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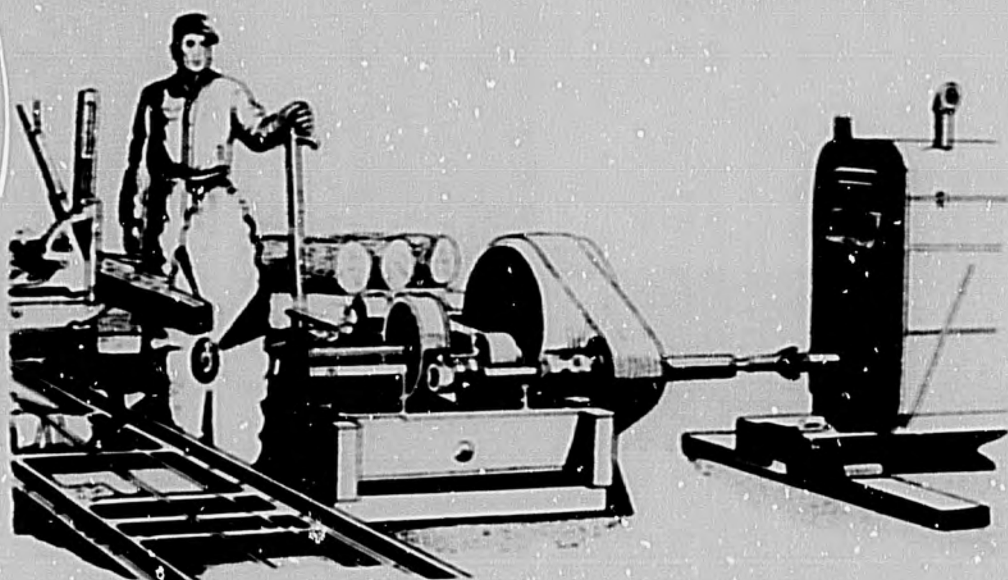
EQUIPMENT, TECHNIQUES AND FINANCIAL REQUIREMENTS . . .

A SMALL SAWMILL ENTERPRISE

Revised

APRIL 1959



AN OPERATION MANUAL FOR COOPERATIVE PROGRAM USE

Technical Aids Branch, Office of Industrial Resources
INTERNATIONAL COOPERATION ADMINISTRATION
Washington 25, D.C.

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PREFACE

This publication deals with the machinery and processes for conversion of logs into lumber as an industrial enterprise, including both the mechanical and business aspects. It does not include the processes of extracting logs from forests or the seasoning of products of sawmills. It is intended to be useful to those considering the establishment of a small sawmill business in foreign countries, and may be helpful to some of those already conducting such a business.

The selection, erection, and operation of small circular sawmills of standard and traditional types are described. Little will be said about the possibilities of making such a mill almost completely automatic in its operation. These automatic small mills have recently become quite popular in the United States, where wage rates are relatively high, and where labor, which has been educated to do a variety of jobs requiring considerable technical skill, is available.

The mills described in this publication should require a minimum of seven to ten less-highly skilled men to produce between 10,000 and 20,000 board feet a shift, but call for a capital investment of only $10,000 to $20,000.

Three types of small sawmills are included in this report: (1) a portable mill for small logs with a capacity of from 6,000 to 8,000 board feet per day, (2) a permanent mill for large logs with a capacity of from 10,000 to 20,000 board feet, and (3) a mobile mill with a capacity up to 10,000 board feet per day.

This publication was prepared for the Office of Industrial Resources of the International Cooperation Administration by Fred C. Simmons, a specialist in logging and primary wood processing, Forest Service, United States Department of Agriculture. The author is assigned to the Forest Service's Northeastern Forest Experiment Station, Upper Darby, Pa. as Forest Products Utilization Technologist. He is author of such Forest Service publications as the Northeastern Loggers Handbook, 1951, and Harvesting Farm Wood Crops, 1955, and a paper on Sawmill Techniques in the U.S.A., prepared for the United Nations Conference on National Resources Conservation and Utilization, 1950. He is chairman of a Subcommittee on Small Sawmill Accuracy Goals of the American Society of Mechanical Engineers.

For further information and assistance, readers should contact their local Productivity Center, Industrial Institute, Servicio, or United States Operations Mission. Three other ICA publications related to the lumber industry are available. They are "Rough Sawing of Logs," "Planning Mill — Dressed or Finished Lumber," and "Sash and Door Plant." These deal with capital requirements, techniques and operations.

This publication is a revision of the June 1957 edition.

April 1959

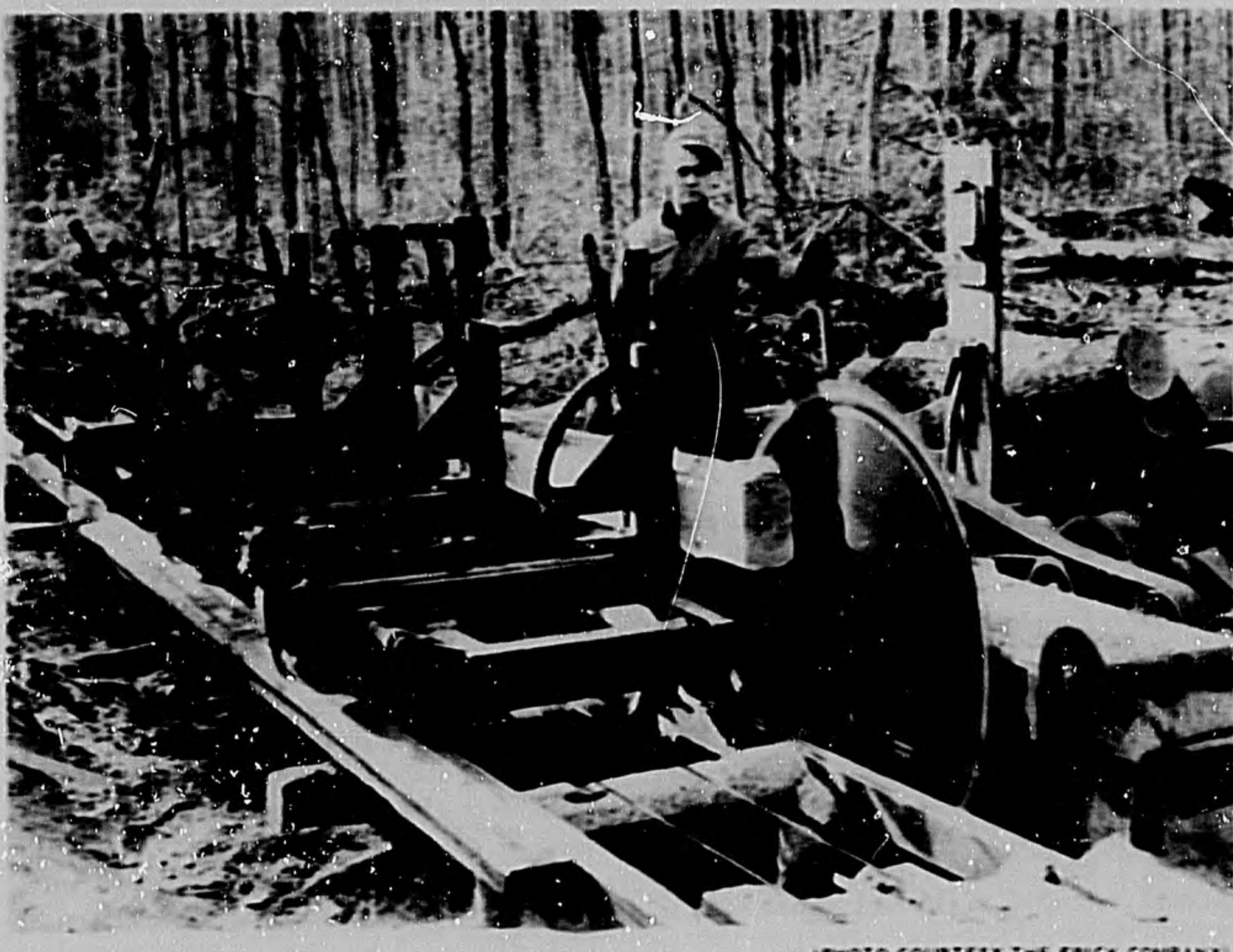
INTRODUCTION

The Lumber Business

The business of converting logs into boards, planks and timbers is called the lumber business in the United States. It is an excellent type of enterprise to consider in underdeveloped areas where there are amply available supplies of suitable timber and where industrial expansion is getting under way. In such areas much of the timber produced may be used locally in building homes, bridges, factory buildings, and as the raw material for other industries, such as furniture factories and boat-building works. In addition, lumber of certain kinds may be exported to other countries to build up a favorable trade balance.

The business of manufacturing and exporting lumber was one of the earliest established in many of today's most industrialized nations and helped create the capital necessary for building up other industries. Not only was this true in the United States and Canada, but also in many countries in Europe.

In terms of capital and equipment



(PHOTO COURTESY THE FRICK COMPANY)

Figure 1. A typical small circular sawmill located in the forest.

requirements, lumber enterprises may vary greatly and still operate successfully. The machinery required to manufacture lumber is basically simple. The essential requirements are (1) a machine to rip round logs, along lines generally parallel to the long axis, into pieces of the thicknesses desired, (2) another machine to cut the round edges off these flat-faced pieces, and (3) a machine to square-up the ends of the pieces cut in the two preceding operations. These operations can be performed by hand, but hand sawing is slow, hard, and inefficient and the product is not likely to be cut very accurately. Hence, a variety of machinery has been developed to do the required work. Some of this machinery is simple and relatively inexpensive, as illustrated in figure 1 and described in this book; some is quite elaborate and costly. Properly operated, the simple types of equipment may be made to produce as good and as salable a product as the more elaborate machinery.

Definition of a Small Sawmill

There is no generally recognized definition of what constitutes a small sawmill and what distinguishes it from a medium-sized mill, or a large one. Sawmills may be classified on the basis of the number of people they employ, the size and type of machinery, the amount of power required, or their output of lumber per eight-hour shift or per work day. None of these criteria is completely satisfactory. Rate of daily production is probably best, since it is easily determined, is applicable to all types of mills, and is a relatively good indication of size and efficiency. In the United States, this daily output is measured in terms of thousands of board feet* produced. In this publication a small sawmill will be considered as one which produces less than 20,000 board feet of lumber per day or per eight-hour shift.

Advantages and Disadvantages of Small Sawmills

The small sawmill as a business enterprise has some very real advantages over a medium-sized or a large sawmill. In the first place, a small mill can be erected and put into operation for a relatively modest capital investment. This feature in itself makes it a good type of business for a person with limited financial resources. In the second place, for successful operation, relatively small amounts of timber are required. This may be particularly important in countries where transportation facilities have not been developed and a mill may count on getting logs at an economical price only from a limited area. In the third place, small sawmills can be moved from one location to another relatively cheaply and easily and thus adjust to limited timber supplies. It is usually more economical to transport lumber than logs. About 50 percent of the weight and a considerably larger proportion of the cubic volume is removed from the log at the sawmill site. In the fourth place, a small sawmill requires only a minimum of labor; often the few men needed may be recruited locally, eliminating need for extensive recruiting or the establishment of camps or villages. Finally, the whole enterprise is of such a size that it may be readily supervised by the mill owner or operator himself.

Another important advantage of a small mill enterprise is flexibility in

*See Appendix I - Glossary for definition of terms relation to economic conditions. Because of limited labor and capital requirements, a small mill may be operated when conditions are good and shut down when they are bad, with minimum loss. Bad conditions may be brought about by poor markets, unfavorable weather, or temporary loss of labor due to periodic engagement in other activities such as farming.

To balance against these advantages, a small mill has certain disadvantages as compared to larger operations. In the first place, the operator is usually unable to afford employing much skilled help, and hence to be successful must know much more about all details of his business than does the owner of a larger-sized establishment. It is common practice for many small mill owners to perform or direct their own mechanical repair work. They often "doctor" their own saws and handle the sawyer's duties. In addition, they may procure the logs and sell their mill products. The latter task, particularly, is frequently not done to best advantage and this is a common reason for failure of small sawmill enterprises. Because they lack knowledge of markets and market specifications, many such owners sell their products at a price that does not adequately reflect their true values.

Another disadvantage of a small mill is that in many countries it has the reputation of being a producer of inferior lumber — lumber that is inaccurately sized, not sawed to grade specifications, or degraded by checks, warping and twisting, staining, and even rot and insect damage. These conditions are not necessarily related to mill size and can be avoided or improved if they occur.

REQUIREMENTS FOR STARTING A BUSINESS

Personal Requirements

As has already been mentioned, an operator of a successful small sawmill must be versatile. Generally, he must have both business and mechanical ability. In some cases, mills are operated by partners: one takes care of the business details, including purchase of logs, payments for labor, equipment and supplies, and sale of the mill products; and the other, the mechanical work, including setting up, operating and maintaining the mill and its accessory equipment. More often a small mill will not support two owners and all of these things have to be handled by one man.

If at all possible, a prospective sawmill operator should gain experience before embarking in business for himself by working for a time in other sawmills, where he may become familiar with the jobs that have to be done. If a mill operator has helped set up and maintain a mill, operated a headrig, edger and trimsaw, filed saws, and graded and stacked lumber himself, he is better able to instruct and supervise others. In some parts of the world there are schools where men may learn these jobs.

Lacking such experience or training, it is best for a prospective sawmill operator to start out on a very small scale, so any mistakes will not be too disastrous.

Timber Supplies

When, after study or training, or both, a prospective small sawmill operator is ready to enter business, one of the most important first decisions is selection of a suitable site. Of first consideration is the availability of enough timber suitable for the enterprise and the cost of obtaining it. If timber is scarce, closely held or too high priced, a profitable enterprise may be impossible.

In judging the timber supply where local markets are limited, export sales possibilities should be considered. Some species, like mahogany, Spanish cedar, limba, and obeche, with an established reputation in the world markets, are comparatively easy to sell. Other species not so well known are more difficult to market abroad even though their technical qualities are excellent. Before attempting to introduce a little-known species into the export markets, sellers must assure prospective purchasers of a continued supply in considerable quantities. The individual small millman may not be able to give such assurance.

Marketing possibilities for many species may be limited because of their properties. Some species may be difficult to season. The usefulness and salability of others may be limited by heavy weight, extreme hardness, or poor machinability.

Labor

In addition to a thorough evaluation of the timber supply, a prospective mill operator must also make sure that sufficient labor will be available. A small mill properly equipped does not need a large labor staff, but the few men it does need must be reliable, industrious, and have certain aptitudes. Although the output of many small mills is 2000 board feet per worker per day, the average is about 1000. Productivity rates between 500 and 2,000 board feet per worker per day should be possible for almost any small mill. Attainment of such efficiency, however, requires careful selection and training of the mill crew as well as smoothly operating mechanical equipment.

Markets

The type and quality of timber available will dictate to a considerable extent the markets to be catered to. One type is lumber from coniferous trees such as pine and cedar. This is commonly called "softwood" and has wide utility. It is especially useful for construction purposes, and can be sold in a great range of qualities. The other type, lumber from broad-leafed trees, is called "hardwood". The quality is quite variable, uses are more specialized, and markets more demanding than for softwood. Actually, the wood of some "hardwoods" is lighter and softer than that of many "softwoods"; banak and balsa are examples. High-grade hardwood lumber is often salable for much higher prices than softwood lumber.

A prospective millman must investigate the market situation carefully. Perhaps there is a local market, such as a construction industry, that will absorb all of his product at a fair price. Perhaps such a local market will absorb his poor lumber, and the more select grades may best be sold for a higher price in the export market. Least desirable of all is the situation where the local market is nonexistent and the export market has to be depended upon to absorb all of the sawmill products. In such cases usually only the best logs of the more desired species are sawed, and then only the better-grade lumber produced from them shipped away for sale. The lower-grade material remains behind as "waste" to be burned or otherwise disposed of.

Contract and Custom Sawing

If a prospective sawmill operator is uncertain about timber supplies or markets, he may still enter the business by engaging in contract sawing. For instance, a timber operator may be found who desires to sublet the job of sawing part or all of his log production to an independent mill operator at an agreed-upon price per thousand board feet processed. When considerable volumes of logs are to be sawed, a portable or semi-permanent sawmill is usually moved in on the property to process the logs. A contract between the timber operator and the mill owner is drawn up. This should stipulate the type and quantity of logs to be supplied the mill, the specifications for the products to be made from them, the unit of measure and the price per unit to be paid, the method and the time of payment, and all other pertinent details covering the operation. If the agreement is to extend several years, there should be provision for periodic revisions to cover changes in costs or other conditions.

This same type of operation may often be conducted on small lots of logs sawed to order for farmers or other local settlers. In the United States, this is called "custom sawing." Under this system a mill may be permanently located, with hauling of the logs and lumber done by their owner and sawing done at the mill for an agreed-upon price per unit of output. In some areas a mobile truck - or trailer-mounted sawmill may be taken to some place along a road where the logs have been collected for sawing. The log owner usually stipulates the method of sawing.

Contract or custom sawing is, of course, apt to limit the returns from the business that might be realized by a competent sawmill operator through good business methods in his log buying and lumber sale practices. On the other hand, when the operation is reasonably efficient and the contract rate fair, contract work often provides a good way for a small sawmill operator to get started, since it reduces his initial need for working capital and many elements of risk.

Legal Requirements

In the United States, sawmill operators are subject to specific Federal, State and local laws governing their business, depending on where they are located. Somewhat similar regulations may be required of sawmill operators in other countries. It would be well for a prospective sawmill operator to consult the local laws and regulations that may apply in any area in which he plans to locate.

The phases of sawmill operations affected by regulations may include the following:

1. Safeguards of the health and working conditions of employees. These may include regulations

covering sanitation of drinking water and toilet facilities; details of spacing of the equipment within the mill; guards for saws, belts and shafting; and construction requirements and safety devices for steam boilers. Workmen's compensation insurance, to cover awards made to employees in case of injury, may be required.

2. Measures to minimize community hazards. These may include controls over stream pollution and refuse disposal, zoning ordinances, and fire prevention measures.

3. Special regulations controlling the employment of women and children.

4. Wage-hour regulations. In the United States, Federal, and in some instances, State laws prescribe the maximum number of hours employees may work per day or per week, and the minimum hourly wage that may be paid.

5. License to do business. Such a license, and perhaps a bond to cover possible failure to carry out obligations, is required by some States and communities.

6. Social security taxes applying to employees. In the United States, each employee must have a social security number assigned by the Federal government, and a specified percentage of his wages must be withheld and paid to the Government for old-age and unemployment insurance. The employer is required to match this contribution.

7. Sales and excise taxes on the mill products. These may include taxes on freight bills and ton-mile taxes on trucking.

Safety

It is advisable for the small sawmill operator to be alert to the reduction of danger to his employees and to others, even where he is not required by law to do so. If available at reasonable rates, he should carry insurance to protect himself from possible loss of his business should a worker be seriously injured or a fire break out.

Wherever practicable, moving parts such as saws, belting and shafting should be covered with guards or fences to prevent workers or visitors being caught in them. Such guards are not expensive — often they can be made from scrap lumber — and they may prevent serious accidents. An example of a simple protective device is a sturdy post behind the sawyer and on the side toward the log deck, to prevent any log from rolling down upon him and throwing him against the saw. Keeping the mill clean and promptly repairing hazards such as loose floor boards, rickety steps and ladders, and holes in the floor are other important safety measures.

Most important of all, however, is a safety consciousness on the part of a mill operator and all of his employees. Workers must be constantly warned against doing things in an unsafe way. Loose or flapping clothing that might catch in a saw or a moving belt and pull the worker into it should be prohibited. A practice such as reaching with a bare hand, instead of a stick, to clear chips or slivers from the side of a moving saw should be strictly banned.

Such safety precautions will not only be profitable in eliminating payments to injured employees, but they will also help assure continuity of operation. Every accident is apt to demoralize the employees and result in lost production, in addition to the possible loss of a trained and difficult-to-replace worker.

Capital

Finally, a prospective mill operator must be sure that he has enough financial resources to engage in business. The initial cost of machinery and other equipment necessary to start a small sawmill operation may be easily determined.

More variable and more difficult to determine, however, is the "working capital" needed to launch a business. This includes money that will be tied up in timber and logs, payrolls, repair parts, fuel oil and small tools, as well as that in lumber stacked for drying and awaiting sale. In the United States, the amount needed for working capital to run a small sawmill business is commonly considered to be twice the amount invested in machinery and equipment. This will vary, of course, with the method of payment for the various items needed and the arrangements for payment for the lumber.

Sometimes a prospective buyer of some or all of the mill products will advance funds to be used as working capital. Such advances should be accepted with caution, because they may carry the obligation to supply the purchaser with the best species and grades and prohibit the sawmill operator from taking advantage of more profitable markets that may develop later.

CHOICE OF MACHINERY

Headrig

Many different types of machinery are used for sawmilling operations. The primary equipment used for the first operation in sawing a log is known as the headrig. It may consist of one, two, or a larger number of saws through which the log is passed. Each type of headrig has its special advantages and disadvantages.

A headrig may have a single circular or band saw, with the log moved back and forth by it on a carriage which holds the log in line as it is cut and advances it between each pass by the thickness of the next cut desired. This kind of headrig, making only one cut at a time, is by far the type most commonly used in the United States.

A second kind of headrig consists of two saws, mounted parallel to each other, with provision for varying the distance between them, through which logs are moved by a conveyor in a continuous line.

A third type of headrig consists of more than two saws, set in such a way that the intervals between them are the thicknesses of lumber desired to be cut, with provision for moving logs through them by means of a chain or feed rollers. The most common form of this headrig is the frame or sash gang saw, commonly used in Scandinavia and other parts of Europe, in which the straight saws are mounted in a sash frame which is moved up and down to provide the cutting action as logs are pushed through it. Another form of this type of headrig has a series of circular saws, mounted on a single shaft, through which logs are pushed and pulled to be cut.

Frame or Sash Gang Saw

The frame or sash gang saw (figure 2) generally cuts the most accurately of any of these devices and needs little or no allowance for variations in sawing. Consequently, the saws may be set almost exactly at the interval desired. Also, the frame saw converts a relatively small portion of a log into sawdust, because of the relatively thin saws used, generally about 3/16-inches wide at the edge. In addition, reasonably smooth cut surfaces are produced. Production rate of the frame saw is relatively high.

On the other hand, the frame saw is relatively inflexible. To obtain different thicknesses of lumber, it is

(PHOTO BY FOREST SERVICE, U.S.DEPT. AGRICULTURE)

Figure 2. Frame or sash gang sawmill.

necessary to shut a mill down and shift the position of the saws. Furthermore, the frame saw functions efficiently on only a relatively small range of diameters of logs. At the better Scandinavian mills, this disadvantage is overcome by a sorting of logs into about one-inch diameter classes. One diameter class at a time is sawn. Before another diameter is sawn, the mill is shut down, the interval between the saws altered, and the frame adjusted so that the saws will engage the log throughout the down stroke and thus cut most efficiently.

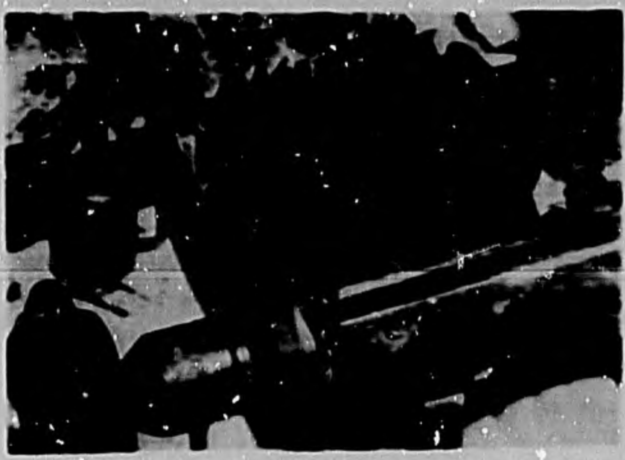
The frame saw does a relatively poor job of cutting maximum grades of lumber, for all cuts are made parallel to the main axis of the log. With many species it is more desirable to make the first cuttings parallel with the bark, since the best grades – those that bring the highest prices -- are generally found in the clear lumber that lies just under the bark. To qualify for these grades, the lumber must be of a certain minimum width throughout its length; and the percentages of lengths shorter than 8 or 12 feet that may be included is closely restricted. "First and Second" hardwood lumber in the United States calls for lengths of 6- to 16-feet, and at least 70 percent must be 12 feet or longer with a minimum width of 6 inches.

In some species the sapwood and heartwood have different technical qualities, often requiring different treatment in drying. In such cases, "taper sawing," or cutting parallel with the bark, may increase the value and utility of the products. Such sawing is possible on most single-cut headrigs employing a carriage but is impracticable on multiple-saw headrigs.

In other markets "quarter sawing" produces lumber which is more readily marketable at the highest price. Such sawing is approximately parallel with the radii of the log. It generally produces lumber which is more dimensionally stable than that obtained at right angles to the radii. Quarter-sawed lumber also may have a more attractive figure than flat-sawed. Logs cannot be quarter sawed on frame saws. Consequently, in the United States the use of frame saws is recommended for sawing of types of logs in which lumber grade is not important and for mills specializing in relatively few thicknesses of product.

Multiple or Gang Circular Saw Headrigs

Another type of headrig is one using more than two circular saws mounted on a single shaft. As with the frame saw, this cuts parallel to the hearts of the logs and, consequently, is subject to the same objection -- failure to get the maximum output of the higher grades from logs in which grade sawing is important. In addition, these machines require relatively heavy saws with deep indentations in the rim (rift saws) to overcome the heating difficulties experienced when a number of saws of this type are cutting parallel with each other (figure 3). Each saw converts about 3 8-inch of wood into sawdust with each cut. Such multiple circular sawing devices, however, are relatively inexpensive, compact, easy to maintain and productive. They are sometimes used as portable units and will economically convert low-grade small logs to standard lumber items in the woods, when such logs could not be hauled to the main mill and sawed profitably.



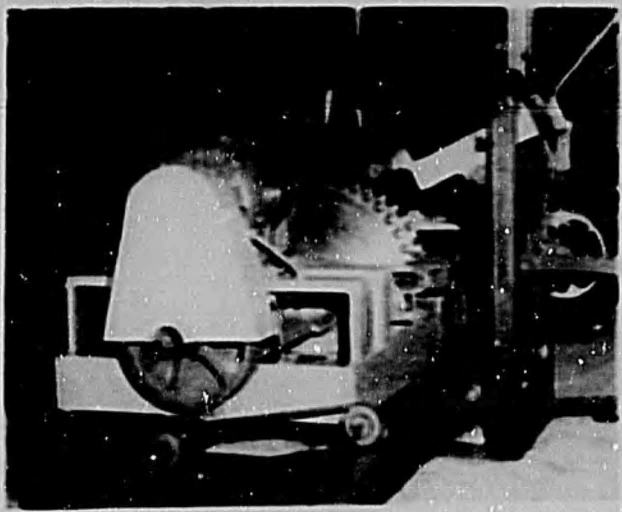
(PHOTO BY FOREST SERVICE, U.S.DEPT. AGRICULTURE)

Figure 3. Gang circular sawmill. (Note thickness of saws and indentations around rim to dissipate heat)

Twin Circular Saws

There is also a twin circular sawmill, with two saws which can be adjusted to vary the distance between them, before a log or cant is carried through them on a conveyor chain (figure 4). A twin circular mill can use thinner saws, cutting about a 1/4 inch kerf, because each saw is mounted on its own shaft. These shafts can be set at such an angle that the backs of the saws do not rub on the log side and heating difficulties are thus reduced. Such twin saw machines make their cuts parallel with the heart of the log, as do the frame saws. They are sometimes used to remove (slabbing) the curved exteriors of two sides of logs that are to be run through a frame saw. These slabbed logs are then given a quarter turn so they can be fed more evenly through the frame-saw feedworks. Slabbing also lessens trouble from grit and in edging round-edge lumber that occurs when round logs are fed through this latter type of machine.

Twin circular sawing machines are also used to saw standard lumber items, such as softwood dimension, from very small logs. Mills developed specifically for this type of use are called "skrag" mills in the western part of the United States. These mills are recommended for the specialized uses indicated.



(PHOTO COURTESY SUMTER MACHINE WORKS)

Figure 4. Twin circular sawmill.

Single-Cut Headrig

Generally, the American type of single cutting headrig, with the log held on a carriage, is best adapted for installation in small sawmill enterprises in under-developed parts of the world. This type of headrig is available with either a circular saw or a band saw and with carriages of either the log-beam or headblock type.

Band vs. Circular Saws

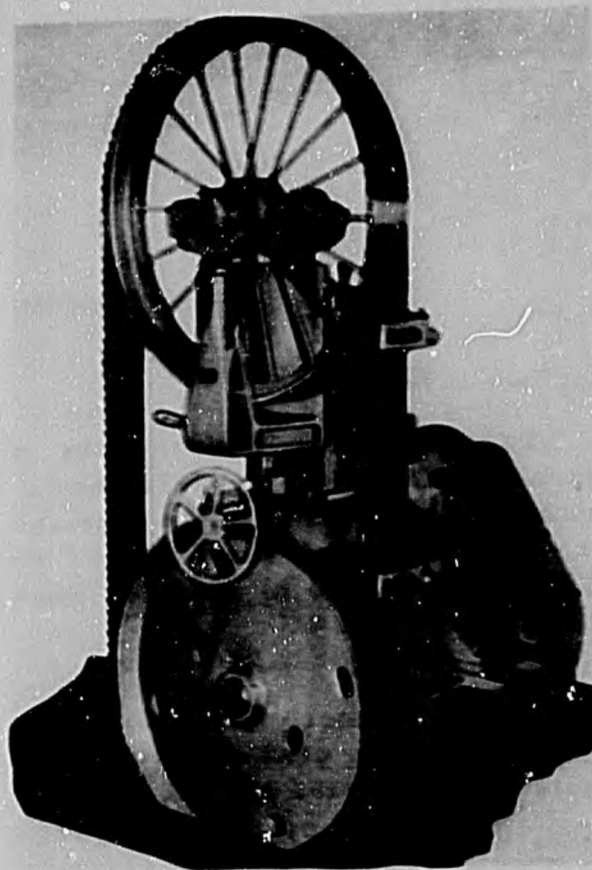
The circular saw is recommended for most small mill installations, despite the fact that it potentially converts about twice as much wood into sawdust as a small band sawing machine.

Band sawmills (figure 5) of the small-mill class have wheels 54 inches in diameter or smaller. These mills can use quite thin saws that cut a kerf of about 1/8 inch, but such saws are "temperamental" and weak. The mills and saws must have constant and expert maintenance in order to run correctly. If not maintained properly, the saws will flutter and cut off line and the potential saving in sawdust will be lost. Moreover, thin bandsaws cannot cut much faster than 100 lineal feet per minute — about half the rate of a comparable circular saw. The first cost of small band sawing machines is three to five times as much as that of a circular sawing machine of similar capacity. Proper maintenance is also much more costly. The larger band saws, with wheels over 54 inches in diameter, cut about the same kerf as circular saws.

It is believed that purchase of a circular sawing machine would be the wiser choice for small mill operators, since first cost is lower, productivity is higher, and maintenance is easier and less costly than with band saws. Logs can be fed through a properly maintained circular saw at rates of 200 lineal feet per minute or more -- twice that of a band mill.

A circular mill can produce accurately and smoothly-cut lumber. The kerf cut by a circular saw can generally be held to 1/4 inch or very little more. Generally, the larger the diameter of a saw, the heavier the plate from which it has to be made if it is to run correctly.

Circular saws are available in diameters up to 72 inches. A 72-inch saw can cut logs 40 inches in diameter, but will make about 3/8 inch kerf. Installation of a saw over 60 inches in diameter is rarely justified, since a mill with a 58- or 60-inch headsaw can be equipped with a topsaw (figure 9) which will enable it to cut logs even larger than 40 inches. It is easier to maintain, uses less power, and converts less wood into sawdust than the giant single saw. If a topsaw is not available, logs too large to be run through a single saw of normal size may be split to a size that can be handled before putting them on the carriage.

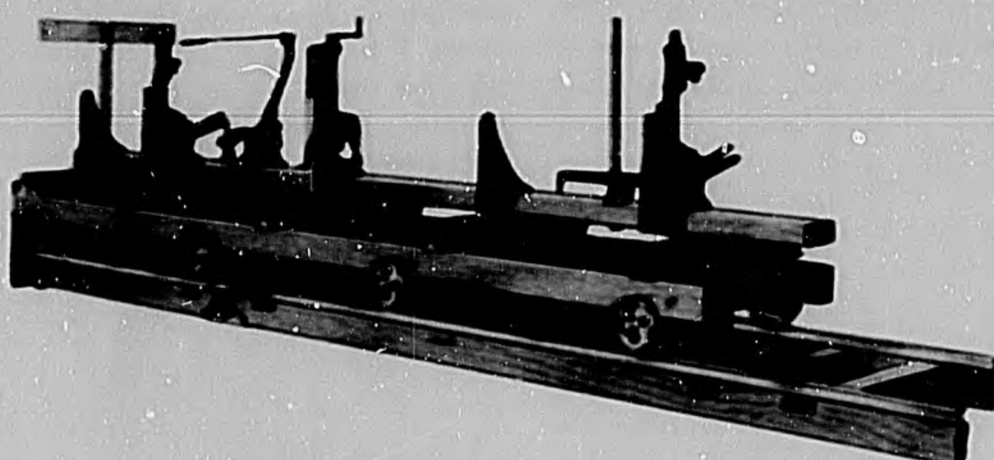


(PHOTO COURTESY MCDONOUGH MANUFACTURING CO.)

Figure 5. Small band sawmill with 54-inch wheels.

Long experience in many parts of the world has shown that the standard American type of circular sawmill headrig with a saw of the size indicated is more productive than any other type of mill of similar cost. It can obtain maximum grades of lumber and it can turn out lumber sufficiently accurately cut and smooth-surfaced for practically any type of use. Furthermore, these small circular saws can be installed, operated, and maintained by relatively unskilled labor.

beam have dogs for holding logs in place. These are of special types. A front dog, which usually is manipulated by the sawyer, is generally a screw type (figure 8a). Gross adjustments are made by squeezing a trigger in a pistol grip on the dog itself and sliding it up and down; and fine adjustments



(PHOTO COURTESY THE LANE CO.)

Figure 6. Log beam type sawmill carriage.

are made by turning a vertical screw which ends in a crank at the top of the dog upright. The most commonly used rear dog, which is ordinarily manipulated by the deck man, is a post or drop dog (figure 8b). This may be rotated on its shaft to provide different depths of dogging, and then merely dropped on the top of the log to give penetration and grip.

Log Beam vs. Headblocks

There are two major types of circular mills with the difference mainly in construction of the carriage. These different types are called the "log beam" (figure 6) and the "headblock" (figure 7).

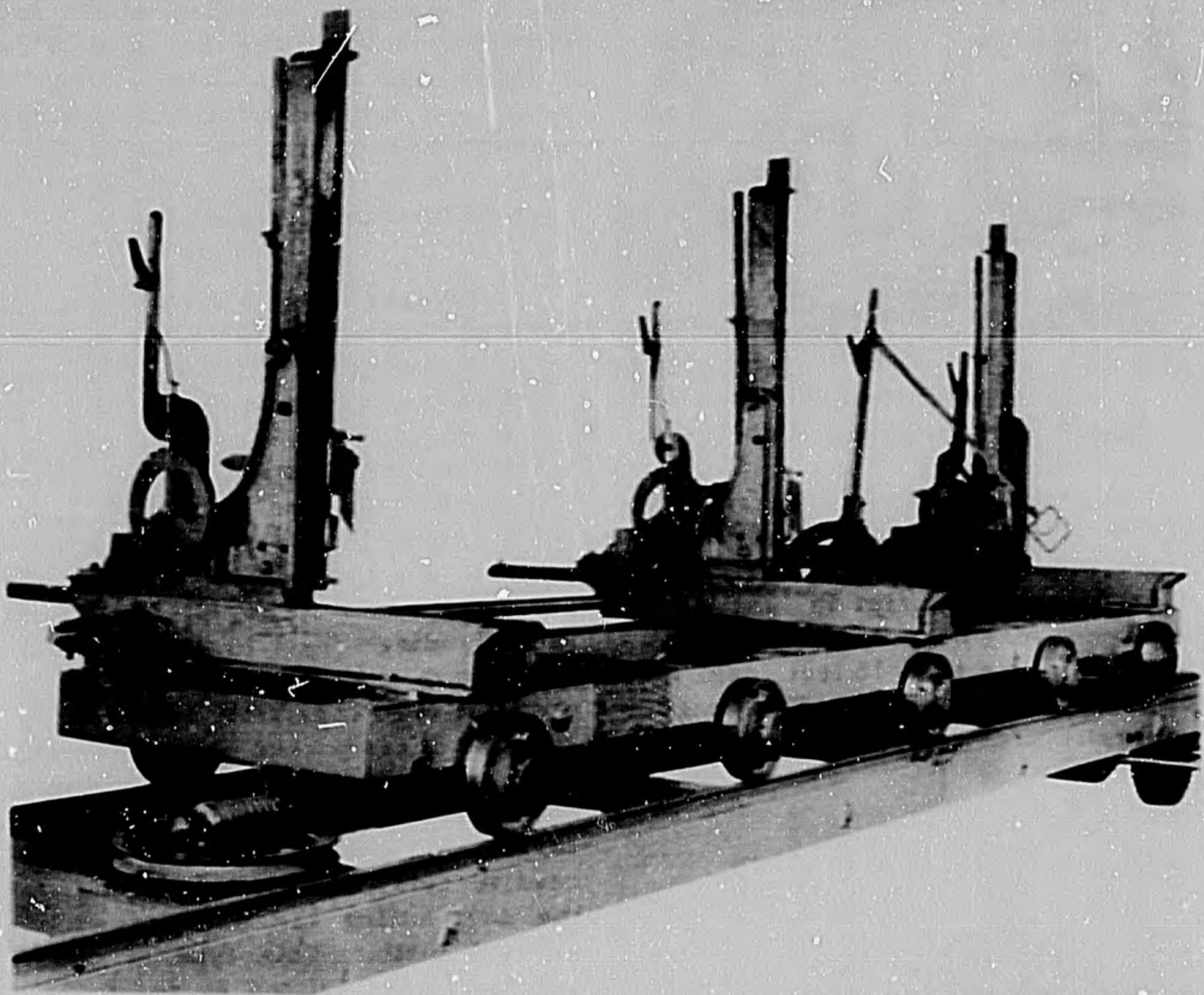
In North America, the log beam type carriage is used mainly in New England and eastern Canada. In this type, the knees supporting a log from the rear are mounted on a heavy timber beam which is advanced and receded by racks near the ends, engaging pinions on a setshaft mounted at the rear of the carriage. This type of carriage ordinarily has more knees than a headblock sawmill of similar size.

Only a portion of the knees on a log

Some of the rear knees may also be provided with screw-type or pistol-grip "board" dogs which are generally used to provide a tighter grip only as the piece on the carriage becomes thin, especially in springy timber which is apt to twist or bow if insufficiently held. Thus, the log beam mill is best adapted to cutting small and springy timber, particularly softwoods.

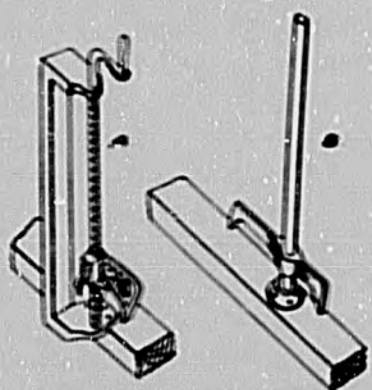
The second major type of carriage,

used in larger circular and band mills throughout the United States and in smaller mills everywhere except in New England, is the headblock type.



(PHOTO COURTESY THE ENTERPRISE CO.)

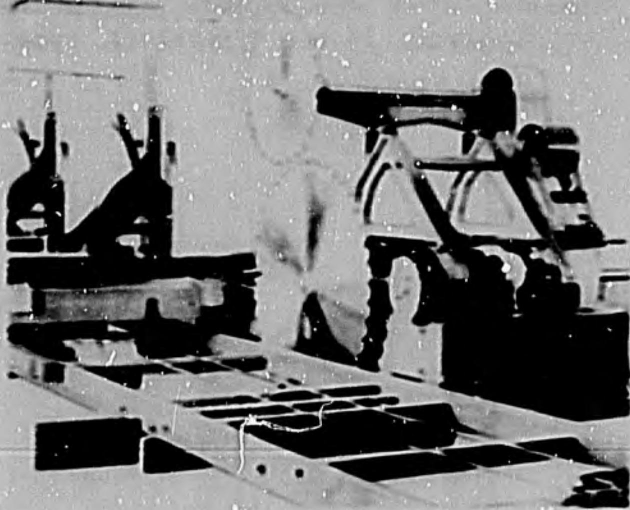
Figure 7. Headblock type sawmill carriage.



(FROM U.S.D.A. HANDBOOK #27)

Figure 8. Log beam carriage dogs.
A. Screw type, B. Post dog.

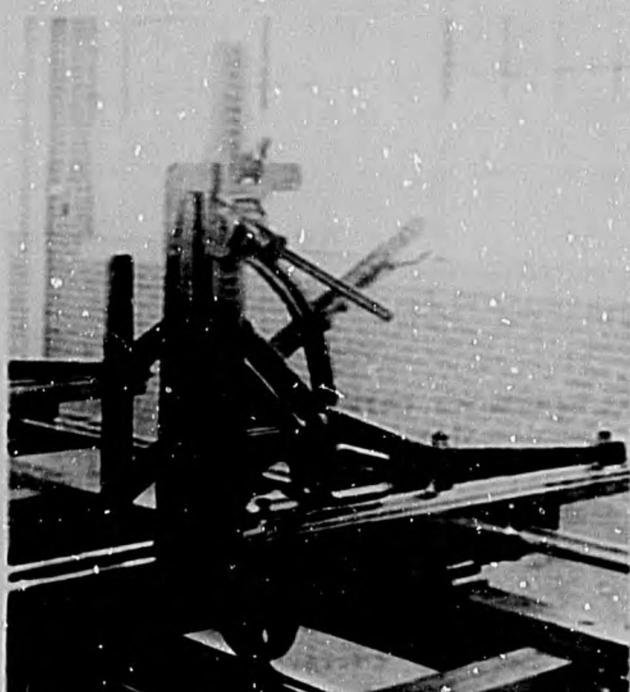
A headblock carriage has independent knees, which are most often advanced or receded by individual racks underneath each one, engaging individual pinions on the setshaft. Some of the larger headblock carriages have rotating screws to provide for advancing and receding the knees, and others use roller chains; both are somewhat more sturdy and accurate than the rack and pinion.



(PHOTO COURTESY THE FRICK COMPANY)

Figure 9. Small circular sawmill with topsaw.

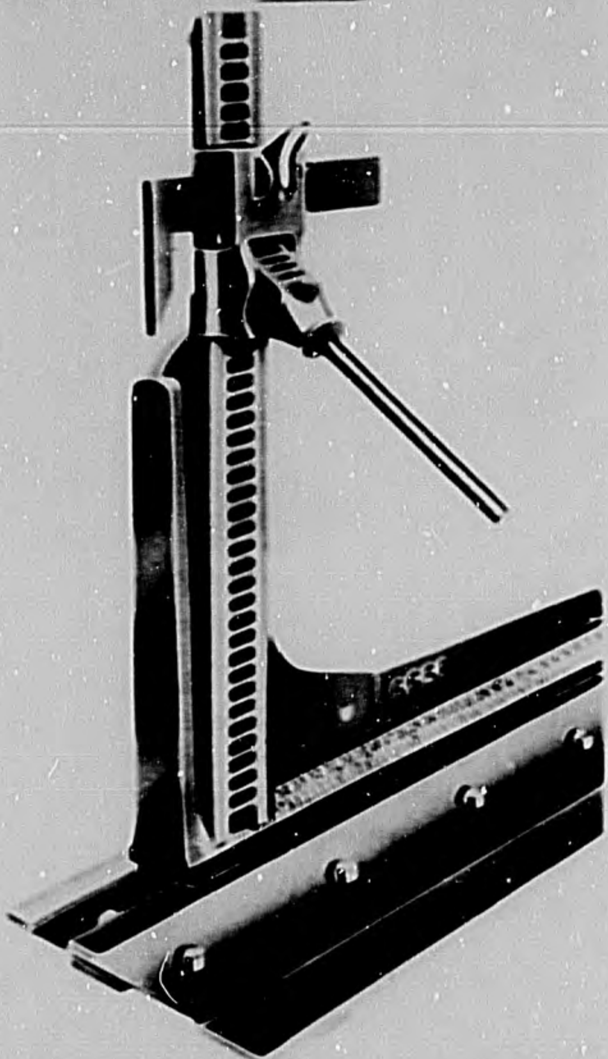
Usually, a headblock carriage for sawing logs up to 16 feet long is provided with three knees. For sawing short logs, 8 to 12 feet in length, only two knees may be provided. For sawing logs more than 16 feet long, four or five knees are needed. Each knee is generally provided with a taper offsetting device. This is usually a false front which may be advanced or receded by a hand lever (figure 10). Some carriages provide means for advancing or receding each knee individually. Such offsets make it possible to set out the small end of tapering logs so that they may be sawn parallel with the bark and also to provide better support for crooked logs.



(PHOTO COURTESY THE FRICK COMPANY)

Figure 10. Offset device to permit taper sawing.

An even greater variety of dogs is available for the headblock type carriage than for the log beam. The most common hand-operated dogs for very small mills are controlled by side levers or screws and slide up and down a steel bar attached to the side of the knee (figure 11). The dog itself is made from an L-shaped steel forging, the long leg of which can be pulled or pushed in its holding socket to vary the depth of dogging. It is necessary for an operator to be constantly alert to make sure the dog is pushed back as the cant (part of the log remaining after one or more sides have been slabbed) on the carriage is pushed forward for successive cuts. He must guard against the saw hitting the dog and ruining several teeth. This type of dog is generally manipulated by members of the sawmill crew as they stand in front of the carriage. Where crew members ride the carriage, lever-controlled dogs are commonly provided (figure 12). Some carriages have dogs underneath which engage the bottom face of a log or cant at the same time as the top dog is pushed home by means of a lever. Other dogs, called "boss dogs," have opposed talons, all up and down the face of the knee, which grip the face of a log or cant opposite them (figure 13). Still other carriages have a series of spring-loaded, self-retracting top dogs, and a bottom dog (figure 14). Only top dog above a log or cant is driven into the wood. Those dogs opposite its face are automatically pushed out of the way into the knee. This later type of dog, known as the tong dog, is becoming very popular, since it is non-defacing, sturdy and sure, and can be readily adapted to automatic operation by means of a hydraulic or pneumatic cylinder (figure 15).



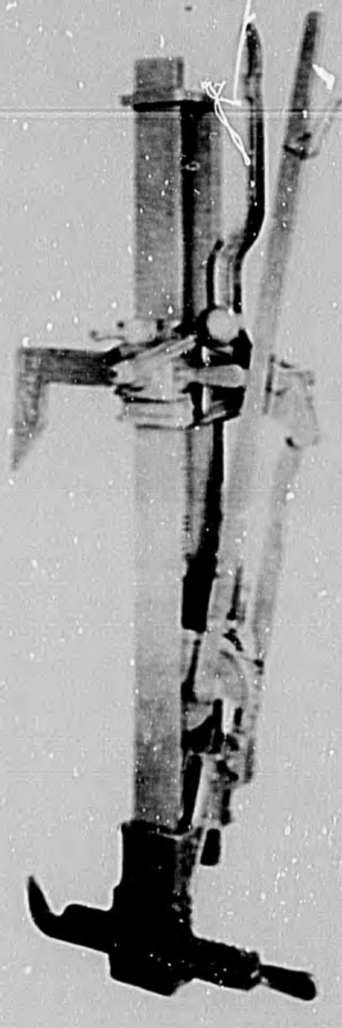
(PHOTO COURTESY CORLEY MANUFACTURING CO.)

Figure 11. Side Lever type of dog.

The headblock type carriage is generally considered better than the log beam type for bigger logs, particularly of hardwoods. Headblocks provide for easier tapering and firmer support for crooked logs.

Setworks

Both log beam and headblock carriages are equipped with a variety of setworks. The setworks is a mechanism by which a log is moved forward between each successive cut to the depth of the next cut. They are of two types — single-acting and double-acting.

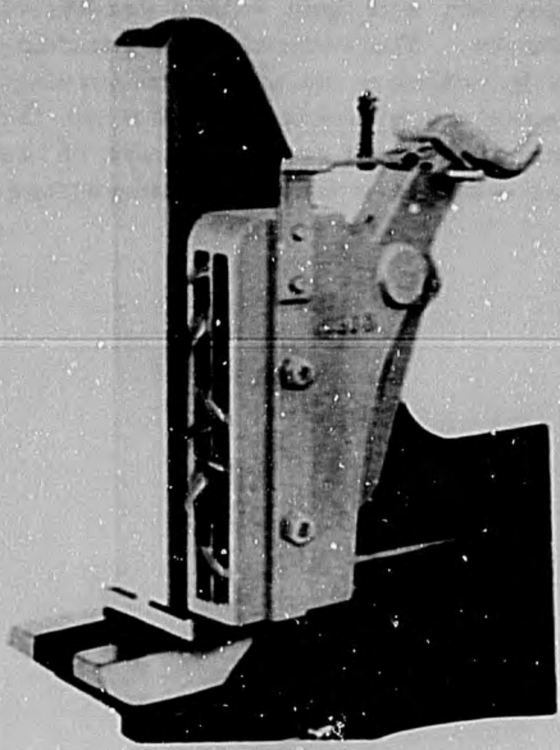


(PHOTO COURTESY KENT MACHINERY CO.)

Figure 12. Lever-controlled dog, duplex action to grip top and bottom of cant.

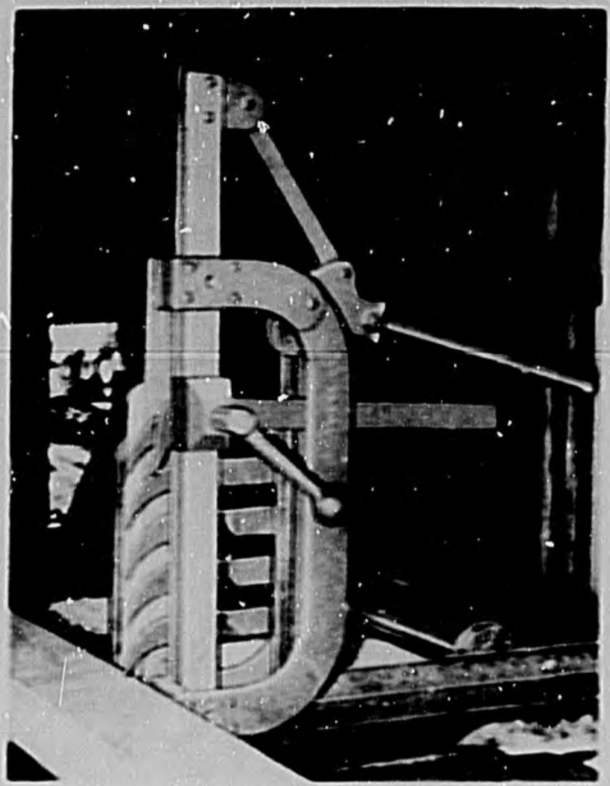
Single-acting setworks are favored for small mills because they are operated by the head sawyer as he stands in his position on the ground (figure 16).

Each pull on the lever to a stop advances the knees a predetermined distance, but there is no movement of the knees when the lever returns. In the double-acting setworks, which are more generally used when a crew member rides the carriage, the knees are advanced whenever the lever is either pulled or pushed (figure 17). The knees can be receded manually with single-acting setworks by turning the hand lever. This lifts the setting pawls in the setworks from the geared setshaft drum and engages the opposed receding pawls. The knees are then pushed back to the desired distance by pulling the lever.



(PHOTO COURTESY MCDONOUGH MANUFACTURING CO.)

Figure 13. Boss dog.



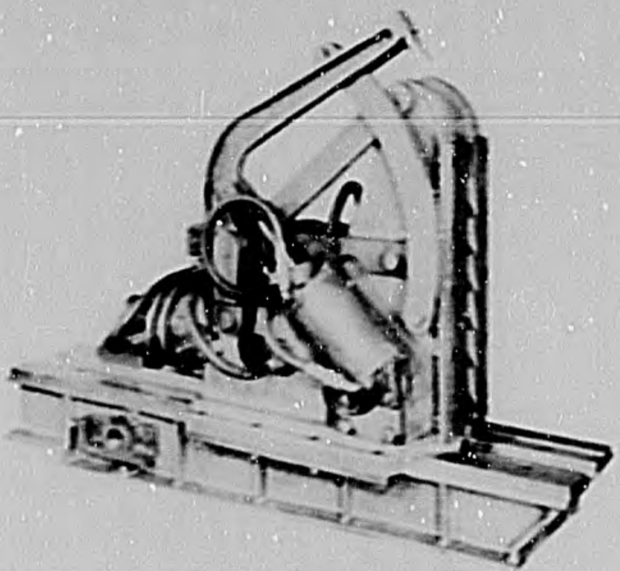
(PHOTO COURTESY MCDONOUGH MANUFACTURING CO.)

Figure 14. Non-defacing, or tong dog.

Single-acting setworks also frequently have a power receder. With this receder, the sawyer pushes a foot pedal which lifts a friction bar; this bar in turn engages a wheel at the back of the carriage (figure 18); this action lifts the pawls from the setshaft drum and, as the carriage is returned, pushes the knees backward on the carriage. With a double-acting setworks, a spring receder is frequently used. When the pawls are lifted from the setshaft drum, recession is automatic.

Feedworks

Several types of feedworks are used to advance and recede the entire carriage past the saw. Most small mills have carriages which are moved along by a cable attached to the front and rear of the frame. The cable pulls the carriage backwards and forwards as it rotates on a cable drum mounted between the tracks on which the carriage rides. The drum is generally actuated by a belt-type feedworks (figure 19) mounted in the husk of the mill and beneath its main shaft or "mandrel". Two opposed belts riding over pulleys mounted on the mandrel are tightened or loosened as the sawyer moves his feed lever forward or backward, tightening first the belt which feeds the carriage forward to make the cut, and then the belt that brings it back into position to make a fresh cut.



(PHOTO COURTESY THE ENTERPRISE CO.)

Figure 15. Tong dog and hammer dog hydraulically operated.

Belt feedworks are available with belts from 3 inches to 6 inches wide. Those with three-inch belts are only suitable for light mills, powered with 50 to 75 horsepower, cutting intermittently and sawing logs less than 20 inches in diameter. A 4-inch belt is satisfactory for mills with up to 100 horsepower available on the mandrel, cutting logs up to about 30 inches in diameter at a rate of up to 10,000 board feet a day. For mills cutting bigger logs, or producing at a rate of between 10,000 to 20,000 board feet a day and with 150 horsepower available on the mandrel, six-inch belts are recommended.

A variety of other types of feedworks drives are available in place of belts, including friction drums, roller chains and clutches, planetary gears and brake drums. Choice among them is largely a matter of individual preference. Also available for the higher-production mills, at the very top of the small sawmill classification, are still faster and more responsive but more expensive feedworks using hydraulic pumps or rams, air motors and even direct-current electric motors.

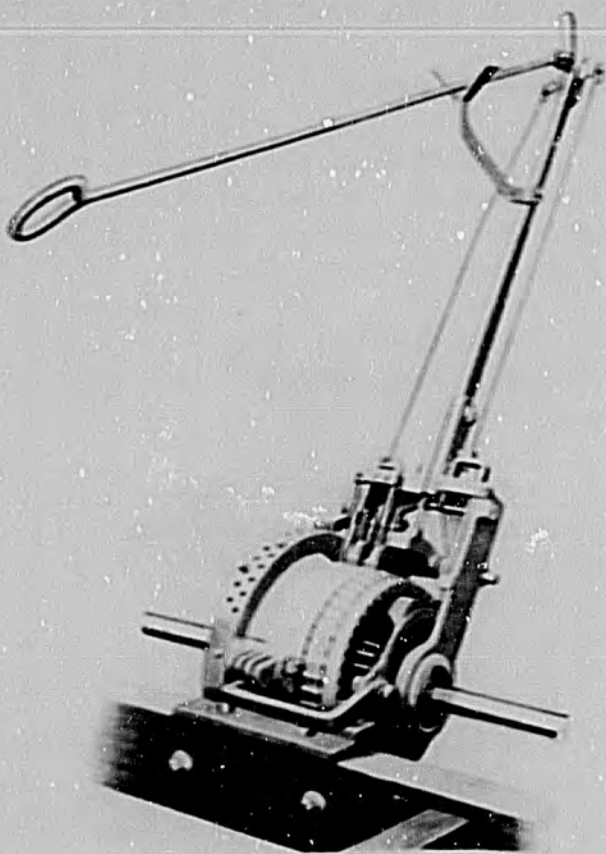
Permanence or Mobility

All of the different types of circular sawmills can be permanently mounted on wooden or concrete foundations; they can be temporarily located, generally on wooden foundations, or they may be mobile — mounted on trailer wheels or on a railroad car, barge, or motor truck.

Several complete mobile mills have been developed and put on the market in the United States in recent years. Figure 20 shows one mounted on a steel framework that resembles an upside-down bridge truss. This kind of mill is most often operated as a trailer behind a motor truck. Other mobile mills are mounted directly on a truck chassis and use the truck motor as a source of power. Such mills can be moved in to a sawing site, leveled up by means of the attached jacks, and started sawing within 30 minutes.

Mobile mills were designed primarily for custom sawing small lots of logs for individual farmers or settlers and have been most successful in this kind of use. They may also be used for squaring up cants from logs located at a considerable distance from the sawmill where they are to be cut. This reduces bulk and weight for transportation to the main mill for further manufacture.

Practically every type and size of small circular sawmill can be mounted as a mobile mill, but the larger and more completely equipped ones, of course, are heavy, unwieldy and large, requiring good highways for transport.



(PHOTO COURTESY CORLEY MANUFACTURING CO.)

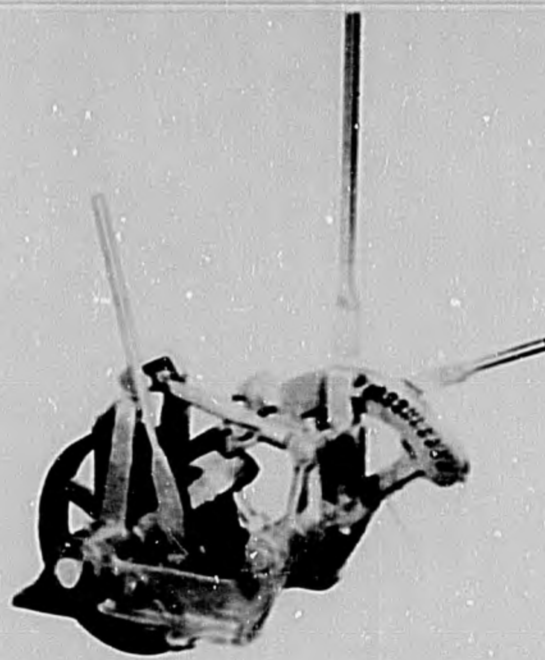
Figure 16. Single-acting setworks.

The smaller and less completely equipped mills are necessarily of more limited productivity and generally require more labor per unit of daily production than does a good temporarily or permanently located mill that can be moved to its site over poorer roads by being disassembled into smaller-sized units.

Headrig Costs

A summary of current (1956) costs of several typical small circular sawmill headrigs, f.o.b. factory in the United States, follows:

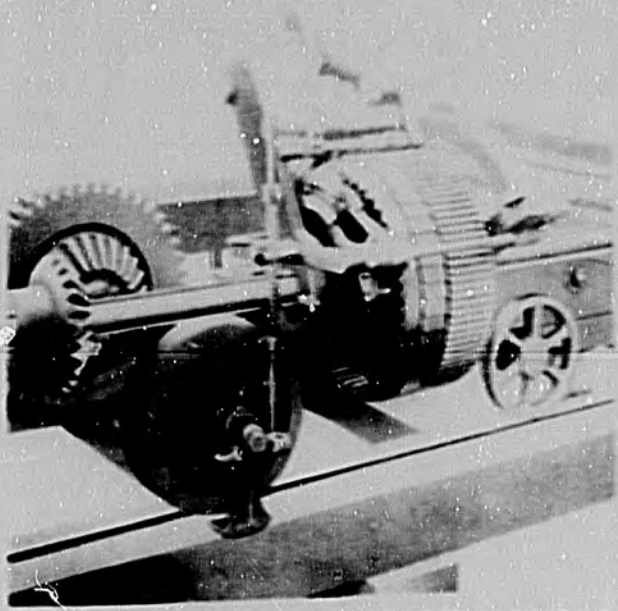
1. Lightweight circular sawmill suitable for small logs and



(PHOTO COURTESY KENT MACHINE CO.)

Figure 17. Double-acting setworks.

temporary location. Complete with 4-inch belt feedworks; 2-7/16-inch diameter mandrel; 10-foot long carriage, 32-1/8-inch wide, with two headblocks, each with taper offset, and single-acting setworks. Maximum carriage opening is 36 inches. Feed is up to 5 inches per revolution of saw. This will carry a 60-inch diameter saw. Weight is 4,000 pounds. Price is $1,550 without saws, mandrel pulley, or belting, which will add approximately 20 percent to the cost.

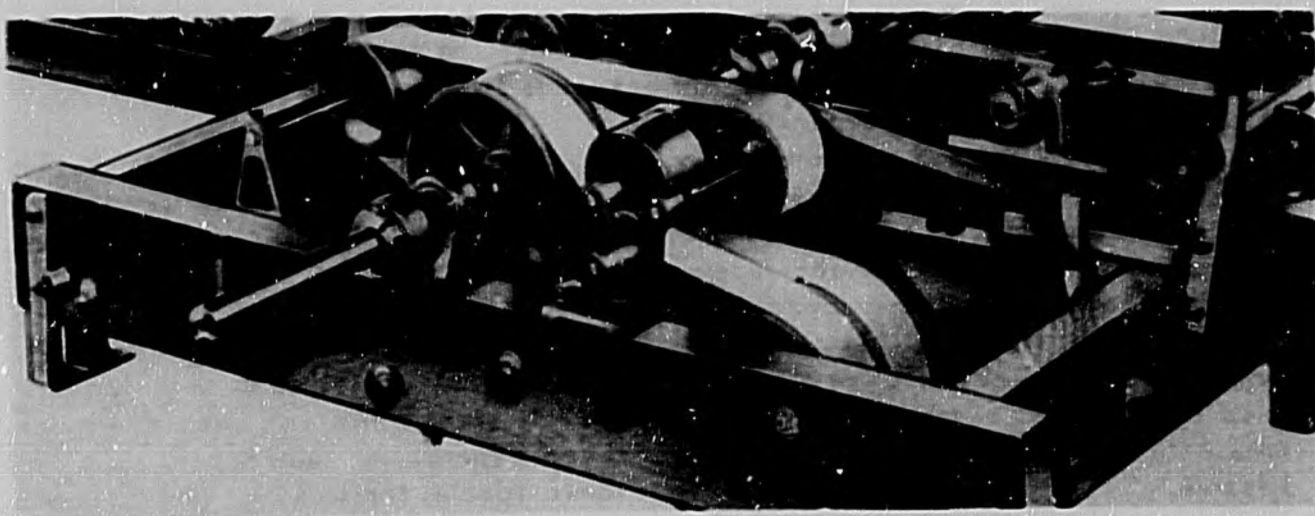


(PHOTO COURTESY THE FRICK COMPANY)

Figure 18. Power receder for single-acting setworks.

2. Heavier circular sawmill suitable for temporary or permanent location and continuous use. This is complete with 6-inch belt feedworks; 3-inch diameter mandrel; 20-foot long carriage, 40-5/8" wide, with three headblocks each with taper offset and single-acting setworks. Maximum carriage opening is 44 inches. Feed is up to 6-3/4 inches per revolution of saw. This will carry a 68-inch diameter saw. Weight is 7,000 pounds. Price is $3,100 without saws, mandrel pulley, or belting, which will add approximately 20 percent to the cost.

3. Mobile, trailer-mounted mill complete with a 4-inch belt feedworks and 2-3/16-inch diameter mandrel. The carriage is 18 feet long, has a 34-inch opening, three headblocks, and single-acting setworks and spring receder. This will carry a 54-inch diameter saw. It is mounted on tubular-steel truss frame trailer. It is complete with two 9:00 x 16-inch tires, saw, drive belt, two-section lumber rolls, and sawdust drag. Weight is 5,600 pounds. The price is $3,200.



(PHOTO COURTESY CORLEY MANUFACTURING CO.)

Figure 19. Belt feedworks for driving cable drum feed.

(PHOTO BY FOREST SERVICE, U.S. DEPT. AGRICULTURE)

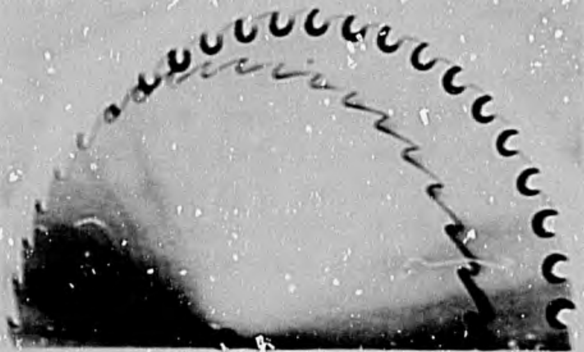
Figure 20. Mobile circular sawmill.

Saws

Headsaws for a small circular sawmill are of two general types — solid-tooth and insert-point (figure 21). The solid-tooth saws are less expensive to buy but more difficult to maintain properly. Also, as they are repeatedly sharpened and the gullets deepened, they gradually lose diameter and eventually cannot saw logs as large as originally. For these reasons the solid-tooth saw is generally used only in the larger circular sawmills where there is a full-time and expert "saw doctor" available and where there are alternate uses for the saws when they get too small for use on headrigs, such as on resaws.

The almost universal choice of small sawmill operators is the insert-point (I.P.) saw. The I.P. saw has sockets ground in its periphery in which the forged steel teeth and their holders are easily inserted by means of the special wrench (spanner) provided. Various patterns of teeth are available for sawing different kinds of wood and for use at different carriage feed speeds (figure 22).

Teeth are also available faced with different metals, such as chrome or tungsten carbide, or made from high-speed steel. Although these work very well in edgers and resaws, they cannot stand up to dirt and grit in headsaw use any better than the standard carbon steel tooth and they are much more expensive. Moreover, many of these special teeth cannot be sharpened with a file or the points spread by a swage to regain the original clearance. The ordinary carbon-steel forged tooth is recommended for headsaw use on most circular mills cutting species with the usual properties and with the bark left on. For cutting species that contain siliceous deposits, stellite-surfaced teeth cut longer than standard teeth, but the stellite-surfaced teeth will not take a sharp edge; consequently, they require about 25 percent more power than ordinary teeth. The best way to cut such species is to use the stellite teeth and provide more power on the mill.

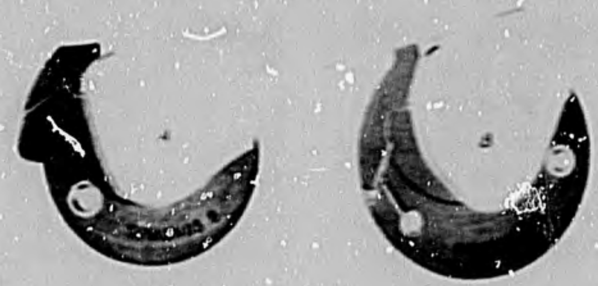


(PHOTO COURTESY R. HOE AND CO., INC.)

Figure 21. Solid-tooth and insert-point saws. (Solid-tooth saw in front, insert-point saw behind.)

Choice of a saw will involve decision as to (1) diameter, (2) gage, (3) number of teeth, and (4) tooth pattern desired. The speed at which a saw is to be run will also have to be specified, so that it can be prepared at the factory to run straight at that speed.

Diameter. — The diameter of a saw will generally be governed by the maximum diameter of the logs to be cut. Since cuts need not be made through the center of logs, the maximem diameter saw needed may be calculated by taking twice the diameter of the largest log to be cut and subtracting 8 inches. The answer is the desirable saw diameter. If the largest log to be cut is 32 inches in diameter, a 56-inch diameter saw can be counted on to do the work desired. As already pointed out, circular headsaws are available in sizes up to 72 inches in diameter, but maintenance and operation of saws this large are difficult unless the saws are made from such heavy plate as to cut an excessively heavy kerf. Small mill operators would be well advised to get saws no larger than 60 inches in diameter. If most logs are more than 34 inches in diameter, a topsaw should be installed. If only a few logs larger than this are encountered, these may be ripped with a power-driven chainsaw, if one is available, or split by hand or with black powder before being placed on the carriage.



(PHOTOS COURTESY SIMONDS SAW AND STEEL CO.)

Figure 22. Commonly used patterns of teeth and holders for insert-point saws.

A. Double circle type. Styles B, D, and F.
B. Single-circle type. Styles 2-1/2 and 3.

Gage. — The thinner the saw plate, the more accurately it must be tensioned so that it will run straight. "Tensioning" is hammering the saw plate so that is is free from lumps and is less tight in the center than at the rim, to counteract expansion of the latter when running at the intended speed.

Thinner saws lose tension more readily than thicker saws. As diameter of a saw increases, more tension is needed, with gage being constant. The higher the speed at which a saw is run, the more tension it needs. Tensioning is quite a technical job, and competent "saw doctors" capable of doing it correctly are not available in many countries. Therefore, it is recommended that thicker saw plates than used in the United States be ordered in most cases. In addition, saw speeds should be kept within a range of 400 to 600 revolutions per minute. If these precautions are taken, need for retensioning will be less frequent.

When retensioning is finally needed, a saw should be shipped back to it's manufacturer or to a competent saw shop. Operators will be well advised not to try to do this job at the mill. Saw plates are generally ground so that they are a gage or two thinner at the rim than they are at the center, to add stiffness and make retensioning necessary less often.

For fairly easy sawing (softwoods with relatively few knots, or hardwoods of less than .45 specific gravity) and with saws no larger than 48 inches in diameter, an 8 x 9 gage saw plate is recommended. For more difficult sawing (hardwood with specific gravity of over .45 or very knotty softwoods) and with saws of less than 48 inches, a 7 x 8 gage saw plate should be ordered. For saws 50 to 60 inches in diameter, a 7 x 8 gage plate is recommended for easy sawing, and a 6 x 7 gage saw for the more difficult work.

Number of teeth. -- The number of teeth needed in a saw will vary with the diameter, the speed (r.p.m.) and feed (inches per revolution of the saw) to be attained by the mill. The most efficient cutting for easy sawing is done when each tooth takes a "bite" of approximately 1/8 inch. For difficult sawing, a bite per tooth of about 1/10 inch is best. A smaller bite per tooth consumes more power per inch of lumber cut. In addition, the sawdust is so fine that it will not chamber properly in the gullets and hence will not be carried out of the cut; instead, it will slip by alongside the sawplate and the cut surfaces, causing the saw to heat and run off line. Consequently, a saw to be fed at 4 inches per revolution should have about 32 teeth for easy sawing and 40 teeth for difficult sawing, regardless of diameter. One to be fed at 6 inches per revolution should have about 48 teeth for easy sawing and 60 teeth for more difficult sawing.

Tooth pattern. -- The number of teeth desired in a saw of a given diameter will govern to a considerable extent the tooth pattern ordered (figure 22).

The smallest tooth pattern generally available for headsaw use is the No. 2-1/2. In this pattern the standard number of teeth usually provided is equal to the saw diameter in inches -- a 52-inch saw will have 52 teeth. For the other commonly used patterns, including No. 3, and styles B, D and F, the standard number of teeth ordinarily furnished is six less than the saw diameter in inches -- a 52-inch saw will have 46 teeth. Saws may be obtained on special order with two or four more or less teeth than these numbers.

The No. 2-1/2 tooth, being the smallest, also has the most restricted gullet capacity. With a 1/10 inch bite per tooth, the gullets are apt to become completely clogged with sawdust and the saw stalled when the cut face is wider than 10 inches. The style F tooth also has a restricted gullet capacity. Consequently, when cuts of a greater depth than 10 inches are to be made, it is better to order one of the coarser-tooth patterns (such as 3, B or D) rather than decreasing the feed rate, even though this would mean getting a larger-diameter saw than is actually needed as calculated from log size.

Tooth width is another important variable. Width should be sufficient to provide clearance over the saw plate; nothing is gained by using teeth narrower than that. For easy sawing, a plate 9-gage thick at the edge should be fitted with teeth about 1/4 inch wide at the edge; for an 8-gage plate, teeth should be 9/32 inch wide; and for a 7-gage plate, 5/16 inch. For hard sawing species, teeth should be 1/64 inch narrower than these specifications.

Accessories

The performance of a mill may be improved by the addition of a few well-chosen and inexpensive accessories.

Log Cleaners

One almost indispensable accessory in a small sawmill is some kind of a log cleaner that will remove grit and dirt from the bark and the cut ends of logs before they are put through the headrig. If such a cleaner is not provided, this grit and dirt will dull the saws so rapidly that productivity will be lost and expense increased while they are being replaced or resharpened. Running a mill with dull saws will also result in inaccurate cutting. Dirt and grit will be present even when the logs are stored in a pond or floated to the mill site. Some mills get rid of it by scrubbing logs by hand or debarking them with an ax. These are both slow and relatively costly methods.

A log washer may be provided by installing a pump to supply water at about 70 pounds per square inch of pressure to a hose. A jet from the hose played over the surfaces and ends of logs will remove most of the dirt and grit (figure 23). Where an ample supply of clean water is readily available, a high-pressure pump system generally can be provided for less than $500.

(PHOTO BY FOREST SERVICE, U.S. DEPT. AGRICULTURE)

Figure 23. Log washing with a jet from a hose.

Where clean water is not available, a fairly good job of partial cleaning may be provided by a mechanical "grit gouger" or log cleaner. This is a powered cutting wheel mounted on a counter-balanced arm which can be pulled down to rout out a path about 1/2 inch wide through the bark on top of the log, on a line just ahead of that which the headsaw will cut (figure 24).

(PHOTO COURTESY CORNELL MANUFACTURING CO.)

Figure 24. Mechanical grit gouger cleaning saw line.

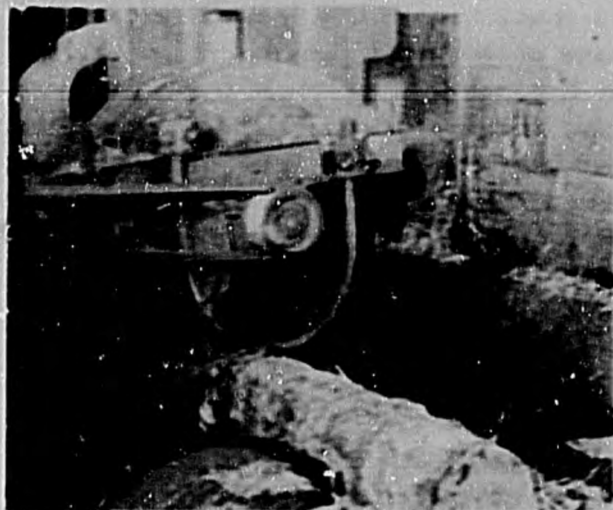
Better than water or a grit gouger is a log debarker (figure 25). These machines cost $10,000 or more and their installation at a small sawmill is justified only where there is a nearby market for the bark-free sawmill residues. Such markets might be pulpmills or wood particle board plants.

Edgers

A circular sawmill headrig may be run by itself without other accessory machines. If so, much of the product is "round-edged" lumber, that is, with bark on it. This round-edged material may be put back on the carriage, the bark removed and the edges squared on the headsaw. Round-edged lumber is undesirable, and edging on a headsaw is costly and wasteful. Thus, installation of an edger is recommended.

An edger is a machine with two or more circular ripsaws installed on a single shaft (figure 26). The position of one of these saws is fixed, and the others are generally movable so that the width of the boards or timbers edged can be varied. To feed the boards through the saws, a pair of fluted feed rolls with power applied to them in front of and behind the saw arbor is provided. These feed rolls engage the flat faces of the lumber and advance it as the edges are being cut off. Some edgers have a moving chain instead of rolls for this purpose.

Shifting the distance interval between saws is usually done manually by a long lever at the rear end of which are attached forks that slide the saw sideways along the keyed revolving shaft. The front end of the lever is convenient to the edger operator's (feeder man's) position. There are other simple arrangements, some of which are electrically operated, for moving the saws, but for a small mill



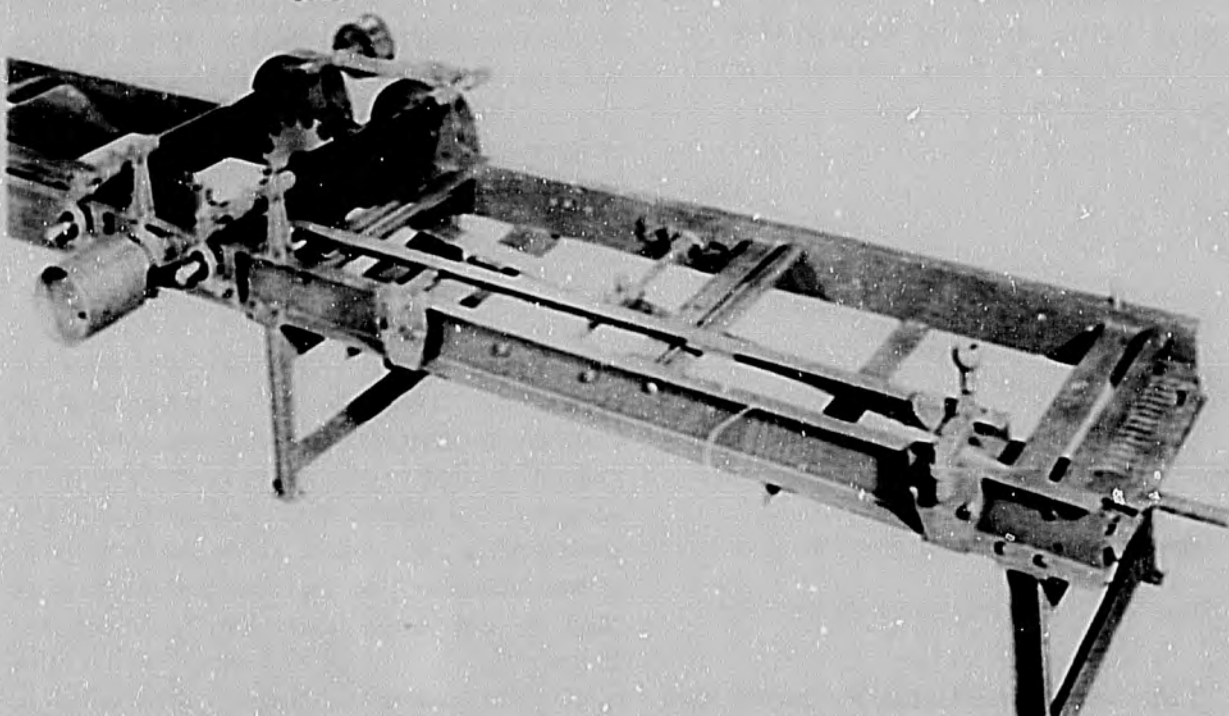
(PHOTO BY FOREST SERVICE, U.S.DEPT. AGRICULTURE)

Figure 25. Mechanical log debarker. (Chain Flail type)

the direct manual operation is adequate.

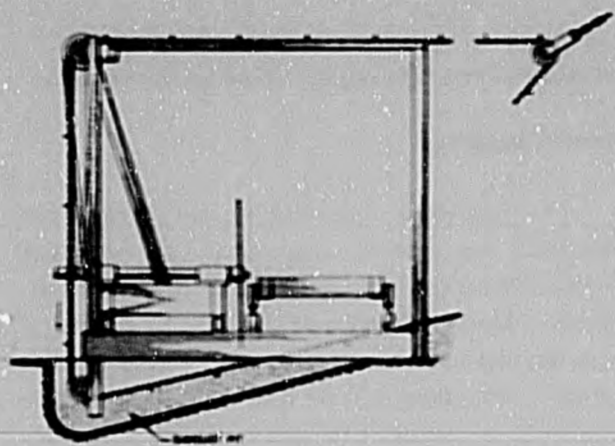
Material Handling

A number of different types of devices for conveying logs, lumber and residues are also useful for small sawmills. Most conveyors take the form of travelling chains or belts, gravity slides or rollers, and blowers. Logs are frequently brought into the mill by a heavy chain. Sawdust may be conveyed out of the saw pit beneath the headsaw by a similar but lighter chain (figure 27). Larger volumes can be handled effectively by a fan blower system. Lumber may travel from the carriage to the back of the mill on a series of gravity pipe-like rollers (figure 28) or on a continuously moving belt. Sawmill residues, including slabs, edgings, and trim are usually dropped onto a residue conveyor, either a chain or belt, which carries them out of the mill with no further attention.



(PHOTO COURTESY CURLEY MANUFACTURING CO.)

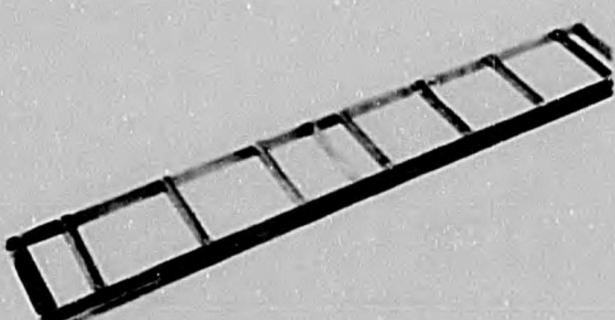
Figure 26. A small two-saw edger.



(ADAPTED FROM DRAWING, COURTESY CORLEY MANUFACTURING CO.)

Figure 27. Sawdust pit and overhead chain sawdust conveyor.

To handle material outside a mill, the most common and useful device, even at small-sized installations, is fast becoming the fork lift truck. These machines are made in a variety of sizes and costs vary over a wide range. A good complete machine of suitable size for most mills may be purchased for $8,000 to $12,000 f.o.b. manufacturer in the United States.



(PHOTO COURTESY CORLEY MANUFACTURING CO.)

Figure 28. Gravity ball bearing lumber rolls.

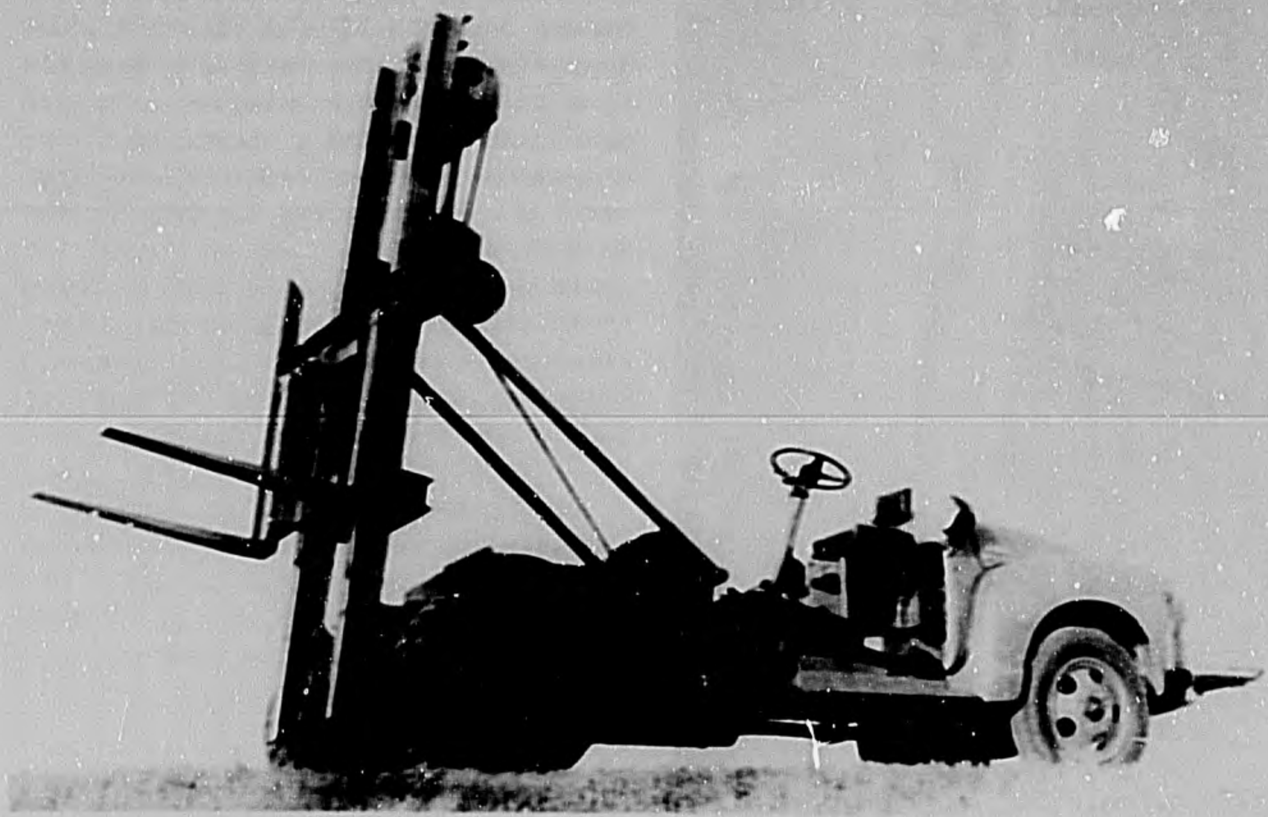
For very small mills conversion kits are available for $1,100 to $2,400 f.o.b. manufacturer in the United States (figure 29). These units make a standard motor truck of about 16,000 pounds gross vehicle weight with only a single operator into a very useful tool for handling logs, bundles of lumber, and slabs and edgings weighing up to 5 tons.

Many United States mills sawing as much as 15,000 board feet a day have only one of these units operating in the yard, supplying the mill with logs from stock decks, carrying the bundles of lumber out to prepared foundations in the yard or loading them on motor trucks, and also handling the slabs and edgings. Fork lift conversion kits for handling less than 5 tons are available for standard makes of wheel tractors.

Small mills may also have a variety of motor trucks or wagons operating outside the mill. A "pickup" truck of 1/2 or 3/4-ton capacity is frequently used for transporting light loads of supplies or tools and for general-purpose transportation of the mill operator and workers. Many mills also have one or two flat-bed motor trucks of larger capacity for transporting lumber to market.

Trim Saws

Trim saws also are of various types, and are used for crosscutting lumber to length, for cutting slabs and edgings, and cutting timbers to given lengths. Among the simplest is the swing saw, mounted between a pair of arms attached to an overhead shaft so that it can be pulled by the operator through a board positioned on a set of rollers ahead of it (figure 30). Power can be taken off the main shaft.



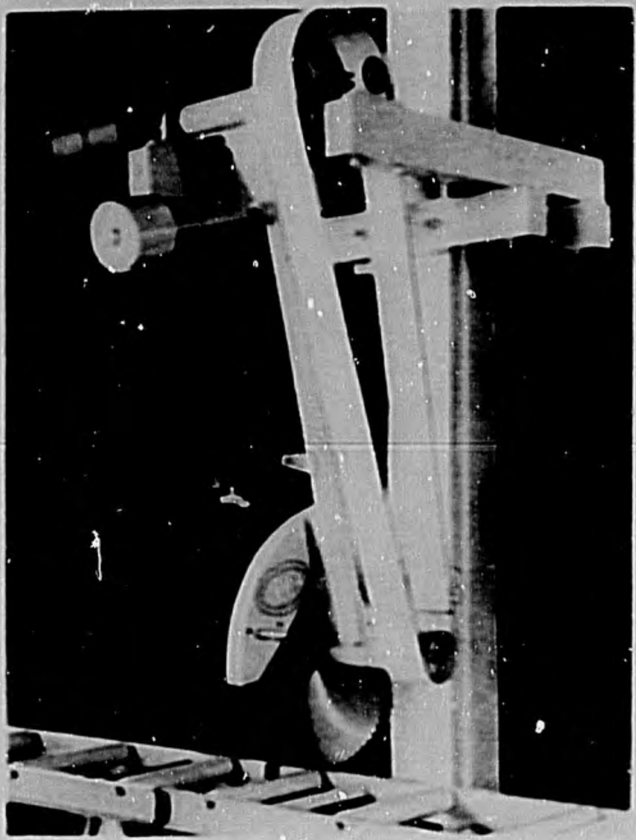
(PHOTO COURTESY TAYLOR MACHINE WORKS)

Figure 29. Ordinary motor truck converted to fork lift.

Another type is known as the Canadian trimmer (figure 31). This has two saws permanently mounted in staggered positions at two ends of a horizontal chain conveyor which carries the lumber past them laterally. The two saws are generally spaced a distance equal to the maximum length of lumber desired (usually 16 feet). When shorter lengths are desired, an operator pulls the lumber across the chains after the one end has been trimmed by the first saw and places it so the second saw will cut it to the proper length.

A third and very efficient type of trimmer has two movable saws keyed to a common shaft like an edger (figure 32). Distance between the saws may be varied by moving a shaft equipped with pinions by means of a crank. The pinions actuate roller chains mounted in the front and back frames of the machine which move the saws to cut the desired length. More expensive types of trimsaws, often with a large number of saws, are available, but are generally too expensive and too elaborate for use in small sawmills.

Another special-use trim saw is an automatic machine (figure 33) for cutting slabs and edgings to length. These are available in inexpensive models, costing $500.00 in the United States. Slabs and edgings are piled onto an intermittently moving chain or belt and cut into predetermined lengths for use as fuelwood or merely for convenience in disposing of them. These machines save so much labor that their installation is generally profitable.

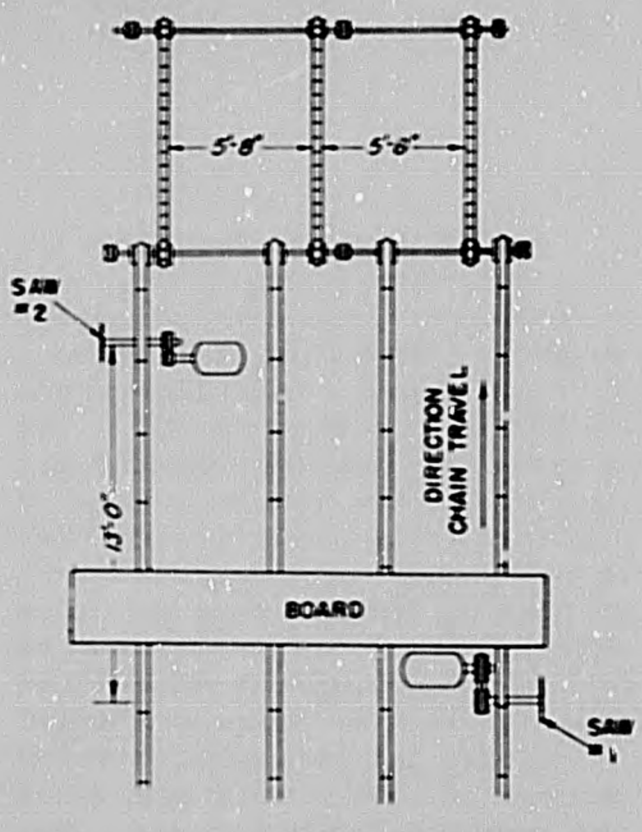


(PHOTO COURTESY FRICK COMPANY)

Figure 30. Swing saw used for trimming lumber.

A better type of inexpensive log turner consists of a drum on a shaft suspended over the carriage, powered by a belt from the mandrel. Around this drum is wound a chain which terminates at its lower end in a hook (figure 35). When a log too big for the deck man to handle must be turned, the chain is let down and the hook fastened in the side of the log. Then the sawyer actuates the drum and pulls the log with a rolling motion onto the carriage, or turns from one face to the other.

A simpler turner of the same type consists merely of a chain attached to an overhead beam (figure 36). The hook at the end is attached to the side of the log, which is then turned by advancing or receding the carriage.



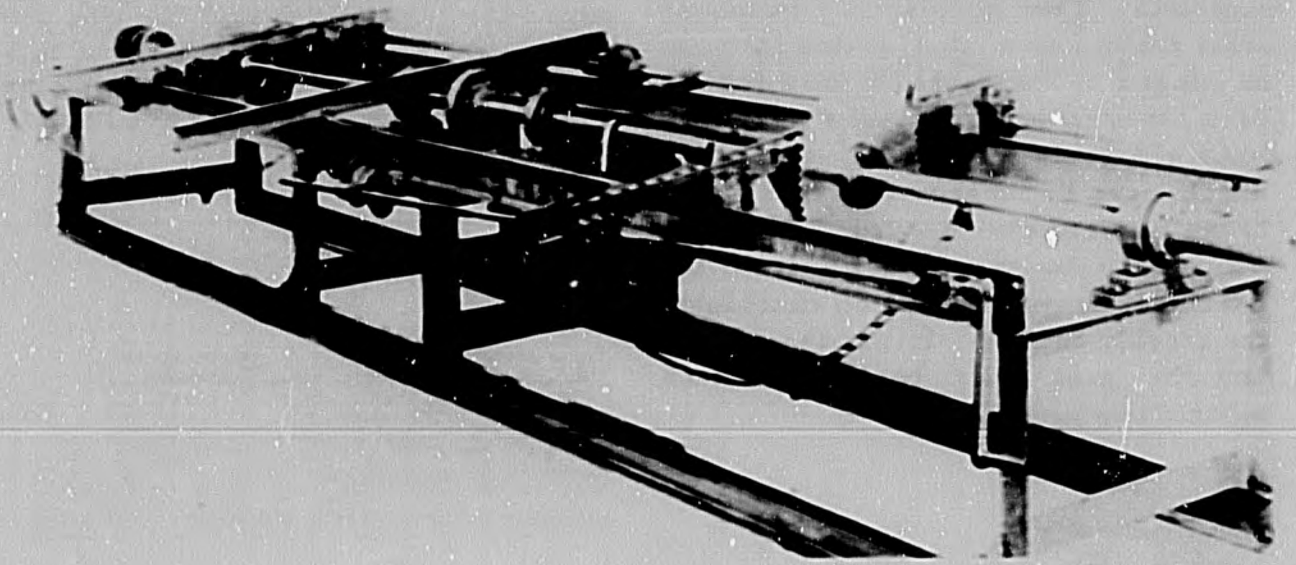
(FROM U.S.D.A. HANDBOOK #27.)

Figure 31. Canadian trim saw.

Log Turners

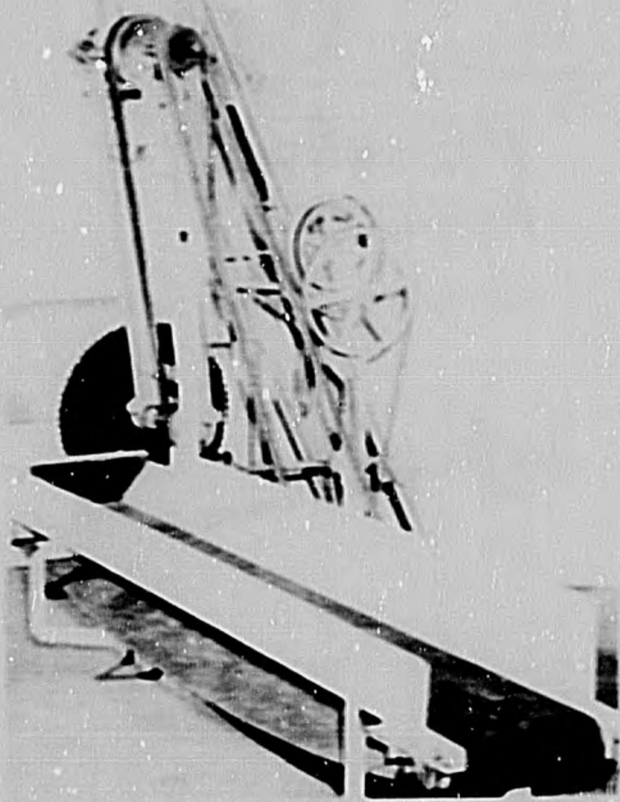
Another worthwhile accessory for small mills, especially those confronted with big logs, is a log turner. Logs under about 15 inches in diameter can be turned about as quickly and easily by hand as mechanically. It is difficult to turn larger logs by hand, and frequently a number of men have to be called from other jobs to turn them.

The type of log turner usually installed at small mills is illustrated in figure 34. This type takes power from the mandrel and transmits it to two reciprocating toothed arms, which claw a log over to its new position. It is slow in its action, and the teeth deface the cut surface being clawed.



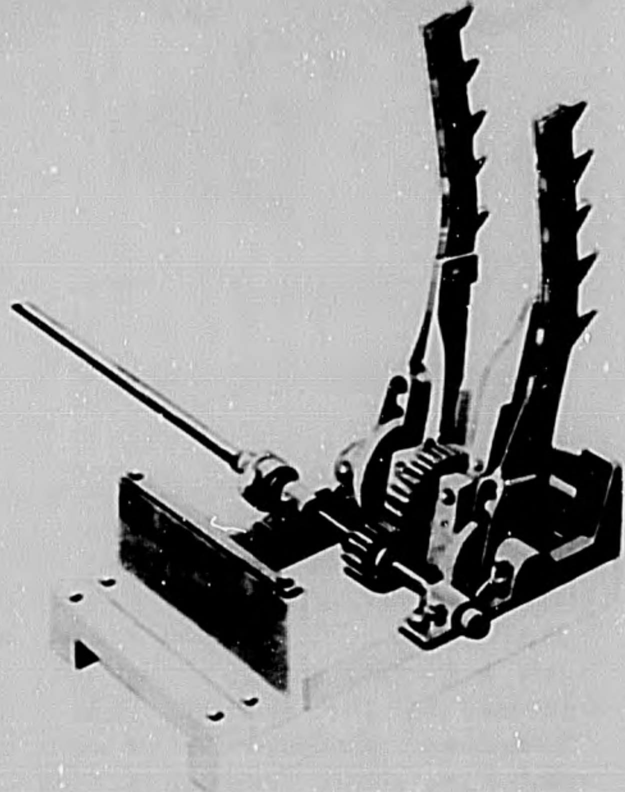
(PHOTO COURTESY CORLEY MANUFACTURING COMPANY)

Figure 32. Adjustable two-saw trimmer.



(PHOTO COURTESY CORNELL MANUFACTURING CO.)

Figure 33. Automatic slab saw.



(PHOTO COURTESY CORLEY MANUFACTURING CO.)

Figure 34. Standard type of log turner for small sawmills.

When it is necessary to hand turn large logs, a pair of "turndown" blocks is of considerable help. Commercial blocks for this type of use are available. They consist of a couple of steel rollers in a steel frame that can be hinged to the front ends of the log deck timbers in such a way that they hang alongside the timber when not in use, but can be turned up to rest on top of the timbers when needed. Then, when a log is to be turned down from the carriage, by men pulling on canthooks, the freshly cut face strikes the rollers and the cant rolls back into place against the knees.

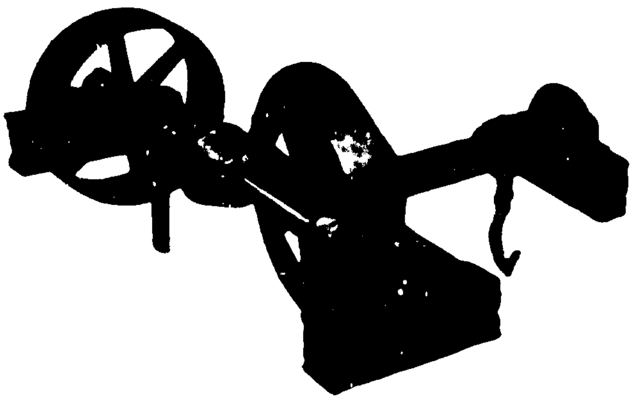


ILLUSTRATION COURTESY [illegible] MACHINERY CO.

Figure 35. Overhead type of log turner.

A similar and equally effective device can be made at a mill. This consists of a pair of semicircular steel blocks hung alongside deck timbers on a shaft (figure 37). On the end of the shaft is a crank or lever that may be operated by the sawyer. When the "turn-down" blocks are to be used, he rotates the shaft, bringing the convex surfaces of the blocks above the deck. The cant is turned down by hand against them; its weight rotates the blocks toward the carriage, pushes the cant against the knees, and carries the "turn-down" blocks down alongside the timbers, with their flat face upward, where they will be out of the way until they are again needed. A set of this type of blocks can be made by cutting an old truck wheel in half, and mounting the halves as shown.

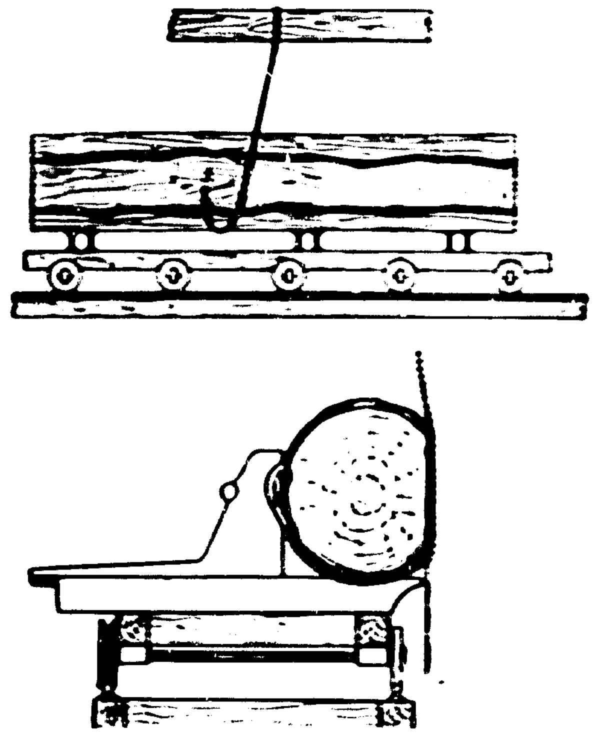


Figure 36. A simple overhead log turner.

ILLUSTRATION COURTESY [illegible] MACHINE CO.

Figure 37. Log "turn-down" blocks.

Residue Disposal Equipment

At temporary locations in a forest, the disposal of residues made by a small sawmill is usually not much of a problem. The sawdust, slabs and edgings are conveyed out of a mill to a pile and then the pile is left behind when the mill moves.

At permanent locations, especially in or around cities or villages, it is frequently possible to sell mill residues at a profit. In the United States, for example, sawdust is used in considerable quantities as an absorbent bedding material for livestock. It is also used for spreading on croplands to improve the physical condition and moisture-holding capacity of the soil. Sawdust which has not been first used for bedding must be supplemented with nitrogen in some form before it is spread on land, because the bacteria which multiply in the soil to rot the wood fragments require large quantities of nitrogen for their life processes. This agricultural market for sawdust might be worth cultivating in other countries. It generally requires construction of an elevated bin for the sawdust, under which a farmer's truck can be driven to be loaded by gravity (figure 38).

Slabs and edgings have high utility as fuel and are good raw material for manufacture of charcoal. An automatic slabsaw to cut these materials into convenient lengths has already been mentioned. Bark-free slabs and edgings are also good raw material for paper pulp or wood particle board.

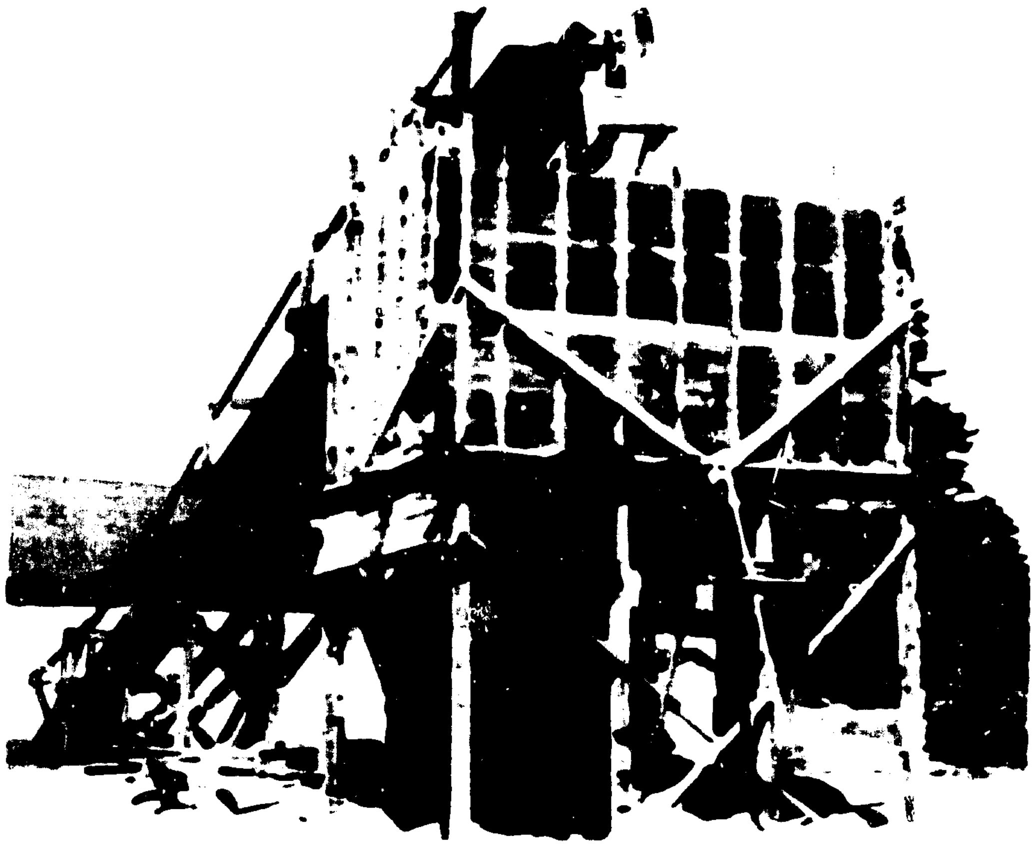
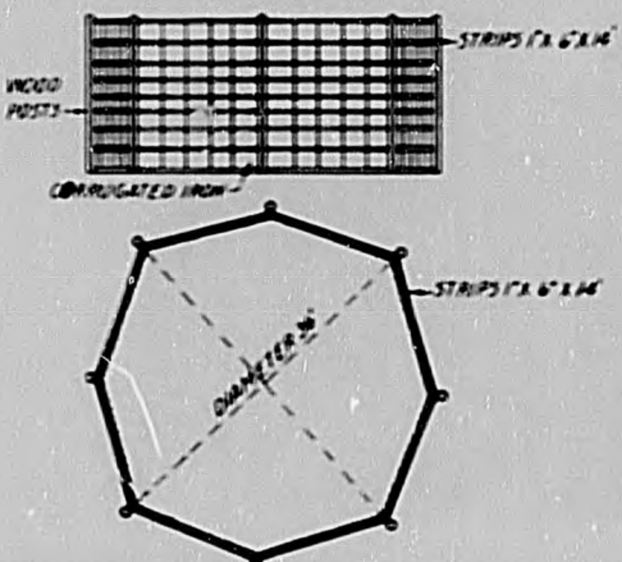


PHOTO BY FOREST SERVICE, U.S. DEPT. AGRICULTURE

Figure 38. Sawdust bin at small sawmill arranged to load farmers' trucks by gravity.

If no markets are available for mill residues, the best way to dispose of them at permanently located mills is to burn them. But burning such residues in an open pile may create a serious fire hazard. Commercial sawmill refuse burners of sheet steel with a screened top are available from a number of manufacturers in the United States.

A satisfactory burner may be built with masoury or scrap iron by small operators. Such burners consist merely of a wall around the fire pit, with openings at the bottom into which air can enter for draft, and an open, sometimes screened, top (figure 39). A conveyor drops mill residues on the fire from the top. If the material to be burned is very wet, sometimes a forced draft is needed. This calls for a powered blower to force air up through grates or a pile of loose rock at the bottom of the burner.



(FROM U.S.D.A. HANDBOOK #27)

Figure 39. Plan for sawdust burner made from corrugated iron.

Other Accessories

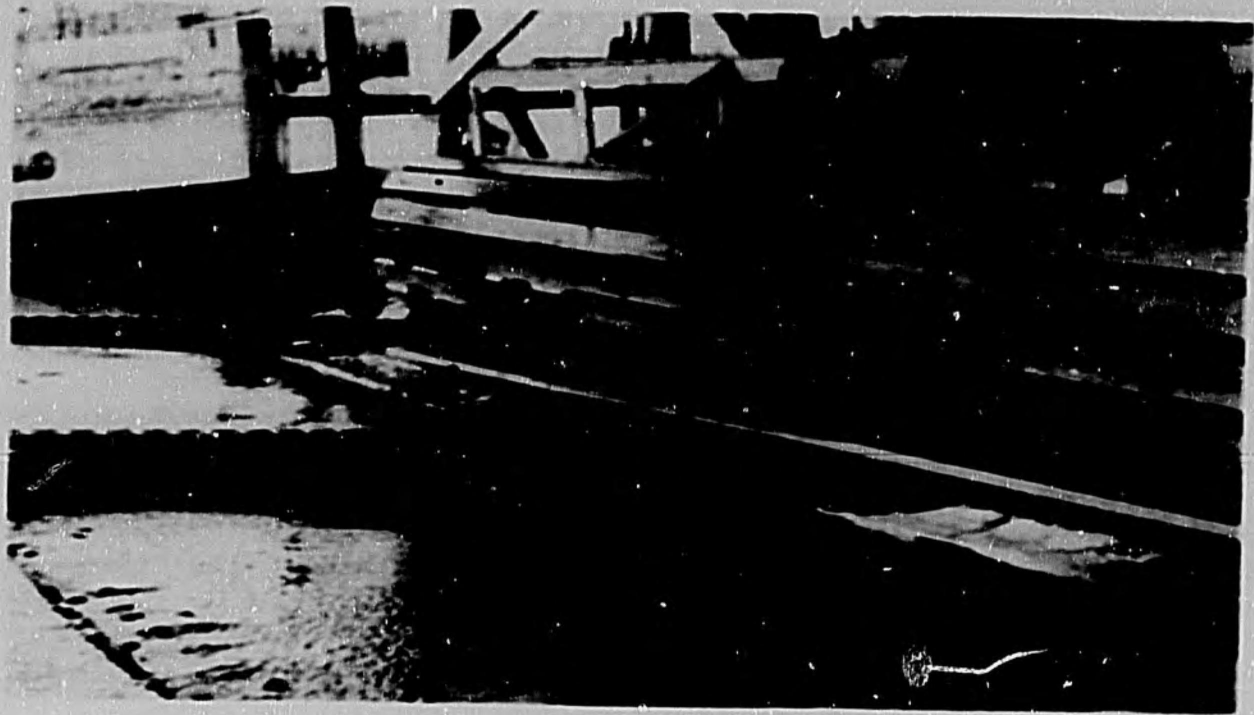
A number of other accessories are desirable for installation at small sawmills in certain instances. One is a dipping vat. Fungi and insects frequently attack freshly cut lumber and deface or degrade it. A number of chemical compounds, most of which are soluble in water, have been developed to prevent these losses (See Appendices 3 and 11). To be protected, lumber has merely to be dipped in a tank containing one or more of these chemicals dissolved in water. This dipping may be done automatically in an inexpensively constructed trough through which freshly cut lumber is run on a chain conveyor and beneath some kind of a hold-down so that it will be completely immersed (figure 40).

Some small mills may also wish to install remanufacturing equipment to supply special markets. This type of equipment includes planers, moulders, and various types of cross-cutting and ripping machinery.

Power Units

The most expensive part of a small sawmill installation is usually the power unit. For this reason, it is common to find power supply deficiencies. A 150-horsepower diesel unit costs about $5,000; a 100-horsepower unit, $3,000. Prospective operators often compromise and buy the less costly.

Sufficient power increases productivity, and it increases the life of the power unit itself. Furthermore, it increases accuracy of cutting for, when a headsaw slows down in a deep cut because of lack of power, the tensioning of the saw is no longer correct for the speed and the saw begins to cut off line. This means that the sawyer must compensate for this inaccurate cutting by setting his mill to cut at greater average thickness, so as to



(PHOTO BY FOREST SERVICE, U.S. DEPT. AGRICULTURE)

Figure 40. Automatic lumber dipping vat with slotted rollers for hold-down.

make sure all pieces are of the necessary minimum thickness. Production is lower, less-salable lumber is obtained from the logs received, and unit costs go up. Hence, power should be adequate.

A good guide to the power a small sawmill needs is furnished by a series of recent studies at the Forest Products Laboratories of Canada.* There it was found that the power needed on the mandrel of a small mill varies directly, not only with the depth of cut but also with the specific gravity of the wood. With a saw speed of 700 revolutions per minute and a carriage feed speed of 170 feet per minute, a lightweight wood like white pine (specific gravity .34) takes only about half the power required to cut a heavier wood like sugar maple (specific gravity .56).

The actual figures are given below:

Average Power Requirements at the Headsaw for Species Tested

Species	Average Specific Gravity	Depth of Cut						
		(Inches)						
		2	4	6	8	10	12	14
		(Horsepower Required)						
White Pine	.34	10	20	29	39	49	59	68
White Birch	.48	14	29	44	59	73	88	102
Yellow Birch	.55	16	33	48	65	79	95	111
Sugar Maple	.56	18	37	54	71	89	106	123

*Andrews, G. W., Power at the Headsaw. Canada Dept. Northern Affairs and National Resources, Forestry Branch, Forest Products Laboratory, Ottawa, 1954, 4 pp. illus.

When only one power unit runs the entire mill, to the above power requirements must be added those for feeding the carriage (5 H.P.), edger (12-15 H.P.), swing cutoff (5 H.P.), two-saw trimmer (7.5-10 H.P.), sawdust chain or blower (1-4 H.P.), plus an excess of about 10 percent on the over-all power needed to cover friction loss in pulleys and belting.

Consequently, 150 horsepower is none too much for a single power unit in a mill cutting a species as dense as sugar maple, with the saw running at 700 revolutions per minute and the accessory units listed above attached to it.

Tests have also shown, however, that a saving may be obtained by reducing the r.p.m. of the headsaw and maintaining the same feed rate. For example, a drop in saw speed to 400 r.p.m. brought about a saving of approximately 18 percent in the amount of power required. This feature is of particular value to a mill which is marginally or under-powered. When such a speed change is made, the saw, of course, has to be retensioned to run straight at the new speed. An additional saving can be made by running some or all of the auxiliary equipment from another power unit.

In choosing the correct size of pulley for the mandrel, the speed at which the power unit is to be run and the size of the power unit pulley must be known, and the saw speed desired must be decided upon. Then the following formula can be used: $D = \frac{d \times rpm\text{-}E}{rpm\text{-}M}$

D is the diameter of the mandrel pulley, and rpm-M is the desired saw speed; d is the diameter of the engine pulley and rpm-E is the engine speed. Thus, if the power unit pulley is 8 inches in diameter and the engine is governed to rotate at 1750 revolutions per minute, d x rpm-E will be 14,000. This divided by a desired saw speed of 600 r.p.m. will give about 24, the diameter in inches of the necessary mandrel pulley. (See tables of power transmission ability of "V" and flat belts in Appendix 6).

Diesel power is the most generally used type at small sawmills throughout the world. Steam engines are practically obsolete at small mills because of their high initial and maintenance costs, a danger of explosion, and cost of labor to keep a fire under the boiler night and day. Steam engines also require a dependable supply of clean water.

Electric motors make a good source of power for small mills, but commercial electric power is available at only a few small sawmill sites, generally those located around the larger cities. It is very expensive to equip a small sawmill to generate enough power to run its major equipment.

A small home-sized generator (3 to 4 kilowatts capacity) run by a gasoline engine would be a good investment for many small mills located away from supplies of commercial electric power. Such an outfit can be purchased for about $500, and it would furnish enough power for lighting around the mill and running a refrigerator and small tools such as drills and grinders. For the mill itself, it could run an electric grit gouger ahead of the headsaw and a shadow line guide for the edger operator.

Gasoline and distillate engines are cheaper than diesels, but the fuel to run them costs more than diesel fuel, their life is shorter and they need more continuous maintenance than diesel units.

Equipment Costs for Typical Small Sawmill Installations*

Portable Mill for Small Logs

Capacity 6,000 to 8,000 board feet per day, logs up to 28 inches in diameter

Mill #1 (Layout figure 42)	$1,550
Sawdust drag	170
Two 48-inch diameter I.P. saws	600
V-Belt drive complete, with 2 pulleys	270
100 h.p. diesel power unit	3,500
Two-saw 27-inch "pony" edger, with saws	850
Swing cutoff saw	300
Grit gouger	300
Miscellaneous belting, shafts, conveyor chain, and small tools	1,000
Total	$8,540

Permanent Mill for Large Logs

Capacity 10,000 to 20,000 board feet per day, logs up to 32 inches in diameter (50-inch with topsaw)

Mill #2 (Layout figure 46)	$3,100
Topsaw rig (optional)	1,015
Sawdust blower with pipe, pulley and belt	600
Two 54-inch diameter I.P. saws	850
V-Belt drive complete, with 2 pulleys	350
150 h.p. diesel power unit	5,000
Three-saw 32-inch standard edger, with saws	925
Swing cutoff saw	300
Two-saw trimmer	1,700
Grit gouger	300
Miscellaneous belting, shafts, conveyor chain and small tools	1,500
Total, with topsaw	$15,640

Mobile Mill

Capacity up to 10,000 board feet per day, logs up to 31 inches in diameter

Mill #3 (figure 20)	$3,200
Trailer-mounted 27-inch edger, complete with power unit	1,330
100 h.p. diesel, mounted on motor truck	6,000
Main feed belt	200
Total	$10,730

Optional Accessory Equipment	
Log turner (figure 35)	$ 150
Fork lift truck (figure 29) complete	5,000
Motor trucks (each)	3,000-5,000
Dipping vat (figure 40)	500
Automatic slab saw (figure 33)	700

*Note: These prices are f.o.b. manufacturer. They do not include transportation and erection costs.

SETTING-UP OPERATION

Mill Location and Layout

Location

The first decision a prospective mill operator must make is whether his sawmill is going to be mobile, semi-permanent, or permanent. The type of machinery selected will depend, in part, on this decision.

In the more highly developed countries, a larger proportion of the small mills are being permanently located each year. One reason for this is that they are becoming geared to the sustained-yield capacity of a forest and can depend on a continuing supply of logs from nearby managed timber stands. Another is that sawmill labor generally is no longer satisfied to lead a nomadic life, living only a few months at a time in one temporary shack after another in the woods. Still a third reason is that in its permanent location a sawmill can be supplied with more sturdy and longer lasting foundations, which reduce maintenance and make for more accurate cutting. Also, in a permanent mill there is usually a better opportunity to find profitable uses for mill residues, to provide conveyors and other labor-saving equipment, and to engage in some remanufacture which may result in up-grading and greater salability for the lower-grade portion of the cut.

A notable exception to the growing proportion of permanently located small mills is the increase in the number of mobile mills. These wheel-mounted machines are best adapted for use, of course, in a country with a network of good roads. They are used largely for custom sawing small lots of logs for farmers, ranchers and other local settlers.

A landowner will bring his logs to the roadside and make arrangements with the operator of a mobile mill to move in and convert them to lumber to the owner's specifications. In this way, the owner is sure that he gets all the product of the logs he has supplied, including the slabs, edgings and sawdust. He is also relieved of the job of hauling his logs a longer distance to a permanently located mill and hauling the lumber back home. These mobile mills are frequently set up to saw lots of logs as small as 5,000 board feet. Many of them can move in and be set up and start sawing in less than thirty minutes. When the sawing job is completed, the mill can be prepared for travel again in as little as fifteen minutes.

The mobile type of mill is also used to some extent in regular lumber manufacturing operation. It is taken into the woods and is used there to square up logs into cants, which can be more economically transported by motor truck or barge to a permanently located sawmill for further manufacture. The squared cants pile more compactly in the vehicle than logs, and they weigh 30% to 50% less than logs from which they are derived.

In between these two extremes is the portable or semi-portable mill. Most small American mills have been designed for this type of use. The mill husk containing the feedworks and the mandrel may be transported as one unit. The sills, which go under the husk and extend out under the trackways, constitute another unit. The track itself for this type of mill comes attached to sections of wooden ways 12 or 16 feet long each of which can be handled by two men. The mill carriage is assembled into another unit. The power source (usually a diesel engine), edger and trimsaw constitute additional units. These units can be disassembled, put on a truck and hauled to a new location readily.

Through the years, the portable small sawmill has met a real need (figure 41). When roads are not good, the mill can be moved into the forest to produce rough lumber which can be much more economically transported than the unsawed logs. Sawdust, slabs and edgings may be left behind at each move, so there is no disposal problem. It usually takes about a week to dis-

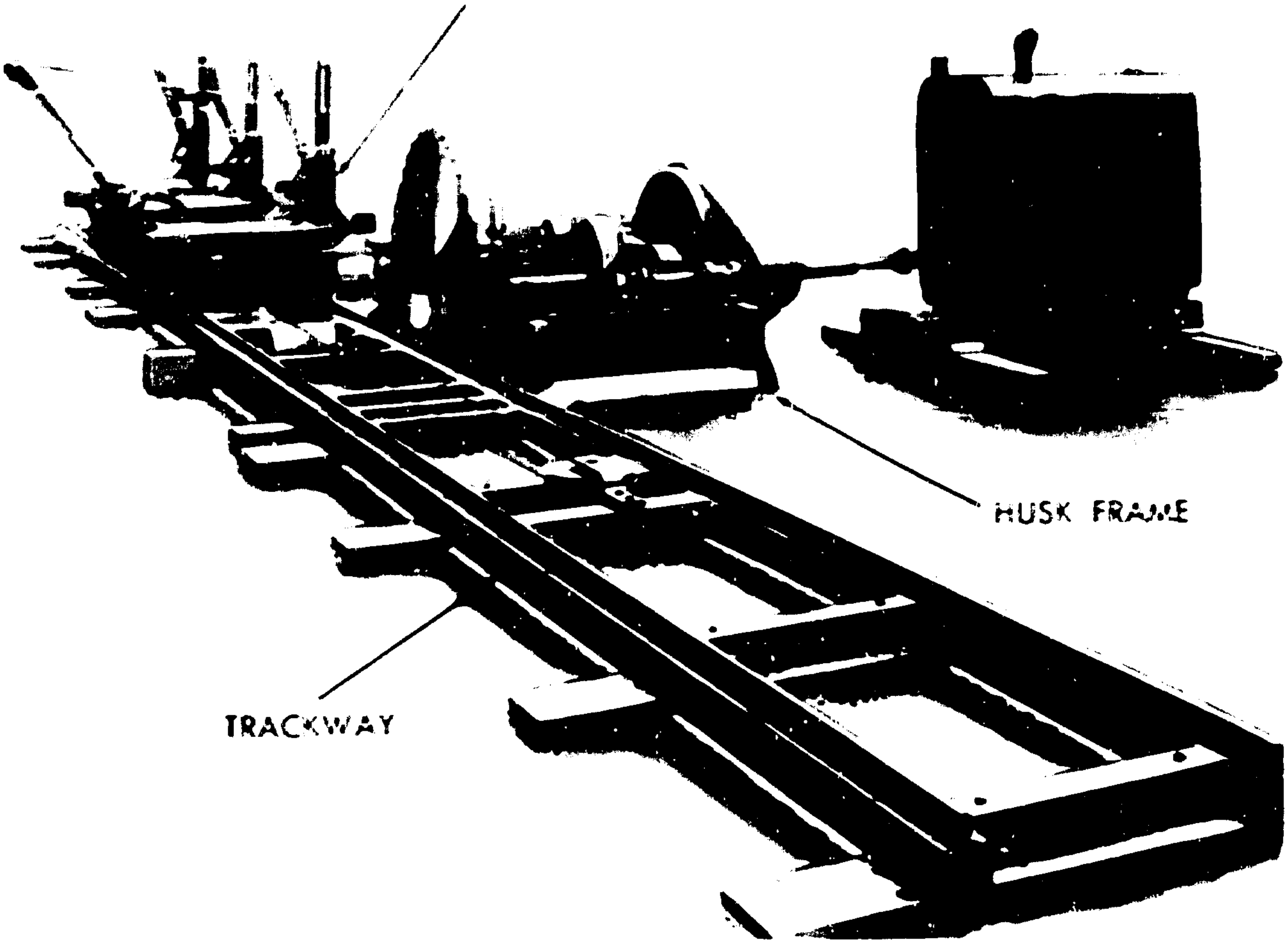


Figure 41. A portable circular sawmill set directly on the ground.

mantle a mill at one site, pack it up and move it to another site and set it up again.

Layout

Mill manufacturers provide a layout diagram for an operator's guidance in setting up a mill. The setting up of a small mill, such as that illustrated in figure 41 and for which a layout diagram is shown in figure 42, is described below:

Setting Up a Portable Mill

The site selected should be in a clearing of from 2 to 5 acres or larger, the size depending on the volume of logs and lumber to be stored. The land should slope gently to provide for rapid drying of the soil after a rain and to facilitate moving logs and lumber at the site.

The actual mill location on the site should be a place to which it is easy to deliver logs by truck; or if the logs are to arrive by water or are to be dumped and stored in a pond, a place so located that a chain conveyor or cable lift from the river or pond can bring them to the mill log deck. In a small mill this log deck is generally made up of two or three straight-sloping smooth timbers or poles. The dust from the pit and carry it up onto a pile, or to a bin or burner. The pit, then, does not have to be very deep; four feet is generally enough.

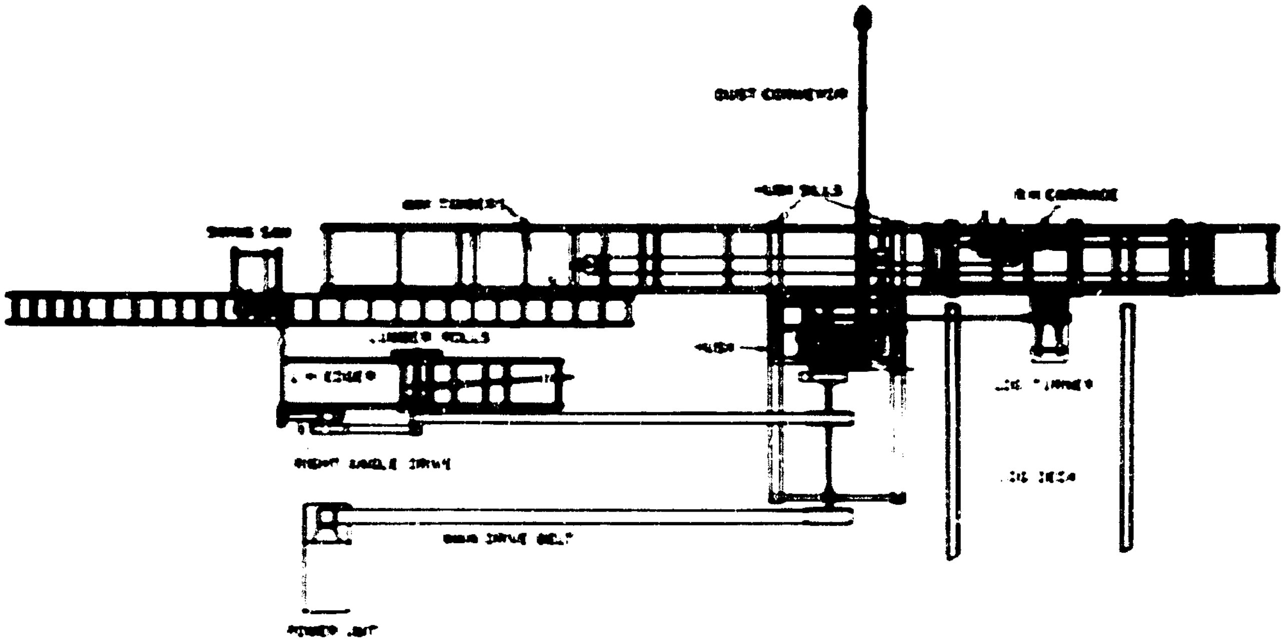


Figure 42. Layout diagram for small portable sawmill, set directly on ground.

upper ends are embedded in the earth and the lower ends rest on pilings or cribwork, so as to bring them to carriage height.

Alongside the place selected for the log deck, the husk is placed. First, two timber sills about 10" x 10" in size are firmly embedded to about half of their depth in the ground, the width of the husk apart, with their front ends extending out under the location of the trackways. The husk frame is placed on the rear ends of these sills, leveled in both horizontal directions. Between the front extensions of the husk sills and under the trackway the sawdust pit is dug. Generally, in this type of mill a sawdust drag (chain conveyor - figure 27) is used to remove the saw-

Next, crossties, or sleepers, about 6 by 8 inches in cross section are embedded in the ground parallel with the front extension of the husk sills, and with their tops level with the tops of the husk sills, the length of the trackway on either side. To the rear of the husk, these ties need be no closer than 18 inches or two feet apart, but opposite the log deck they should be placed about 12 inches apart, for the reason that in this area they will be subjected to the greatest strain and shock from rolling logs on the carriage and turning them during the sawing operation. These ties should all be level horizontally and vertically. Over the sawdust pit, timbers at least 6 by 8 inches in cross section should be saddled between the husk sills under the line the "way" timbers will cross, to provide additional support for them.

The way timbers with the track mounted on them are then placed on the ties, parallel with the front of the husk; leveled crossways and lengthways, using shims or wedges on the ties and husk sills, if necessary; brought to line, and then bolted firmly into place. Many makes of mills provide steel brackets on the front of the husk frame, to give the correct distance and height of the adjacent portion of the ways. If these have not been provided, two wooden blocks of the correct size should be made and bolted into place on the front of the husk to give this placement.

Both tracks, but especially the guide rail, must be perfectly straight. This may be tested with a tightly stretched string or wire and the necessary adjustments made. If a section of track is kinked or bent in moving, it will be necessary to get a new one. Experience has shown that it is practically impossible to straighten a damaged track. Kinks and bends in the track result in strains on other parts of the mill and in inaccurately cut lumber.

With the way timbers firmly and accurately placed, the next step is to put the cable drum shaft in place and bolt its bearings tightly to the way timbers. Then the carriage is placed on the rails and pushed by hand, backward and forward, with a spirit level placed on each of its bolsters in turn, to make sure that there are no sags or dips in the track.

Once the carriage is operating properly, the carriage feed cable is installed. This is done by backing the carriage alongside the log deck, carrying one end of the cable underneath it and attaching it to the bracket on the rear end of the carriage frame. The other end of the cable is carried the length of the track, passed through the sheave or pulley near the rear end and brought back over the cable drum and down and around it for four wraps. Then the end of the cable is carried under the carriage again, through the sheave near the front end of the track, and fastened to the bracket on the forward end of the carriage frame. It is necessary that the cable be tight to insure against its coming off the cable drum.

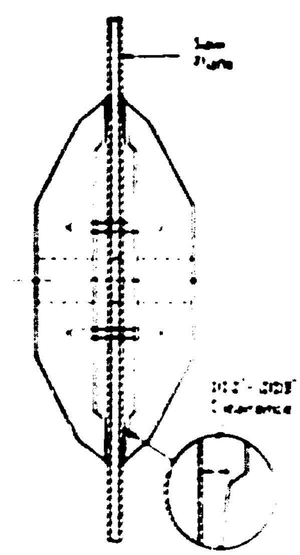
Next, the mandrel is installed in its bearing blocks on top of the husk, the main pulley hung on one end, the saw on the other. The saw must be absolutely vertical. To see whether it is, a plumb bob, not a spirit level, should be used. If the saw is not vertical, the husk frame or the mandrel should be leveled with shims. A saw tensioned to be run at less than about 600 r.p.m. should hang perfectly straight when idle, touching the plumb line throughout its height. A saw tensioned to run at higher speeds may be slightly concave on the log side when idle, but should stand straight when up to speed.

If it is dished one way or another, the collars holding it probably are not "true," are dirty, or have burrs around the lug pin holes. If dirty, the gripping surface of the collar and the part of the saw it touches should be thoroughly cleaned. Burrs can be removed with a bit of emery cloth or a file. But if the collars are not true, due to poor machining or to wear, they must be remachined in a properly equipped shop.

The difficulty can often be remedied temporarily by the installation of soft paper washers. A washer about 1/2 inch wide, with an outside diameter equal to that of the saw collar, is cut. Blotting paper is ideal, but any relatively heavy, soft-surfaced paper can be used, including several layers of newsprint. Another washer fitting inside should have an inside diameter equal to that of the saw eye. If the saw is convex on the log side, the larger washer is placed against the face of the tight collar, using a bit of cup grease as an adhesive. The saw is then put in place, turned backward a little to make sure it has a fair bearing on the lug pins, and the loose collar, with the smaller washer adhering to its face, slipped on. Then the nut holding the loose collar is tightened with a wrench (spanner) of the proper size -- never with a hammer and cold chisel. The saw may then be tested for "dish" again; and if it is still present, an additional set of washers may be tried.

If the washers do not correct the condition, the collars should be taken to a machine shop and resurfaced on a lathe or new ones purchased. The lathe operator should be instructed to make his surfacing cut from the inside edge of the flat face toward the rim, rather than from the rim toward the center. Then the dulling of the lathe tool as it makes the cut will give the slight degree of concavity shown in figure 43 and will result in a collar that will continue to grip the saw correctly for a much longer period than if the surfacing had been perfectly straight.

The saw should "lead" a little into the log to hold it in line in the cut and to give clearance to the back of the saw (the edge farthest from the sawyer). The correct amount of lead will vary slightly with different mills, different saws and different species, so it must be determined by trial and error. As explained later, under the heading "trouble shooting," heating of the saw in service, either at the rim or at the center, may be an indication that the lead is incorrect and requires adjustment. It is suggested that a lead of 1/16-inch in the width of a 48-inch diameter saw be tried initially on a new mill, unless previous experience has indicated that a different lead is better suited to local conditions.



DRAWING COURTESY SIMONDS SAW AND STEEL CO.

Figure 43. Correct machining of saw collars

An easy way to test for lead is to move the carriage so that one of the bolsters is opposite the cutting edge of the saw. Then a sharp stick is clamped to this bolster so that the point just touches the sawplate near the bottom of a gullet. The place on the saw where it touches should be marked. Then the carriage is rolled forward until the bolster with the stick is opposite the rear edge of the saw, and the saw is turned so that the marked point on the blade is opposite to the end of the clamped stick. The stick should clear the saw at this point by about 1/16 inch. If it does not, the alignment of saw should be changed by adjusting the position of the mandrel bearing box holders. Before making the adjustment, all belts to the mandrel should be slacked off and both of the pins on each bearing should be loosened. Pins on the rear bearing should be slacked off only slightly, so as to provide a pivot point; those on the center bearing, to a greater degree, so that they will not bind and bend the mandrel; and those on the front bearing, just enough to give the proper lead to the saw. Then all adjustment pins should be retightened in such manner as not to bend the mandrel.

Once the saw is properly hung, the power unit should be installed on separate supporting timbers. The pulley on the power unit must be aligned exactly with the one on the mandrel, in both horizontal directions. This is especially important when V-belt drive is being used because, if the two pulleys are not parallel to one another, all of the belts will not be under the same tension and power will not be transmitted properly. In addition, if the grooves on the pulleys are not aligned, the belts will bind against the sides of the grooves and will wear out prematurely.

The saw guide should be placed so that it is as high as possible without interfering with the fronts of the carriage bolsters, and also so that the guide pins clear the saw bit holders by 1/4 to 1/2-inch. If the pins touch the holders, the holders will heat as the saw revolves and will lose their temper and resiliency. The pins should be adjusted so that they just clear the saw by about 1/32-inch; then, when the saw is up to speed, the whole guide should be further adjusted so that the saw runs freely between the guide pins. The saw guide should never be used to put lead in the saw because this will result in heating the rim of the saw and in loss of proper tension.

The splitter should be installed at the rear edge of the saw, not more than 3/4 inch away from it, and so that it is in line with the saw but does not rub against the cut face of the log. The function of the splitter is to keep springy timber from "clamping back" together after it is cut and binding the rear edge of the saw, with resultant danger of the piece being cut from the log kicking back.

After the whole mill is set up, it should be given a final check to make sure that everything is level, that all bolts and nuts are properly tightened, and that all moving parts are free of obstacles. Moving parts should then be lubricated in accordance with the manufacturer's instructions. If everything is in order, the feed belt should be installed and the power turned on, making the mill ready to operate.

After the mill has been operating a few days, everything should be checked again, even though the lumber is well manufactured. During operation, it should be rechecked at least once each month to be sure that shock loads and wetting and drying or freezing and thawing of the soil have thrown nothing out of adjustment or alignment.

The position of the various sawmill accessory devices is shown on the layout diagram (figure 42). The way they are attached to the power source is plain. The edger should be installed as close as possible to the lumber rolls, and its table should be even with or a little below the level of the rolls. Then the edgerman (who also may act as off-bearer) will have a minimum of lifting and shifting to do to get the lumber from the rolls to the edger. A simple aid to mill efficiency is to power the lumber rolls by running a piece of narrow belting over them and back under them, passing it over a pulley operating at a reduced rate of speed from another pulley on the extended edger shaft.

Another labor saver is a belt or chain operating in a trough under the lumber rolls, to carry slabs, edgings and trim out of the back end of the mill to a storage pile or burner. This can be powered off the main shaft in the husk.

If the mill is to remain at a site for more than a few weeks, a simple roof to protect the machinery and make working conditions better should be erected.

The mill described, if supplied with a good run of logs, should cut 4,000 to 5,000 board feet of hardwoods, or 6,000 to 8,000 board feet of softwoods per day with a crew of 3 to 5 men in the mill. A common crew organization consists of a deck man, a sawyer, a combination off-bearer and edgerman, and a combination tail edgerman and swingsaw operator. An additional man may easily grade and stack the product of such a mill in unit packages or on carts for transportation to the seasoning yard or to market.

Setting Up a Mobile Mill

The mill is driven to a site which is reasonably level and clear of debris. Using the jacks provided, it is levelled and then hitched to its power unit. Nothing else need be done to make it ready to saw (figure 44). The various adjustments and checks discussed above have already been made at the factory, or at the time of assembly, and once made they are practically permanent, because of rigid construction. However, tests should be made from time to time to be sure that the saws remain straight, that the mandrel is level and has the correct lead and that the saw hangs plumb.

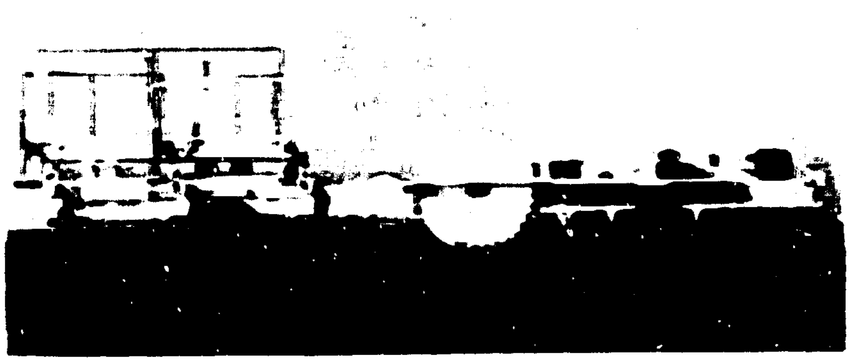


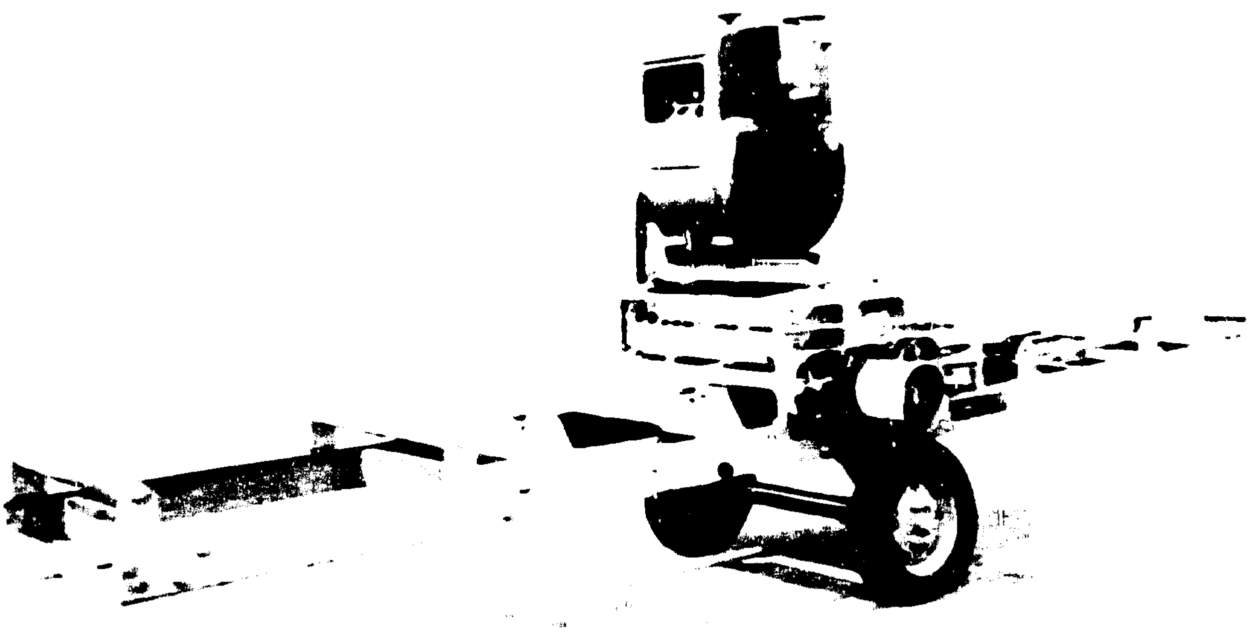
PHOTO COURTESY BACH MACHINERY CO.

Figure 44. Mobile truck-mounted circular sawmill

The adjustments outlined for the portable mill should be made if necessary. Lubrication, of course, is a recurrent necessity. Such mobile mills can cut 5,000 to 10,000 board feet a day but require a crew somewhat larger than that of the portable mill, because of the absence of conveying facilities.

To go with such mobile mills, mobile edgers with self-contained power units are available (figure 45).

A plan for poured concrete mill foundation is shown in figure 47. Machine bolts of the proper length to hold the husk sills and way timbers in place are installed in the concrete at the points indicated. Steel rails, or husk frames should not be bolted directly to the concrete; a wooden cushion is necessary between the two. Such cushions should be of treated wood. When the timbers are bolted down, it is usually necessary to use shims underneath them to make them absolutely level and straight throughout.



[illegible] COMPANY

Figure 45. Wheel-mounted edger with gasoline power unit.

Setting Up a Permanent Small Mill

Basically, procedures for setting up a permanent mill are the same as those for making a temporary set-up.

The permanent small mill is frequently set up off the ground, on wooden or concrete piers, with a sturdy floor and a building built around it. Detailed plans for such layouts, some including sawmill buildings, are available from the mill manufacturers (figure 46).

Tests for alignment and adjustment of these permanently located mills are identical with those already outlined for the portable and mobile mills. The carriage track is heavier than for smaller portable mill and is not available assembled on the ways. The operator must provide these way timbers. They should be preservatively treated or made from wood resistant to decay and insect attack. When the

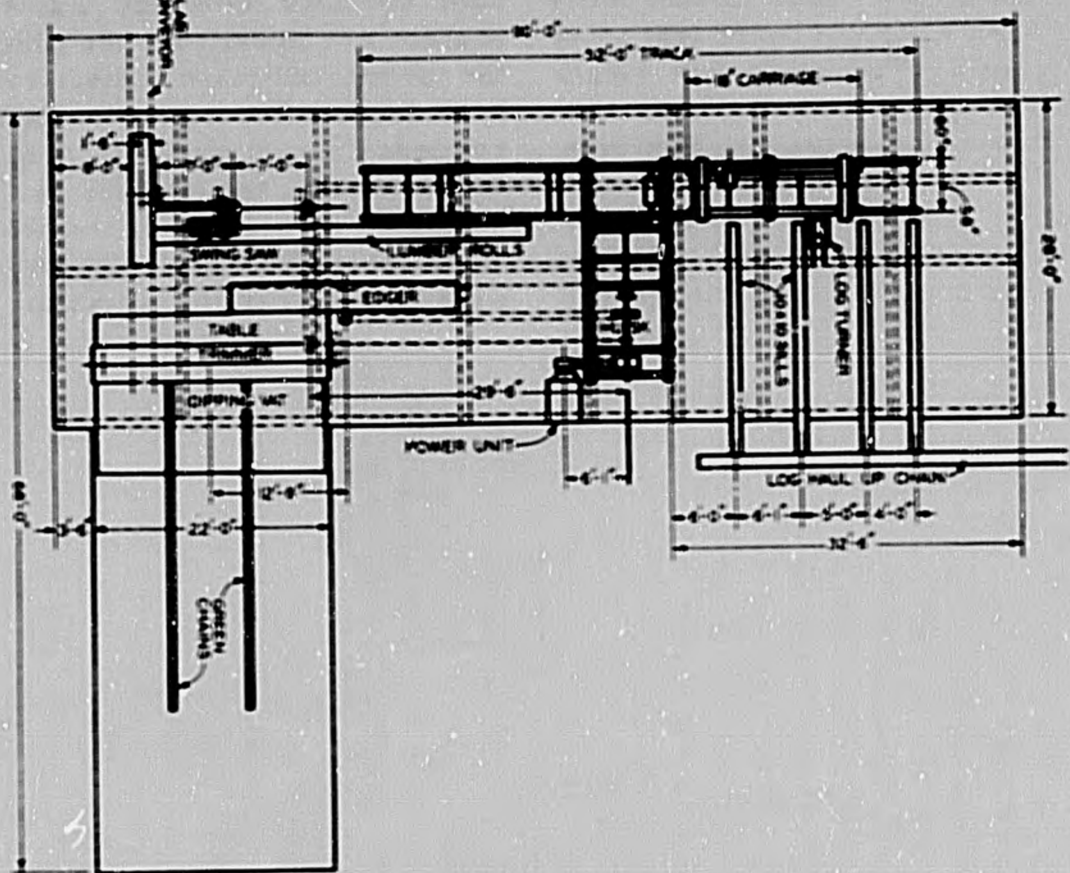


Figure 46. Layout plan for permanently located small mill.

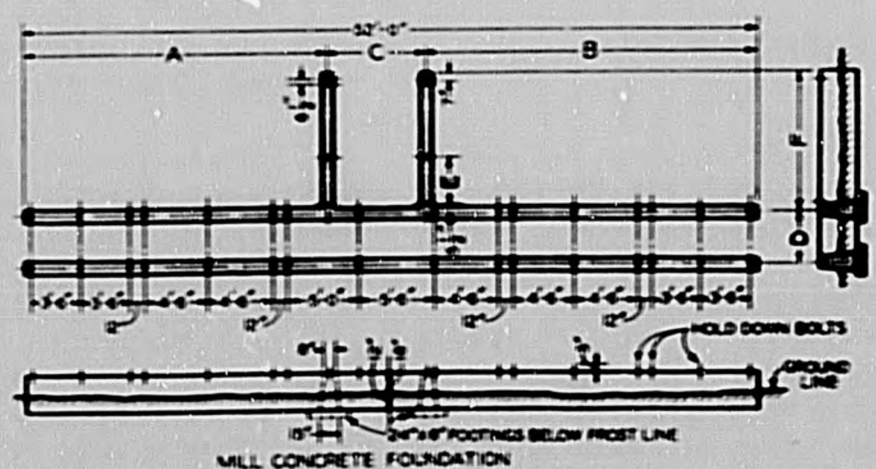


Figure 47. Plan for concrete foundation for permanently located small mill.

track is installed on them, a line (cord) is used to give alignment. This line is fastened to the way timber at one end of the track, brought up over the center of the track end and down over the center of the other end, pulled taut, and fastened to the way timber again. Then the entire track is brought to the line and bolted tight. The guide rail should be placed at the back of the carriage, away from the saw. This is particularly necessary when a log turner is being used. Otherwise, the entire carriage would frequently be derailed. Also, the guide rail at the rear is less likely to be cluttered with debris. Track cleaning devices, which are often small whisk brooms or pieces of leather belting fastened to the carriage frame, should be provided in any case. This is different from the portable mill where the guide rail is next to the saw.

A dipping vat is frequently installed in such a permanently located mill to insure against stain and insect attack in the cut lumber. Such a vat, which needs only periodic attention to check the level and concentration of the chemical solution, is shown in figure 48. Sources of chemicals to be used in such vats and recommended solutions are given in Appendix 11. Anti-stain chemicals are toxic to the skin of some workers. Rubber gloves should be provided to guard against skin irritations.

When wooden pilings are used for the mill foundation, it is essential that they and all other wooden parts of the mill be pressure-treated with a reliable wood preservative such as coal tar creosote or be made of some species with a demonstrated resistance to insect and decay attack. Pilings should be at least eight inches in diameter at the small end and sunk at least four feet into the ground, deeper if the ground is soft. Throughout most of the mill these pilings can be six feet apart each way, but under the log deck and the portion of the ways opposite it they should be no more than four feet apart.

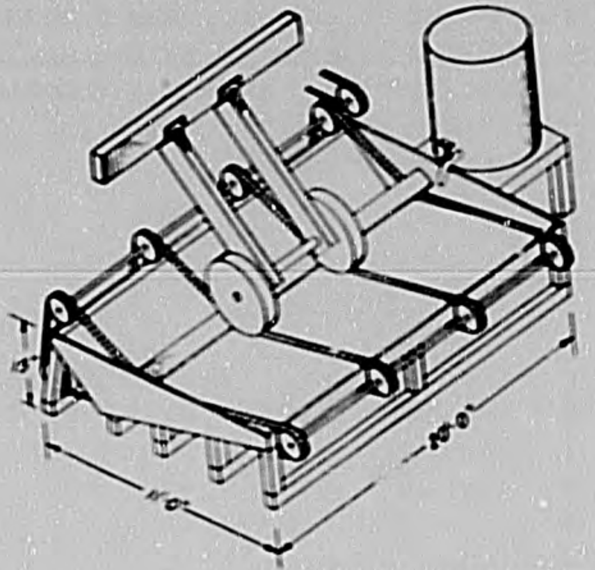


Figure 48. Conveyor chain lumber dipping vat.

The power unit should be mounted on a separate base, usually a cribwork of logs built from the ground up, so that it does not impart vibration to the mill building. The pilings should be connected at the top by joists at least 4 by 10 inches in cross section, bolted on. To these can be spiked 3-inch thick flooring. The floor is generally 6 feet or more off the ground. This gives room for belting, shafts and residue conveyors underneath.

Electric-powered mills can be mounted on a concrete slab laid directly on the ground. This is possible because use of electric motors does away with the shafting and belting necessary in a steam or internal combustion engine powered plant. Waste is conveyed out of such ground floor mills in a tunnel provided under the lumber rolls. Sawdust is usually handled by a blower system.

The usual crew in one of the larger circular sawmills is seven men, including a deck man, a sawyer, an off-bearer-edgerman, a tail edgerman and swingsaw operator, a trimmer operator and a tail trimmerman. Such a mill crew should be able to produce 10,000 to 15,000 feet a day of hardwoods or 15,000 to 20,000 feet a day of softwoods. Two additional men are usually used to load out the cut lumber.

Log Storage

At smaller mills, such as the portable mill duscussed in this section, log storage is usually not a problem. Very few logs are normally accumulated ahead of sawing. At the larger permanent mills, which may be located at greater distances from the sources of supply and where there is greater necessity for continuous operation, a considerable supply of logs often has to be kept on hand.

In many areas in the tropics, and particularly with hardwoods, there may be substantial deterioration in such a log supply, because of sun crack and insect and fungus activity. The best way to prevent this is to store the logs in fresh water, if it can be made available. Salt or brackish water may contain teredos or other marine wood borers. Lacking a fresh water pond, logs may be decked in the open air and kept continuously wet with a spray. If this, too, is impracticable, there are several chemicals and end coatings that may be applied to logs stored in the open air to retard deterioration. These generally have to be applied to the logs within 24 hours after they are cut to be effective.

Prevention of Damage from Insects and Stain

"Since insect and fungus damage occur together most of the year, it is generally best to combine the treatment. The treatment consists of thoroughly spraying the sides and ends of each log immediately after cutting, using a liquid chemical solution made as follows:

Step 1. Procure pentachlorophenol solution and No. 2 fuel oil, and mix the cheapest one of the following combinations:

Pentachlorophenol type	No. 2 fuel oil	To make
(In Gallons)		
25 of 5% solution	25	50
4 of "1-5" concentrate	46	50
2 of "1-10" concentrate	48	50

Step 2. In 50 gallons of the above mixture, dissolve an amount of one of the following technical grades of benzene hexachloride as indicated:

10% gamma isomer concentration	17 pounds, or
12% gamma isomer concentration	14 pounds, or
36% gamma isomer concentration	4 2/3 pounds

The resulting solution will contain about 2 to 2-1/2 percent pentachlorophenol and about 0.5 percent of the gamma isomer of benzene hexachloride.

"The solution may be effectively applied by spraying. For maximum protection against insect attack, it is extremely important that the log be completely covered with the solution. This can be done satisfactorily with an ordinary hand-operated garden sprayer. If decks of logs are to be treated, a power sprayer must be used and every effort made to direct the spray into all the spaces between logs." It must be emphasized that a general spray directed toward the deck will not prevent beetle attack within the deck." (From: "Prevention of Deterioration in Stored Southern Hardwood Logs", May 1949, Southern Forest Experiment Station, New Orleans 12, Louisiana, 6 pp.)

Prevention of End Checking

"End checking of logs can be controlled for a few months by application of appropriate coatings to the log ends. Since a rather thick application of the coating mate . is necessary, ordinary paint is not effective enough.

"A relatively cheap material suitable for end-coatings is a thick asphalt preparation. Such thick asphalt preparations, either in the water-emulsion or in the cut-back form, appear to be particularly effective over long periods. Use of the emulsion form is limited to mild weather (above 40° F.), but has the advantage of lower cost. If suitable asphalt coatings are not available locally, they can be obtained from some of the United States suppliers listed in the Appendix.

"There are a number of relatively cheap end-coatings of other types on the United States market that have promise of being effective and easy to apply. A partial list of United States suppliers is given in the Appendix with no implication of endorsement.

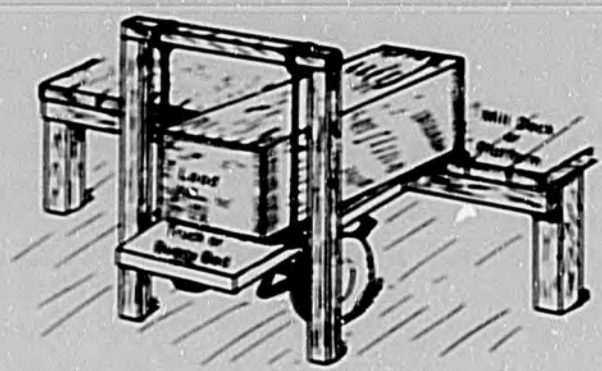
"The coating may be applied with a stiff brush or by spraying. If cold weather makes application difficult, the material should be warmed. One coat should be sufficient if the preparation is of heavy painting consistency and has good moisture-retarding properties. The ends should be coated soon after the logs are cut, as control of checking becomes difficult after fine checks have developed.

"One gallon of end-coating will cover about 70 to 100 square feet of end surface, or, on an average, both ends of about 30 logs 18 inches in diameter. Assuming a cost of $1 per gallon, the coating needed for 1,000 board feet (log scale) of such logs would cost about 15 to 20 cents. Labor costs of application would be additional." (From: "Storage of Beech Logs and Bolts in the Northeast," December 1951, Northeastern Forest Experiment Station, Upper Darby, Pa.)

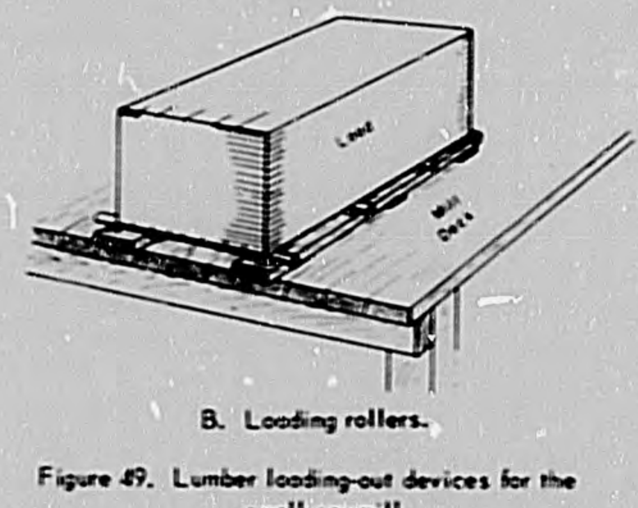
Before applying end coatings, toxic spraying should be completed. Debarking before spraying is not recommended. In recent tests in the Gold Coast (Ghana) the recommended .5% solution of the gamma isomer of benzene hexachloride gave unbarked logs complete protection from ambrosia beetle attack for 6 weeks. A 1 to 2% solution gave protection for 3 to 4 months. On peeled logs, the spray gave protection for about one third as long. Tests in other tropical areas did not indicate quite as complete protection, but in every case the treated logs were freer of pinholes made by this insect than those which had not been sprayed.

Lumber Storage

At some small mills the lumber is hauled away immediately after it has been cut, for sorting, grading and drying at a separate concentration yard. In such cases, the freshly cut lumber is piled on racks or in slings, designed so that a motor truck can be backed under them and the entire load taken aboard and hauled away as a unit. Diagrams of two of these loading-out devices are given in figure 49.



A. Loading sling.



B. Loading rollers.

Figure 49. Lumber loading-out devices for the small sawmill.

At most small mills, however, the lumber is piled near the mill until it is at least "shipping dry." This eliminates the deterioration from stain and insect attack that occurs when green lumber is bulk-piled, and helps reduce the weight. Often such drying is allowed to proceed until the moisture content of the lumber is in equilibrium with that of the air. In relatively dry climates 1-inch thick lumber can usually be dried to this condition in from 60 to 90 days.

An efficient way of handling lumber for storage is to make "stickered" piles in racks at the back end of the mill. These unit packages can be easily carried by a fork lift truck out onto prepared foundations in the drying yard. The inexpensive fork lift attachments for old motor trucks previously described have made it possible for even very small mills to take advantage of the economy and efficiency of package handling, to reduce the size of their yard crew, and to have the yard at a considerable distance from the mill, where fire danger will be reduced. In the United States, fire insurance rates on stacked lumber go up sharply when the nearest pile is closer than 400 feet to any part of the sawmill, even when the latter is powered by a diesel engine or electric motors.

Remanufacture

Installation of additional equipment to further process the rough lumber produced is frequently desirable at a small sawmill. Sale of the lower grades of lumber, particularly of many hardwood species, at a profitable price is often a problem for small mill operators. One of the best ways of making this class of material more easily marketable is to cut out the clear sections at or near the sawmill and dispose of the knotty and otherwise defective portions. The resultant small clear pieces must generally be cut to specific sizes for predetermined uses, such as furniture parts. It is usually necessary to have orders for them before they are cut, because the specifications of possible customers will vary appreciably even for similar items.

The equipment needed for making this "dimension stock" is not costly or elaborate. Generally, dimension stock is made from dry material, so that defects developing in drying can be cut out, as well as any natural defects. Rough dimension stock can be made with only a swing cut-off saw and straight line ripsaw. For making squares, to be used for dowels and other turnings, a multiple-saw ripping machine, called a "stripper," is used.

It is recommended that small mill operators having difficulty in disposing of #2 Common and poorer hardwood lumber consider producing dimension stock as a means of upgrading the lower-grade portion of their output.

Some small millmen go even further and install planers or moulders to make such material as flooring, semi-finished furniture parts and other similar products. Others find the best outlet for their low grade is to cut it into heavy timbers, including railroad ties, industrial blocking, mine timbers and structural material. Some have gone so far as to put in simple wood preservation plants to treat this material against insect attack and decay, and thus make it more salable.

RUNNING THE MILL

Log Procurement

Unless the small mill operator is sawing someone else's logs on a contract or custom basis, log procurement will probably be a problem, particularly when he first starts operating.

Logging is a business in itself, but many small millmen, in addition to operating a mill, conduct their own logging operations. Sometimes only one crew is used, dividing its time between the woods and the mill.

Logging in the United States is even more commonly done on a contract basis than is milling. Sometimes the complete job is contracted, with a flat price paid for the logs delivered to the mill.

Frequently, logging is contracted piecemeal; one contractor will take the job of felling and bucking the trees, another that of skidding the cut logs to the roadside, and still another that of loading and hauling them to the mill. In such cases the mill owner usually buys the standing timber, either by the lot or by individual marked trees, contracts the logging, and is able to devote the majority of his time to managing the mill. He owns little or no logging equipment, but he does have money tied up in the standing trees purchased and in advances to logging contractors until such time as the logs can be converted into lumber, and the lumber sold.

Outright purchase of logs delivered to a mill is generally the best and most satisfactory practice where good logs may be obtained at a reasonable price and in constant volume.

In any case, a mill operator is vitally concerned with the grade and condition of the logs he receives. The percentage of good-grade lumber that can be produced from low-grade logs is definitely limited. The mill operator must learn to differentiate between good and bad logs and exercise some control over the grade he accepts for his mill. In every area there will be logs that it will not pay to convert. A marginal log is often a matter of inferior species, but more often it is one of small diameter, crookedness, excessive knots, worm holes or other features that degrade the product. Diameter alone, which is frequently used as an indicator of quality, is only an approximate and quite untrustworthy guide. Relatively small, smooth, straight logs may be considerably more profitable to handle than bumpy, crooked and otherwise defective large ones.

A mill operator would be well advised to make some tests to determine both sawing time and quality of lumber outturn for logs of various types, to determine the specifications of the marginal log; then he can take steps to see that no logs of submarginal quality are accepted at the mill.

Intelligent bucking (cutting the tree into log lengths) in the woods can do much to increase the volume of above marginal logs brought to the mill. This means supervision or control of log making. Involved are such things as making the cuts at points of greatest crook and in defective portions of the tree stem, rather than throwing these bad portions into the middle of the logs. It is also possible, as has already been mentioned, to minimize the incidence of cracking, checking, and of insect and decay damage to cut logs by certain treatments given them within 24 hours of the time they are cut. Removing the bark is another but somewhat less effective method of accomplishing the same ends.

Mill Operation

Recruiting and Training Labor

In order to have a smoothly operating small sawmill, it is necessary to have an efficient mill crew, with each man knowing and doing his job and interested in doing it well. Effective recruiting and training of labor is one of the most important steps in organizing an efficient operation.

In small mills, recruiting and training must generally be done by the mill owner himself. He must not only be able to properly evaluate job applicants before hiring them, but he must be able to show them exactly how he wants each job done and instill in them an interest in doing it well. Various incentive schemes have been used successfully in different instances. The most common one is promotion of the best workers to positions of more responsibility and higher pay. This is often difficult to apply with a small crew. Another is to offer a bonus to the entire crew each day or week that production exceeds a certain amount, provided, of course, that quality standards are maintained. Still another is to give the best workers, or the entire crew, some other type of recognition or reward for extra effort; this can be verbal praise, better living or working conditions, an outing, or some other special reward.

Standards of Efficiency

To run his mill successfully, an operator must have some standards to guide him. Quantity standards are not difficult to determine. It will very soon become evident how much the mill should be producing when things are going well. This will vary, of course, with the kind of material being handled from day to day, the general condition of the mill, and the skill of the crew. When production falls off, the operator should be able to determine the cause and to make corrections. If it is due to small or defective logs, bad weather, or some other condition beyond his or the worker's control, he should be able to recognize that.

Standards of quality in the output of a small mill are more difficult to establish and to check.

One standard of quality is the accuracy of sizing of the material cut. Of prime importance is whether or not the lumber is cut accurately in thickness. Generally, buyers will complain if any portion of the material delivered to them is too thin. Lumber that is too thin will be culled out and thrown away or dropped to the next lower thickness class. Consequently, many small mill operators are so impressed with the necessity of getting all their material heavy enough to meet the minimum thickness specifications that they go to the opposite extreme and cut everything too thick. This is an easy but an unsatisfactory solution to the small millman's problem of scant thicknesses. When he cuts all his material thick he is getting less salable volume from the logs he saws. The oversize lumber is heavier and more costly to handle and transport. It costs more to dry because it takes a longer time and occupies more space. And when it is finally brought down to the proper thickness in a planer, it frequently overloads that machine and results in breakdowns.

More and more buyers of lumber produced in small mills are beginning to discriminate against lumber that is cut too thick, as well as against that which is too thin. Even when the buyer will accept extra-thick lumber, it is poor business for a small mill operator to supply it. Also important, but less so, particularly in hardwoods, are the widths and lengths of the lumber produced.

The answer to a small mill operator's problem of dimensional accuracy, especially thickness, is to make a periodic check on the dimensions of the lumber produced. This can be done by measuring a sample from time to time, using a set of "go-and-no-go" gages, such as the one illustrated in figure 50.

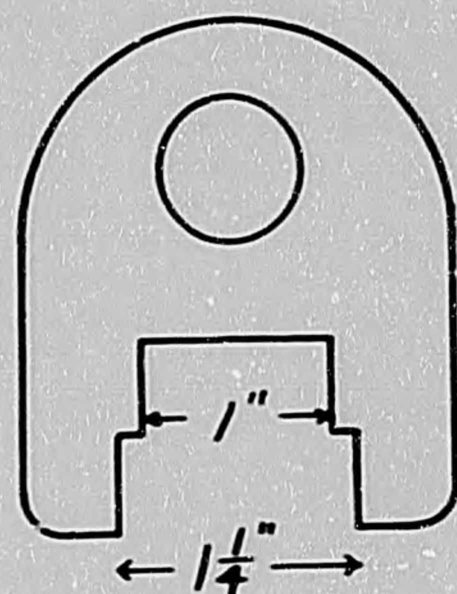


Figure 50. "Go-and-no-go" gage for testing thicknesses of lumber. Dimensions of notches can be altered for any desired thickness.

These can easily be made by grinding the notches to the proper dimensions in pieces of scrap iron or brass. The width of the interior notch is the minimum thickness of the lumber the purchaser will accept, and the width of the outside notch the corresponding maximum thickness that the mill operator has decided he will supply. It has been found that almost any circular mill can produce practically all of its material within a thickness range of 1/4 of an inch (1/8 inch plus or minus the thickness set for). Consequently, this is the maximum variation recommended to be allowed for in such go-and-no-go gage. For many mills which find they can meet this standard with ease it will be profitable to reduce the maximum thickness variation allowed by the gage to 3/16 inch or even 1/8 inch greater than the agreed-upon minimum.

In making the check of thickness, an occasional miscut piece, which may have been caused by a chip lodged between the back face of the cant and the knee, or by a springy log, may be disregarded. But when more than a small percentage of the measurements made fail to go into the outside notch of the gage or even worse, go into the inside notch, something is seriously wrong with the operation or condition of the mill and needs correction. Pointers as to what to look for when the gage measurements indicate miscuts of various types will be given in the section of this publication on "trouble shooting." Periodic checks of the lengths and widths produced, particularly of softwoods, should also be made.

Quality standards as a measure of the success attained by the mill in getting maximum grade from logs handled are more difficult to apply. In a small sawmill at which no segregation of grades of lumber is made as they are produced such a check is practically impossible to make. Yet, grade is important, even in mills sawing on contract or in those selling their product ungraded. It is particularly important in mills sawing hardwoods, because of the tremendous difference between the value of top-grade and lower-grade material. In species used for cabinetry, the top-grade material may easily be worth ten times as much per board foot as the lower-grade boards. Proper methods of sawing can increase the proportion of the higher-grade material to the extent that the value of the total product sawn may be increased by 25 percent or more. Such methods are described later in this chapter.

A small mill operator should become as familiar as possible with the grade specifications pertaining to lumber of the species he is sawing and the markets he is supplying. Furthermore, he should make sure that the key personnel in his mill are familiar with them. The sawyer, the edgerman, the trimmer operator, and the stacking-out crew constantly need this information in their work. A grade-conscious crew will achieve a general upgrading of the product that will enhance the mill's reputation and increase the salability of its products.

At the outset, mills supplying the United States hardwood market should sort lumber as it comes out of the mill into at least two quality classes, #1 Common and Better and #2 Common and Poorer. A rough check can be kept on the proportions of these two classes, and this, correlated with knowledge of the type of logs being cut, will indicate whether the mill crew is doing a good job recovering maximum grades, or only a fair one. Watching the various members of the crew as they work will enable the operator to discover and correct the mistakes.

Duties of the Sawmill Crew

Deck Man

Logs may be delivered to the skids of the log deck in one of several ways. Frequently, they are dumped off onto the deck directly by the motor truck bringing them from the logging job. Sometimes they will have to be dumped into storage piles, and then skidded to the log deck by a tractor or carried there by a fork lift truck. If the logs have to be taken from a mill pond, there is generally a powered conveyor (jack ladder) to bring them out of the water and deposit them on the deck.

Once the logs are on the deck, the deck man washes them if a high pressure hose is available. Frequently, he measures them and records contents. Where a grading system is used, he grades the logs and records the grade. Then he rolls them forward, so that one is always in position to be rolled onto the sawmill carriage. When the sawyer returns the carriage and recedes the knees to receive a fresh log, the deck man promptly rolls it on. He positions it in accordance with the sawyer's signals, adjusting the back taper offsets, if required, and setting the back dogs. During the sawing process, he helps turn a log when required, readjusts the taper offsets, and resets the dogs.

Sawyer

The sawyer takes care of the front taper offset and the front dog and, of course, operates the setworks and feedworks levers.

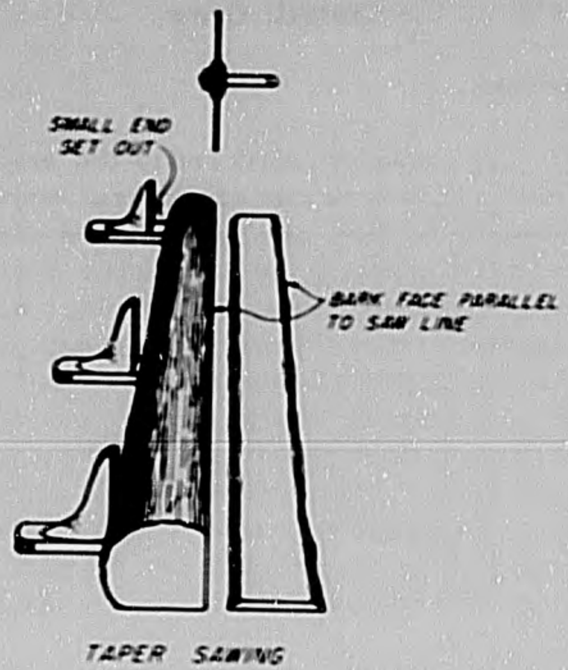
1. Sawing Hardwoods -- In sawing hardwoods, particularly, the first positioning of a log is very important. It determines the position of all four faces to be subsequently sawed and has a great effect on quantity and quality output. The sawyer determines which face shall be sawed first and how it is to be positioned. As a log is rolled onto the carriage, he inspects it and decides in a general way what he will cut out of it. If it is a sizable log and contains high-quality material, he will probably decide to cut in from all four faces, to obtain the maximum amount of the high-quality material that generally lies just under the bark on each good face.

United States hardwood lumber grading specifications for the higher grades stipulate a minimum width that must be maintained the full length of the board and a maximum proportion of short pieces that will be allowed in a shipment. Consequently, it is very important to taper saw those hardwood log faces that promise high grades, so as to obtain this minimum width the full length of the log in the first board under the slab. This does not mean that the taper offsets have to be used in every case.

If a poor face that promises to produce only low-quality material lies opposite a good face, the poor face may be placed so that it will be sawed first without using the taper devices. Only two or three short boards are taken off, just enough to give a firm bearing when the log is turned 180°, and this poor face is placed against the knees (figure 51). Then the good face will automatically be parallel to the saw and the first cut will be parallel to the bark the full length of the log.

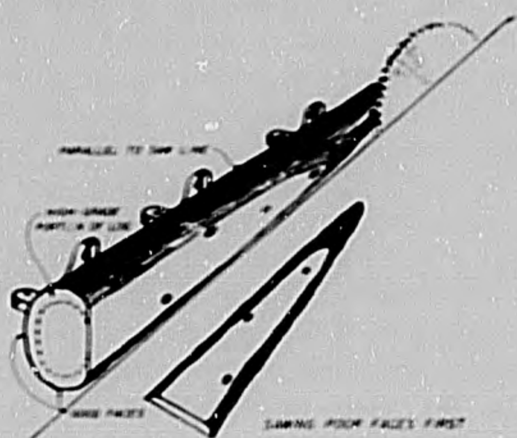
If good faces are opposite one

another, the taper devices should be used (figure 52). First, one face is sawed parallel with the bark, and then, after turning the log 180°, the opposite face is also sawed parallel with the bark on that side. When the saw gets down into lower-grade material, the offset is pushed back and the taper taken out in two or three short boards, as the cant is straightened up to give two parallel faces (figure 53). Boards, planks or timbers may be made of the remaining low-grade material in the heart center. As mentioned previously, sawing such low-grade material into timbers, if it is sound and otherwise suitable, is often profitable business for the small millman.



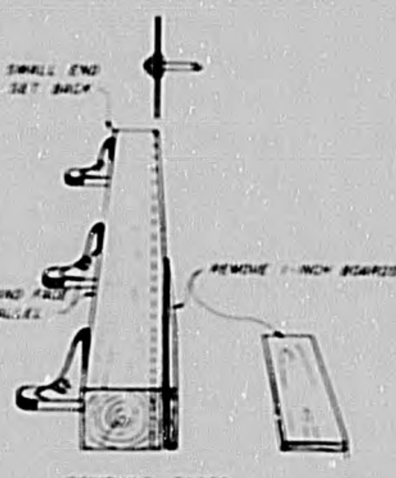
(FROM U.S. FOREST PRODUCTS LABORATORY
REPORT #2194)

Figure 52. Taper sawing of log with good faces on two opposite sides.



(FROM U.S. FOREST PRODUCTS LABORATORY
REPORT #2194)

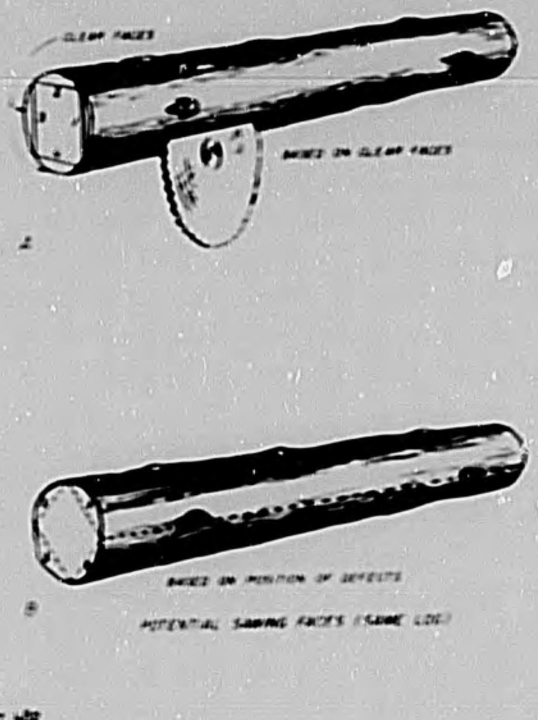
Figure 51. Sawing poor face first, when it is opposite a good face.



(FROM U.S. FOREST PRODUCTS LABORATORY
REPORT #2194)

Figure 53. Removing taper from cant after high-grade material has been sawed.

Frequently, in the first positioning of a log, the sawyer will be able to place cracks or some other gross defects so that they will fall between two faces to be cut (figure 54). In this way he will minimize their effect on grade and quantity, because they will fall at the edges of the boards rather than near their centers; this is desirable because they can then be edged out with a minimum of loss, leaving high-grade material. If it is not possible to place these gross defects at the corners of the cant, because they are so scattered, the sawyer should try to position the log so that their effect is confined to one or two faces.



(FROM U.S. FOREST PRODUCTS LABORATORY REPORT #[illegible])

Figure 54. Positioning log to minimize the effect of defects. More high-grade lumber will be obtained when log is first positioned as in B, above.

Generally, it is better to saw thin stock (4/4-inch or thinner) just under the slab, to minimize edging loss. If there is a special high-priced market for thicker cuttings in the higher grades, these may be obtained after the first 4/4 board or two have been removed under the slab, so edging loss will not be so serious.

The sawyer should be alert to turn the log whenever the next face to be cut promises to produce higher quality material than the face he is sawing. If he does not do this, he will take off part of the volume that would have been available in the next higher-grade face in the lower-grade boards on the face he is cutting (figure 55) and thus lose lumber value.

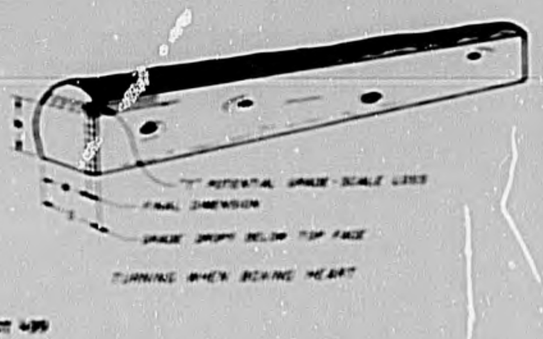


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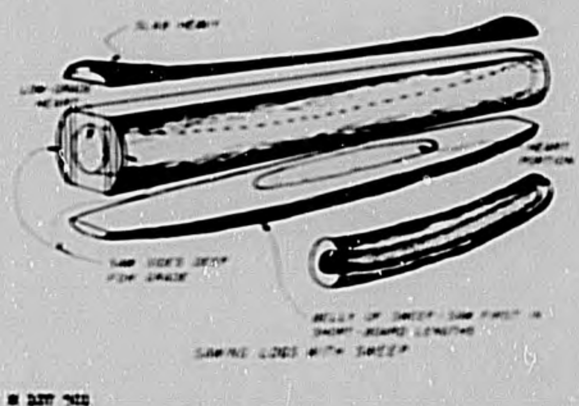
Figure 55. Turning to avoid grade loss.

Crooked logs present special problems (figure 56).



(FROM U.S. FOREST PRODUCTS LABORATORY REPORT #[illegible])

Figure 56. Sawing crooked log.

Frequently, they result from misbucking in the woods. But the sawyer is sure to receive a percentage of crooked logs and it is his job to cut them as best he can. Generally, this is done by laying the crook horizontally on the carriage with the "horns" to the rear, and taking off one or more short boards from the center of the convex face. Then the log can be turned, either 90° or 180°, and the flat face just made will provide a firm bearing against the knees or the bolsters. When the log is turned 180°, the "horns" are cut off and short lumber is made from them if it is possible. The majority of the cutting is done, however, from the two flat faces at the sides of the crook in order to recover as much full-length lumber as possible.

The general objective of the sawyer in sawing hardwoods should be to give faces promising to produce high-grade lumber as much attention as is necessary to insure recovery of all the high-grade material available. He should also saw low-grade faces as rapidly as possible, in order to get the resultant low-priced product out of the way with a minimum expenditure of time and effort.

Logs that promise to produce only low-grade material should be sawed "through-and-through" with little or no attention to placement or turning. It is usually a good idea to slab such logs on two sides, however, before giving them a quarter turn and starting through-and-through sawing, so that the resultant boards will mostly be square-edged and will not be an additional burden on the edgerman. Again, many of these low-grade logs will have sound heart centers that may be sold as railroad sleepers or other construction timbers.

2. Sawing Softwoods. — The sawing of softwoods is somewhat different because most of this type of material is made into boards for construction or plank and heavy dimension for structural members. Most of the "select structural" grades are found in the centers of old-growth logs. The heartwood of most conifers is more durable than the sapwood and also contains mostly tight-knotted material very suitable for structural use. On some old-growth softwood logs, however, clear material will be available just under the bark and will bring a premium price for finish and factory use. If such markets are available, the sawyer should be alert to produce the maximum possible of this class of material. This, of course, means using the tapering devices, and taking the first boards in this high-grade portion of the log parallel with the bark, the same as is done in hardwoods.

Once this select material has been removed, the center is sawed into structural lumber. Between the high-quality clear stock near the bark and the tight-knotted stock near the heart may lie a zone of the poorest material in the log, with loose black knots. It is suitable only for remanufacture into uses requiring short cuttings, or for the least-demanding uses, such as sheathing, subflooring or concrete forms. It is recommended that taper losses be taken in this zone.

Low-grade and generally small softwood logs are mostly sawed through-and-through in softwoods, as in hardwoods, producing boards and low-grade structural stock such as 2 x 4's, 2 x 6's and 2 x 8's, largely used for home building.

3. Other responsibilities of sawyer. — The sawyer sets the pace for

the entire mill. If he lags in his work, productivity of the whole mill falls off. If he is careless in his setting, inaccuracies in thickness and losses result. If he does not position his logs and turn them to the best advantage, grade recovery is poor. Consequently, selection and training of the sawyer is of utmost importance.

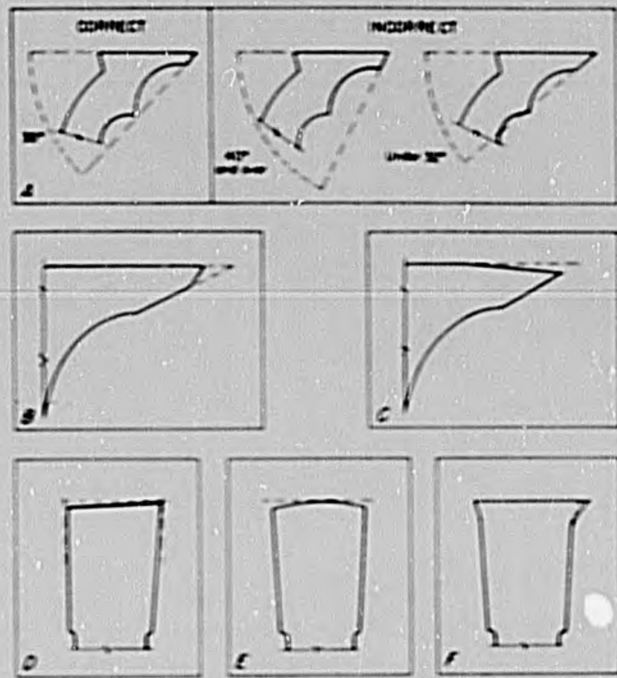
Many small mill operators do their own sawing, but this ties them down and prevents their giving attention to important details elsewhere, particularly to the business aspects of managing the mill. When the sawyer is an employee, his wages are generally higher than anyone else's, frequently twice as high as those of the average laborer.

Saw Filer

Operators of larger mills have a specialist who "doctors" the saws for the entire operation. In a small sawmill, however, frequently the sawyer maintains his own saws, filing and setting them during the periods when the mill is shut down.

Maintenance of insert-point saw teeth is fairly simple, but it must be done correctly. The points of the teeth must be filed straight across and to the correct angles, and they must all be filed the same amount (figure 57). A file guide (figure 58) is available, which is of great help in doing this job. There are also several types of grinder wheels or hones on the market that are particularly valuable for the harder types of teeth.

For a saw to run smoothly and not heat, the teeth must have adequate side clearance. It is not injurious to the saw to spread the tooth points by use of the upset-type swage when the teeth have been sharpened to the correct angle; it is injurious to do it when they are dull.



(ADAPTED FROM PHOTOS COURTESY R. HOE & CO., INC.)

Figure 57. Filing and swaging insert-point saw teeth.

A. Tooth angle should be uniform, approximately 35°. In no case should it be more than 40° or less than 32°.

B. Do not change tooth angle between filings.

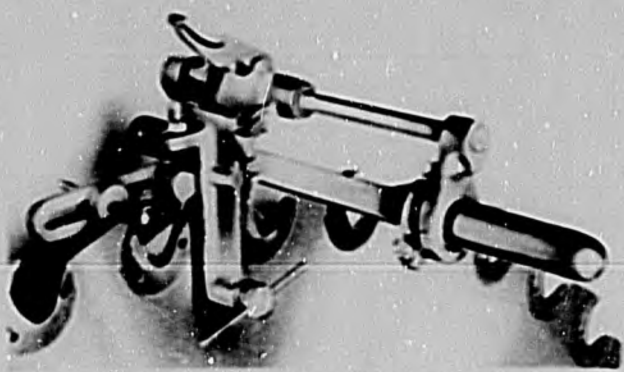
C. Back of tooth should never be filed.

D. Teeth should be filed straight across, not on angle.

E. Nor on a curve.

F. Swaging should be equal on both sides.

Some mill operators, however, prefer that the teeth be removed from the saw and swaged in a special saw segment clamped in a vise, to make sure that the tooth sockets are not injured. This practice is not to be recommended, because it is apt to cause the tooth holders to collapse prematurely.



(PHOTO COURTESY CORLEY MANUFACTURING CO.)

Figure 58. File guide for obtaining uniform hand filing.

Others insist that swaging be done with a roller type swage. This is a good practice, but roller swages are expensive and their proper adjustment and use requires considerable skill and experience.

It is very important that neither teeth nor holders be used when they are worn beyond the point of further satisfactory service. For teeth, this means that they should be discarded when they can no longer be filed to the correct angle (not more than 40 degrees), as shown in (figure 57). Filing to a greater angle means that the teeth will require excessive power and that the cutting action will exert unnecessary pressure on the socket shoulders.

Holders should be discarded when the flange has been rounded off by wear so that they no longer chamber and carry the sawdust out of the cut. Partially worn holders can be given a longer life by squaring their faces a few times with a half-round file. But when the flange is completely worn away the holder cannot chamber the sawdust properly. Neither can it exert the pressure necessary to hold the tooth in place or to give the rim of the saw its proper tension. The price of both new teeth and holders is relatively low, and their replacement is easy (figure 59). Holder sockets, too, become worn. This means that they become larger. When this occurs, over-size holders should be installed.

Edgerman-Offbearer

The edgerman-offbearer has a very important function to perform. He guides the lumber produced as it comes off the carriage, either on down the lumber rolls to the back of the mill, or over to the edger table if the edges need to be squared up or if ripping is needed to raise the grade or to meet market specifications. The edgerman should be about as familiar as the sawyer with grade and market specifications. He should operate so as to edge off as little material as necessary. Much good lumber is lost at small mills every day from edging cuts that are too heavy, and much grade is sacrificed by failure to rip a board when half or more of it can be raised a grade thereby.

Where electricity is available, a valuable device is the shadow line guide light. This is mounted over the edger and casts a shadow line on the board in the position where the fixed saw will make its cut, and also along the line of cut of each movable saw. This is a big help to the edgerman in lining up his board correctly on the edger table and determining the correct placement of the saws.

(PHOTO COURTESY R. HOE & CO., INC.)

Figure 59. Replacing insert-point teeth and holders.

Trimmerman

The trimmerman also has a responsibility for obtaining maximum volume and value in the product. He must take the boards from the edger table, and also from the lumber rolls, and run them through his machine, making sure that the saws are positioned correctly to bring the lumber to proper length. He must use care not to cut it shorter than necessary. Although much lumber from small mills is sold untrimmed, or trimming is postponed until after drying so that drying defects as well as natural ones can be cut out, proper trimming in the green state can simplify future operations.

Loading-Out Crew

Finally, the loading-out crew must keep the rear end of the mill free of debris, taking the cut lumber away from the rolls as it is produced and stacking it properly, according to size, species and grade, if that is desired.

It should be obvious that all of the workers in a small sawmill have important jobs, involving continuous mental alertness. Consequently, anything that can be done to make their physical effort less arduous should result in their doing a better job throughout the entire work day. This is the principal value of good conveying and transfer equipment.

Preventive Maintenance and Trouble Shooting

Preventive maintenance means keeping the mill properly adjusted and lubricated to prevent undue wear and tear. It also means discovering troubles when they are small and correcting them before they develop into serious breakdowns.

Behavior of the Headsaw

The behavior of the headsaw will provide clues to several possibly serious troubles of this sort.

If the saw heats at the center it may mean:

1. That the mandrel bearings are too tight or that they need lubrication. In many of the newer mills roller bearings are sealed, and center heating may mean that they are over-lubricated. Such bearings need lubrication only about once a month. The manufacturer's instructions should be followed carefully.

2. That the saw itself is too flexible in the center for the speed at which it is being run. Either the speed should be increased or the saw retensioned.

3. That the saw does not have enough lead into the log. Lead should be checked and corrected if not enough.

4. That the saw is sprung or is dished away from the log, because the collars do not fit properly. The collars should be remachined or a job of papering done.

5. That the mandrel itself is bent. A test for this is to loosen or take out the bolts holding the front mandrel bearing, and then watch the bearing while the main drive belt is pulled by hand. If the bearing heaves up and down, or from side to side, the mandrel is bent, and either a new one is needed or a machine shop straightening job required.

If the saw heats at the rim if may mean:

1. That the saw is too stiff in the center for the speed at which it is being run. The saw speed should be reduced or the saw retensioned.

2. That the saw has too much lead into the log. Lead should be checked and reduced as necessary.

3. That the saw is sprung or is dished toward the log because the collars do not fit properly. The collar should be machined or paper washers fitted.

4. That the guide pins are incorrectly adjusted, binding too tightly against the saw on one or both sides. The guide pins should be readjusted.

5. That the saw teeth are incorrectly swaged and so provide insufficient clearance. Reswaging is probably necessary.

6. That the saw has become coated with pitch or resin and needs cleaning. Cleaning may be done with kerosene or commercial cleaning compound.

7. That the saw teeth are incorrectly sharpened; the backs of the teeth may be too high. Use sharpening guide.

8. That the flanges in the holders have become worn and are letting sawdust slip by between the saw plate and the cut faces. Either the flanges should be squared up by filing or, if they are too badly worn, the holders should be replaced with new ones.

Counteracting the tendency of the saw to heat by running a stream of water on it while it is running serves only to hide this type of difficulty, not correct it. A heating saw may tend to "flutter" and cut too wide a kerf, or to "lead" and cut off line. The thing to do is to find out what is making it heat and then correct it.

If the saw tends to "lead," either into or out of the log, it may mean that:

1. The teeth may not have been sharpened straight across, or they may have been swaged too heavily on one side or the other.

2. The saw may not be hanging absolutely plumb. If the saw leans toward the carriage, it will tend to lead into the log; if it leans toward the husk, it will lead out of the log. Test whether or not the saw is vertical with a plumb line, not with a level. If it is not hanging plumb, level up with wedges under the mandrel bearings or the husk frame.

If the saw tends to develop cracks around the collar, it usually means that:

1. The wheel bearings on the carriage have become loose and that the carriage is shifting as it travels by the saw, exerting great pressure on it. To test for such "play" in the carriage wheels pry against the side of the carriage with a crowbar.

2. The foundations under the track may be sagging. Sag may be detected by watching carefully for deflection when the loaded carriage is passing the saw. Common causes of sag are soft ground or rotten wooden member.

Lumber Thickness Measurements

Lumber thickness measurements recommended in the previous section will provide clues to troubles developing in a mill. Discrepancies are most apt to show up in the dog board or in the first board taken off a face which has been previously sawed, when the log has been turned 360° and this face is sawed a second time.

If the dog board is thinner at the top than at the bottom, it may mean:

1. That the husk and mandrel are too low on the side toward the saw.
2. That the track is too low on the side toward the saw.

3. That the knees are not plumb; base and knee should be square.

If the dog board is thinner at the bottom than at the top, it may mean:

1. That the husk and mandrel are too high on the side toward the saw.

2. That the track is too high on the side toward the saw.

3. That the knees are not plumb; base and knee should be square.

If the dog board is thinner at one end than another, it may mean:

1. That the knees on the carriage are out of line.

2. That the log has been dogged incorrectly.

3. That the log is too long for the carriage -- extends too far beyond rear headblock.

If the dog board is thinner at the center than at the two ends, it may mean:

1. That the track is sagging as the carriage passes the saw, or is out of line and bent toward the saw.

2. That there are an insufficient number of knees.

3. Poor dogging, especially on a springy log.

4. That there is a headblock out of line.

If the entire dog board is thicker or thinner than the other boards cut from the log, it usually means that the sawyer has miscalculated in placing his first parallel cut on the last face sawed. It is necessary to calculate the sum total of the thicknesses to be cut from the cant when setting for this cut, and make the setting so that the thickness will come out even on the last cut. Admittedly this is a difficult job, because it is necessary not only for the sawyer to anticipate the total of the thicknesses of lumber to be cut, but also the total of the thicknesses of the saw kerfs. This calculation is made easy, however, by a scale board that has been correctly calibrated to indicate the thicknesses graphically. Horizontal and vertical scale boards calibrated to different thicknesses of saw kerfs are available from manufacturers of sawmill machinery. Their use is strongly recommended.

If there are variations in the thickness of boards other than the dog board, these generally indicate other types of trouble. For example, if almost every board varies in thickness throughout its length from the one sawed before, it will usually mean:

1. That the setworks have become worn and the setwork pawls are slipping or the retaining pawls are not holding, or

2. That there is backlash between the pinions on the set shaft and the racks under the knees, or

3. That the sawyer is setting carelessly, usually by guess rather than to stops.

If the boards vary in thickness, not only from board to board, but also from end to end, without pattern, it may mean:

1. That the saw is dull.

2. That the saw has improper lead into a log.

3. That the sawtooth holders are badly worn and do not provide enough clearance to hold the sawdust.

4. That the speed for which the saw is tensioned is not maintained in the cut.

5. That the mill has inadequate power for the rate of speed of the saw.

If only the first board under the slab varies in thickness from end to end, it usually means that the corners of the sawteeth on the log side have become worn or rounded off and are not severing the stringy inner bark properly.

Summary

The following list of some of the most common troubles that may be experienced in a small sawmill also includes remedies that may be applied to correct them:

1. Improper saw lead -- increase or decrease according to the way saw heats.

2. Improper filing and/or swaging of sawteeth -- check angles of filing (figure 57) and side clearance of teeth, and refile and/or reswage.

3. Incorrect saw speed -- have the saw retensioned or change speed by installing different-sized mandrel pulley.

4. Husk and track not level or out of line -- check with level and tighten and straighten by means of shims or install new foundations if necessary.

5. Guides used to force lead in saw -- adjust guides correctly and realign mandrel to impart lead, if necessary.

6. Setworks ratchet and pawls worn -- install new ratchet and/or pawls or build up pawls by welding on new metal and machining to proper contours.

7. End play in carriage wheel bearings and/or saw mandrel -- tighten or install new bearings.

8. Insufficient number of headblocks to hold logs securely -- either cut shorter logs or install additional headblocks.

9. Logs not dogged securely -- check dogging practice of sawyer and deckman. If dogs are at fault, repair or install new ones. Dogs must be kept sharp and enter log at correct angle to snug it against knee.

10. Inadequate power -- repair power unit or power transmission equipment if it is at fault. If not, relieve power unit of part of its load (edger, trimsaw, blowers, etc.); install saw with fewer teeth, or slow down the r.p.m. of saw, or install larger power unit.

11. Loose guides on husk -- repair guides or install new ones. If husk

timber is rotten, install new one.

12. Bent mandrel -- send back to factory to have straightening job done or install new one.

Marketing

Good manufacturing practices at a small sawmill will make it possible to demand top prices for practically everything that is sold. An operator should be sure that he keeps up to date on requirements when he is able to cut for established markets. This is not always the best and most profitable course, however.

In many forested areas the more desired species grow in association with other species that do not have established markets. Handling the desired species exclusively is frequently expensive, because log costs delivered to the mill are usually high. Moreover, the supply of these desired species may be quickly exhausted in any given locality. Consequently, the mill operator should do all that he can to cultivate markets for the less well-known and less-desired species. Information to help him may be available at governmental offices.

Selling in Established Markets. -- The marketing of high-grade lumber from the better-known species, such as mahogany, teak and rosewood, presents practically no problems. Generally, buyers will find such lumber, no matter where the mill producing it is located, and pay good prices for it.

Selling the lower-grade lumber even of prized species may present difficulties. One course open to the millman is to require a purchaser to take some lower-grade material in each shipment of the higher grades. Or the millman can sometimes upgrade and make salable some lower-grade material of the more desired species by remanufacturing it into dimension stock -- cutting out the defective portions, and cutting the clear portions to desired sizes for furniture parts, flooring and other uses.

In many localities there will also be a market for lower-grade material for local use. Local cabinet shops, vocational schools and construction projects will frequently reward the sawmill man who keeps in touch with them with orders for material that would be difficult to sell elsewhere. In many localities, for example, imported waterproof plywood is being used for concrete forms, when rough-sawed, low-grade native lumber would serve equally well. Similarly, timbers and decking for construction projects might frequently be better obtained from local mills than brought in from outside.

Cultivating new markets. -- There will remain in many countries the problem of selling species which do not have an established reputation in the markets, although technically they may have excellent qualities. This problem is particularly serious in tropical hardwood regions where many species having good technical properties are not cut at all or are cut in very small quantities compared to the quantities available, simply because little is known of them in the world markets. Tests of the qualities and potential uses of such species are constantly being made, however, and more and more of them are being introduced into the world's markets. The mill operator should keep himself up to date on these developments. Contacts with the forestry or trade development departments of his own government, with the local university, or with other well-informed persons or agencies will often make this possible. Membership in a sawmiller's association or subscription to one or more good lumber trade journals will help the small mill operator keep informed.

Sometimes the mill man will be able to encourage the establishment of a new local wood-using industry by showing bankers, development bureaus or like organizations that raw material can be made available locally to supply them.

Aggressive and imaginative marketing practices often make the difference between success and failure of a small sawmill enterprise.

Cost Control

Need for Accounts

If a mill operator is to be successful, he must have good cost records and know how to use them. Such records are essential in pricing the various items he produces, in paying for logs, in setting labor rates, in determining marginal species and grades, and, generally, in analyzing mill efficiency. In addition, good records are needed as the basis for financial statements required by supply houses and banks or for calculating taxes. In many countries, including the United States, tax returns must have definite supporting evidence.

As his business grows, a mill operator may want to take in a partner who can supply capital needed for a profitable expansion. Records will help in obtaining a partner who, before investing, may want to be able to see clearly the state of the business in which he is investing, including both its present value and its past earnings.

Records are even more important when a partnership is dissolved. Where one partner buys out the interest of the other, the transaction is seriously complicated unless records are available to aid in determining the price. If the owner of a business should die without clear and complete account records, his heirs would be left at the mercy of his creditors.

Most small mill owners keep some kind of records, but they are often kept in such a way that they are not realistic or not informative enough to really tell the mill man where he stands in his business affairs. Often, important items of cost, like interest on the money he has invested himself, depreciation on important items of equipment, or his own wages, are not considered at all. Uncollectable or bad debts or unsalable lumber items are carried as assets far longer than they should be. This may give a false picture, with the result in many cases that the enterprise may be on the verge of bankruptcy before the operator realizes it.

A useful set of business records for a small mill need not be elaborate, and keeping them up to date need not be costly or time consuming.

Systems of Bookkeeping

There are two basic methods of keeping accounts: the single-entry

system and the double-entry system.

Single entry is a simple system for accounting for the receipts and expenditures of cash. A journal or daybook for entering memorandum-type information and a ledger are sufficient for a straight single-entry system. Where banking service is available, stubs in a checkbook help keep track of bank deposits and expenditures of cash. The daybook, which may be only a pocket notebook, is used to make notes of transactions as they occur; these are posted later to the ledger or form the basis for a monthly profit and loss statement. The ledger holds the record of money owed by customers.

The true double-entry system, although much more complicated than the single-entry and requiring a knowledge of accounting methods to be operated properly, is much more complete. The necessary books are journals of original entry, the general ledger, and one or more subledgers. "Double entry" means that the accounts are split into two sections, one known as "debit" and the other as "credit." For each debit entry in one account, a credit entry is made in another; this keeps the books always in balance.

Under a single-proprietorship form of business, or even a partnership, the choice of bookkeeping system is at the discretion of the owner or owners. A single-entry system, with some modifications, is adequate for most small sawmill businesses. When the business gets larger or if it is organized as a corporation, a double-entry system is essential, and a trained bookkeeper is necessary to maintain it.

Recommended Accounting System

A modified single-entry system adapted specifically to small mill accounting, which can readily be converted to double entry when the need arises, is recommended. This system consists of a carefully and completely kept cash or checkbook (if the mill owner has access to a bank), a day-by-day journal of other transactions, and a ledger. The ledger is used to summarize the volume and value of material sold, by customers' names, for a record of purchases and payments, and of accounts receivable and payable. If labor is paid by the hour, or if it is required by law, a separate time record will also be needed.

The records in these books are posted periodically, generally each month, to a series of profit and loss statements which show the mill owner exactly the status of his business. Annually, or more often if needed, a balance sheet is drawn up.

The most essential thing in an accounting system is keeping records up to date and complete. When money is spent, a receipt should be obtained and filed. When cash is paid out, it should be recorded in the daybook. This includes money taken from the business for personal needs. Every evening at the close of business, notations should be transferred to the "record of purchases and payments." When money is received, it should be recorded in the daybook or deposited in the bank and the necessary record made and posted to the sales ledger as soon as possible, preferably the same day.

The Checkbook

When starting a business it is generally desirable to establish a checking account in the firm's name. Use of banking facilities will free a mill operator from the risk of carrying large sums of cash on his person or at his place of business.

The checkbook stubs should be filled out completely, showing to whom the check was written and for what purpose. All deposits should be recorded currently and balance carried forward. If a mill operator does not do this, he may find he has issued a worthless check, which will hurt the reputation of the business.

Notes Payable

If he has to borrow money to start in business, or has to buy some of his equipment or supplies on credit, a mill operator should file the copies of any signed notes, so that the information may be entered on the first balance sheets. The information on each note should be complete, even though it has to be written on the back or on a separate sheet of paper clipped to the note, to show the purpose for which the money was borrowed, the amount, the interest rates agreed upon and the due date of repayments.

Notes Receivable

Information on notes receivable should be posted in the sales ledger, similar to the posting of notes payable, after making sure that they contain complete information.

The Daybook

The daybook may be merely a pocket notebook, but it should be kept for accounting purposes. The record for each day should be started on a new page, clearly dated at the top. Transactions should be noted as they occur; entries might be as follows:

"1. Received $5 cash from George Singer for 5 cords slabwood.

2. Paid $2 cash to Rhea's filling station for 10 gallons gasoline for Truck #1.

3. Paid $2 cash to Straw's Hardware Store for 3 files for filing headsaw.

4. Received $20 cash from Silas Straw. Cash purchase 100 board feet pine 2 x 4's.

5. Deposited $21 in petty cash box at mill office.

6. Mill sawed 8,500 board feet, mostly low grade oak (5,000 feet #2 and #3 Common and 1,000 feet #1 and Better, stacked).

7. 2,500 feet 3B Common loaded on Pallet Co. truck on their order #23.

8. Truck #1 hauled 6,000 feet #2 4/4 oak in three trips from mill yard to Bellow's yard."

Transactions 1, 4, 7, and 8 are posted to the sales record the same day and a line drawn through them in the daybook. Transactions 2 and 3 are posted to the record of purchases and payments.

The Ledger

The ledger is a simple standard-ruled account book. In the sales portion, which is posted currently, a complete page is assigned to each major customer and all transactions entered on it. Space will usually be provided for necessary credit information at the top (see Sales Record, below). Miscellaneous small sales, which are generally cash transactions, may be entered together on a page at the back of the ledger. Index tabs on the edges of the pages will help in the use of this book.

The second half of the ledger will contain the record of purchases and payments. There will be a sheet devoted to each major item of equipment being purchased (see Equipment Account, below) and each major account (see Record of Purchases and Payments, below). There will also be a separate sheet for withdrawals of cash from the business by the owner. This last sheet is especially important if the venture is to be conducted in a business-like manner. The mill owner should plan to make regular withdrawals of no more than a fixed total amount, monthly or bi-weekly, as if he were paying himself a salary.

SALES RECORD

Sheet No. 1
Terms
Rating Prompt
Credit Limit $2500

Account No. 1
NAME Albert Adams
ADDRESS Tecumseh, Tenn.

Date (1956)	Item	Number of Units	Price per Unit	Total Value of Sale	Amount Paid	Unpaid Balance	Claims and Discounts
5/2	#1 & Better Red Oak	20M	$120	2,400	1,000	1,400	
5/15					1,400	0	
5/20	#1 & Better Walnut	5M	$150	750	--	750	
Monthly Summary - May		25M		$3,150	$2,400	$ 750	
6/1	Brought Forward					750	
6/3	#2 Yellow Pine	15M	$ 70	$1,050	$ 500	$ 550	

EQUIPMENT ACCOUNT – TRUCK #1

Total Price $5,000
Terms $1,400 cash, Balance 36 monthly installments $100 each with interest at 1/2 of 1% on unpaid balance.

NAME National, 16,000 lb GVW, Flat Bed
Serial No. 16Y-570513, Motor No. 167,470

ADDRESS Purchased from Terminal Motor Co., Moretown, Tennessee

Date (1956)	Item	Payments		Balance	Owner's Investment	Interest on Investment
		Principal	Interest			
1/1	Initial purchase	$1,400.	18.00	$3,600	$1,400	7.00
1/15	1st payment	100.	17.50	3,500	1,500	7.50
2/16	2nd payment	100.	17.00	3,400	1,600	8.00
Yearly Summary - Dec.		$2,600	$183.00	$2,400	$3,600	$117.00
(Depreciated Total Value – $4,000.)						

RECORD OF PURCHASES AND PAYMENTS

NAME Rhea's Filling Station
ADDRESS Moretown, Tenn.

Date (1956)	Item	Quantity	Price	Total	Amount Paid	Unpaid Balance
6/1	Brought forward					$ 55.00
6/5	Diesel fuel (Sawmill)	500 gallons	.15	$75.00	--	130.00
6/10					$100.00	30.00
6/15	Gasoline (Truck #1)	10 gallons	.20	2.00	2.00	
6/16	Oil (Truck #2)	6 quarts	.35	2.10	--	32.10
	Gasoline (Truck #2)	20 gallons	.20	4.00	--	36.10

A separate sheet may be set aside for miscellaneous small purchase from a variety of vendors. These sheets are posted periodically from the checkbook and daybook entries. The important thing is to know where the business stands currently in its major accounts and to have a complete and clear record of all expenditures, so that the periodic profit and loss statements may be compiled together with balance sheets of net worth as needed. Generally, the profit and loss statement is made up once each month, and the balance sheet annually.

The Time Report

The time report (see sample, below) is filled out each day to show the hours worked by each member of the mill crew. Each week the entries are summarized and the payroll figured out.

The inventory of lumber will be simplified if each pile of lumber, as it is put up, or each unit package of lumber before it is carried to the yard, is labelled to show the date, footage, species and grade. This may be done with crayon on the edge of one of the lower boards or stickers, somewhat as follows: "2,400 ft. 4/4 #2 Common Red Oak, 5/5/56."

At first, inventory items should be

TIME REPORT – MILL CREW

Work week Ending May 15, 1956 Date of Payment May 20, 1956

Name in Full	Account Number	Hours Worked S M T W T F S	Total	Hourly Rate	Earnings Reg.	Extra	Total	Deductions Ins.	Other	Total Paid
W. G. Banks	154-99 4231	8 8 8 8 8 5	45	$1.10	44.00	8.25 (O.T.)	52.25	1.10	20.00 (Adv.)	31.15
Ann Knowles	154-99 2176	8 8 8 8 8	40	.75	30.00		30.00	.65		29.35

Explanation of abbreviations:

O.T. – extra payment for overtime work.
Adv. – advance of funds made previous week.
Reg. – regular payment.
Ins. – deduction for insurance.

Profit and Loss Statement

For the profit and loss statement, the monthly summary data from the sales record will be used together with that from the time reports and the record of purchases and payments. An inventory of lumber, logs and supplies will also be needed.

valued conservatively, usually on a cost-of-production basis. As experience is gained in the business it will be easier to value the inventory items realistically. Logs should be valued where they are located, in the standing tree, at the roadside or in the mill yard, on the basis of the money invested in them. Ordinarily, no inventory value is given to slabs, edgings and sawdust unless there is a regular and steady sale for them at a substantial price.

The profit and loss statement is based on the total receipts during the period, minus the total direct costs during the period, plus or minus an adjustment for inventory changes. This gives gross profits of the milling business. From this must be deducted the various overhead or indirect costs. These costs include salaries not shown in the labor record, interest on business investments, taxes and insurance and the amount deducted for losses and bad debts.

Another indirect cost is the amount added during the accounting period to the reserve being maintained for depreciation of major items of equipment and buildings. This is to provide for necessary replacement of these facilities when they are no longer useful, because they are worn out or obsolescent. Small tools and current supplies that are generally useful no more than a year, like axes, hand saws and circular saw bits, are charged for under "materials and supplies" under "direct costs."

The cost of major items of sawmill equipment, like the headrig, edger and trimsaw, is generally depreciated over a ten to twelve-year period. If, for example, the equipment cost $12,000 and a twelve-year depreciation period is decided upon, this would amount to a depreciation of $1,000 a year, or $83.33 a month. The cost of temporary sawmill buildings and other structures is depreciated over the period during which they will be occupied and at permanent locations, over a period of from 10 to 20 years. Diesel power units are generally depreciated over a period of about seven years; and motor trucks and tractors, about five. (See "Useful Life of Sawmill Equipment," Appendix 10.)

The final item in indirect costs to be entered is the amount spent for rent, repairs, etc. during the period for which the profit and loss statement is being prepared. This includes the payments for options and leases, as shown in the record of purchases and payments.

A sample profit and loss statement for a typical mill which is buying its logs at the mill site:

PROFIT AND LOSS STATEMENT

January 1-31, 1956

SALES

Sales of Lumber	(204 Mbf*)	$14,280		
Sales of Slabs	(52 cords)	260		
Sales of Sawdust	(20 tons)	100		
Sales of Veneer Logs	(14 Mbf*)	1,400		
Total Sales			$16,040	

DIRECT COSTS

Log Purchases	(245 Mbf*)	$12,250		
Labor		3,000		
Materials and Supplies		1,050		
Other Direct Costs		150		
Total Direct Costs			$16,450	
Less inventory increase (See attached schedule)			2,305	
Total Cost of Goods Sold			$14,145	
GROSS PROFIT				$1,895

GENERAL EXPENSE

Salaries	$400		
Interest on Business Investments	180		
Taxes and Insurance	120		
Losses and Bad Debts	200		
Depreciation	200		
Rent and Repairs	250		
Total General Expense		$ 1,350	
NET PROFIT			$ 545

*Thousand board feet.

INVENTORY SCHEDULES

January 1-31, 1956

Inventory of Logs

Inventory, January 1	(50 Mbf*)	$2,500	
Inventory, January 31	(81 Mbf)	4,050	
Increase	(31 Mbf)		$2,450

Inventory of Lumber

Inventory, January 1	(440 Mbf)	$30,800	
Inventory, January 31	(436 Mbf)	30,520	
Decrease	(4 Mbf)		$ 280

Inventory of Materials and Supplies

Inventory, January 1		$1,075	
Inventory, January 31		1,210	
Increase			$ 135
Net Inventory Increase			$2,305

*Thousand board feet.

For subsequent months, a profit and loss statement may be cast up, not only for the month, but also a cumulative one for the year to date. The individual monthly and cumulative statements for each period may be compared with similar statements for the same periods during the preceding year.

If this mill had also been conducting a logging business, there would have been several cost items to be added to the profit and loss statement, including purchase of standing timber, timber extraction expense and log hauling cost. There would also have been expenses to be added to the "General Expense" totals. Many operators prefer to handle their logging and their milling activities as separate businesses, making a profit and loss statement for each, to keep the record clearer and to make sure that both activities are self-supporting. In this latter case the sawmill is charged a fixed price for the logs, as was done in the profit and loss statement above.

Balance Sheet

In addition to the profit and loss

statement, another statement is necessary to show the worth of a business. This is the balance sheet, which should be made up at least at the end of each year. As stated previously, balance sheets are sometimes needed at other times to justify a loan, for the purpose of selling an interest in the business and similar purposes.

The balance sheet shows the assets, liabilities and net worth of the business as of a given date.

Assets include cash on hand, or in banks; accounts and notes receivable; inventories of logs, lumber and other salable commodities; and investment items such as the sawmill and auxiliary equipment, depreciated in value to date.

Liabilities include accounts and notes payable, mortgages payable, and other obligations.

Net worth is the difference between the totals of assets and liabilities. Book value is not necessarily a reflection of what a buyer would be willing to pay for a business or of what the owner would want to sell it for. The sale price would depend on the estimate of the two parties as to future business prospects, the good or ill will built up in the conduct of the business in the past, and the actual usefulness and liquidity of the assets. The balance sheet, however, is one good guide to the value of a business.

A typical balance sheet follows:

BALANCE SHEET

January 1, 1956

ASSETS

Cash (on hand and in bank)	$5,025		
Notes Receivable	500		
Accounts Receivable	3,050		
Inventory			
Logs	2,500		
Lumber	30,800		
Supplies	1,075		
Investment in Equipment			
Depreciated Value	16,000		
*Depreciation Reserve	7,000		
Total Assets		$65,950	

LIABILITIES

Accounts Payable	$1,200		
Notes Payable	500		
#Mortgage	4,010		
Total Liabilities		$ 5,710	
NET WORTH			$60,240

*Kept in Savings Account
#Unpaid Balance

APPENDIX 1

GLOSSARY

Air Dried - Lumber which has been stacked after sawing in the open air in open piles (stickers inserted between each layer) and which has come to approximate equilibrium with the moisture content of the air.

Arbor - The shaft and bearings on which a circular saw is mounted. (Also called mandrel or main drive shaft.)

Band saw - An endless beltlike blade of steel, toothed in one or both edges, which is used to saw lumber.

Bearings - A support or guide in which the journal, shaft, pin or the like turns or revolves.

Boards - Lumber less than 2 inches in thickness.

Board foot - A unit of measure used in the United States lumber trade. For softwoods it is the "quantity of lumber contained in or derived from a piece of rough green lumber 1 inch thick, 12 inches wide, and 1 foot long, or its equivalent in thicker, wider, narrower or longer lumber." In practice, standards have been set for the thickness and width of dressed and dry softwood lumber of the various standard "nominal" dimensions. For example, a dressed and dry piece of softwood to be sold as a "2 x 4" (2 x 4 inches in cross section) must be 1-5/8 inch x 3-5/8 inches in its actual measurements under the American Lumber Standards. Hardwood, on the other hand, is commonly sold according to its actual dimensions in length (to the nearest foot) and width (to the nearest inch) at the time of measurement, but of a stipulated thickness depending on its condition. Dressed and kiln-dried hardwood of 1 inch "nominal" thickness must usually measure 13/16 inch in thickness. To obtain this it is usually necessary to cut the green lumber 1-1/16 inches or even 1-1/8 inches thick. For purposes of conversion, however, 1,000 board feet may be considered the equivalent of 83-1/3 cubic feet, or 2.36 cubic meters, rough green lumber measure.

Cant - A segment of a log, slabbed on one or more sides destined for further sawing on the same or different machines. It generally contains the heart center of the log, is of a nominal thickness in excess of 5 inches, and has wane remaining on one or more sides.

Board mill - A sawmill that makes a specialty of manufacturing 4/4 inch or 8/4 inch lumber, as compared to a mill that makes a specialty of material of greater thickness.

Bolster - A horizontal 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 opposed lever-controlled talons which can be brought to grip with the outer surface 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.

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.

Check - A lengthwise separation of the wood the greater part of which occurs across the rings of annual growth.

Chip - A shaving or segment taken by a single sawtooth. Also wood fragments made by hogs or chippers.

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 saw tooth and a line along the top of the tooth intersecting the tangent.

Collar - A metal ring or round flange upon, surrounding or against an object and used chiefly to restrain motion within given limits, to hold something in place.

Conical roller bearings - Roller bearings with tapered rollers.

Custom sawing - Lumber sawed under contract for someone else. Generally sawed to owner's specifications.

Dimension (softwood) - All yard lumber except boards, strips and timbers, that is, yard lumber 2 inches and over in thickness but less than 5 inches thick and of any width.

Dimension stock (hardwood) - Small selected cuttings of hardwood, accurately sized and sometimes semi-finished for use as furniture parts and for other purposes.

Dog - A steel tooth-like 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 (backing 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 into the wood and releasing them from it.

Dressed lumber - Lumber that has been dressed or surfaced on one or more sides.

Edge - To make square-edged.

Edger - A machine used in sawmills to square-edge any lumber parallel to its long axis and also to rip lumber. It consists of a frame supporting an arbor on which are mounted one to several circular saws.

Edgings - Strips that are cut from the edges of boards.

Eye (saw) - The hole through the center of the saw which receives the shaft.

Face (log) - Generally, a quadrant of the surface of the log which is parallel or at right angles with the saw when placed on the carriage. Also, the flat surface resulting when a slab has been removed.

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 - The man who sharpens, fits and maintains saws in a sawmill or other woodworking plant. (Also known as a "saw doctor".)

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.

Flitch - A section cut from a log which has wane on one or both edges; usually resawed.

Footage - Quantity of lumber expressed in board feet.

Gage - A standard series of sizes indicating by numbers the thickness to which saws are made.

Gig - The act of running the sawmill carriage back after a board is cut from the log.

Green - Unseasoned, wet.

Ground floor mill - Any mill not using a floor raised off the ground.

Guide (saw) - A device for steadying the saw.

Guide blocks - The arms of the saw guide mechanism which hold the guide pins.

Guide pins - The parts of the saw guide which actually contact the saw; usually end-grain hardwood blocks.

Guide rail - The rail that guides the movement of the sawmill carriage.

Gullet (throat) - On a saw, the rounded cavity between the teeth in which the sawdust accumulates and is carried from the cut.

Hammering (tensioning) - The art of pounding a saw plate on an anvil with a hammer in order to stretch the steel to the desired degree to overcome tensions produced in sawing. Also includes leveling.

Headblock - That portion of a sawmill carriage on which the log rests. Each headblock consists of a base, a knee, dogs, and a rack and pinion gear or some other device for advancing the knees toward or withdrawing them from the sawline.

Headrig - This is a term used by sawmill men to describe parts of the sawmill equipment used for breaking down the log itself, that is, for sawing slabs and boards off the round log. In some sections of the country the term is confined to the sawing equipment itself, being descriptive only of the type of saw and the drive. Other sections of the country use the term to include the carriage, and sometimes the carriage feed, as well as the break-down equipment.

Heartwood - The inner layer of wood which in the growing tree has ceased to contain living cells and in which the reserve materials have been removed or converted into heartwood substances. It is generally darker in color than sapwood though not always clearly differentiated from it.

High-speed steel - Alloy steel which is heat treated and retains much of its hardness and toughness at high temperatures. Used for some saw teeth.

Holder (sawtooth) - A device for locking inserted saw teeth in a circular saw. (Also called shank, halfmoon and circle.)

Hook - Angle between the face of a sawtooth and a line drawn from the extreme point of the tooth to the center of a circular saw.

Husk - The framework which supports the main shaft (mandrel) of a mill. On one end of this shaft is the pulley which receives power from the power unit, and on the other, collars that hold the saw. In between may be other pulleys to transmit power to the feedworks, sawdust conveyors, edger and topsaw.

Inserted-point tooth - The tooth that can be removed and replaced in an insert-point saw plate.

Jointing - The act of reducing points of all teeth in a circular saw to the circumference of a true circle when the saw is rotated.

Kerf - The width of the cut made by a saw.

Kickback - A sharp reversal of motion of the log or board during sawing caused by a binding of the kerf slot on the saw. Kickback occurs on edgers mainly, and occasionally on headsaws.

Kiln-dried - Lumber dried in a compartment (kiln) under controlled conditions of heat and humidity.

Knee - The part of a sawmill carriage headblock that bears the carriage dogs and supports the rear of the log away from the saw. It also supports the levers used to operate both the carriage dogs and the taper set.

Lead - Adjustment of the saw so that the distance to the track rail is slightly less at the front than at the back edge, in order to hold the saw in the cut and give clearance to the back of the saw.

Left-hand sawmill - A sawmill in which the carriage is on the left-hand side of a person standing on the log deck and facing the saw.

Lift truck - A conveying device mounted on pneumatic tires or crawler tracks with arms used to lift, transport and deposit loads of lumber, logs or other materials. Lift trucks are of two types: fork and straddle.

Log-beam mill - The type of mill employing a carriage on which the knees, dogs, and sometimes the setworks are fixed to a movable beam extending lengthwise of the carriage frame.

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 turner - A device used to turn the logs on the carriage.

Loose collar - The collar that is held against the circular saw by a nut on the end of the mandrel.

Lug pin - A metal pin chambered in the fixed and loose collars on the mandrel and passing through a pin hole in the saw plate to prevent the saw from slipping on the shaft.

Main drive shaft - See arbor.

Mandrel - See arbor.

Moisture content - The weight of water in a piece of lumber. Generally expressed as a percentage of the oven-dry weight of the wood.

Pawl - A pivoted tongue or sliding bolt on one part of a machine, adapted to fall into notches or indental spaces on another part. Used in set works on a sawmill carriage.

Pinion - A small gear with teeth designed to mesh with those of a larger gear or with a rack.

Plain-sawed - Lumber sawed parallel to the pith of the log and approximately tangent to the growth rings.

Quarter-sawed - Lumber cut parallel to the radius of the log rather than tangential to it. Practically applied, lumber in which the annual rings are at an angle greater than 45^{o} with the face of the board. (Also called vertical grain or edge grain.)

Rack - A bar with teeth in one face for gearing with those of a pinion.

Resaw - A machine to cut boards, cants, slabs or other material lengthwise into two or more pieces.

Right-hand mill - A sawmill in which the carriage is on the right-hand side of a person standing on the log deck and facing the saw.

Rip - To cut a piece of wood lengthwise in the fiber direction.

Rip tooth - The kind of a sawtooth adapted for cutting parallel to the fibers and main axis of wood.

Roller bearings - An anti-friction device made up of a series of rollers rotating between an inner and outer metal race. The races can be tapered so that the bearing can carry a thrust load as well as radial load (See "conical roller bearings").

Round-edge lumber - A piece of lumber with wane on one or both edges, usually two inches or less in thickness. Round-edged lumber is commonly sold in this condition in New England, but in other parts of the United States it is generally made square-edged before it leaves the sawmill.

Sapwood - The living portion of the wood in the tree located in a zone of varying thickness just under the bark. Generally lighter in color than the heartwood.

Setout - A lever attached to the knee of a sawmill carriage headblock which can be used to place the knee out of alignment. It is of service in supporting crooked logs and in sawing tapered logs parallel to the bark. (Also called taper bar or taper knee.)

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 on the setworks attached to the setshaft which, when turned with a lever, causes the knees to advance.

Shank - See holder.

Shim - A thin piece of metal, wood or other material used to fill in, as in leveling.

Shipping-dry lumber - Lumber that has been partially dried to prevent stain and mold in transit.

Shoulder - An abrupt projection that forms an abutment on an object.

Sills - The horizontal timbers supporting the husk of a sawmill.

Side dressing - The act of adjusting all sawteeth on a saw to project laterally the same distance from the plate.

Side gage - A measuring device to indicate the amount of lateral projection of sawteeth beyond the surface of the saw plate.

Slab - The curved exterior portion of a log that is removed to give the log a flat face.

Solid tooth saw - A saw having the teeth cut into its edge.

Spreader - A thin disk or scythe-like blade fixed behind a circular headsaw to guard against the boards and pieces contacting the rear edge of the saw and kicking back toward the sawyer.

Spring set - A method of setting saws whereby one tooth is sprung to the right and the next to the left. Most commonly used on cross-cut saws.

Stickers - Strips of wood used to separate layers of lumber in air and kiln-drying.

Stop shoe - The part of the setting mechanism on a sawmill carriage which contacts the peg or back stop and shuts off further advance of the knees.

Swage set - To spread the ends of the teeth in a saw to a width greater than the thickness of the saw plate.

Taper bar - See "setout."

Tension - To make a circular saw looser in the mid-radial zone than on the cutting edge (see "hammering"), so that when revolving at high speed it cuts straight and true.

Throat - See "gullet."

Tie or timber mill - A sawmill that specializes in the production of ties or heavy timbers.

Tram - A wagon, cart or other conveyance running on rails. Used to transport lumber around a yard or mill.

Trim - Short pieces cut from ends of lumber in squaring and cutting it to length.

Turning - Rotating the log on its longitudinal axis.

Upset swage - A tool used to spread the points of the teeth of a band or circular saw.

Wane - Bark or absence of bark on the edges or corners of a piece of lumber, dimension or timber.

Way timbers - The timbers supporting the carriage track. They are usually supplied as an assembled unit with the track spiked on them in portable circular sawmills made in the United States.

APPENDIX 2

Partial List of Sawmill Machinery Manufacturers in the United States*

A. Sawmills, Standard Circular

1. American Sawmill Mach. Co., Corinth, Miss.
2. Belsaw Machinery Co., Kansas City, Mo.
3. Chase Turbine Mfg. Co., Orange, Mass.
4. Corinth Machinery Co., Corinth, Miss.
5. Corley Mfg. Co., Chattanooga, Tenn.
6. Crabbe Gas Engine Co., Independence, Iowa
7. The Enterprise Co., Columbiana, Ohio
8. Frick Company, Waynesboro, Pa.
9. General Foundry & Machine Co., Sanford, N. C.
10. Gunderson Bros. Engineering Corp., Portland 8, Oregon
11. Hart Brothers, Clarksburg, W. Va.
12. R. R. Howell Co., Minneapolis, Minn.
13. Ireland Mill and Supply Co., Cayuta, N. Y.
14. Kent Machine Co., Cuyahoga Falls, Ohio
15. Lane Manufacturing Co., Montpelier, Vt.
16. Lewis Manufacturing Co., Memphis 2, Tenn.
17. Mater Machine Works, Corvallis, Oregon
18. Meadows Mill Company, North Wilkesboro, N. C.
19. Mill Equipment Incorporated, Seattle 8, Washington
20. The Peters Company, Portland, Oregon
21. Salem Equipment and Supply Co., Salem, Oregon
22. Sumter Machine Co., Sumter, S. C.
23. J. A. Vance Co., Winston-Salem, N. C.
24. The Wheland Co., Chattanooga, Tenn.

B. Sawmills, Band

1. Guy W. Conner, Inc., Sheffield, Pa.
2. Filer and Stowell, Inc., Milwaukee, Wisconsin
3. Klamath Machine and Locomotive Works, Klamath Falls, Oregon
4. McDonough Manufacturing Co., Eau Claire, Wisconsin
5. Monarch Forge and Machine Works, Portland 10, Oregon
6. The Prescott Company, Menominee, Michigan
7. Sinker Davis Division, The Enterprise Co., Indianapolis, Ind.
8. Sumner Iron Works, Everett, Washington
9. The Wheland Company, Chattanooga, Tenn.

*Inclusion of names of companies implies no recommendation or endorsement of their products by the United States Government.

C. **Sawmills, Mobile**

1. C. S. Amidon and Sons, East Willington, Conn.
2. Bach Machinery Co., P. O. Box 1215, Eugene, Oregon
3. Calvert Machine Service, Boring, Oregon
4. Corinth Machinery Company, Corinth, Miss.
5. Crescent Machinery & Manufacturing Co., Dallas, Oregon
6. P. L. Crooks Company, Portland, Oregon
7. Hart Brothers, Clarksburg, West Virginia
8. Jackson Lumber Harvester, Inc., Brewton, Alabama
9. Pittsfield Box and Lumber Co., Pittsfield, N. H.
10. Timberwolf, Inc., Portland 5, Oregon

D. **Sawmills, Sash Gang**

1. Gunderson Bros. Engineering Co., Portland 8, Oregon
2. Johnson Manufacturing Company, Seattle 8, Washington
3. Mill Engineering and Supply Co., Seattle 4, Washington
4. Western Steel and Supply Co., Dallas, Oregon
5. Wickes Bros., Saginaw, Michigan

E. **Saws, Circular and Band**

1. Atkins Saw Division, Borg Warner Corp., Indianapolis, Ind.
2. Corley Manufacturing Co., Thomas St., Chattanooga, Tenn.
3. Disston Saw Division, H. K. Porter Co., Philadelphia 35, Pa.
4. R. Hoe and Co., Inc., New York 54, N. Y.
5. Simonds Saw and Steel Co., Fitchburg, Mass.
6. Southern Saw Works, Taylor St., East Point, Georgia
7. Spear and Jackson Co., Eugene, Oregon

F. **Edgers**

1. American Sawmill Mach., Co., Corinth, Miss.
2. Belsaw Machinery Co., Kansas City, Mo.
3. Chase Turbine Manufacturing Co., Orange, Mass.
4. Corinth Machinery Co., Corinth, Miss.
5. Corley Manufacturing Co., Chattanooga, Tenn.
6. The Enterprise Co., Columbiana, Ohio
7. Frick Company, Waynesboro, Pa.
8. General Foundry and Machine Co., Sanford, N. C.
9. Ireland Mill and Supply Co., Cayuta, N. Y.
10. Lane Manufacturing Co., Montpelier, Vt.
11. Memphis Machine Works, Memphis, Tenn.
12. Miner Edger Works, Meridian, Miss.
13. Montague Inc., Sumter, S. C.
14. Sumter Machine Co., Sumter, S. C.
15. J. A. Vance Co., Winston-Salem, N. C.

G. Trimsaws

1. American Sawmill Mach. Co., Corinth, Miss.
2. Belsaw Machinery Co., Kansas City, Mo.
3. Corinth Machinery Co., Corinth, Miss.
4. Corley Manufacturing Co., Chattanooga, Tenn.
5. The Enterprise Co., Columbiana, Ohio
6. Frick Company, Waynesboro, Pa.
7. General Foundry and Machine Co., Sanford, N. C.
8. Ireland Mill and Supply Co., Cayuta, N. Y.
9. Lane Manufacturing Co., Montpelier, Vt.
10. Miner Edger Works, Meridian, Miss.
11. B. L. Montague and Sons, Sumter, S. C.
12. Sumter Mach. Co., Sumter, S. C.

H. Sawdust Blowers

1. American Blower Corp., Tireman Ave., Detroit, Mich.
2. C. S. Amidon, East Willington, Conn.
3. Bayley Blower Co., S. 66th and Burnham, Milwaukee, Wisc.
4. Buffalo Forge Co., 465 Broadway, Buffalo, N. Y.
5. Champion Blower and Forge Co., Lancaster, Pa.
6. Chase Turbine Mfg. Co., Orange, Mass.
7. Kirk and Blum Mfg. Co., 3186 Forrer Ave., Cincinnati, Ohio
8. New York Blower Co., 333 W. 32nd St., Chicago, Ill.
9. Pangborn Corp., Hagerstown, Maryland
10. Phelps Manufacturing Co., 713 Thomas St., Little Rock, Ark.
11. Rees Blow Pipe Mfg. Co., Berkeley, Calif.
12. Sterling Blower Co., Hartford, Conn.
13. Harold Van Auken, Elmira, N. Y.

I. Grit Gougers

1. Burrill Saw and Tool Works, Ilion, N. Y.
2. W. O. Dutton Lumber Co., Brandon, Vt.
3. Cornell Manufacturing Co., Laceyville, Pa.
4. Jackson Lumber Harvester Co., Brewton, Ala.
5. Harold Van Auken, Elmira, N. Y.

J. Automatic Slab Saws

1. Burrill Saw and Tool Works, Ilion, N. Y.
2. Cornell Mfg. Co., Laceyville, Pa.
3. General Foundry and Machine Co., Sanford, N. C.

K. Engines, Diesel

1. Buda Division, Allis Chalmers Mfg. Co., Harvey, Ill.
2. Caterpillar Company, Peoria, Illinois
3. Continental Motors Corp., Detroit, Mich.
4. Detroit Diesel Engine Division, General Motors Corp., Detroit 28, Mich.
5. Diesel Division, Harnischfeger Corp., Crystal Lake, Illinois
6. Enterprise Engine and Mach. Co., San Francisco 10, Calif.
7. Fairbanks Morse and Co., Chicago, Ill.
8. Hercules Motors Corp., Canton, Ohio
9. International Harvester Corp., Melrose Park, Illinois
10. Murphy Diesel Co., 5317 W. Burnham Ave., Milwaukee 14, Wisc.
11. Waukesha Motor Co., Waukesha, Wisconsin

APPENDIX 3

Partial List of Manufacturers of Supplies for Sawmills*

A. Chemicals for Sapstain Prevention in Green Lumber

1. Borax Cons. Ltd., 630 Shatto Place, Los Angeles, Calif. (Borax)
2. Chapman Chem. Co., 714 Dermon Bldg., Memphis, Tenn. (Permatox)
3. Dow Chem. Co., 1000 Main St., Midland, Mich. (Dowicide)
4. E. I. duPont de Nemours Co., Grasselli Chems. Dept., Wilmington, Delaware (Melsan), (Lignisan)
5. Monsanto Chemical Co., St. Louis, Mo. (Santobrite)
6. Wood Treating Chems. Co., St. Louis, Mo. (Noxtane)

B. Chemicals for Prevention of Insect Attack in Green Lumber

1. Chapman Chemical Co., 714 Dermon Bldg., Memphis, Tenn. (Ambrocide)

(See Appendix 11 for recommended concentrations.)

C. Log and Lumber End Coatings

1. Akron Paint and Varnish Co., Akron 1, Ohio
2. Angier Products, Inc., 120 Potter St., Cambridge, Mass.
3. Barrett Div., Allied Chemical and Dye Corp., 40 Rector St., New York 6, N. Y.
4. Chapman Chemical Co., 333 N. Michigan Ave., Chicago 1, Ill. (for air seasoning only)
5. Cities Service Oil Co., 70 Pine St., New York 5, N. Y.
6. E. I. du Pont de Nemours and Co., Finishes Division, Wilmington, Del.
7. The Flintkote Co., Industrial Products Div., 17th and Wentworth Ave., Chicago Heights, Ill.
8. W. P. Fuller and Co., 301 Mission St., San Francisco, Calif.
9. General Industrial Chemicals, 3048 Michigan Dr., Louisville 12, Ky.
10. General Paint Corp., Second and Taylor, Portland, Oreg.
11. General Petroleum Corp., 612 Flower, Los Angeles, Calif.
12. Gilbreath Chemical Co., 383 Brannon St., San Francisco, Calif.
13. Koppers Company, Tar Products Div., Koppers Bldg., Pittsburgh, Pa.
14. Lion Oil Company, El Dorado, Ark.
15. Longview Paint and Varnish Co., 1203 California Way, Longview, Wash.
16. Mautz Paint and Varnish Co., 933 E. Washington Ave., Madison, Wisc.
17. Moore Dry Kiln Co., Jacksonville 1, Fla.
18. Ohmlac Paint and Refining Co., 6550 S. Central Ave., Chicago, Ill.
19. Pittsburgh Plate Glass Co., 235 E. Pittsburgh Ave., Milwaukee, Wisc.
20. Reilly Tar and Chemical Corp., 1615 Merchants Bank Bldg., Indianapolis 4, Ind.
21. Schorn Paint Mfg. Co., 1128-32 W. Spokane St., Seattle 4, Wash.
22. Sloss-Sheffield Steel and Iron Co., Birmingham 2, Ala.
23. Socony Vacuum Oil Co., Inc., 26 Broadway, New York, N. Y.
24. Standard Oil Co. of Calif., 220 Bush St., San Francisco, Calif.
25. R. T. Vanderbilt Co., 230 Park Ave., New York 17, N. Y.

*Inclusion of names of companies implies no recommendation or endorsement of their products by the United States Government.

APPENDIX 4

Selected References

----------May 1952 Sawing Methods Being Used in the Pine Region, The Timberman, Portland, Oregon, p. 142.

--------March 1952 Operating the Edger for Grade Recovery, The Timberman, Portland, Oregon, p. 128.

Betts, H. S. and Helphenstine, R. K.
1933 How Lumber is Graded, U. S. Department of Agriculture Circ. 64, Washington, D. C. 48 pp., illus. (Out of print)

Brown, Howard L.
1947 The Fundamentals of Good Lumber Manufacturing and Grading Practice, West Coast Bureau of Lumber Grades and Inspection, 1410 S. W. Morrison St., Portland, Ore., 88 pp., illus.

Brown, N. C. and Bethel, J. S.
1958 Lumber — the Stages of Manufacture from Sawmill to Consumer. John Wiley and Sons, N. Y. 379 pp., illus.

Cahal, R. R.
1947 Sawmilling Practices that Pay, Southern Pine Inspection Bureau, National Bank of Commerce Bldg., New Orleans, La. 107 pp., illus., 50 cents.

Cuppett, D. G. and Bennett, H. D
1955 More Money in Sawing Mine Timbers, Conservation Commission of West Virginia, Charleston, W. Va. 10 pp., illus.

Darwin, W. N. and Thurmond, A. K.
1951 Good Management — Key to Successful Sawmilling, Tennessee Valley Authority, Norris, Tenn., 15 pp., illus.

Lane, P. H. and Fechner, G. H.
1952 Sawed Tie Production in the Tennessee Valley, Tennessee Valley Authority, Norris, Tenn. 31 pp., illus.

Muller, Joseph L.
1947 Establishing and Operating a Small Sawmill Business, U. S. Dept. of Commerce, Industrial Series #20, 154 pp., illus., Superintendent of Documents, Washington, D. C., 35 cents. (Out of print)

Pfeiffer, J. R.
1958 Log-Gang and Scrag Mills' Sawing Efficiency. Forest Products Research Center, Corvallis, Oregon. Inf. Circ. 11. 20 pp., illus.

Simmons, F. C.
1951 Sawmill Techniques in the U. S. A., Proceedings of the United Nations Scientific Conference on the Conservation and Utilization of Resources, United Nations, New York, pp. 217-224, illus.

--------------- et al
1956 Handbook for Small Sawmill Operators, ASME 109-1956, 62 pp. illus. American Society of Mechanical Engineers, New York, N. Y. $3.00.

1957 Mechanization and Automation in Small Sawmills. American Society of Mechanical Engineers, N.Y. Paper No. 57-A-48. 8 pp., illus.

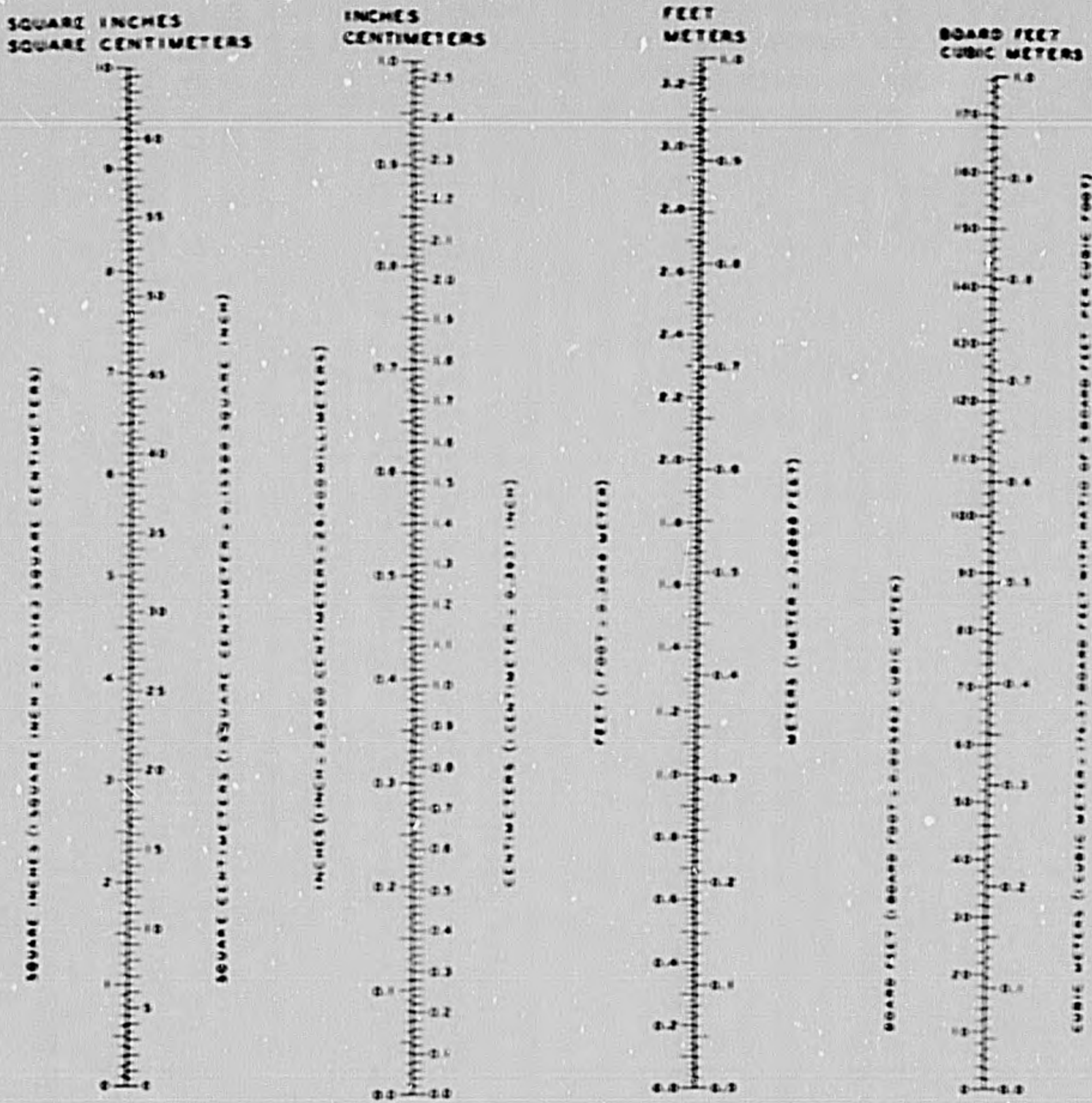
Telford, C. J.
1952 Small Sawmill Operator's Manual. U. S. Dept. of Agriculture Handbook No. 27, 121 pp. illus., Superintendent of Documents, Washington, D.C. 65 cents.

1954 Small Sawmills, A Pocket Guide. U.S. Dept. of Agriculture Handbook No. 70, 26 pp. illus., Superintendent of Documents, Washington, D.C. 15 cents.

Equipment catalogs of manufacturers in Appendix 2.

APPENDIX 5

Alignment Charts for Converting from English Units of Measurement to Metric Units



(Log Volume)

(From "Converting Factors and Tables of Equivalents Used in Forestry," U.S.D.A. Miscellaneous Publication No. 225, 1935, Revised 1949.)

APPENDIX 6

Horsepower Transmission Rating for V- and Flat Belting

a. Manufacturers' Approximate Horsepower Rating per inch of width, for standard flat sawmill belts subject to mild shock leads, when distance between pulleys is 15 feet or more.*

Belt speed (ft. per minute)	Leather belts		Rubber belts, per ply
	Single-ply	Double-ply	
	Horsepower	*Horsepower*	*Horsepower*
1,000	1.35	2.33	0.333
1,500	2.00	3.45	.474
2,000	2.62	4.50	.625
2,500	3.20	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	1.022
3,800	4.65	7.86	1.070
4,000	4.80	8.16	1.109
4,200	5.03	8.49	1.149
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

b. Manufacturers' Horsepower Rating Per Belt of Five Types of Standard Sawmill V-Belts Under Mild Shock Load, When Arc of Contact is 180°.*

Belt speed (ft. per min.)	V-belt type A (1/2 by 11/32 inch)			V-belt type B (21/32 by 13/16 inch)			V-belt type C (7/8 by 17/32 inch)			V-belt type D (1 1/4 by 3/4 inch)			V-belt type E (1 1/2 by 1 inch)		
	Sheave pitch diameter			Sheave pitch diameter			Sheave pitch diameter			Sheave pitch diameter			Sheave pitch diameter		
	3 inches Hp.	Change per inch diameter of pulley Hp.	5 inches Hp.	5 inches Hp.	Change per inch diameter of pulley Hp.	7 inches Hp.	9 inches Hp.	Change per inch diameter of pulley Hp.	12 inches Hp.	13 inches Hp.	Change per inch diameter of pulley Hp.	17 inches Hp.	22 inches Hp.	Change per inch diameter of pulley Hp.	29 inches 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	.73	.206	1.06	1.4	.25	1.9	3.2	.30	4.1	5.4	.50	7.4	10.2	.42	12.7
2,000	1.00	.27	1.54	1.8	.35	2.5	4.2	.40	5.4	7.3	.55	10.2	13.2	.52	16.4
2,500	1.14	.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	.52	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	.62	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	.72	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	.85	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	1.29	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	.95	10.1	12.0	1.70	18.8	23.2	1.38	31.5

*Adapted from U.S.D.A. Agricultural Handbook No. 72. Derived from data in catalog of L. H. Gilmer Co., Tacony, Philadelphia, Pa.

* - See Note on following page.

Note: The values given in Appendix 6a and 6b 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:

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

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

When the arc of contact of the smaller pulley for a given hook-up is found by this formula, the reduction factor used with values in Appendix 6a for flat belts will be:

Arc of contact	Reduction factor
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]

Similarly, the reduction factors used with values in Appendix 6b for V-belts on pulleys of dissimilar sizes are:

Arc of contact	Reduction factor
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]

APPENDIX 7

STANDARD SAW GAUGES

Gauge (Birmingham)	Fraction Inch		Thousandths Inch	Millimeters
	1		1.000	25.40
	7/8		.875	22.225
	3/4		.750	19.05
	5/8		.625	15.875
	1/2		.500	12.70
	15/32		.4688	11.905
0000	29/64		.454	11.53
000	27/64	Full	.425	10.79
00	3/8	Full	.380	9.65
0	11/32	Scant	.340	8.64
1	5/16	Scant	.300	7.62
2	9/32		.284	7.21
3	1/4	Full	.259	6.57
4	15/64		.238	6.04
5	7/32		.220	5.59
6	13/64		.203	5.18
7	3/16	Scant	.180	4.57
8	5/32	Full	.165	4.19
9	5/32	Scant	.148	3.76
10	1/8	Full	.134	3.40
11	1/8	Scant	.120	3.05
12	7/64		.109	2.77
13	3/32		.095	2.41
14	5/64	Full	.083	2.10
15	5/64	Scant	.072	1.82
16	1/16	Full	.065	1.65
17	1/16	Scant	.058	1.47
18	3/64		.049	1.24
19	—		.042	1.06
20	—		.035	.89
21	1/32		.032	.81
22	—		.028	.71
23	—		.025	.64
24	—		.022	.56
25	—		.020	.51
26	—		.018	.46
27	1/64		.016	.41
28	—		.014	.36
29	—		.013	.33
30	—		.012	.30

APPENDIX 8

Extent to Which Inserted-Point Sawteeth and Tooth Holders Produced by Various Manufacturers Can Be Interchanged.

(Teeth and Holders in the Same Vertical Column are Interchangeable, except as noted.)

Manufacturer	Saw part	Manufacturer's part number																				
Atkins	Teeth	2	2½	3	3½	6	4½	5	B	[1]C	[1]33											
	Holders	2	2½	3	3½	6	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	F[3]	F[3]	F[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	6	4½	5	B	[1]6	[1]33										44	25
	Holders	2	2½	3	3½	6	4½	5	B.D.F.	[1]6	[1]33										44	25
Liggett	Teeth	2	2½	3																		
	Holders	2	2½	3																		
Ohlen-Bishop	Teeth		2½	3														1	2F	22		
	Holders		2½	3														1	2F	22		
Simonds	Teeth	2	2½	3	3½	6	4½	5	B.D.F.[2]													
	Holders	2	2½	3	3½	6	4½	5	B.D.F.[2]													
Southern	Teeth	2	2½	3		6			L.F.	[1]3D	[1]33							1	2F		44	
	Holders	2	2½	3		6			B.D.F.	[1]3D	[1]33							1	2F		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.

(From U.S.D.A. Handbook #27)

APPENDIX 9

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	6-10
	Gear drive	15-25
	Chain lift from sluice opposite deck	10-15
Log conveyor chains on deck		5-10
Log turners	Double-bar friction kickers	3-5
	Overhead shaft-and chain friction drive	6-10
	Single-bar friction drive	6-10
	Rocker-arm shaft	15-20
Carriage drive	Heavy	10-15
	Light or medium-weight	5-10
Carriage setworks		3-5
Carriage dogs		1-2
Carriage log unloader		5-10
Sawdust chain		1-3
Sawdust blower		5-10
Refuse chain	Heavy	20-25
Live rolls		5-10
Transfer and conveyor chains		15-20
Sorter chains		5-10
Edger	Single-saw, manual	5-10
	2- to 3-saw, 27-inch	15-20
	2- to 3-saw, 33-inch	20-25
	4-saw, heavy-duty	100
Two-saw trimmer		15-20
Cut-off saw		8-10
Slab cut-off saw		5-8

APPENDIX 10

Useful Life of Sawmill Equipment As a Basis for Estimating Depreciation.

Item	Expected life Years
Horses	3-5
Mules	3-5
Sleds	3-5
Log wagons	3-5
Felling tools	1
Motor truck (logging)	4-5
Crawler tractors	4-5
Wheel tractors	4-5
Shacks and buildings	5-10 or life of operation
Jammers	3-5
Mill building	10-20 or life of operation
Steam engines	20
Gas units	5
Diesels	7-10
Edgers	5-10
Headrig	10-12
Trim saws	5-10
Rolls	5-10
Saws	2-5
Lumber trucks	5
Lumber wagons	5

APPENDIX II

Recommended Solutions for Prevention of Stain, Mold and Decay in Lumber.*

Product	Suggested number of pounds per 100 gallons of water
Borax	32
Dowicide G	7
Dowicide H	6
DN-4400A	4
Lignasan	2
Noxtane	10
Permatox 10s	10
Santobrite	7
Mixture 1	
Lignasan	1
Plus Dowicide G or Santobrite	4
Mixture 2	
Lignasan	1/2
Plus Dowicide G or Santobrite	2
Plus Borax	6

*From Proceedings of the Forest Products Research Society, Vol. III, p. 464.

Note: 5 pounds of Ambrocide may be added to any of the above solutions to provide an insect repellant.