when sawing cants that have unbalanced stresses ("springy" timber). Some types of dogs are better designed to hold the cant firmly than others. The "boss" dog normally grips firmly and draws the cant tight to the face of the knee. Dull tooth points, knots, or loss of the correct hook when the point is sharpened may result in faulty sizing.

The saw can be the source of faulty sizing if the mandrel has end play, if the lead is not correct, or if the fitting of plate or teeth is incorrect. 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 is more erratic than a sharp one.

(SPECIES) (GRADE) (THICKNESS) (DATE)

WIDTH	LENGTH	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	PCS
3	6																
	8	///															3
	10																
	12	//															2
	14																
	16	///															3
4	6																
	8	//															2
	10																
	12	///															3
	14																
	16	卌	/														6
5	6																
	8	/															1
	10																
	12																
	14	/															1
	16																
6	6	卌	//														7
	8	卌	卌	卌	卌	/											21
	10	///															3
	12	卌															5
	14	///															3
	16	卌	卌	//													12
8	6																
	8																
	10																
	12																
	14																
	16																
10	6																
	8																
	10																
	12																
	14																
	16																
12	6																
	8																
	10																
	12																
	14																
	16																
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	

FIGURE 126.—Tally form for softwood lumber, showing total number of pieces of various widths and lengths for a given species, grade, and thickness.

Tallying and Grading

A daily tally of green lumber cut at the mill, separated by ownerships, is kept by small cus-

(SPECIES) (GRAOE) (THICKNESS) (OATE)

SURFACE MEASURE	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	NO. PCS.	TOTAL SURFACE MEASURE
1	卌															5	5
2																	
3																	
4	卌	///														8	32
5	卌	卌	/													11	55
6	///															3	18
7	卌	卌	//													12	84
8																	
9																	
10																	
11																	
12																	
13																	
14																	
15																	
16																	
17																	
18																	
19																	
20																	
21																	
22																	
23																	
24																	
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15		

FIGURE 127.—Tally form for hardwood lumber, showing total number of pieces for each board foot of surface measure, and total surface measure. Quantities shown calculated on basis of stock 1 inch thick.

tom and tie mills. As a rule, other small mills depend upon recording the amounts of product shipped out of the yard and the amounts in the yard as shown by periodic inventories. Large mills usually record the daily production at the green chain; or, if the product is shipped green, by truckloads.

When production does not exceed 1,200 board feet per hour, a total footage tally can usually be taken without adding to the crew. For softwood or custom records on hardwoods a board peg (fig. 124), a dial pointer (fig. 125), or some similar device is used. It is operated by any crew member in position and with time to check items—usually the pile-out man. The workman memorizes the footage outrun for the range in sizes normally produced (table 17) and places pegs or moves pointers to record the footage summation.

Usually all species are lumped together, but a series of boards may be used where separate tally by species is possible. At some custom mills where edging is done on the headsaw, the sawyer records items on a tabulation sheet. Headings are written in for each size (length, thickness, and width) normally sawed and a dot placed for each item sawed. Footage is computed from these records. Where a total item count is desired, as in tie mills, a metal-cased, patented counter is available that registers totals on dials with each pull of a trigger.

Hardwoods produced for remanufacturing outlets are sawed to random widths, and a special tally rule is used to get the surface measure for each piece. An allowance of 5 percent for drying shrinkage is usually applied to this green tally. Items are recorded by species, thickness, surface footage (the board-foot tally is computed from the thickness and surface tally), and, if green grading is done, by grades on special forms.

The occasional mill that sells green lumber on grade, or that for other reasons practices green grading, stations a grader beyond the trim saw to mark the grade on each piece and enter the footage on tally sheets (fig. 126 and 127). Usually the pile-out men separate the stock to the extent feasible to make loads of one grade, species, or item, but the grader sometimes also does the piling out where production remains less than 1,500 board feet per hour.

At mills selling on a dry-grade basis and shipping rough lumber, the grader usually grades, marks, and tallies the shipped material as the piles are taken down. Items not in the grade being shipped are marked and segregated by grades, bulk-piled, and tallied when shipped.

Grading of dressed lumber is done after machining. Pieces not making the shipped grade are bulk-stored in sheds and segregated according to market requirements, such as grade and pattern. Footage for dry hardwood items is measured with a tally rule showing the actual surface footage, with no allowance for shrinkage.

SOME BUSINESS ASPECTS OF SMALL-MILL OPERATION

Efficient milling is not the only important factor contributing to a profitable operation. The actual cost of converting logs to products approximates only about one-third of total costs; the other two-thirds consists of log costs and sales expenses. The profit or success of the business depends upon keeping total costs below sales values—in other words, sound business management. A lag of several months exists between the time when investment is made in logs and that when returns from converted products are realized. Lumber prices rarely hold constant over such periods (fig. 128). Hence, success is greatly influenced not only by how well the operator adjusts his costs and volumes but by how well he anticipates future sales values.

It is impossible to set up instructions that guarantee correct evaluation of future trends, but adjustments to meet prospective market conditions can be indicated.

Several direct costs can be varied to some extent with the prospective market through such measures as direct changes in wage and servicing costs, stumpage or log prices, transporting distances, size and quality of logs, and in total log and lumber volumes carried. A low price level tends to depress wages and stumpage prices, reduce hauling distances, and curtail inventories of logs and lumber, as well as to raise size and quality requirements; a high one reverses this tendency. Certain other costs cannot be varied so readily; charges for taxes, insurance, depreciation, and management vary only with the total annual production. An increase in total annual production reduces the unit cost, and a reduction increases it. Volumes tend to shrink as price levels recede, so that normally these fixed costs increase per unit precisely when a reduction is required.

Fixed costs are relatively less for small mills than for large ones; hence, the small mills are under less pressure to operate, and can more readily suspend operations in a losing market. Some protection from the effects of fluctuating price levels can be gained through measures

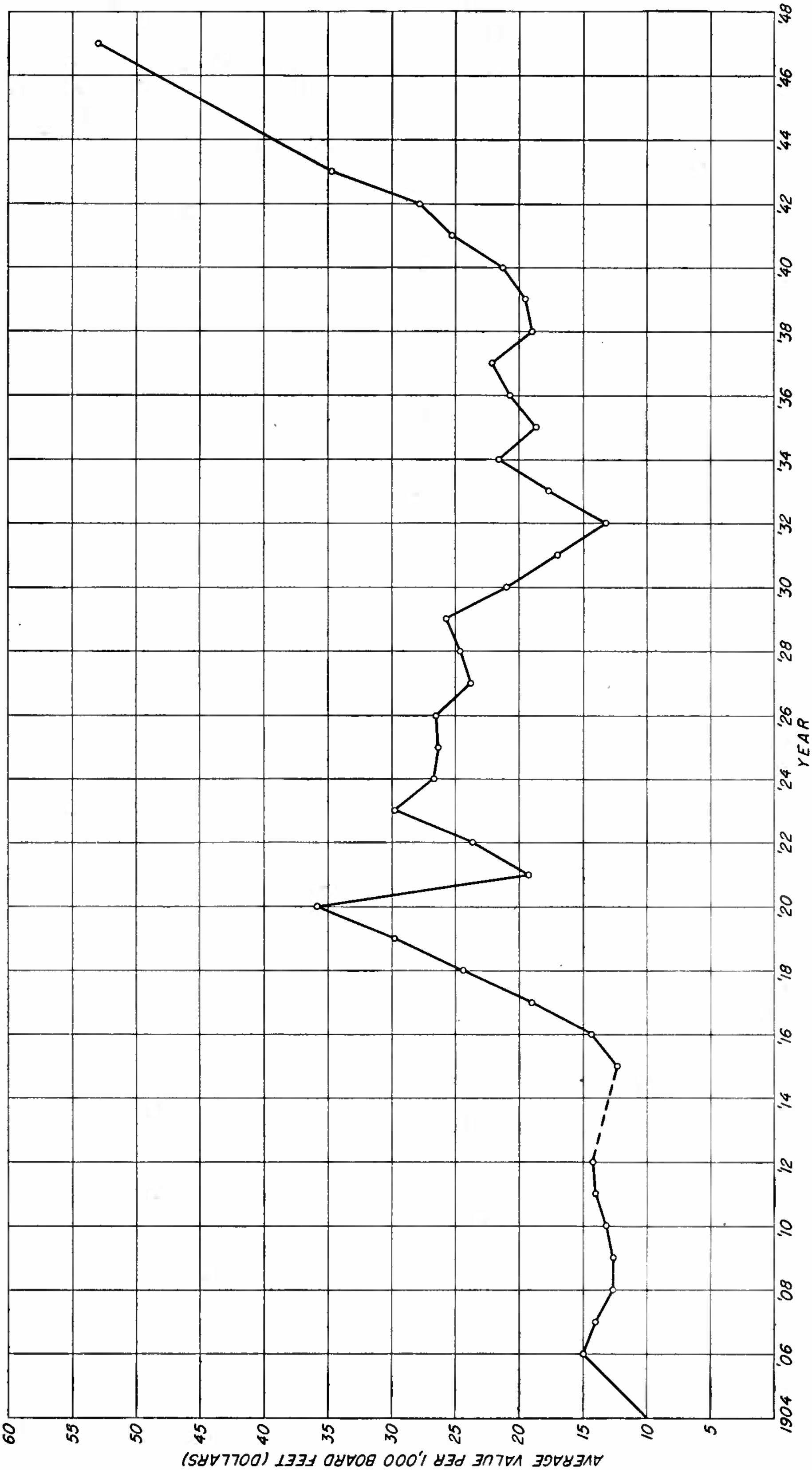

FIGURE 128.—Trend of average f.o.b. mill price of southern yellow pine lumber, 1900–47.

that reduce the inventory investment; for example, use of dry kilns permits faster turnover, or investment in stumpage or logs can be restricted.

Capital Requirements

The business mortality of small sawmill ventures is high. Aside from the hazards entailed in fluctuating price levels, the greatest single cause of this is usually the operator's failure to appreciate all the costs involved and the sum required to conduct the operation. His misconception of costs leads him into unprofitable contracts. Underestimating the capital requirements leads to excessive borrowing, forced sales, and loss of control of the business. From a broader point of view, the effect of considerable numbers of poorly financed small mills undertaking impossible contracts and under constant pressure to liquidate is to weaken the price structure of the lumber industry and wreck the forest capital. It will profit a prospective operator to canvass his probable capital needs thoroughly and to keep an accounting system when operating.

The amount of capital required to start and to keep going obviously varies with types of operations and general business conditions. For any operation, however, it can be broken down into (1) investment in equipment; (2) investment in stumpage and logs; (3) costs of conversion and marketing; and (4) reserve for contingencies.

To determine the equipment investment, the type of operation undertaken must be decided upon. Mill equipment is somewhat specialized according to products made, log size, and hourly output. An estimate of the total initial and installation costs includes this item.

The probable stumpage and log investment can be estimated by determining the customary prevailing arrangements for stumpage or log purchases and estimating the total quantity of stumpage and logs normally bought to insure adequate supplies.

The probable capital investment needed to carry conversion and marketing costs can be estimated by approximating the total sum spent over the normal period required to convert and collect. A suggested method is to list the costs recurring daily for working days, such as labor, fuel, and sustenance, and multiply these by the number of work days normally elapsing between the time the trees are cut, if the operator does his own logging, or the time payment is made for logs delivered to the mill, and the date when the receipts are at hand for a definite turnover. To this total should be added expenditures for repairs, licenses, taxes including social security, legal fees, rent, and insurance; interest on operating loans; and an allowance for depreciation. These items can usually be summed up for the year and properly prorated to the various turnover periods.

Allowance is made for contingencies to offset such items as shrinkage in quality during turnover, bad debts, unforeseen costs, extension of turnover period, abnormally large inventories, and reduced market values. It is suggested that an amount equal to 50 percent of the figure for conversion and marketing costs be allowed these items, and that this amount be added to the estimated figure for conversion and marketing costs.

Marketing

Small sawmills differ considerably in the type of product they put on the market, and for this reason their marketing techniques differ as greatly.

In general, they may be classified as (1) custom mills, (2) short-log or specialty mills, (3) mills placing a semifinished product with finishing plants, (4) mills cutting for a local market, and (5) mills putting a finished product on the general market.

The major business of custom mills, either permanent or mobile, is the sawing of relatively small individual ownerships of logs into products consumed by the owner, at a fixed rate per thousand board feet. Normal production is between 100,000 board feet and 1,500,000 board feet per year.

Operators of custom mills get customers by advertising in local newspapers, by filing a statement of services at the office of the county agent, local U. S. Department of Agriculture office, or State or extension forester,[6] and by canvassing farmers directly. Emphasis should be given to collecting for each job at completion, and records should be kept of the customer's name, the date of completion, the time charged, the amount of lumber or other products sawed, and the charge made.

Short-log or specialty mills cut a special product, such as ties, rough-sawed blanks for heel stock, shuttles, or spools, or box lumber. They are selective as to species. Individual mills usually sell the major product to a single outlet and often contract production prior to manufacture. Customers are usually contacted directly and agreements reached on specifications, conditions of delivery, volumes, price schedules,

[6] Periodical marketing bulletins are prepared in many States by the State Forester at the State Capital, or by the State Extension Forester at the agricultural college.

terms of payment, and contract period. Each party should have a written copy of the agreement, properly signed. The record for each consignment is kept by the mill operator as a check against the buyer's tally; this record includes date, amounts by items, and price.

Mills placing a semifinished product with finishing plants sell it unsurfaced and usually ungraded, or in classifications requiring regrouping for yard and industrial outlets. The operator usually sells directly to big sawmills, planing mills, box manufacturers, and, in the case of hardwoods, to wholesalers. Such an operator can use immature and low-grade timber, streamlining his costs by concentrating on a limited number of items that are in a semifinished, incompletely graded state and are sold usually to a single buyer who provides a quick turnover and prompt collections. Customers are contacted directly and recording procedure is similar to that described for specialty mills.

Mills placing a finished and semifinished product on the local market cater to local business within the limits imposed by species suitability. The usual items are surfaced framing, sheathing, subflooring, siding, interior finish, flooring, and miscellaneous material used by local industries, farms, and communities. These mills combine manufacturing and retailing and can advantageously use timber of a broad range of qualities.

Customers are reached through advertising in local newspapers and through contacts with building contractors, highway departments, local wood-using industries, county agents, and farmers. This type of business requires complete accounting that covers, for each sale, the date, the customer, the quantity and price by items together with totals, the terms of payment, and, for each account, the charges and payments made to date and the balance due. Sales slips are made in duplicate for each consignment, one copy going to the buyer and the other to the seller. This type of business should follow a conservative policy in extending credits.

Mills placing a finished product on the general market should have a production rate and quality of timber that make practical the diversification of products by grades and patterns in sufficient quantities to fill normal orders. Such mills normally produce more than 3,000,000 board feet annually, and draw upon mature timber. They sell directly to retailers, through wholesalers and commission agents, and to industrial users. Complete accounting, as outlined for mills serving local markets, is required; credit terms commonly extended by well-managed mills usually are about as follows:

1. To retailers, 60 days net from date of invoice or 2 percent cash discount of net after deducting freight, if paid within 10 days of car arrival.

2. To wholesalers, 80 percent of net, minus freight, within 15 days after date of invoice; balance, less 2 percent of total net minus freight, within 30 to 60 days of date of invoice.

3. To industrials and buyers not otherwise classified, 60 days net from date of invoice, or 2 percent cash discount if paid within 10 days. Discounts and commissions for distribution service adhere to the following pattern: (a) To wholesalers, discounts up to 8 percent on f.o.b. mill price; (b) to commission salesmen, discounts up to 5 percent on f.o.b. mill price.

When credit is extended the buyer gains possession of the lumber before he pays for it. Therefore, the seller has the responsibility of checking on the buyer as a credit risk. The financial and moral integrity of local outlets can be judged from the experience of business associates or banks, or through businessmen's ratings; that of nonlocal outlets of perceptible size and permanency can be ascertained from credit-rating lists usually available at banks, trade association offices, and large manufacturing corporations.

Accounting

Operators lacking an accounting system are likely to underestimate their actual costs, particularly in such items as depreciation, maintenance and repairs, interest on capital tied up in their business, and taxes. Following is a description of an accounting system which is suggested as a pattern to meet the requirements of small-sawmill management. The records called for under this system show the essential details of expenditures, receipts, and inventories, reflect the status of individual accounts, furnish facts for use in connection with the Fair Labor Standards Act of 1938, and permit segregation of costs and returns for income tax purposes.[7]

The pattern suggested is reduced to the simplest form necessary, and requires but a single listing of all expenditures and receipts. In the forms presented, the labor account is segregated from other expenditures in order to have this information available to meet the Federal wage-hour requirements. Individual operations may benefit from further separation of special classes of items in the purchase led-

[7] See U. S. Dept. of Commerce, Bureau of Foreign and Domestic Commerce, Industrial Series Bulletin No. 20, "Establishing and Operating a Small Sawmill Business for Additional Cash."

SALES, RECEIPTS, ACCOUNTS RECEIVABLE FOR MONTH OF FEBRUARY 1950

Date sold	Name and address of customer	Item	Number of units	Price per unit	Total value of sale	Amount paid	Date	Unpaid balance	Claims and discounts
2/6	John Doe Columbia, Va.	8/4 #2C R.L.	20.000	19.00	380.00	350.00		47.50 30.00	
	Monthly summary		150.000		2500.00	1500.00		1,000.00	30.00

FIGURE 129.—Sample sales-receipts ledger sheet. A separate record is made for each account, and is balanced at the end of the month, the unpaid balance being brought forward as the first entry for the ensuing month. Year-end balances and profit-and-loss statements will be simplified if a different colored ink or symbol is used for equipment subject to depreciation and for purchases of timber, logs, and lumber.

ger, carrying as separate accounts such items as timber and its products, interest, taxes, insurance, and rent.

Records of purchases and expenditures (fig. 129) and of sales and receipts (fig. 130) are entered currently and balanced monthly. A year-end balance is made between assets and liabilities, and the net profit or loss from the current year's operation is computed.

A balance sheet is ordinarily made yearly in small enterprises. The procedure is to balance assets (cash, accounts receivable, timber, logs, lumber, plant, and supplies) against liabilities (debts owned by the business). By definition, cash includes all cash, checks, and negotiable notes on hand at the end of the year. Accounts receivable include all collectible unpaid balances owed by customers as shown on the December 31 records of sales, receipts, and accounts receivable. Uncollectible accounts are written off and listed as bad debts for income tax purposes.

A year-end inventory is made of all timber, logs, and lumber in stock, and a value allotted them. This value should be either the cost or the market value, whichever is lower. Yard inventories are simplified if the date, item, footage, and species are marked on the pile when it is completed, for example, 1/12/50 – 4/4 No. 1 – 3,650 – Ash. Logs are inventoried by checking their footage and computing their cost or value after deducting expected transportation costs for logs in the woods or in transit. Timber is inventoried by estimating the footage and computing its cost or value.

For balance-sheet purposes, the plant consists of all buildings and equipment required for the operation. Its value should be based on material purchase price plus installation cost, and apportioned over the remaining useful life to the operation. Buildings in permanent operations are commonly discounted at the rate of 5 percent yearly (original cost divided by 20); for temporary operations, the original cost is divided by the expected life of the operation at that site. Other equipment is discounted yearly by a sum equal to the purchase cost divided by the expected life. If the item outlasts its estimated life, no value is henceforth given; if the useful life falls short of the estimated life, the undiscounted balance is subtracted from the value of all equipment. The total sum of these yearly discounts on equipment and plant is the

RECORD OF PURCHASES AND PAYMENTS FOR MONTH OF JUNE 1940

Date bought	Supplies - Services - Timber: Name and address of supplier	Item	Price	Amount paid	Date paid	Unpaid balance	Personal account--amount withdrawn from business	Date
6/1	Roe Filling Sta., Rhea, Vt.	Brt. fwd.				16.00		
6/1	. . . . . do.	100 gal. gas	15.00	12.00	6/1	3.00		

FIGURE 130.—Sample sheet of purchases-payments ledger. At the end of the month, each account is balanced and the unpaid balance entered as the first item for the succeeding month.

depreciation account required for income-tax purposes.

Supplies, as distinguished from equipment, are short-life items (less than a year), such as stock feed, gas, oil, and small tools. For the balance-sheet account, those carried into the new year are given a value as of December 31.

Liabilities include all unpaid bills as of December 31, as shown in the December record of purchases and payments.

The accounts carried to this point serve as records of individual transactions between the business, its creditors, and its debtors, and provide in the balance sheet a yearly statement contrasting assets with liabilities. A further analysis is necessary to determine the net profit or loss over the year. The items and method of making computations for Federal income-tax purposes consist of the following:

1. Total receipts (accounts paid and receivable)
2. Labor
3. Materials and supplies
4. Merchandise bought for sale
5. Other costs
6. Plus inventory at beginning of year
7. Total of items 2 to 6
8. Less inventory at end of year (cost or market)
9. Net cost
10. Salaries
11. Interest on business indebtedness
12. Taxes and insurance
13. Losses
14. Bad debts
15. Depreciation
16. Rent, repairs, etc.
17. Total (items 10 to 16)
18. Total deduction (item 9 plus item 17)
19. Net profit (or loss) (item 1 minus item 18)

Item 1, total receipts, includes all accounts paid and payable for sales of current year as shown in the total value of all sales over the year as taken from monthly totals, after deducting total claims and discounts. Accounts payable carried from the previous year (shown on the January record of sales, receipts, and accounts receivable for the current year) are not included. Accounts payable at the end of the current year for items sold within the year are included. Item 2, labor, includes all wages paid and payable for work performed within the current year, taken from the payroll form as the total-earnings summation. Unpaid wages carried from the previous year are excluded. Unpaid wages at the end of the current year are included.

Under item 3, materials and supplies, are included all purchases normally used up in a year or less. Equipment normally used for more than a year is excluded and accounted for under item 15 (depreciation). Purchases of timber, logs, and lumber are accounted for under item 4 (merchandise bought for sale). Materials and supplies thus include all such items as feed, veterinary service, shoeing of animals, oil, gas, files, bits for saws, and belt lacings. The total cost is taken from the record of purchases and payments.

Item 4, merchandise bought for sale, takes in all purchases of timber, logs, and timber products made during the year and shown in the record of purchases and payments. Under item 5, other costs, are included all exchange charges on checks, abstracting and attorney's fees, surveying expenses, and like costs.

Item 10, salaries, embraces all wage payments for regular employees not recorded in the labor ledger (fig. 131) as shown in the record of purchases and supplies (fig. 129). Item 11, interest on business indebtedness, covers interest payments made during the current year on money borrowed for conducting the business. These are taken from records of purchases and payments. Item 12, taxes and insurance, takes in all Federal, State, and local taxes, social benefit assessments, and insurance payments assessed against the business during the current year, as shown on the Record of Purchases

Work week ending______ Date of payment (f)______

Name in full (a)	Social security account No.	Hours worked: S (d)	M (d)	T (d)	W (d)	T (d)	F (d)	S (d)	Total (d)	Regular rate of pay (g)	Wages: Earnings: At regular rate of pay for total hours worked (h)	Extra for overtime (i)	Total earnings	Deductions: Federal old age insurance taxes	Other (itemized)	Total wages paid (e)	Unpaid balance	Advances
1. John Henry Doe	129-99-4231	...	8	8	8	8	8	8	48	$1.55 per hr. ($1.50 per hr. plus bonus)	$ 74.40	$6.20	$ 80.60	$ 1.21		$ 79.39		
2. Martha Jane Doe	154-99-2176	...	8	8	8	8	8	5	45	$1.25 per hr. ($50.00 per wk. of 40 hrs.)	56.25	3.12	59.37	.89		58.48		
3. Henry John Roe	356-99-4578	...	8	8	8	8	8	7	47	$1.10 per hr. ($1.90.48 per mo. on a wk. of 40 hrs.)	51.70	3.85	55.55	.83		54.72		
4. Mary Beatrice Roe	369-99-7241	...	8	8	10	8	8	8	50	$0.75 per hr. ($37.50 per wk.)	37.50	3.75	41.25	.62		40.63		
Total													$236.77			$233.22		

FIGURE 131.—The sample payroll form of the Wage and Hour Division of the U. S. Department of Labor, shown here, is, with minor additions, a convenient labor ledger. The "Employers' Digest of the Fair Labor Standards Act of 1938" issued by that division interprets provisions denoted by letters in parentheses.

and Payments. Any assessments included in the payroll form are not repeated here.

Item 13 involves losses within the current year not reimbursed by insurance to the property or stock from fire, flood, theft, and other misfortune. These losses are given a value in line with book values carried in the balance-sheet inventory of assets. They are not to be confused with item 14, bad debts, under which is lumped all credits which are uncollectible and eliminated from the assets in the balance-sheet inventory of assets. Item 15, depreciation, represents the total sum of the yearly discounts on equipment and plant (table 18).

TABLE 18.—*Useful life of mill equipment and tools as a basis for estimating depreciation*

Item	Expected life	Yearly depreciation
	Years	*Percent*
Horses	5	20
Mules	5	20
Sleds	5	20
Log wagons	5	20
Felling tools	1	100
Truck (logging)	4	25
Cats	4	25
Tractors	4	25
Shacks and buildings	[1]	----
Jammers	3	33⅓
Mill building (permanent) [2]	20	5
Steam engines	20	5
Gas units	10	10
Diesels	15	7
Edgers	10–12	10
Mill machinery	10–12	10
Trim saws	10–12	10
Rolls	10–12	10
Saws	4	25
Lumber trucks	5	20
Lumber wagons	5	20

[1] Life of operation.
[2] Temporary set-ups estimated on basis of life of operation.

Under item 16 are included all rents, payments for options and leases, and repairs on equipment not recorded under item 3 (materials and supplies), and shown in the monthly record of purchases and payments.

The method used on income-tax statements to determine the net profit or loss is as follows: To the sum of the costs of items 2, 3, 4, 5, 10, 11, 12, 13, 14, 15, and 16, add the value of the inventory taken at the beginning of the year and then subtract the value of the inventory taken at the end of the year. This represents the total costs of doing business for the year, which are subtracted from the total receipts in order to determine the total net profit or loss for the year.

Total net profit or loss per thousand board feet is found by dividing the year's net profit or loss by the number of thousand board feet sold during the year as given in the totals on the record of sales-receipts-accounts receivable.

An accounting can be begun by making a balance sheet of the business. The assets consist of (1) cash, checks, and negotiable paper on hand, (2) accounts receivable, (3) the value of timber, logs, and lumber in stock, and (4) the value of plant and supplies. The liabilities include all unpaid bills and obligations.

Enough space should be allowed in the purchases-payments and in the sales-receipts ledgers for entering under an individual account all probable purchases during the month. At the end of the month each individual account is balanced on both ledgers, and unpaid balances are entered as first items of these accounts for the succeeding month. A sheet is reserved for monthly summaries going to make up the year-end balance sheet and profit-or-loss statement, and for filling in the totals for the month for the headings suggested on the lower part of the purchases-and-payments form and on the sales-receipts-accounts-receivable form.

Public Regulations Affecting Sawmills

Sawmill operators are subject to specific Federal, State, and local regulations. The subjects covered by regulations affecting a sawmill operation usually include those following.

1. Safeguards of the health and working conditions of employees. These include provisions on sanitation of drinking water and toilet facilities, and details of spacing from wall to mill carriage, guards for saws and belts, and construction requirements and safety devices for boilers.

2. Measures designed to minimize community or commonwealth hazards; for example, control over stream pollution and refuse disposal, zoning ordinances, and fire-prevention measures.

3. Child-labor provisions.

4. Social-security taxes applying to employees on a national and, in some cases, a state basis. Each employee must have a social-security number. The assessments are for unemployment and old-age insurance.

5. Sales and excise taxes. Federal or state taxes in this category may consist of special taxes carrying over from war emergency measures, such as the Federal tax on freight bills, or more permanent tax measures, including state and city sales taxes and ton-mile tariffs on intrastate motor trucking.

6. Wage-hour regulations. Federal and, in some instances, state laws prescribe the maximum number of hours employees can be worked per day or week and the minimum hourly wage that can be paid.

7. License to do business. Such a license is required by some states.

The above list is not all-inclusive. Federal regulations apply to mills in all states. State regulations vary in scope among the different states. A mill operator should determine the rules and regulations of Federal, state, and local agencies which affect his business. Federal regulations included under the seven groups listed should be requested from the U. S. Department of Labor, Division of Labor Standards, Washington, D. C.; state regulations from the Secretary of State of the state in which the mill is located; and those of municipal units from the mayor's office.

Aside from the regulatory aspects, it is to the employer's interest to promote safety measures. It is practical for all mills to foster a consciousness of hazards on the part of workers. This can be done in the course of job training by talks emphasizing safety measures, and displaying posters and other literature published by equipment manufacturers where employees will see them.

The degree of permanency of the mill greatly influences how much can be done in the installation of guards for moving parts. Virtually all mills can install a barrier between the headsaw and the sawyer to deflect chips and fine particles. A wire screen (½-inch mesh) is adequate.

Areas occupied by workmen should have floors cleared of trash or obstacles and leveled; if planked, they should be free of loose parts or holes.

The top portion of swing saws which cut below the arbor should be enclosed in a guard and the frame equipped with a chain limiting the arc of pull. In less temporary sets, guards can be installed to prevent workers from contacting moving parts. Belts can be fenced off and posts or other barriers placed to prevent injury when flat belts break. Shafting, pulleys, gears, and similar revolving members should be enclosed to a maximum degree.

When repairs or adjustments are necessary the rotating members should be stopped. Set screws or comparable projections on a revolving member are a particularly dangerous source of accidents and should be guarded or screened from contact with workmen.

The tail sawyer should wear goggles, and all men piling or transferring material should wear heavy aprons.

Insurance

Two types of insurance are available to the sawmill owner, that which protects him against property loss and that which covers liability claims. Fire-insurance rates are relatively high for sawmills and lumber yards. Fire losses are the dominant type of disaster, but insurance may also be had against wind and cyclone losses. Liability insurance is commonly carried on trucks and automobiles to protect the owner when claims result from accidents.

SCALING AND GRADING LOGS

Logs are usually valued on the basis of quantity as interpreted by a log scale and quality as interpreted by a log grade.

Log Scaling

A number of log scales are in use. Scaling consists of noting, on the log rule, the quantity of material in a sound, straight log of the given length and average diameter inside the bark, and making deductions for the estimated amounts by which crook, shake, decay, and other defects lessen the quantity of material recoverable from the actual log being scaled.

Most log rules have been so constructed that they apply to average diameter at the small end to the nearest inch. The waste in a defective log can be computed with accuracy if its boundaries are known. The boundaries of internal defects must usually be guessed, and knowledge of the characteristics of rot, shake, and similar defects is vital to accurate work. This knowledge is best acquired by checking at the mill as to actual yields of merchantable material sawed from defective logs. The full scale minus the amount computed for defects gives the computed merchantable scale of the defective log. The details of waste computation may vary with the different log scales and other factors.

The Forest Service instructions for scaling with the Scribner Decimal C rule indicate that the amount computed for defects is usually regarded as four-fifths the squared-up portion that must be sawed out to eliminate the defect, an allowance of one-fourth inch for saw kerf being made for each inch board. The amount can therefore be found by multiplying the width by the height of this squared portion in inches, and that product by the length in feet, dividing the final product by 15.

For internal defects, such as hollows, rots, shake, and cracks, an allowance of 1 inch is customarily added to both their height and width. Where a defect is visible on both ends of the log, the larger visible area is used in computations; if it is visible only on one end, the length of the defect is estimated.

For external defects, such as fire scars, the only portion considered is that which is not slabbed off when the saw is started an inch inside the bark at the small end and sawing is done parallel to the axis of the log. In computing the affected portion of the log, the greatest depth, average width, and total length of the defect are used.

For crooked logs, it is customary to assess a length penalty sufficient to compensate for the waste. Thus, a 16-foot log may be scaled as a 14-foot, or even a 12-foot log, of similar diameter. The beginner can check this estimate as follows.

Estimate the length of the straight section. If the crook is nearer the top end, the waste becomes a portion of four-fifths of a squared piece with a depth corresponding to the distance the crook distorts the end of the log from straightness; that is, the distance from the top inside bark of the straight section of the log to the top inside bark of the crooked section (fig. 132, *A*, line *a—b*); the length is the number of feet to the crook (line *a—c*); the width is the average in inches of a slab face starting an inch inside the bark at the end of the crooked section and extending through the crooked section on a plane parallel to the axis of the straight section.

If the crook is nearer the bottom end, the depth of the squared-up portion is the distance in inches from a line parallel to the axis of a straight log, starting an inch inside the bark at the top, to an inch inside the bark at the lower end (fig. 132, *B*, line *a—b*); the length is the distance in feet back to the crook (line *a—c*); the width in inches is the average face width of the cut from an inch inside the bark at the lower end back through the crook, taken

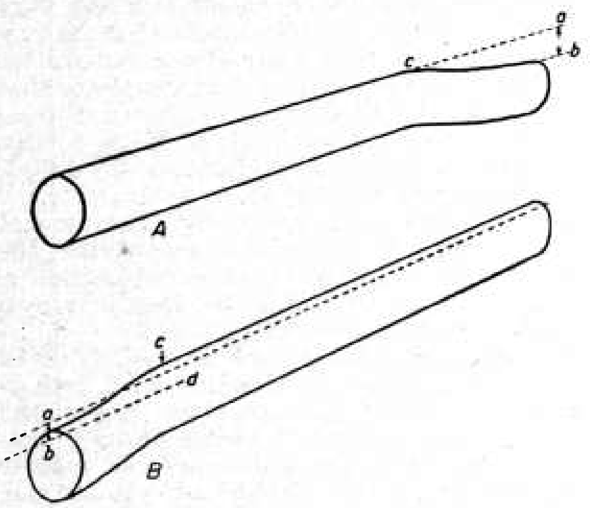

FIGURE 132.—Method of deducting for crook in scaling crooked logs. *A*, Crook near top end; *B*, crook near bottom end.

parallel to the axis of the straight section (line *b—d*). Since some of this square piece can be recovered, the scaler must estimate the portion lost (one-half, one-third, or more of four-fifths the volume of the squared piece) and subtract this from the scale of a straight log. The reduction in length that gives the nearest comparable scale is used in reducing the length when proficiency is attained.

Log Grading

The practice of purchasing and selling logs on a log-grade basis is gaining acceptance because prices can be correlated to the variability between logs in value per unit of product. By such grades, logs are usually segregated according to quality into high, medium, and low classes, each showing a substantial differential in average lumber values. Log grading, like scaling, requires individual log examination but should decrease the risk of incorrect appraisals.

The buying and selling of logs on a log-grade basis has resulted in the use of many log-grade specifications. Some standardization has been reached in the case of black walnut and for several species of the Pacific Northwest. Specifications relating to black walnut are promulgated by the American Walnut Manufacturers' Association, 616 S. Michigan Avenue, Chicago 5, Ill. Those relating to Douglas-fir, Sitka spruce, western hemlock, noble fir, Port Orford white-cedar, western white pine, and silver and white fir are issued by the Columbia River Log Scaling and Grading Bureau, 708 U. S. Bank Building, Portland 4, Oreg.; Puget Sound Log Scaling and Grading Bureau, 4459 Stuart Building, Seattle, Wash.; and Grays Harbor Log Scaling and Grading Bureau, Finch Building, Aberdeen, Wash.

Descriptions and discussion of defects that may affect the grade of hardwood logs of some species will be found in U. S. Department of Agriculture Handbook No. 4, "Log Defects in Southern Hardwoods" (for sale by Superintendent of Documents, Washington, D. C., at 25c a copy).

Specifications that have gained considerable acceptance as applying to hardwoods are described in Report No. D1737-A, "Hardwood Log Grades for Standard Lumber and How to Apply Them," issued by the U. S. Forest Products Laboratory, Madison 5, Wis. Specifications for eastern softwood species have not thus far received so much recognition as those for other kinds mentioned here. However, experimental work is underway on certain of the eastern and southern softwoods. Pending the development of better log-grade specifications, those currently available are given in table 19.

TABLE 19.—*Log-grade specifications for some eastern softwood species*

Species	Log grade	Minimum sizes: Diameter	Minimum sizes: Length	Maximum defect permitted	Surface requirements on visible faces
		Inches	*Feet*	*Percent*	
Eastern white pine	1	13+	8+	10	Surface clear.
	1	13+	10+	30	Must be 50 percent clear in cuttings at least 8 feet long or one face clear full length.
	2	9+	10+	30	Sound, tight knots not larger than 2½ inches in diameter. Occasional larger knots permitted if others are not larger than 2 inches.
	2	17+	8+	40	Tight knots not over 3 inches in diameter. Occasional larger knots permitted if others are tight and not over 2½ inches in diameter.
	3	6+	8+	50	Any log below No. 2 generally sawed. Logs with knots 4 inches or more in diameter in whorls less than 2 feet apart not accepted unless ¼ full length has knots 2 inches or less in diameter.
Spruce and balsam	1	8+	12+	20	Sound, tight knots not over 2 inches in diameter or in whorls not closer together than 2 feet.
	2	8+	10+	50	Sound, tight knots not over 3 inches in diameter in whorls not closer together than 2 feet unless ¼ full length has knots only 2 inches in diameter.
Eastern hemlock	1	8+	10+	25	Sound, tight knots not over 2½ inches in diameter or in groups not less than 2 feet apart. Shake not over 15 percent of gross scale.
	2	8+	10+	50	Sound knots; no size limitation. Shake not over 25 percent gross scale. Logs generally sawed for lumber.
Red pine	1	13+	8+	10	Surface clear; no shake.
		13+	10+	20	Must be at least 50 percent clear in cuttings 8 feet or longer, or clear one face for full length. No shake.
	2	9+	10+	30	Sound, tight knots not over 2½ inches in diameter. Occasional larger knots if other knots not over 2 inches in diameter.
	2	17+	10+	40	Sound, tight knots not over 3 inches in diameter. Occasional larger knots if other knots not over 2½ inches in diameter.
	3	8+	10+	50	Any log below No. 2 generally sawed. Logs with knots 4 inches or more in diameter in whorls less than 2 feet apart not accepted unless ¼ full length has knots 2 inches or less in diameter.
Southern yellow pine	1	12–15	12+	20	Clear. No knots or indications of knots.
	1	16+	12+	30	Two clear faces or 75 percent of 3 faces clear in one piece.
	2	10–14	12+	40	Sound, tight knots not more than 1½ inches in diameter.
	2	15+	12+	50	Sound, tight knots not more than 2½ inches in diameter.
	3	8+	12+	50	Any log below No. 2 that is generally utilized.

ORGANIZATIONS ISSUING GRADING RULES

Standard grading rules for lumber can be secured from the following sources:

For southern yellow pine—Southern Pine Association, New Orleans, La.

Eastern white pine, red pine, eastern spruce, tamarack—Northern Pine Manufacturers Association, Minneapolis, Minn., or Northeastern Lumberman's Association, New York, N. Y.

Baldcypress—Southern Cypress Manufacturers Association, Jacksonville, Fla., or National Hardwood Lumber Association, Chicago, Ill.

Douglas-fir, western hemlock, Sitka spruce, western redcedar — West Coast Lumbermen's Association, Portland, Oreg.

Ponderosa pine, western white pine, sugar pine, western larch, white fir, Douglas-fir, California incense-cedar, and spruce—Western Pine Manufacturers Association, Portland, Oreg.

California redwood—Redwood Association, San Francisco, Calif.

Eastern hemlock and tamarack—Northern Hardwood and Hemlock Association, Oshkosh, Wis.

Hardwoods and eastern redcedar—National Hardwood Association, Chicago 5, Ill.

GLOSSARY

Adventitious buds.—Abnormal groups of buds found at points on the stem unrelated to the crown.

Air drying.—The practice of seasoning lumber in the open air as contrasted with seasoning it in a kiln.

Alligator fastenings.—Metal belt fastenings that can be attached to a belt end by means of barbs and to each other with a key inserted in a sleeve resulting from intermeshed dentated parts.

Anvil (swage).—The fixed jaw in a swaging device that supports the back of the tooth while the die or roller presses against the front of the tooth.

Arbor.—The shaft and bearings on which a circular saw is mounted.

Back rest.—A wood bench opposite the tensioner, used to support a circular saw when checking tension.

Band saw.—An endless beltlike blade of steel, toothed on one or both edges, which is used to saw lumber.

Barb.—A sharp projection, the point of which is at right angles to the fastener proper.

Bearings.—A part in which the journal, gudgeon, pivot, pin, or the like, turns or revolves.

Blue stain.—A bluish or grayish discoloration of sapwood caused by the growth of certain moldlike fungi on the surface and in the interior of the piece; made possible by the same conditions that favor the growth of other fungi.

Boards.—See Lumber.

Board foot.—A unit of measure in the lumber trade. A board foot is a section 12 by 12 inches in size and 1 inch thick.

Board mill.—A sawmill that makes a specialty of 1- and 2-inch lumber as compared to a mill that makes a specialty of material of greater thickness.

Bolster.—A structural part intended to afford support for logs on a sawmill carriage.

Boss dog.—A dogging device on the knees of a sawmill carriage consisting of lever-controlled talons which can be brought to grip the face of a log, cant, or timber.

Boxed heart.—The term used when the pith falls entirely within the four faces anywhere in the sides of the length of a piece.

Box lumber.—Lumber from which boxes are manufactured.

Box piling.—A method used in piling lumber for drying by which boards of differing widths and lengths make up a course.

Bulk pile.—To pile closely, without cross strips.

Bummer.—A low, two-wheeled truck for skidding logs.

Bunk.—The cross beam on a log car or sled, upon which the logs rest.

Burl.—A large, wartlike excrescence growing on a tree trunk. It contains the dark piths of a large number of buds which rarely develop. The formation of a burl apparently results from an injury to the tree.

Burner.—An open or enclosed structure in which slabs, sawdust, bark, and other sawmill wood refuse are burned.

Canker.—A pronounced, local distortion of the stem due to injury or disease, in advanced stages evidence of serious heart rot.

Cant.—A log that has been slabbed on one or more sides.

Cant hook.—A tool like a peavy, but having a toe ring and lip at the end instead of a spike. See Peavy.

Carriage.—A frame on which are mounted the headblocks, setworks, and other mechanisms for holding a log while it is being sawed, and also for advancing the log toward the saw line after a cut has been made. The carriage frame is mounted on trucks which travel on tracks, the carriage being actuated by a steam feed, a cable, or a rack-and-pinion device, which propels it back and forth past the headsaw.

Centrifugal force.—The force which impels a thing, or parts of a thing, outward from a center of rotation.

Check.—A lengthwise separation of the wood, the greater part of which occurs across the rings of annual growth.

Chip.—The shaving or segment taken by a single sawtooth.

Chucks.—Any of the various contrivances for holding work or a tool in a machine.

Circular headsaw.—A circular plate having cutting teeth on the circumference and used to ripsaw logs.

Clearance angle.—The angle between a tangent to the cutting circle of a tooth and a line along the top of the tooth intersecting this tangent.

Clear face.—1. In cutting hardwoods, board surface area free from defects recognized in grading hardwood lumber. 2. In a log, quadrant of log surface without blemishes indicative of causing defects in lumber.

Clipper fastening.—A belt fastening installed by a special tool (belt lacer) and consisting of a series of wires, each making a loop around a metal core, and the two hooked ends embedded in the belt end, with adjacent units attached to opposite belt ends.

Clutch.—A coupling for connecting two working parts, permitting either to be thrown at will into or out of gear with the other, as by moving a lever.

Collar.—A ring or round flange upon, surrounding, or against an object and used chiefly to restrain motion within given limits, to hold something in place, or to cover an opening.

Commission agent.—One who undertakes to sell products on a commission basis.

Conveyor chain.—An endless chain used for carrying material from place to place.

Conical roller bearings.—Roller bearings with tapered rollers.

Conk.—The fruiting body of a rot-producing fungus contained in the tree.

Course.—A single layer of boards in a pile of lumber.

Crib piling.—Piling lumber to form a triangular pen with the end of a board overlapping the end of the board below. Usually each side is a single tier.

Crook.—See Sweep.

Cross alleys.—Alleys in the lumber yard at right angles to main alleys to facilitate lumber movement and air flow.

Custom sawing.—The sawing of lumber under contract, usually to given specifications.

Cutting face.—That part of a sawtooth which extends from the point or edge down toward the gullet, a distance equal to that where cutting or shearing of fibers is done.

Cutting.—In hardwood lumber a cutting is a portion made by imaginary ripping, by crosscutting, or by both.

Dead rolls.—Rollers used for the handling of lumber, but not power-driven.

Decay.—Disintegration of wood substance through the action of wood-destroying fungi.

Deck.—The platform in a sawmill on which logs are collected and stored before they are placed on the carriage for sawing.

Deckman.—In a sawmill, one who alines logs on the deck and rolls them down for loading on the carriage.

Deck skids.—Sets of timbers used to form a rollway for logs at the mill deck.

Defect.—Any irregularity occurring in or on wood that may lower its strength.

Die (swage).—One of a pair of shaping tools, which, when moved toward each other, produce a certain desired form in an object. In a swage tool the die is the movable part, the anvil the fixed part of the shaper.
Dimension.—All yard lumber except boards, strips, and timbers; that is, yard lumber 2 inches and under 5 inches thick and of any width.
Dock.—An elevated structure at the rear of a sawmill on which sawed products are stored and from which they can be loaded on cars or ships by gravity.
Dog.—A steel, toothlike projection that is attached to a carriage knee and usually operated by a lever. Carriage dogs are used to hold the log firmly on the carriage.
Dog board.—In sawing lumber on a headsaw, the last board in the log to which the carriage dogs are attached.
Dogging.—Process of fixing the dogs in the wood or releasing them from it.
Dog housing.—The metal frame sheltering and supporting the dog.
Dolly.—A two-wheeled truck for transporting lumber around a sawmill plant and yard.
Double-acting setworks.—A device on the carriage of a sawmill which feeds the timber to be sawed transversely at both the thrust and return stroke of the activating lever.
Double bed.—The metal member supporting the slab or flitch being sawn. It is divided into two parts each of which can be independently set at a desired distance from the saw.
Double sheave.—A pulley block with two grooved wheels.
Down-graded.—Placed in a lower grade.
Dressed lumber.—Lumber that has been dressed or surfaced on one or more sides.
Drive pulley.—The first of a train of wheels, giving motion to the rest.
Drum.—A revolving cylinder upon which the cable imparting motion to the carriage is wound or unwound.
Dump log.—A mill platform on which logs are unloaded from log cars. It may be built around the edge of a pond or along the bank of a stream to aid in dumping logs into water, or it may be so built for use as a place for dry storage of logs.
Dump ramp.—The platform and incline from which logs are unloaded.
Dutch oven.—An extension front used with boilers burning sawdust and similar fuel. It provides greater fuel space and permits more complete combustion.
Eccentric.—Not having a true center.
Edge.—To make square-edged.
Edgings.—Strips, usually discarded or burned as fuel, that are cut from the edges of boards.
Edger.—A machine used in sawmills to square-edge wavy lumber and also to rip lumber. It consists of a frame suporting an arbor on which are mounted one to several circular saws, and may have feed rolls, press rolls, and transmission gear.
End pile.—Comparable to an up-ended flat pile.
End rack.—Lumber edge-tilted against a ridgepole to form an inverted V.
Eye (saw).—The hole through the center of the saw which receives the shaft.
Face (log).—A quadrant of the surface of a log.
Fake knees.—See Taper bars.
Feed.—In sawing lumber the linear length of log, expressed in inches, which is cut at each revolution of the saw.
Feed works.—The mechanism which moves the carriage past the saw.
Filer.—One who fits saws in a sawmill or other woodworking plant.
Fixed collar.—A collar firmly attached to the saw arbor, as distinguished from a loose collar, which is held to the arbor with a nut.
Fixed post.—A bar or rod firmly fixed to the knee or log beam of a sawmill carriage, which supports all or part of the dog mechanism.
Flat pile.—Lumber piled so that each piece rests on its wide face.
Flexible coupling.—A coupling of jointed links placed in a shaft to allow slight misalinement between two connected shafts.
Flitch.—A thick piece of lumber with wane on one or both edges.
Floating block.—A block to hold down the log against conveyor chains, one end being pivoted above the conveyed logs by means of a shaft and the other free to float or move up and down in bearing on the top of the moving log.
Flooring.—Patterned lumber used for floors.
Footage.—Quantity of lumber expressed in board feet.
Friction wheel.—A wheel or disk driving or driven by direct contact with another wheel or disk.
Gage.—A standard series of sizes indicating by numbers the thickness to which saws are made. The particular series of sizes adopted by saw manufacturers is the Birmingham wire-gage one.
Gang circular.—A machine having a battery of circular saws, from 22 to 26 inches in diameter, all of which are fitted to the same shaft.
Gate.—The frame in which gang saws and sash saws are stretched. The frame moves up and down in vertical grooves or slides, and is actuated by a pitman attached to its base.
Gig.—The act of running the sawmill carriage back after a board is cut from the log.
Grade.—The designation of the quality of a manufactured piece of wood.
Green.—Unseasoned, wet.
Ground mill.—A small sawmill placed directly upon the ground—unfloored.
Guide (saw).—A device for steadying a saw.
Growth ring.—See Ring, growth.
Guides (dip-tank chains).—Metal channels in which conveyor chains run.
Guide blocks.—Arms of the saw-guide mechanism which hold the guide pins.
Guide bracket.—Frame supporting the saw-guide pins.
Guide pins.—Parts of the saw-guide mechanism which actually contact the saw.
Guide plates.—Metal plates fixed to synchronize with the kerf at the rear of the saw.
Guide rail.—A rail that guides the movement of the sawmill carriage.
Gullet.—On a saw, the rounded cavity in which sawdust accumulates and is carried from the cut.
Gumming.—The process of cutting out the gullets of a saw.
Hammer bench.—A wood bench as an extension of the anvil opposite the tensioner's position and supporting the rim of the saw when testing for tension; it contains a peg on a sliding panel for centering the saw when it is hammered.
Hardwoods.—The botanical group of trees that are broadleaved. The term has no reference to the actual hardness of the wood. Angiosperms is the botanical name for hardwoods.
Headblock.—That portion of a sawmill carriage on which the log rests. Each headblock consists of a base, a knee, a taper set, dogs, and a rack-and-pinion gear, or some similar device for advancing the knees toward or withdrawing them from the saw line.
Headrig.—Sawing equipment used in the primary breakdown of logs.
High-speed teeth.—Sawteeth made of an alloy steel

which is heat-treated and retains much of its hardness and toughness at red heat, thus enabling tools made from it to cut at such speeds that they become red through friction.

Holder (sawtooth).—A device for locking inserted sawteeth in a circular saw.

Hollow ground.—Having concave surfaces.

Honeycomb.—Checks, often not visible at the surface, that occur in the interior of a piece, usually along the wood rays.

Hook.—The angle between the face of a sawtooth and a line drawn from the extreme point of the tooth perpendicularly to the back of a bandsaw, or to the center of a circular saw.

Hopper.—A receptacle, usually funnel-shaped, with an opening at the lower part for delivering material.

Horizontal resaw.—A band resaw that cuts in a horizontal line, as compared to a vertical band resaw, which cuts in a vertical line.

Husk.—The frame supporting the arbor and other working parts of a circular headsaw.

Infeed rolls.—Rolls placed ahead of certain types of saws to force the material through the saw.

Inserted point.—The tooth used in an inserted-tooth saw.

Interior finish.—Dressed and often patterned lumber used for finishing the interior of buildings.

Jackladder.—An inclined plane with a trough up which logs are drawn into a sawmill.

Jointing.—The act of reducing points of all teeth in a circular saw to coincide with the circumference of a circle when the saw is rotated; it is accomplished by abrasion.

Kerf.—The width of cut made by a saw.

Key.—A small, parallel-sided piece, flat or tapered on top, for securing pulleys and other parts to shafts.

Keyway.—A groove or channel for a key, as in a shaft or the hub of a pulley. A keyseat.

Kiln.—A heated chamber for drying lumber.

Kiln drying.—The process of drying wood in a kiln with the use of artificial heat.

Knee.—The part of a sawmill carriage headblock that bears the carriage dogs, which hold the log being sawed. It also supports the levers used to operate both the carriage dogs and the taper set.

Knot.—That portion of a branch or limb which has become incorporated in the body of a tree.

Lead.—Adjustment of the saw so that the distance to the track rail is slightly less at the front than at the back edge of the saw.

Left-hand blower.—A blower in which, viewed when standing on the log deck and facing the rear of the mill, the fan-drive pulley is on the right and the intake on the left side of the housing.

Left-hand sawmill.—A sawmill in which the carriage and saw are on the left-hand side of a person standing on the log deck and facing the rear of the mill.

Leveling.—Act of bringing a saw to a flat, even surface.

Lever-type swage.—Device for widening the tips of sawteeth by drawing out the tooth point between a lever-actuated die and a fixed anvil.

Log-beam mill.—The type of mill employing a sawmill carriage on which the knees, dogs, and sometimes the setworks, are fixed to a movable beam extending lengthwise of the carriage frame, and advanced or receded by a setworks mechanism.

Log dog.—A metal bracket attached at intervals to the log-haul chain to prevent slippage in logs being transported from log pond or yard level to mill deck.

Logging.—The operations of felling trees, cutting them into logs, and transporting them to the sawmill.

Log rule.—A table showing the estimated number of board feet of lumber that can be sawed from logs of various lengths and diameters.

Log scale.—The board-foot content of logs as determined by a log rule.

Log turner.—A device, usually attached to beams over the log deck, consisting of a drum driven by friction gearing, on which is wound a chain or cable; used in turning logs on a sawmill carriage. A device actuated by a steam piston and consisting of two or more arms or skids and a hook, which are used to shove or turn logs on a sawmill carriage. Its movements are controlled by the sawyer.

Loose collar.—The flanged collar that is fixed against the circular saw by attachment to the arbor by means of a nut.

Lug.—A projection, as on a chain, by which anything is supported or carried.

Lug pin.—A metal pin chambered in the fixed and loose collars and passing through a pin hole in the saw to prevent the saw from slipping on the shaft.

Lumber.—The product of the saw and planing mill not further manufactured than by sawing, resawing, and passing lengthwise through a standard planing machine, cross-cut to length and worked.

Boards.—Yard lumber less than 2 inches thick, 8 inches or more in width.

Dimension.—All yard lumber except boards, strips, and timbers; that is, yard lumber 2 inches and less than 5 inches thick, and of any width.

Dressed size.—The dimensions of lumber after shrinking from the green dimension and planing; usually ⅜ inch less than the nominal or rough size; for example, a 2 by 4 stud actually measures 1⅝ by 3⅝ inches. (See Lumber, Nominal size.)

Factory and shop lumber.—Lumber intended to be cut up for use in further manufacture. It is graded on the basis of the percentage of the area which will produce a limited number of cuttings of a specified, or a given minimum, size and quality.

Matched lumber.—Lumber that is edge-dressed and shaped (worked) to make a close tongue-and-groove joint at the edges or ends when laid edge to edge or end to end.

Nominal size.—As applied to timber or lumber, the rough-sawn commercial size by which it is known and sold in the market. (See Lumber, Dressed size.)

Plank.—A broad board, usually more than 1 inch thick, laid with its wide dimension horizontal and used as a bearing surface.

Rough lumber.—Lumber as it comes from the saw.

Shiplapped lumber.—Lumber that is edge-dressed to make a close rabbeted or lapped joint.

Strips.—Yard lumber less than 2 inches thick and less than 8 inches wide.

Surfaced lumber.—Lumber that is dressed by running it through a planer.

Yard lumber.—Lumber that is less than 5 inches in thickness and is intended for general building purposes.

Lumber scale rule.—A rule indicating the number of surface feet contained in boards of various widths and lengths.

Magnetic brake.—A friction brake controlled by means of a solenoid.

Main alley.—A lumber-yard alley on which lumber piles front.

Mandrel.—See Arbor.

Millwork.—Generally all building materials made of finished wood and manufactured in millwork plants and planing mills, excluding flooring, ceiling and siding.

Mine detector.—An electrical device for detecting the presence of metal.

Miscut.—Lumber having greater variation in thickness, except as to wane, between any two points than provided for in copyrighted editions of association grading rules.

Moisture content of wood.—Weight of the water contained in the wood; usually expressed in percentage of the weight of the oven-dry wood.

Offsetting the carriage.—The shunting of the carriage frame away from the sawline when the carriage is gigged back by a device attached to a sawmill carriage frame and also to one or more axles of the carriage trucks.

Offset (Knee).—See Taper bar.

Oil motor.—A rotary engine actuated by the reaction, under pressurized oil, of radial pistons on a shaft eccentric to a containing ring.

Overlap.—In a belt splice, the part extending over another part.

Patterned.—Following a mechanical design.

Pawl.—A pivoted tongue or sliding bolt on one part of a machine adapted to fall into notches or interdental spaces on another part.

Peavy.—A stout lever from 5 to 7 feet long, fitted at the larger end with a metal socket and spike and a curved steel hook that is pivoted on a bolt. Differs from a cant hook in having a pike instead of a toe ring and lip at the end.

Pinion wheel.—A gear with teeth designed to mesh with those of a larger wheel or with a rack.

Pitch diameter.—In belt measurements, the diameter at the outside of the belt minus the belt thickness.

Pitman.—A connecting rod.

Plain sawed.—Lumber sawed parallel with the pith of the log and approximately tangent to the growth rings; that is, the rings form an angle of less than 45° with the surface of the piece.

Planetary gears.—A train of spur or bevel gears in which one or more move around the circumference of another which may be fixed or moving.

Pond slip.—The extension of a mill pond to allow floating of logs to a point opposite the mill dock.

Poor face.—That surface of the board containing the lesser area in clear cuttings.

Prime mover.—The initial source of motive power, the object of which is to receive and modify force and motion as supplied from some natural source, and apply them to drive other machinery.

Rack.—A bar with teeth on one face for gearing with those of a pinion.

Rack and pinion.—A form of carriage drive used in portable sawmills. A rack is attached to the underside of one of the beams of the carriage frame, and into it meshes a pinion wheel driven from a shaft on the saw husk.

Random width.—All widths of lumber haphazardly mixed.

Refuse conveyor.—An endless chain traveling in a trough which transports sawmill refuse.

Resaw.—A machine to cut boards, planks, slabs, or other material lengthwise into two or more pieces of equal length and width.

Rider.—A pulley placed to bring pressure on a belt in order to increase its effectiveness.

Right-hand mill.—A sawmill in which the saw and carriage are on the right-hand side of a person standing on the log deck and facing the rear of the mill.

Rip.—To cut a board lengthwise, parallel to the fibers.

Rip tooth.—The type of sawtooth adapted for cutting parallel to the fibers of wood.

Roller.—A cylindrical body movable about its longitudinal axis.

Rope drive.—A carriage feed system employing a rope or wire cable to propel the carriage when a drum, about which the cable is looped, is revolved.

Rosser.—An attachment to plane a flat surface on a log.

Rot.—See Decay.

Round-faced hammer.—A type of hammer used to flatten the surface and put tension in circular saws. It has a circular face with a convex plane, the curvature conforming to a radius of 4½ inches.

Running board.—The board of the hammer bench extending back from the anvil, which partially supports the saw.

Sap.—All the fluids in a tree, such special secretions and excretions as gum excepted.

Sapwood.—The layers of wood next to the bark, usually lighter in color than the heartwood and totaling ½ to 3 or more inches wide, that are actively involved in the life processes of the tree.

Seasoning.—Removing moisture from green wood in order to improve its serviceability.

Setshaft.—The shaft on a sawmill carriage to which the pinions are fastened and which causes the knees to advance or recede as it is turned.

Setting.—The process of advancing the log on the carriage the distance required to get the sawed thickness desired.

Set wheel.—The wheel of the setworks attached to the setshaft, which, when turned with a lever, causes the knees to advance.

Shake.—A separation along the grain, the greater part of which occurs between the rings of annual growth.

Shank.—A device for locking inserted teeth in a circular saw.

Shaper.—An implement, consisting of dies and levers. which is used to compress sawteeth to a prescribed pattern.

Sheathing.—The structural covering, usually of boards or wallboards, placed over exterior studs or rafters of a structure.

Sheave.—The grooved wheel of a pulley.

Shim (bearings).—A thin piece or slip of metal, wood, or other material used to fill in, as in leveling.

Shipping-dry lumber.—Lumber that has been partially dried to reduce weight and freight costs, but may still have a moisture content of 30 percent or more.

Shotgun feed.—A long cylinder with a piston attached to the rear end of the sawmill carriage to draw the carriage back and forth.

Shoulder.—An abrupt projection that forms an abutment on an object or limits motion.

Side dressing.—The act of adjusting all sawteeth on a saw to project laterally the same distance from the plate. It is accomplished by filing.

Side gage.—A measuring device to indicate the amount of lateral projection of sawteeth beyond the surface of the saw.

Siding.—Material manufactured for the special function of serving as outside covering for buildings.

Sills.—The horizontal timbers supporting the husk of a sawmill.

Single-acting lever.—A device on the carriage of a sawmill which feeds the timber to be sawed transversely at the thrust or the return stroke of the lever, but not at both strokes.

Single piston.—A lever of a setworks that causes knee movement only on the pull or backward thrust, as contrasted with the double-acting type, which causes movement on both forward and backward lever thrusts.

Skid.—A timber bar or rail used in sets fastened to the bottom of a machine or structure that is to be slid on the ground.

Slab.—The exterior portion of a log that is removed to get a flat face for sawing lumber.

Slasher saw.—A device consisting of several circular saws mounted on a shaft at intervals varying from 16 to 48 inches and used to cut slabs, edgings, and other wood refuse into lengths suitable for laths, firewood, and pulpwood, or for transportation to the refuse burner.

Softwoods.—The botanical group of trees that have needle or scale-like leaves and are evergreen for the most part—baldcypress, western larch, and tamarack being exceptions. The term has no reference to the actual hardness of the wood. Softwoods are often referred to as conifers, and botanically they are called gymnosperms.

Solid-tooth saw.—A saw having the teeth cut into its edge.

Sorted-length piling.—The practice of placing material of a single length or of a definite series of lengths in a single pile.

Sound cutting.—A hardwood cutting free from rot, pitch, shake, and wane but permitted to contain sound knots and others items listed as defects and excluded from clear-face cuttings.

Sound defect.—Any defect allowed in sound cuttings, such as sound knots, sound bird pecks, stain, streaks or their equivalent, season checks not materially impairing the strength, and worm holes.

Speed reducer.—An apparatus for reducing speed.

Split.—A lengthwise separation of the wood, due to tearing apart of the wood cells.

Splitter-resaw.—A combination of sawmill equipment consisting of a circular saw fixed in a trough to rip into halves logs carried by conveyor chains, and a horizontal band saw to reduce these halved logs to merchantable products.

Spreader.—A thin disk or scythe-like blade fixed behind a circular headsaw to guard against boards and pieces contacting the rear edge of the saw.

Spring set.—A method of setting saws whereby one tooth is sprung to the right and the next to the left. Cross-cut saws are spring-set, as are very narrow band saws.

Square-faced hammer.—A type of hammer used to flatten the surface and put tension in circular saws. The face has a rectangular outline with a convex plane, the curvature conforming to a radius of 9½ inches.

Stickers.—A piece of lumber that separates the different courses of lumber in a pile.

Stock items.—Lumber in even widths from 3 to 12 inches.

Stop shoe.—That part of the setting mechanism on a sawmill carriage which contacts the peg or backstop and shuts off further advance of the knees.

Straight friction feed.—Feed-works mechanism entirely dependent upon friction contacts of moving parts to give motion to the sawmill carriage.

Subflooring.—Boards placed between the joists and the finish flooring material.

Surface area.—The area of the sawed surface or, in wane, corresponding to the sawed surface.

Surfaced stock.—A board, plank, timber, or other sawed material one or more sides of which are planed.

Surfaced framing.—Material for joists, rafters, studding, and similar framing items which has been planed.

Surface measure.—The area of the surface; in lumber this area is calculated in square feet.

Swage set.—To spread the ends of the teeth of a band or circular ripsaw. A saw is swage set when the ends of the teeth are spread to a width greater than the thickness of the saw.

Sweep.—A deviation in any direction from a straight line drawn from one end of a log to the other, excluding the deviation due to taper.

Tail sawyer.—One who stands directly behind the headsaw in the mill and seizes slabs and boards as they come from the saw, placing them flat on rolls.

Tally.—A record of the number of pieces and grades of lumber in a pile.

Tally stick.—See Lumber scale stick.

Tandem rigs in multiple lines.—Several lines of machines, each line having at least two machines, one placed behind the other.

Taper bar.—A lever attached to the knee of a sawmill carriage headblock, by means of which any knee may be placed out of alinement. It is of service when making the first cuts on swell-butted logs.

Taper block.—See Taper bar.

Tension.—To make a circular or band saw looser in the center than on the cutting edge.

Tension gage.—Similar to a straight edge but having a convex edge, the curvature of which exactly coincides with the concave curvature of a properly tensioned saw, used when making the test for tension.

Throat.—See Gullet.

Tie or timber mill.—A sawmill that specializes in ties or heavy timbers.

Tier.—One of two or more vertical rows, one beside the other, as of boards in a pile.

Timber.—Sawed material 5 inches or larger in least dimension.

Top face.—The back of the tooth, that part extending back from the point along the continuation of the line forming the gullet of the preceding tooth.

Top roll.—A roll so placed as to press down on the top of the log, and automatically adjustable to log irregularities.

Top saw.—The upper of two circular saws on a headsaw, both hung on the same husk.

Tram.—A box-like wagon running on a tramway.

Trial mandrel.—A shaft, collars, nut, bearings, and frame to support a circular saw when checking its condition.

Turbine.—A rotary engine actuated by the reaction, or impulse, or both, of a current of fluid subject to pressure.

Turning.—Turning the log about on its longitudinal axis.

Twin circular.—A mill that has both a right-hand and a left-hand saw; used to slab logs or to rip cants. Both saws may be so mounted as to permit altering the distance between them.

Twists.—Ridged projections on the surface of a circular saw.

Unit.—An area, equal to 12 square inches, used in determining the grade of hardwood lumber.

Universal joint.—Any of various couplings or joints to permit swiveling or turning at any angle within defined limits.

Upset swage.—A tool used to spread the points of the teeth of a band or circular ripsaw.

Wane.—Bark or the lack of wood or bark, from any cause, on the edges or corners of a piece.

Warp.—Any variation from a true or plane surface.

Yarding logs.—The process of moving logs from mill yard to sawmill.

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