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CAPITAL REQUIREMENTS, TECHNIQUES AND OPERATIONS

ROUGH SAWING OF LOGS

October 1956

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FOREWORD

The purpose of this report is to present basic information for establishing and operating a logging and sawmilling operation in any country where logging operations are considered feasible. The information includes general logging and sawmill methods, mill layout, machinery requirements, and the costs of materials, equipment, labor, and overhead expenses.

Costs are necessarily predicated on certain basic assumptions, but are in accordance with good practice and normal conditions existing in the United States. The mill described is of minimum size to be economically efficient and to utilize the most modern equipment.

As an essential preliminary, potential plant operators must determine whether or not there is a market within the locality for the lumber and lumber by-products of this mill. Naturally, they must be willing to assume the risks inherent in any business. The results shown in the profit and loss statements are illustrative and depend upon market conditions, good management, and local factors.

The cost and profit projections have been presented on a conservative basis. Undoubtedly, if this mill were located outside the United States, the costs of operation would be considerably reduced, permitting a lower selling price. On the whole, the mill should be a profitable venture.

For further information and assistance, readers should contact their local Productivity Center, Industrial Institute, Servicio or United States Operations Mission.

This report is one of a series prepared for the Office of Industrial Resources of the INTERNATIONAL COOPERATION ADMINISTRATION by the Wolf Management Engineering Company, Chicago, Illinois.

THIS REPORT IS DESIGNED ONLY TO PROVIDE A GENERAL PICTURE OF THE FACTORS THAT MUST BE CONSIDERED IN ESTABLISHING AND OPERATING A SMALL SAWMILL. IT SHOULD PROVE USEFUL IN CREATING INTEREST IN MODERNIZING OLD MILLS OR IN ESTABLISHING EFFICIENT NEW MILLS. HOWEVER, IT IS IMPORTANT TO NOTE THAT THE BROCHURE IS NOT DESIGNED AS AN ENGINEERING GUIDE. IN MOST CASES, PLANS FOR ACTUAL INSTALLATIONS WILL REQUIRE SPECIFIC EXPERT ENGINEERING AND FINANCIAL ADVICE IN ORDER TO MEET SPECIFIC LOCAL SITUATIONS.

October 1956

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ROUGH SAWING OF LOGS

INTRODUCTION

Products of the forest industries are so commonplace, the supply so abundant, and their use so widespread that these products are used by nearly everyone.

Lumbering throughout the world is an industry comprising many small units. In the United States, for example, there are more than 53,000 active production and distribution units, and no single enterprise furnishes more than 5 percent of the total consumption.

The annual American production exceeds 40 billion board feet, with a per capita consumption of nearly 250 board feet. By comparison, the world per capita consumption is only 21 board feet. In America, there are about 100 huge lumber producing enterprises; yet, it requires nearly 6,000 of the largest operations to produce approximately 70 percent of the total output.

Unlike the situation in many other countries of the world, in America over 40 percent of the lumber production comes from forests which have been logged from once to as many as six times before. In contrast, throughout the world, there are many areas with enormous stands of virgin forests containing valuable and easily harvested timber. Lumber and other forest products might therefore become the natural resource of a country and, if harvested and marketed, might produce enough foreign exchange to materially improve the economic conditions of that nation.

Forest products industries were America's first adventure in business. Logs and rough sawed lumber were exported world-wide and produced much of the money needed to advance this nation's early economic and industrial progress.

The lumbering industry is noteworthy from the standpoint that the small operation can and does successfully compete with even the

largest operations. This situation prevails in the United States and in many other countries where individual enterprises have been commenced by individuals who have acquired the essential information needed to properly establish and efficiently conduct a logging and sawmill operation.

The principal sawmill operations - after a timber stand has been cruised to determine the nature, extent and variety of timber available - consists of harvesting the logs, and then sawing them into marketable products.

The harvesting operation usually consists of grubbing the area and otherwise preparing it for suitable access to the trees, then felling, bucking, skidding and transporting the logs to the mill site, and disposing of slashings.

Sawing operations usually consist of:

1. Sorting and grading the logs
2. Sawing them into boards, timbers or cants
3. Edging the sawed wood to remove the bark and to cut the wood into the desired widths
4. Trimming to cut the wood into desired lengths

Beyond these, there are usually additional operations such as grading, sorting, piling, drying, handling, and transporting the finished products. The following pages will supply essential information concerning all these operations.

Like almost every business enterprise, a lumbering operation requires the compilation of records to determine cost of operation and insure a profit. Also, record keeping will supply information that will enable an operator to judge the degree of efficiency of his operation. The essential factors on this subject also will be covered.

In addition to the above topics, this prospectus will deal to the extent necessary with facts concerning marketing, quality of product, power, tooling requirements, maintenance, staffing, and types of machinery and equipment needed.

The successful operation of any lumbering business depends greatly upon the amount of information an operator possesses

concerning the problems he encounters. No lumber operator, therefore, should fail to obtain all information necessary to guide him in the successful conduct of his enterprise.

IT IS IMPORTANT TO NOTE THAT THIS BROCHURE IS NOT DESIGNED AS AN ENGINEERING GUIDE. IN MOST CASES, PLANS FOR ACTUAL INSTALLATIONS WILL REQUIRE SPECIFIC EXPERT ENGINEERING AND FINANCIAL ADVICE IN ORDER TO MEET SPECIFIC LOCAL SITUATIONS.

PRODUCTS AND PRODUCTION VOLUME

There are a great many species of trees to be found throughout the world. Tree species are commonly divided into two broad categories:

1. "Softwoods" - the conifer or needle-bearing trees.
2. "Hardwoods"- the broad-leaved trees.

Relative hardness, however, is not a characteristic of one of these categories any more than the other, for many of the conifer species are actually denser, and therefore heavier and more difficult to saw and work into lumber, than some of the so-called "hardwoods."

Forests are located in a variety of terrains, such as swamps and jungles, low but dry flatlands, low hilly areas, plateaus, and almost inaccessible mountains.

An individual forest area often contains a variety of conifer and broad-leaved trees, and the trees vary widely in size and degree of maturity. Both hard and softwood trees are found in many forests. The trees may be young growth, mature and over-mature, the latter particularly in virgin forests.

The term "lumber" is commonly used to include all sawed products, from boards to timbers. Boards are less than 2 inches thick. Plank and dimension are 2 to 5 inches in thickness, and timber is material 5 inches and thicker, used for structural purposes.

There are several ways to fell, buck, skid, load and transport logs. There are at least three distinctive types of machinery used to saw the logs into rough products. Likewise, there are a variety of ways to handle, transport, and store both the logs and the rough-sawed lumber.

Forest products may also be utilized, graded and marketed in many ways. Lumber may leave the mill in green rough-sawed, air dried or kiln-dried condition, and the production volume of each kind of lumber may vary over a wide range.

Since there are so many variables encountered in a lumber harvesting and rough sawing operation, it is impossible to deal with the industry in a composite fashion. Before providing information on a specific operation, it seems advisable to describe the products that may be marketed, the means employed to handle logs and rough-sawed products, and the machinery and equipment usually employed.

TYPES OF PRODUCTS WHICH MAY BE MARKETED

The lumber manufacturer can deal with only what is in the log. Unlike a factory, he cannot produce just the sizes and grades that are in the greatest demand. Most mills do not produce lumber to specific cutting orders, because there is no exact way to tell in advance the grades or items that can be cut from any individual log. The sawyer might have a list of the items wanted, and after each log is opened up he will try to obtain from the log as many of these items as he can. One log may produce largely structural items, another mostly factory-grade lumber items.

Since this is the case, most better managed sawmills, instead of cutting specific orders, get the most out of the logs sawed. This means they try to obtain the highest or most profitable grades the log will yield, and then obtain orders for the lumber produced.

However, it is possible for an operator who is working a large tract in a virgin forest and who has a suitable amount of storage space available, to segregate logs by species and grades, thus accumulating a sufficient number of logs of each kind to supply changing demands for various grades of both lumber and timber.

The storage and additional handling costs occasioned by this method of operating are usually warranted, because by meeting these market demands, the operator is able to obtain higher prices and establish consumer goodwill; he is also more likely to preserve a satisfactory relationship between sales volume and the size of the mill he has established. By utilizing proper segregation methods, and with properly fitted and installed saws, he may utilize his machinery and equipment to produce desired quantities of lumber and timber items from both hard and softwood logs.

As previously stated, many virgin forest tracts have a variety of both the so-called hard and softwoods. Generally, the softwoods are used for construction purposes, for making shipping containers, and for framing in low and medium grades of furniture. Hardwoods are marketable, depending on their quality, either for the cabinet variety of products or for uses where strength is required, such as in wheels and spokes, tool and utensil handles, framing in the better grades of furniture, industrial blocking, and in structural uses requiring a great deal of strength, such as mine timbers.

Cabinet woods are valuable for the reason that they are hard enough to appreciably resist abrasion and because the natural grain and color of the wood presents a pleasing appearance when properly milled and finished.

Obviously, the better grades of cabinet-quality hardwoods command premium prices in world markets. Therefore, when such wood is available, a sawmill operator should exert every reasonable effort to harvest the logs properly and to saw the logs in a fashion tending to up-grade the final product.

There is but little demand in world markets for other than the highest grades of cabinet woods; thus, a mill operator possessing a stand of desirable varieties of these finer woods should carefully study the available literature to become fully aware of the methods which should be used in milling and preparing such woods for the market. Information concerning how cabinet and other hardwoods should be harvested, milled and marketed may be obtained from the following sources:

National Hardwood Lumber Association, 59 East Van Buren Street, Chicago, Illinois

Fine Hardwood Association, 666 North Lake Shore Drive, Chicago, Illinois

National Association of Hardwood Wholesalers, 327 South LaSalle Street, Chicago, Illinois

National Lumber Manufacturers Association, 1319 - 18th Street, N. W., Washington, D. C.

Forest Products Laboratory, Madison, Wisconsin

Softwoods

The production volume of softwoods of various species amounts to over 75 percent of the total world demand for all kinds of lumber and, while the demand for such wood is very great, so also is the available supply; hence, selling prices are regulated largely by the demand and supply conditions prevailing.

Unlike hardwood market demands, there usually exists a strong market for most of the lower grades of softwood, especially in the country the wood is produced. However, a mill that has acquired a reputation for producing a large percentage of the better grades of softwoods usually can obtain higher selling prices, as well as the first considera ion of the consumers as a source of supply.

There is a market for softwood products of all kinds; the demand is usually for air-dried, green, and kiln-dried wood, in the order given. However, where transportation rates are high enough to become an important element in the final prices of the lumber, demand for air and kiln-dried products predominates. The board-foot cost increases when green lumber is transported to distant consumers, as can be readily understood. In these instances, it is to the consumer's advantage to purchase either the air or kiln-dried product.

Information on how softwoods should be harvested, milled and marketed may be obtained from the following sources:

Southern Pine Association, 520 National Bank of Commerce Building, New Orleans 12, Louisiana

National Lumber Manufacturers Association, 1319 - 18th Street, N. W., Washington, D.C.

Forest Products Laboratory, Madison, Wisconsin

Leading lumber trade publications listed in the appendix section of this report.

Wood Waste Products

When an operation is large enough and a local demand exists for lumber by-products, profits are likely to accrue from the production of charcoal, pulp chips, and sawdust for agricultural or industrial use, besides other by-products resulting from both hard and softwood operations. When a conventional sawmill operation begins to function smoothly, it might be to the operator's advantage and profit to investigate the possibilities of developing both local and distant markets for by-products.

TYPES OF FOREST TERRAIN AND HARVESTING METHODS

The particular logging method employed depends to a considerable extent upon the nature of the terrain on which the trees are located. Trees located on dry, level ground are the easiest ones to harvest, and those growing high on mountain slopes are usually the most difficult to gather.

Unless suitable handling facilities are available, felling and transporting logs in swampy jungle areas are a difficult, time-consuming and often dangerous operation. Therefore, it is suggested that an operator should possess the necessary handling facilities and should be well informed on the methods that must be employed in logging swampy areas. Cable logging methods and/or floatation are the methods most generally used.

Some of the finest cabinet and specialty woods, as well as the cypress species, bringing relatively high prices in world markets, are to be found in many swampy locations. Since jungle areas, for the most part, contain virgin forests, the percentage of mature timber is relatively large in these areas. The export market for good grades of jungle cabinet woods is such that, if properly exploited, this natural resource might accrue a substantial amount of foreign exchange for an operator and his country.

Harvesting logs on comparatively level dry terrain, and the transporting of these logs, requires a minimum of special handling facilities. The motive power may consist of oxen, horses or elephants, or petroleum-powered vehicles such as tractors and motor trucks. Where animals may be purchased and fed cheaply, where labor costs are low and the amount of time consumed is not an important factor, the use of primitive methods in level areas may be fully justified.

However, if sufficient initial capital can be invested to purchase powerized handling equipment, and this equipment is employed efficiently, the probability is that costs of operation, accident rate and over-all time consumed will be much lower and the degree of utilization higher than with the primitive animal methods. One important advantage of harvesting trees located on level ground is that the sawmill plant and storage yards can be located, and readily relocated, close to the actual logging operations.

Due to the wide variety of logging conditions to be found in most mountainous areas, individual situations impose unique harvesting problems. Usually, trees can be felled in the direction desired for skidding to log loading areas; but when trees have to fall into ravines, the situation imposes bucking and skidding problems, usually calling for some sort

of cable logging equipment. Rarely ever is it possible to find a level area large enough in mountainous terrain to provide room for log and lumber storage and for a sawmill site. Consequently, logs have to be transported to wherever it is possible to find sufficient level ground to set up a sawing operation. Frequently, roads must be bulldozed on the slopes of steep hills. Transportation and handling costs are usually much higher in mountainous operations than in level areas.

The reasons for the costs being higher in mountainous logging are:

1. The entire log must be loaded at the log-accumulating area and transported, perhaps for a considerable distance, to the sawmill.

2. Of the log's total weight and bulk, as much as 45 percent may ultimately be "waste" material.

3. Much of the waste material must be disposed of at the sawing site, imposing further handling and transporting costs.

4. Roads must continually be extended into the forest area to follow the felling operations.

In some cases, it may be possible and most economical to locate semi-portable sawmills in a levelled-out area in the forest and saw the logs into cants for transporting to a site where there are the additional sawing facilities required to process the cants into marketable lumber. In such cases, most of the waste will remain in the forest, thus reducing both the transportation cost per board foot and the waste disposal cost.

In the United States, because of the scarcity of mature hardwood trees or because it is desired to engage in light selective cutting, several types of portable sawmill rigs are employed. Some of these rigs are sufficiently mobile to economically haul them to where as little as a day's cutting of trees is to be done. Sometimes this type of operation is restricted to felling and bucking logs, and sawing the logs into cants for transporting to the mill site for further processing.

While these rigs are reasonably rugged in construction, they are nevertheless light and mobile enough to be hauled over quite rough terrain to the felling site. Modifications of this type of rig are used in Ecuador, South America, to harvest balsa wood. The rig is often used on a barge which is floated close to felling locations.

In the United States, such a rig is usually mounted on a rubber-tired vehicle or on a long-bed motor truck. When the truck is used, some sort of hoisting or skidding equipment is used to raise the logs to carriage

level or to lower the rig to the ground where it is operated.

Chain Saws

The ax and the hand saw are not widely used in the United States today to perform felling and bucking operations; they have been replaced by either electric or petroleum-powered chain saws. Chain saws sell for moderate prices, and they perform much better and faster than hand-operated equipment. In fact, they often increase productivity of labor enough in the first few months of their use to pay for the purchase cost.

There are several different makes and types of chain saws. It is advisable to select only the most rugged and well-made ones, as any reduction in the cost of purchase of an inferior piece of equipment might result in excessive maintenance costs and loss of operating time. Figure 1 illustrates both electric and gasoline-powered models of the chain saw. The gasoline-powered units are generally preferred for use in the forest because of their lesser cost and greater portability. Electric powered units are sometimes used at the landing or on the mill dock.

MANUFACTURING VOLUME

Sawmill operations are of many sizes, ranging in the United States from mills producing only a few hundred board feet of finished lumber in an eight-hour day to those with outputs of several hundred thousand board feet daily. The so-called pecker-wood operator, employing three or four assistants to perform all the harvesting and sawing work, represents about the smallest commercial operation that can be run effectively.

The portable sawmill rig operator often falls into this minimum-sized category. These small operators, depending upon the size of their rig, the amount of power available, the character of logs, and the effectiveness of personnel, can produce 3,000 to 10,000 board feet of rough lumber daily.

The larger (medium-sized) operator usually possesses a permanent sawmill housed in a shed-type structure. Frequently his equipment is not actually as modern and efficient as that owned by the smaller operator, but the machinery is larger in size, and necessarily an increased amount of power must be available.

The successful medium-sized operators usually possess what many pecker-wood operators lack, that is, experience, sufficient operating capital, and established markets. Because of this, the former have built up their daily production to between 10 and 25,000 feet a day. The next larger size-class of operators may utilize two or more circular

saw rigs, or they might employ one or more bandsaw rigs instead of, or in addition to, circular saw rigs. Some may utilize gang saws. In output volume, these operators produce from 25,000 to 100,000 board feet of lumber per day.

The fourth category of operation - the very large sawmilling operation - necessarily has to produce upwards from 100,000 board feet of lumber per day to effectively utilize its capacity. In the more modern large operations, the amount of labor required has been appreciably reduced by the installation of mechanical handling equipment, automatic controlling devices, and facilities to insure the efficient performance of auxiliary functions.

The size of a lumbering operation, insofar as profit potentials are concerned, is really unimportant and should not be considered to be a factor contributing materially to effectiveness and profitability. Actually, what really counts towards a successful operation is, first, experience or an understanding of the basic operating requirements, second, adequate capital, and, third, the acquisition of well-constructed, modern machinery and equipment. All three of these factors are equally applicable to a small operation and to the largest and most elaborate operation.

Lumbering, like any other business enterprise, becomes successful to the degree that knowledge of the industry is acquired and proper management principles are employed.

MACHINERY AND EQUIPMENT

Since this report is restricted to the requirements for conducting a small and medium-sized lumbering operation producing rough sawed lumber and timbers, this section will deal with only the types of machinery and equipment applicable for such an operation.

There are many operations confining their activities to merely cutting logs into unedged and untrimmed products. Such operations, however, neglect to take advantage of the increased profit potentials which nearly always accrue from producing marketable rough lumber products. The following text will therefore describe the kind of equipment required to process logs into readily marketable edged and trimmed rough lumber and timber.

As mentioned above, the nature of the terrain often dictates the kind of equipment necessary to fell, buck, skid and transport logs to the sawmill location. Since the terrain conditions impose individual requirements, the operator is urged to study both the conditions prevailing and

the methods other operators have employed to successfully cope with similar conditions.

It is necessary, of course, to get to where the trees are located, and to do so may require the construction of roads or access trails. Either animal-powered or motorized equipment may be employed to perform this work, depending largely upon the extent and size of the area to be harvested and the degree that capital investment is justified to provide efficient means. Careful study of individual conditions should result in the selection of equipment that is most suitable.

For felling and bucking, the use of a power chain saw, preferably the one-man variety, should be seriously considered. Use of axes and handsaws is slow, back-breaking work, and generally results in poorer utilization. Skidding may be done by using animals, motorized equipment or one of a variety of cable ways.

Log transportation from felling to sawmill location may be performed by animals, motorized equipment, waterways or cable way equipment. The distance from felling to the sawmill site usually determines which method of transportation should be used.

The next consideration is how to process the logs into rough sawed lumber. Where a variety of species, grades and sizes of logs is available, there should be a log-sorting area, or, where feasible, there should be constructed a log pond. After grading, the logs should be placed in a suitable storage area, arranged according to specie, grade, and size if there is a wide variety of sizes.

Transportation of logs from the storage piles to the mill may be by gravity, by water, by cable, or by a lift truck.

A log deck at the mill may be constructed as elaborately as production volume conditions and log sizes and weights warrant. Usually such decks are constructed of rough timbers and are provided with a suitable means for retaining the log supply while one log is ejected at a time onto the sawmill carriage.

Types of Head Saws

There are three distinct types of sawmill head saws. They are circular, sash-gang, and band saws. Variations of the circular head saw type are: single circular with or without a circular top saw; twin-circular; and the gang circular. All these types are used by small operators, with the single circular type predominating.

Progressive operators search for methods and types of sawmills to improve quality and lower processing costs. With various types of logs and markets, the objectives sought for head saw equipment may be: maximum recovery of lumber from the log; recovery of maximum qualities on a grade and thickness basis; accurate sizing; and minimum labor and maintenance costs per board foot. The relative importance of these several objectives will determine the type of primary breakdown equipment installed.

Figure 2 illustrates a single circular saw husk equipped with a top saw. This type of head rig ranks high in flexibility for cutting lumber of the highest grade and greatest thickness, but it ranks medium to low in sizing accuracy. Labor and operating costs per thousand board feet are medium, but installation and maintenance costs are relatively low. Lumber loss due to the kerf dimensions is greater for all circular saws compared with the sash gang and band saws, due, of course, to the thickness of the saw.

Figure 3 depicts one make of band saw rig suitable to the requirements of the small or medium-sized operator. A band head rig ranks high in recovery by grades and is very flexible in the matter of adjustment for thickness of material cut. It ranks medium in quantity of material cut and in accuracy of sizes cut.

Labor, power and maintenance requirements are greater than with most types of circular saw rigs, and installation and operating costs are relatively high. Its logical field is in operations assured of timber supplies adequate to amortize the relatively high installation cost and where log and product sizes vary to an extent requiring a flexible head rig capable of quick adjustment.

Figure 4 illustrates a typical sash gang head saw rig with saws adjusted to produce maximum timber values from uniform size logs. Many such rigs are of European manufacture. They are made in several sizes. Rigs of the size illustrated are capable of producing upwards from 6,000 board feet per hour from small logs. Kerf loss is low, since saw thickness may be as little as 7/64-inch. A firm foundation is required to withstand the rapid vertical oscillating motion of the sawing assembly, especially for designs where the weight of the oscillating element is not counterbalanced.

Small-size sash gang head rigs have been used as mobile units when mounted on heavy skids or a rugged chassis. However, such portable applications require that the chassis be tied down on a firm foundation. The sash gang saw ranks high in the quantity of lumber recovered and in cutting accuracy, but relatively low in the grades of lumber recovered and in the flexibility for cutting to various thicknesses.

The operating cost per thousand board feet is medium to low. Most European designs incorporate a type of carriage which permits sawing with the sweep of a log instead of in a straight line; hence, the percentage of short, thick slabs cut from crooked logs can be substantially reduced. The saws are generally set to cut flitches of varying thickness from the mid-section and boards or dimension from the outer faces. The flitches are usually edged, then re-sawed into boards in another gang sawmill, thus reducing edging cost.

Figure 5 illustrates one type of mobile circular saw rig. There is a wide variation in designs of these rigs. Some designers, in an effort to reduce weight and increase mobility, achieve portability at the expense of ruggedness; hence, they impose limitations on the sizes of logs that can be handled and on productivity. Models are made where the sawyer rides the carriage, and others provide for the sawyer to stand at the usual ground position. The power unit is usually mounted on a separate vehicle.

With a sufficiently ruggedly constructed rig, ample power and fairly good logs, it is possible to produce on these mobile rigs from 3,000 to 7,000 board feet of lumber per day. Generally, rigs of this character are best suited for selective cutting, for sawing in widely separated areas where an operator requires several forest crews to supply a central sawmill operation.

In the latter instance, the forest crew merely squares the log or cuts it into cants, thus doing the edging operation and leaving most of the wood waste in the forest. If the crew operating such a rig is provided with suitable means for hoisting both the logs and cants, the over-all labor cost for producing cants should be medium to low. Unless the rig is ruggedly constructed and placed on a firm, level foundation, maintenance costs are likely to be excessive.

It requires from three to seven men to operate these mobile sawmills, depending on design, mode of handling logs, cants and waste, amount of power available, and the extent to which auxiliary facilities are provided at the forest site.

Sawmill Carriages

Every band and circular sawmill must have a suitable carriage to hold and convey a log past the saw husk. Sawmill carriages usually are classified as head block or log beam. Either will function admirably if properly maintained and operated. The carriage should carry the log past the saw in an unvarying straight line; it should be capable of holding the log to prevent turning or excessive vibration. It should be sturdy enough to sustain the stresses and shocks imposed. (See Figure 6)

Carriages are provided with various shapes of grooved guide wheels which roll on matching steel tracks. The tracks should be well supported, level, straight and kept free of debris. There should never be any lateral play of the carriage due to excessive clearances. On the deck of the carriage are securely mounted such fixtures as bolsters and various types of setworks, knees, dogs, and receding devices.

Owing to the multiplicity of designs and the wide variety of deck fixtures available, no attempt will be made here to describe the many designs or their applications. The United States Department of Agriculture Handbook No. 27 illustrates and clearly describes conventional carriage deck features of both the power and manually operated types. This Handbook may be obtained by writing to the Superintendent of Documents, United States Government Printing Office, Washington 25, D.C.

The forward and reverse movement of a carriage past the saw may be accomplished by the application of steam, pneumatic or hydraulic cylinders, electric or internal combustion motors, or cable drives. Nearly all small and medium sized sawmill rigs utilize some form of cable drive. The power required for carriage travel, as well as the power which may be utilized to operate carriage deck fixtures, is often acquired by using some kind of power take-off device engaged to the main source of power used to operate the entire sawmill rig.

The speed and distance of travel of the carriage may be controlled by either the head sawyer or a carriage deck operator. Likewise, rigs are furnished where either the sawyer or the deck operator may control the deck mechanisms, including log haul, log turners and other auxiliary log-handling devices.

Adequacy of Power

Before continuing to describe other machinery, mention should be made of the importance of having an adequate supply of power. Frequently, manufacturers of sawmill equipment, in their endeavors to lower the over-all investment for a sawmill operation, may encourage an operator to spend disproportionate amounts of money on the rig and the power unit. There are makes and types of rigs which are not constructed sturdily enough to utilize the power recommended. Even more frequently, the power unit recommended may be too small to attain the productivity and accuracy desired.

The rig purchased should efficiently process the species of wood intended to be sawed, from a three-fold standpoint of sturdiness: ample power utilization, low maintenance cost, and low operating labor cost. The power requirement increases rapidly in proportion to the number of teeth and speed of saw, carriage feed rate, and the density of the wood.

To acquire maximum efficiency, a sustained high rate of production and low cost per board foot cut, the operator should be certain he possesses all the facts before making an investment. The Handbook mentioned previously supplies information concerning power requirements. Before purchasing machinery, an investor should investigate the standing of the manufacturer, the size of the structural members of the rig and the material these members are made of, the extent to which anti-friction bearings are used in revolving parts, and the provisions which the manufacturer has made for supplying replacement parts. Comparative gross weights of different rigs may be an indication of the ruggedness of the machines.

Edgers and Trimmers

No sawmill operation is complete without suitable edging and trimming machinery.

There are three general types of edgers used by small mill operators. The single saw type employs a lightweight rolling table, on which a board is placed to be manually pushed forward past a circular saw. Only one edge of the board may be dressed each time the board passes the saw. Therefore, machine time is lost because it is necessary to return the board to the forward end of the machine in order to dress the remaining edge. Two men are usually required to operate this type of edger, one to push the board forward and the other to either return the board for additional edging or dispose of the completely edged boards.

A rather small investment is required for this edger. Where daily production is small, it is a device which sometimes proves satisfactory. However, it requires a two-man crew, and human effort is needed to guide and push-feed lumber past the saw.

A more desirable edger is one having two or more saws mounted on a single mandrel (see Figure 7). This type employs power-driven rolls to feed the boards past the saws and to edge the boards completely with a single pass. With a multiple-saw edger, boards may be also ripped for grade and width requirements. Usually one saw is securely attached to the driving mandrel, while the remaining saws may be easily slid along a key-way mandrel to permit ripping of the boards to various widths.

A fork arrangement engaging the collar of the movable saw is mounted on a lever which extends to the infeed end of the machine. The lever slides over an indicator which serves as a guide for the machine operator in spacing the saws at proper distances apart. The feed rolls are either weight or spring-loaded, thus permitting them to rise or lower

while continuing to rest on the surface of varying thicknesses of boards. The feeding speed of this edger is usually synchronized with the mill production rate.

The machine is usually located to receive boards from the mill in almost a straight line of travel. The mill layout should be such that only an off-bearer is needed at the edging operation, the head saw off-bearer using a portion of the time required for unloading the saw carriage to swing round-edged boards to the edger table, to adjust the position of the edging saws and to start the board through the feed rollers.

A less frequently used type of edger is a vertical mandrel device which may be installed in front of the head saw. When properly installed and operated, it becomes a very efficient and accurate device. Vertical edgers are mounted on a specially built sturdy husk frame in such a way that the perimeter of each horizontally mounted saw reaches exactly the log side of the head saw cutting plane at a line about two feet ahead of the head saw. Thus, as the carriage is moved forward for the head saw cut, the boards are simultaneously cut and edged. All saws are adjustable, the adjustments being made by either the sawyer or the head saw off-bearer.

To justify the additional cost of installing a vertical edger, the sawmilling operation should be established on a semi-permanent basis; that is, more than two years of high-production volume of logs should be available.

The edger selected should be of sturdy construction, equipped with anti-friction bearings and designed to permit quick replacement of saws.

Trimmers vary from simply constructed, top-hung manually-operated swing saws to the so-called battery trimmer. The purpose of the trimmer is to cut lumber to desired lengths. Generally, a good location for a trimmer is at the end of the flow line from the head saw and beyond the outboard end of the edger. Pivoted, mounted swing saws require a very low initial investment and may be easy to operate, but when they are employed to trim lumber which is being produced on a sustained high daily rate of production, they require an excessive amount of labor.

A modification of the swing saw is the mounting of either one or two pedestal-supported powerized saws in a table. When two saws are used, one is mounted in a fixed position, while the other may be slid lengthwise of the lumber to adjust for length. This type requires two operators.

Figure 8 illustrates efficient and accurate one-operator trimmers, constructed in two sections which makes it possible to conveniently load and transport them from one location to another. Properly installed and

operated, such a machine should handle the maximum amount of production sawed by any portable mill, even one using a sash gang head rig. Many types of multiple saw trimmers are also available.

Power and Transmission Equipment

Steam, electricity and water, and internal combustion engines are used to supply power to small sawmills. Where electric power is available at a moderate rate, it is usually the most efficient, cheapest and the most trouble-free source of power.

The next best source is the internal combustion engine, with the Diesel engine leading the gasoline engine in cost of operation.

Steam engines continue to be used by many operators with the belief that their power costs should be low because the fuel used is sawdust and forest waste which has to be disposed of in some way. When power requirements approach 100 horsepower, the steam engine and its boiler become rather heavy and awkward to transport and install. Also, the boiler requires the constant attention of one or more men to keep it supplied with fuel. An ample supply of water must be available, and the water must be free of harmful mineral salts. Owing to the liability of freezing, steam engine plants are not suitable in cold climates, especially in remote locations.

Where electric power is available, the wise thing to do is to drive each piece of machinery with an individual motor. Doing this will greatly reduce friction losses that would otherwise be produced by belts and mechanical drives, will reduce installation costs and time required to set up a plant, and will simplify the general plant layout. Elimination of belting and shafting also improves mill safety.

Where an operation is powered by steam or internal combustion engines, it is usually best to integrate the driving mechanism so as to power all machine units from a single power source. Exhibit D under the heading of "Mill Layout," page 32 illustrates a typical setup of this type. Manufacturers who produce complete sawmilling outfits also furnish many variations of the mechanical drive equipment shown. (See also Exhibit E, Forest Products Flow Chart.)

It is ordinarily wise to purchase the complete mechanical drive from a reputable sawmill supplier who produces them in volume. This will usually make the price lower than purchasing and assembling the component parts. Most sawmill m ıufacturers employ competent designers, assuring that components are made of suitable materials and that the parts are effectively designed and can be properly assembled to preserve

proper alignment and trouble-free operation. Most of the machinery manufactured by a large company is designed so that the entire transmission arrangement may be disassembled for convenient transportation to new locations.

While the initial investment may be greater, a good power setup where commercial electric power is not available would include a Diesel engine directly connected to an electric generator with a distribution switchboard to divert power to motors driving the individual pieces of machinery. With such a power plant, electricity would be available for lighting, to drive a water pump to wash logs, to drive saw maintenance equipment, and to supply similar power needs. In many locations, owing to low fuel costs, Diesel-electric power can be produced very cheaply.

Selection and Maintenance of Saws

The varieties of saws most commonly used by a sawmill operator are (1) the head saw for sawing the logs, (2) the chain saw for felling and bucking the trees, and (3) trimmer and edger saws. Both American and European makers of saws issue a wealth of information, written in English and several other languages, concerning the proper selection and maintenance of saws. It is suggested that the reader avail himself of this free literature, because the success of a sawmill operation may depend to a considerable degree upon the care exercised in the selection and maintenance of these tools.

An expensive saw can be quickly ruined if it is not properly fitted or if it is otherwise improperly maintained. Therefore, be sure to select a person capable of understanding the instructions provided by saw manufacturers to file and fit the saws, and be certain to obtain the necessary maintenance equipment to keep the saws in perfect operating condition.

Machinery and Equipment Requirements

The following list is furnished as a guide to machinery and equipment requirements. Total investment required will depend upon the items selected for the specific sawmill. Manufacturers of sawmill machinery and equipment furnish questionnaire forms for recording information they need in order to provide the purchaser with firm price quotations and assist him in selecting equipment for specific needs. Because of the variety of equipment available and the multiplicity of conditions prevailing in the many forest locations, it is advisable to obtain and submit the questionnaire before completing negotiations.

Equipment for Small and Medium-Sized Sawmill
(10,000 to 25,000 Board Feet Per Day)

	Number Required	Unit Price	Total Estimated Cost	Actual Cost
Diesel engine power plant (for sheave drive power take-off) with clutch, approximately 100 h. p.	1	$ 6,000	$ 6,000	_____
Diesel engine power plant with 220/440 volt, 3-phase generator (optional)	1	12,500	12,500	_____
Electric power distribution control panel (optional)	1	365	365	_____
Electric power distribution wiring (optional)			400	_____
Fuel storage tank and piping	1		325	_____
Mobile sawmill rig (optional)	1	3,950	3,950	_____
Edger for mobile sawmill rig (optional)	1	935	935	_____
Diesel engine for mobile sawmill rig, 3-cylinder (optional)	1	3,400	3,400	_____
Gravity dead-roller conveyor, approximately 150 feet			845	_____
Sawdust drag-chain conveyor	1	185	185	_____
Electric driven swing cut-off saw	1	245	245	_____
Gang edger, medium duty	1	865	865	_____
Gang edger, heavy duty (optional)	1	1,350	1,350	_____
Twin-saw trimmer	1	1,050	1,050	_____
Integral mechanical drive (depending on layout)	1	360 to	1,890	_____
Heavy-duty log motor truck	1	18,000	18,000	_____

	Number Required	Unit Price	Total Estimated Cost	Actual Cost
Crawler tractor equipped with bulldozer blade and winch, approximately 50 h. p.	1	13,940	13,940	_____
Log turner (mechanical), depending on make and model	1	460 to	795	_____
Gasoline electric motor generator set, 7-1/2 kw., belt-driven	1	408	408	_____
Gasoline powered chain saws	3	250	750	_____
Head saws, inserted tooth bottom, 48-inch diameter	6	291	1,746	_____
Head saws, inserted tooth top, 40-inch diameter	6	202	1,212	_____
Edger saws, solid tooth. 18-inch	6	63	378	_____
Trim saws, solid tooth, cut-off, 18-inch	6	23	138	_____
Saw grinding and maintenance tools for circular saws and equipment, such as tension gauges and hammers, side dresser and jointer, swages, tooth shaper, small power grinder, benches, holding devices and files			615	_____
Sundry tools and equipment, such as pike poles, hand ax, cant hooks, load binders, skidding tongs, peavies, snatch blocks, cable and sledge			345	_____
Circular saw husk equipped with top saw	1	3,950	3,950	_____
Heavy-duty log carriage	1	5,700	5,700	_____
Heavy-duty log carriage, semi-automatic electro-pneumatic (optional item for faster operation)	1	10,800	10,800	_____

	Number Required	Unit Price	Total Estimated Cost	Actual Cost
Band saw, 54-inch (optional)	1	5,490	5,490	_____
Sash gang saw, medium-duty, 22-1/2-inch X 22-1/2-inch (optional or accessory)	1	11,500	11,500	_____
Short log attachment	1	750	750	_____
Hydraulic saw tightener	1	670	670	_____
Volmer automatic saw sharpener	1	1,675	1,675	_____
Saw blades - American*		18		_____
Saw blades - German*		9		_____
Blade spacers*		4		_____
Outfeed guide	1	1,710	1,710	_____
Electric motor, 100 hp.	1	2,196	2,196	_____
Factory mechanic's fee for installation and training		1,000	1,000	_____
Semi-portable stiff-leg derrick log loader	1	1,290	1,290	_____
Fire protection equipment: Gasoline-powered pump, hose, nozzles, etc.		540	540	_____
Office equipment: Typewriter, adding machine, desk and chairs, filing cabinets, etc.		1,195	1,195	_____
Two-way radio communication set	1	950	950	_____
Export boxing and freight costs of machinery and equipment (estimated)		325	780	_____
Building and shelters (depending upon type desired)		$2.15 per sq. ft. to $4.85 per sq. ft.		_____

* Up to approximately 18 saws and spacers can be used in a 22-inch capacity machine.

BUILDINGS

In all except extremely cold climates, the type of building required to house a sawmill presents but few problems. Usually all that is needed is framing sufficiently sturdy to support a roof structure to shed rain, snow and intense sun rays. Excellent working conditions may be provided in temperate climates with an open-side building that has a generous roof over-hang on all four sides.

It is best to provide a single continuous roofed structure instead of separate roofs over each piece of machinery. Especially does this apply where an integrated mechanical drive is used, since belts, shafting and clutches should not be exposed to rain, snow or hot sun.

For operations set up on a semi-portable basis, the structure may be constructed in sections easily disassembled for transporting to a new location. The Timber Engineering Company, Washington, D.C. issues considerable literature on semi-portable structures suitable for housing a sawmill, and the Forest Products Laboratory, Madison, Wisconsin, issues booklets supplying detailed instructions concerning designs for suitable and inexpensive sawmill structures.

In constructing a sawmill building, one should:

1. Provide adequate floor space.
2. Set column footings and machinery supports deep enough to provide firm foundations.
3. Be sure to have a fairly level site with adequate space for the efficient handling of lumber, sawdust, trash, as well as space for loading and removal of the sawed products.

Having a nearby ample water source is important both for fire protection and for pressure flushing of logs to remove gravel and other abrasive materials which tend to dull and damage saws.

Floors are seldom required, but the ground surface should be level and free of debris in order to promote operating efficiency and reduce fire hazards and injuries to workmen and machinery.

It is recommended that a separate four-wall and roof structure be provided for the saw filer and his equipment and for use as a storage room for hand tools and supplies. Such a structure may be constructed large enough to provide an office area, dressing room and, when necessary, a bunk house for workmen. Usually, such a building is heated by wood-burning salamanders, and sometimes it includes toilet facilities.

GRADING AND STORING LUMBER

To insure maximum profit, a sawmill operator should properly grade, segregate and stack his sawed products. Even though a good local market may exist for random grades of green lumber, it is usually wise to segregate as much high grade material as possible.

Where capital is locally available at moderate interest rates, such capital might be profitably utilized to defray the cost of grading, handling, and stack-storing the better grades of products. Such products may be the commodity that is in sufficient demand in the export market to be the means for acquiring desirable foreign exchange. Well-sawed, graded and seasoned structural timbers of softwood are nearly always in a healthy demand in export markets; and fine cabinet woods, in both rough-sawed and semi-finished dimensions, usually sell in the domestic markets of most countries for prices that should bring a reasonably satisfactory profit. The long-range objective, therefore, should be to produce as much of the better grades of lumber as possible.

Nearly everywhere there are far too many operators who cut and process logs in a rather haphazard fashion, and most of these operators seldom rise above the level of marginal success. They remain merely sawyers of logs and do not demonstrate, by constantly improving the character of their operations, that they are becoming better managers and more successful business men.

Conversely, an operator who continually studies every phase of his operation, from the selection and purchase of machinery and equipment, to the hiring of personnel, and for as long as may be needed to get a firm grasp on all the factors which promote the success of the enterprise, will quite probably enjoy the satisfaction which comes from the realization that he is becoming a successful business man.

It is appropriate here to emphasize what has been mentioned previously; that is, a wealth of literature is available dealing with every phase of a forest products operation. The reader is urged to obtain, absorb, and apply the information contained in that literature. The sawmill operator might well employ others to perform the manual labor required, leaving himself free to learn and apply methods for improving his operation.

RAW MATERIALS

The raw material of a forest products operation is, of course, merely a standing tree, customarily referred to as stumpage.

There are three principal ways to acquire the right to cut down and process trees. They are (1) the outright acquisition of land by purchase, (2) receiving permission to cut and remove trees from an appropriate governmental agency or from a private owner of the forest, or (3) contractual arrangements with the rightful owners of the forest.

When the forest area is acquired by purchase, an operator usually may proceed in a fashion which best suits his purpose, being governed, of course, by certain governmental restrictions concerning land, water, and other natural resources.

Permission granted by governmental agencies or by private owners to remove trees usually involves the payment of fees, and these fees may be based upon a number of contractual arrangements. Contracts may require that, in addition to the payment of a stipulated sum of money for the lumber content of the trees, certain land, water or road improvements must be made at the operator's expense.

Most contractual arrangements limit the activities of the operator to merely felling, bucking, and sawing lumber for a stipulated fee to be paid to the sawmill operator for the use of his machinery, personnel and knowledge of such operations. Under these arrangements, the operator seldom acquires any proprietary rights to the products, land, water, etc.; he merely contracts with the owner to perform a certain kind and amount of work.

Wherever there are large stands of virgin forest, it is usually not advisable for an operator to engage in contractual production of forest products, especially if he possesses adequate capital and know-how with which to establish a logging and sawmilling project of his own.

MANUFACTURING COST

Previous mention has been made of certain basic material costs, namely, cost of land acquisition, royalties, stumpage fees, land, water, road and other improvement costs. All of these and other items of cost might be incurred during the course of setting up and operating a logging and sawmilling operation.

In the matter of land acquisition, the amount of money paid for the land might be treated in one of the following ways:

(a) If it is presumed that the capital invested for the acquisition of the land and forest is going to depreciate greatly in value by the removal of stumpage, then the total investment should be amortized during the life of the cutting period by burdening every unit of product sold with its proportionate cost of the shrinkage in land value. By this method of accounting, the original amount of capital invested in land will be recovered by the time the land has been rendered worthless due to the removal of the forest.

(b) If it is presumed that the land is going to actually increase in value during the course of cutting, then the amount paid for the land should be set up on the books of the project as an asset. In the event this is done, the only charges which should be made to the cost of products sold would be operating expenses such as land and natural resource taxes, cost of fire and flood hazard protection, expenses incurred in making access roads and trails, slash disposal and similar items of expense. By this method of accounting, the original amount invested in land will remain a valuable asset to the project, while the expenses incurred when the land is being logged will be recovered by burdening each unit of product sold with its proportionate share of the cost.

(c) In any of the several kinds of contractual arrangements which may be made to acquire legal rights for the removal of forest products, where the title to the land remains with the owner, only operating expenses will accumulate. These items of cost are fire and flood protection, certain kinds of taxes, royalties or stumpage fees to the land owner for permission to remove the trees, grading and trail building, and similar items usually of benefit to the land owner. Here again each unit of product sold should be burdened with its proportionate share of the cost of such items.

By utilizing any one of the three accounting procedures mentioned above, the basic cost of the raw material processed may be quite accurately determined. To this basic cost of raw material will subsequently be added other operating costs such as the cost of labor, power, supplies and general or overhead items of expense. Exhibit A illustrates the expense and cost items generally incurred in a logging and sawmilling operation.

Since many small forest products operations are engaged in the production of logs for their own use as well as for sale to other sawmills, and since some operators purchase logs from others, accounts should be available to record such transactions in order to know, at all times, the cost of raw material - the logs.

Successful small operators sell both green and air-dried rough lumber. Also, when it can be done at a profit, an operator may sell logs of certain grades and species (veneer logs, for example). The selling of green lumber and logs are usually transactions affording the operator a rapid turnover of working capital. However, the margin of profit is usually much greater when green lumber is graded at the time of cutting, and then yard stacked for seasoning. Accounts, therefore, should be provided to accumulate the additional handling and storage costs which this phase of the operation creates.

Where interest rates for borrowed money are reasonable, the opportunity should be taken to borrow money to finance yard inventories, especially in climates where lumber may be air-dried during reasonably short seasoning cycles. The general practice followed is that of determining a normal sales volume for the better grades of air-dried lumber and then keeping that amount of lumber flowing into and out of the yard storage area continuously.

When good accounting practices are followed, it should be possible to ascertain the current financial condition of an operation dealing in the buying and selling of logs as well as the marketing of both green and dry lumber.

An operator is not sufficiently well informed and prepared to manage an enterprise successfully if he has merely over-all cost, expense and profit figures available. Actually, there are at least four separate and distinct functions involved in most small sawmill enterprises. These are (1) forest operations, (2) logging operations, (3) sawmilling operations, and (4) yard operations. In order to properly control the activities of each of the four functions to maintain a high degree of efficiency, it is necessary to establish accounting procedures similar to those illustrated in Exhibit A, modifying the illustrated procedures to the extent necessary to comply with individual requirements.

Frequently, a substantial amount of money may be expended over a considerable period of time for forest development work, even before a sawmill begins to operate. Such expenditures possess no permanent asset value, yet the money spent must, in some manner, be recovered.

Perhaps the initial amount of development work done is sufficiently comprehensive to include a forest area ample to meet a year or more of

TYPICAL OPERATING EXPENSE AND COST ACCOUNTS

EXHIBIT A

Raw Material Cost and Expense	MONETARY AMOUNT				QUANTITY				
					Log Scale Mbf				
	Dr.	Dr.	Cr.	Balance	Dr.	Dr.	Cr.	Balance	Unit Cost Mbf
Forest Operations									
Cruising, development and blazing	xxx								
Stumpage fees, royalties or standing timber depletion	xxx								
Land rental	xxx								
Grubbing, roads and trails	xxx								
Slash disposal	xxx								
Fire protection	xxx								
Land cost amortization	xxx								
Taxes	xxx								
Sundry forest expense	xxx								
Total Forest Operation Expense		xxxxx	xxxx	xxxxx		xxxxxx	xxxxx	xxxxx	xxx
Forest operation expense distributed		xxxx							
Beginning inventory from logging operations		xxxx							
Logging Operations									
Felling and Bucking	xxxx								
Skidding and loading	xxxx								
Transportation	xxxx								
Maintenance - tools and equipment	xxxx								
Power	xxxx								
Supplies	xxxx								
Taxes and insurance	xxxx								
Depreciation - buildings, equipment, tools	xxxx								
Sundry logging expense	xxxx	xxxxx							
Total Logging Expense		xxxxx							
Supervision - forest and logging operations		xxxxxx							
Log grading and handling (mill yard crew)		xxxx							
Log inventory financial expense (interest, insurance, etc)		xxxx							
Log purchases		xxxx							
Sundry log cost and expense		xxx							
Less: ending inventory of logging operations			xxxx						
Total Raw Material Cost and Expense		xxxxx		xxxxx					
Total Log Scale Mbf content of logs produced, purchased and transferred to inventory						LUMBER TALLY - Mbf			
						xxxxx	xxxxxx	xxxxx	xxxx
Sawmill Operations									
Log handling and washing	xxxx								
Sawing	xxxx								
Edging	xxxx								
Trimming	xxxx								
Grading and handling	xxxx								
Power	xxxx								
Maintenance - building, equipment, tools	xxxx								
Taxes and insurance	xxxx								
Depreciation - building, equipment, tools	xxxx								
Supplies	xxxx								
Waste disposal	xxxx								
Sundry Sawmill Expense	xxxx	xxxxx							
Total Sawmill Operation Expense		xxxxxxx							
Total Raw Material and Sawmill Cost (Green lumber sawed)		xxxxxxxx							
Total Lumber Tally						xxxxxx	xxxx	xxxxxx	
Yield (Difference between log scale and lumber tally)						xxx		xxxx	xxx
Loading and shipping expense (Green lumber)		xxxxxx							
Selling commission (Green lumber)		xxxx							
Total Operating Cost and Expense (Green lumber)		xxxxxxxx							
Financial Expense (interest, etc. - green lumber)		xxxx							
Administrative and sundry expense		xxx							
Total Cost and Expense of Green Lumber Shipped		xxxxxxxx					xxxxx	xxxxx	xxx
Yard Operations						YARD INVENTORY			
Handling, piling and grading	xxxx					xxxxx			
Loading and shipping	xxxx					xxxxx	xxxxx		
Sundry yard expense	xxxx					xxxxx	xxxxx		
Total Yard Operation Expense		xxxx						xxxxx	xxx
Green lumber cost		xxxx							
Financial expense (interest, insurance, taxes - yard inventory)		xxxx							
Commissions - dry lumber		xxxx							
Less: Ending inventory of dry and yard lumber		xxxx							
Total Cost of Yard Operations (dry lumber)		xxxx						xxxxx	xxx

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logging needs. If that be the situation, then this cost of development should be prorated over the production involved; it should not be charged to any one month's production.

Individual accounts must be set up to provide a means to accumulate and to properly prorate the cost of development work and similar items, and to make it possible to determine the entire cost of the separate and distinct functions of the entire forest operation. (See Exhibits B and C)

In many areas of individual countries, logging operations are conducted only during certain periods of the year. During such periods, enough logs must be harvested and transported to a mill to make it possible for the mill to run continuously for the entire year. Also, most sawmills will purchase logs in different lots at varying prices.

Logs being the raw material which the sawmill uses, accounting means must be provided to establish the cost of this raw material. For this reason, logging should be considered as a separate and distinct function, and all costs and expenses incurred to run the function should be properly accumulated and prorated over log usage. It is common practice in the United States to charge overhead and development costs against the more desired species, and only out-of-pocket costs against the lower priced, less desired species. In this way, better utilization can be justified and more realistic prices determined.

Sawmilling operations likewise involve the accumulation and distribution of costs and expenses from the time a log arrives on the log deck until it is processed into marketable rough lumber. Power is required to operate the machinery and equipment; payroll costs are created by the labor employed; supplies are consumed and the raw material - the logs - cost a certain amount of money before they are delivered from the log storage to the log deck.

From the time the log resides in the forest as a growing tree until it arrives at the log deck, someone has probably determined its log scale; that is, the estimated number of board feet of wood it contains. In most cases the log will also have been graded as to its suitability for veneer, factory lumber or structural material.

Still the skilled band or circular saw operator - the sawyer - is relied upon to either saw the log into the maximum number of board feet of a random variety of lumber or to saw the log in a fashion so as to produce the maximum amount of lumber or timber by grades. In other words, the sawyer is relied upon to make the best use of every log, to produce as much of the best lumber as possible, and to obtain the greatest amount of product by descending grades. Moreover, the sawyer is relied upon to determine how much lumber or how much of

what sizes of structural timbers can be most economically cut from each log.

The difference between what the log scaled at the time the scaling was done and what the sawyer succeeded in obtaining from the log is always of sufficient importance to require an accounting system adequate to control and keep the two quantities within reasonable agreement. Therefore, the accounting system should be adequate to determine what the lumber has cost up to the time it is finally processed at the sawmill.

Perhaps a substantial volume of the sawed lumber is sold as green lumber almost immediately after it has been sawed. If the operator knows what the cost has been to produce this product, he can then calculate what the selling price should be in order to accrue the profit he desires to earn.

In well managed lumbering enterprises, operators inspect and grade the green lumber as it is produced, and during this operation they separate the random grades, which are going to be sold as green lumber, from the more select grades that are worthy of being graded and air-dried. The accounting procedure advocated above should provide a means of determining what the select grades have cost up to this point.

Beyond this point, additional costs and expenses will accrue for the inspection work done in making the segregation, for handling and transporting to the lumber storage yard, for stacking to insure proper drying. Also accruing will be such additional expenses as insurance, taxes, interest for borrowed money and other similar items.

The point to be emphasized here is this: what an operator is able to achieve from the time a tree is cut down until it is sawed into green lumber depends to a considerable extent on what was actually in the log; but from the time sawing takes place through the time when air-dried lumber is shipped, the operator himself - by exercising good judgment and by utilizing good management policies - can be instrumental to a remarkable degree in realizing the profit he seeks.

Because generally the degree to which profit potentials are realized depends upon how well an enterprise is managed, it is recommended that the proprietor employ others to perform the manual operations and that he - through the medium of a suitable accounting system to guide him - devote his time and effort to management. Having the finest grades of logs and the best machinery and equipment will not alone assure a profitable and successful enterprise. Good management is imperative, and a good accounting system is one of the most valuable aids to management.

TYPICAL BOOKKEEPING ACCOUNTS

ASSETS

Cash
Bank accounts
Accounts receivable
Bonds and securities
Notes receivable
Inventories
- Logging operations
- Green lumber
- Dry and yard lumber
- Supply

Land
Standing timber
Buildings
Machinery
Equipment - trucking
Equipment - handling
Equipment - office
Deferred forest operation expenses
Other deferred expenses

LIABILITIES

Accounts payable
Accrued payroll
Accrued taxes
Accrued stumpage and royalties
Notes payable
Reserve for depreciation - buildings
Reserve for depreciation - machinery
Reserve for depreciation - trucking equipment
Reserve for depreciation - handling equipment
Reserve for depreciation - office equipment
Reserve for forest depletion
Reserve for bad debts

NET WORTH

Capital stock
Capital surplus
Earned surplus

REVENUES

Sales
- Log
- Green lumber
- Dry and yard lumber
- Sundry

Cost of sales
- Log
- Green lumber
- Dry and yard lumber
- Sundry

EXPENSES

Forest Operations

Cruising, developing and blazing
Stumpage, royalties, etc.
Grubbing, roads and trails
Slash disposal
Fire protection
Taxes and insurance
Land cost amortization
Sundry forest expense

Total forest operating expense

Logging Operations

Felling and bucking
Skidding and loading
Maintenance - tools, equipment
Power
Supplies
Taxes and insurance
Depreciation - buildings, tools and equipment
Log transportation
Log grading and yard handling
Log inventory financial expense
Sundry logging expense

Total logging operating expense

Supervision - forest and logging operations

Sawmill Operations

Log handling and washing
Sawing
Edging
Trimming
Grading and handling - green lumber
Power
Maintenance - tools and equipment
Taxes and insurance
Depreciation - buildings and equipment
Supplies
Waste disposal
Sundry sawmill expense

Total sawmill operating expense

Yard Operations

Loading and shipping - green lumber
Loading and shipping - yard lumber
Handling, piling and regrading yard lumber
Financial expense - yard inventory
Sundry yard operating expense

Total yard operating expense

Administrative expense
Sales commissions - green lumber
Sales commissions - yard lumber
Sales commissions - sundry sales

EXHIBIT C

COST STATEMENT

FOR

TYPICAL LOGGING AND SAWMILLING OPERATION

					Actual	Actual	Actual
Cut per acre	board feet	6,575					
Number of logs per	M. b. f.	10					
Daily production (approx.)	board feet	16,000					
Annual production (approx.)	board feet	5,000,000					
Logging Cost							
Felling and bucking	per M. b. f.	$ 4.30					
Skidding and loading	per M. b. f.	5.54					
Development cost	per M. b. f.	5.18					
Slash disposal and erosion and pest control	per M. b. f.	.92					
Transportation to mill	per M. b. f.	9.56					
General administrative	per M. b. f.	4.96					
Depreciation (equipment)	per M. b. f.	1.04					
Total logging cost			$ 31.50				
Milling Cost							
Sawing and stacking	per M. b. f.	$ 14.00					
Grading and drying	per M. b. f.	9.27					
Shipping	per M. b. f.	1.98					
Selling	per M. b. f.	1.54					
General administrative	per M. b. f.	5.89					
Depreciation (plant)	per M. b. f.	1.41					
Total milling cost	lumber tally	34.09					
Overrun	12%	4.09					
Total milling cost			$ 38.18				
Total logging and milling cost			69.68				
Selling price			83.74				
Conversion return				14.06			
Stumpage cost				5.37			
Profit				$ 8.69			
Profit ratio on sales	$8.69 / $83.74			10.3%	$		

Note: Above figures are average figures for three operations.

28-B

PERSONNEL REQUIRED

For any species of tree, the number of man-hours required per thousand board feet of lumber produced generally decreases as the mill capacity increases. The table on the following page is based on studies made by the Forest Products Laboratory, Madison, Wisconsin, and shows the variation in man-hours per thousand board feet and in the working force from pond or log yard through the mill.

Variations from this general scheme of manpower placement are common. Where logs are delivered directly to the deck, the manpower for the log yard or pond is not needed. Mills using the horizontal saw edger dispense with both the edgerman and tail edger but use a tail sawyer. Mills equipped with deck and carriage controls operated by the sawyer dispense with the dogger and setter. A competent saw filer and fitter is usually needed for every mill that operates continuously, has ample power, and produces a large sustained volume.

On the two-man crew units, the sawyer and tail sawyer fill the deck with logs, then saw them. If edging is done on the head saw, the tail sawyer lays aside boards to be edged and piles edged ones and slabs on racks or dollies. Unedged stock can be collected back of the saw on about 30 feet of dead roll, and accumulations can be loaded onto the carriage to be brought back to the deck for edging. Actually, what happens with a two-man unit is that both men do the work which a larger crew can perform more efficiently.

With three-man crew units, the third man divides his time between yarding logs to the deck and taking lumber and slabs from the back of the mill to the yard. Edging is usually done on the head saw. In operations delivering logs directly to the deck, an edger can be used to advantage, the third man acting as a tail edgerman piling lumber and slabs onto racks or trams. Ordinarily, this also would not be considered an efficient size crew and would be justified only where labor is scarce.

With a four-man crew unit, the log yarder usually can transport lumber and slabs to the yard. With a five-man crew, the fifth man helps the tail edgerman pile out lumber and slabs. He may also operate a cut-off saw. With a six-man crew, the sixth man is the decker, rolling and turning logs and dogging all but the front dog, which is responsibility of the sawyer. With a seven-man crew, the seventh man is usually placed as setter on the carriage. He may also operate one or more dogs. The sawyer will not be required to operate the dogs, but the decker may help the setter. With an eight-man crew, the eighth man operates the trimmer, usually a two-saw machine.

Crews larger than eight men are frequently used. After a sawmill is operating on a settled basis, shifting crew members around will determine the manning pattern most efficient. It should be kept in mind, however, that an investment has been made in manufacturing facilities and that the hourly cost of labor keeps accumulating whether the men are producing or not. The objective should be to have enough men available to utilize the machinery and equipment at maximum capacity with no delays because of lack of operating personnel.

Mill Labor Required to Produce 1,000 Board Feet of Lumber

Species	Man-hour per 1,000 Board Feet		Number of Mill Employees (including Pond Men and Stackers)
	Range	Average	
Douglas fir	2.4 to 5.2	3.9	6 to 26
Eastern white pine	3.5 to 5.5	4.5	2 to 8
Eastern hardwoods	3.3 to 11.7	6.8	4 to 10
Southern pine	5.2 to 10.3	7.5	6 to 10

The relatively low number of man-hours per 1,000 board feet given in the table for western species is largely due to the larger log sizes and vastly greater mill power prevalent in the western areas of the United States. Low man-hours shown for eastern white pine is due to incomplete manufacture - lumber was mostly unedged.

The following table shows the usual positions for members of crews of various sizes for circular head saw mills.

General Assignment of Positions for Crews of Various Sizes for Circular Head Sawmills

Number of Workmen	Log Yard or Pond	Decker	Setter	Sawyer	Tail Sawyer	Edger-man	Tail Edger-man	Cut-Off Sawyer	Trimmer	Pile-Out Men	Saw Filer	Night Watch-men	Main-tenance Man
2				1	1								
3	1			1	1								
4	1			1		1	1						
5	1			1		1	1			1			
6	1	1		1		1	1			1			
7	1	1		1		1	1			1	1		
8	1	1	1	1		1	1			1	1		
9	2	1	1	1		1	1			1	1		
10	2	1	1	1		1	1		1	1	1		
11	2	1	1	1		1	1		1	2	1		
15	2	1	1	1		1	1	1	1	3	1	1	

Labor Rates

The following are average labor rates in Rocky Mountain lumbering areas of the United States:

Occupation	Hourly Pay Rate	Weekly Earnings 40 Hours	Actual Hourly Pay Rate	Actual Weekly Earnings
Fellers and Buckers	$ 1.57	$ 62.80	_____	_____
Skidders and Loaders	1.47	58.80	_____	_____
Tractor Operator	2.25	90.00	_____	_____
Truck Driver	2.10	84.00	_____	_____
Sawyer (mobile rig)	2.25	90.00	_____	_____
Sawyer, Off-Bearer (mobile rig)	1.50	60.00	_____	_____
Dogger (mobile rig)	1.55	62.00	_____	_____
Helpers (mobile rig)	1.47	58.80	_____	_____
Log and Cant Yard Crew	1.47	58.80	_____	_____
Sawyer (semi-permanent rig)	2.35	94.00	_____	_____
Sawyer, Off-Bearer	1.50	60.00	_____	_____
Dogger	1.55	62.00	_____	_____
Edger	1.60	64.00	_____	_____
Trimmer	1.55	62.00	_____	_____
Helpers	1.47	58.80	_____	_____
Saw and Equipment Maintenance Mechanic	2.15	86.00	_____	_____
Forest and Logging Superintendent		110.00	_____	_____
Sawmill and Lumber Yard Superintendent		135.00	_____	_____
Office Personnel	1.55	62.00	_____	_____

MILL LAYOUT

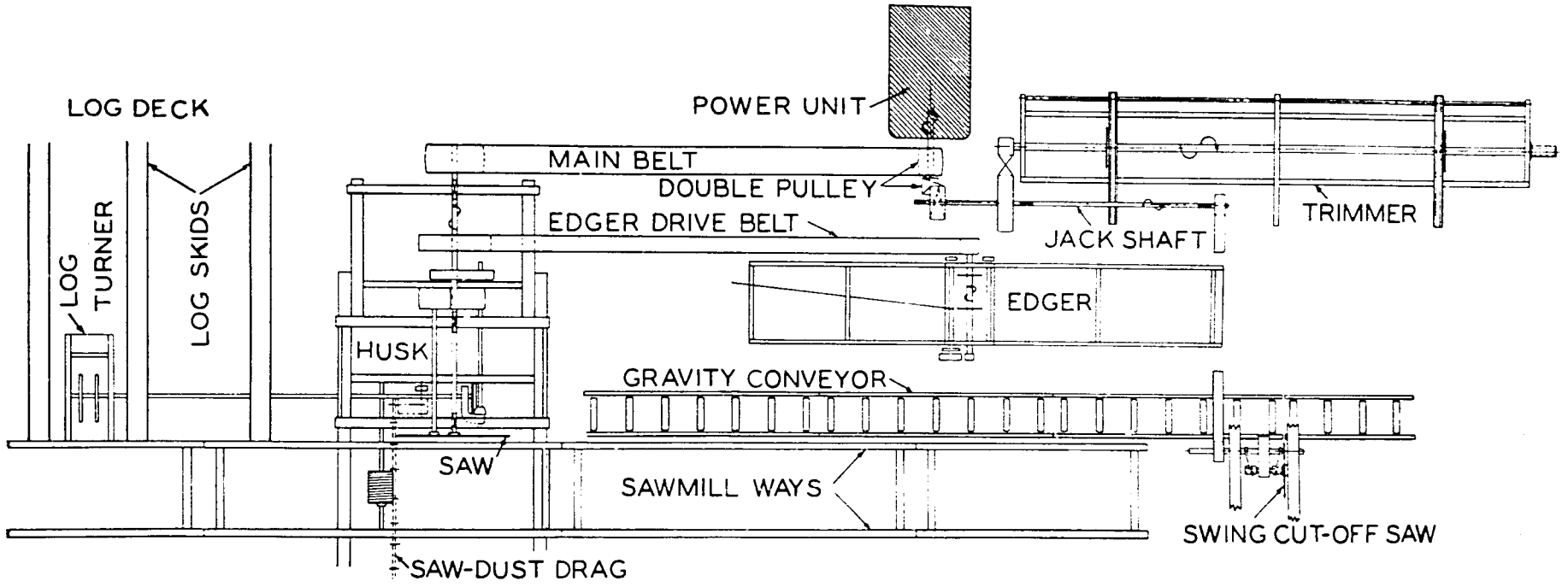
As mentioned in the chapter concerning buildings, there are three general types of buildings and layouts for a circular head saw mill. These are the unsheltered, temporarily sheltered and semi-permanent types. The smaller band mills may be housed in a roof type shelter set on the ground level if a sturdily constructed pit is provided to act as a foundation for the machine itself.

Mobile type mills require so little site preparation that they usually can be economically operated where as little as 6,000 board feet of lumber are available at each setting. The problem is less one of mill setting than of slab and sawdust disposal and lumber handling conveniences. Some types of mobile units are stabilized in working position by means of jacks for leveling and blocking. These jacks provide adequate temporary foundation supports.

Operators cutting up to 500,000 board feet at a setting customarily put the mill directly on the ground with merely a roof structure to shed the rain and sun. However, it is essential that all the machinery and equipment be set level and well secured to adequate foundations. Heavy timbers laid in well compacted gravel may prove satisfactory, so long as the saw husk and carriage are well bedded, bolted together, and remain truly aligned. Care exercised to provide the necessary substructure for the mill and carriage track will prevent later costly maintenance and shutdown periods of the operation.

Sawmill rigs suitable for sawing a half million board feet at a setting are usually powered from a single prime-mover with the saw, carriage, edger and trimmer being mechanically connected by shafting and belts. (See Exhibits D and E on the following pages.) The manufacturers of such machinery usually furnish several suggested layouts from which one suitable for a particular requirement may be selected. It is well to remember that these manufacturers' layouts are the result of years of operating experience gathered from users throughout the world. Therefore, it is wise not to deviate from the manufacturer's designs when the rig is set up at the operating site.

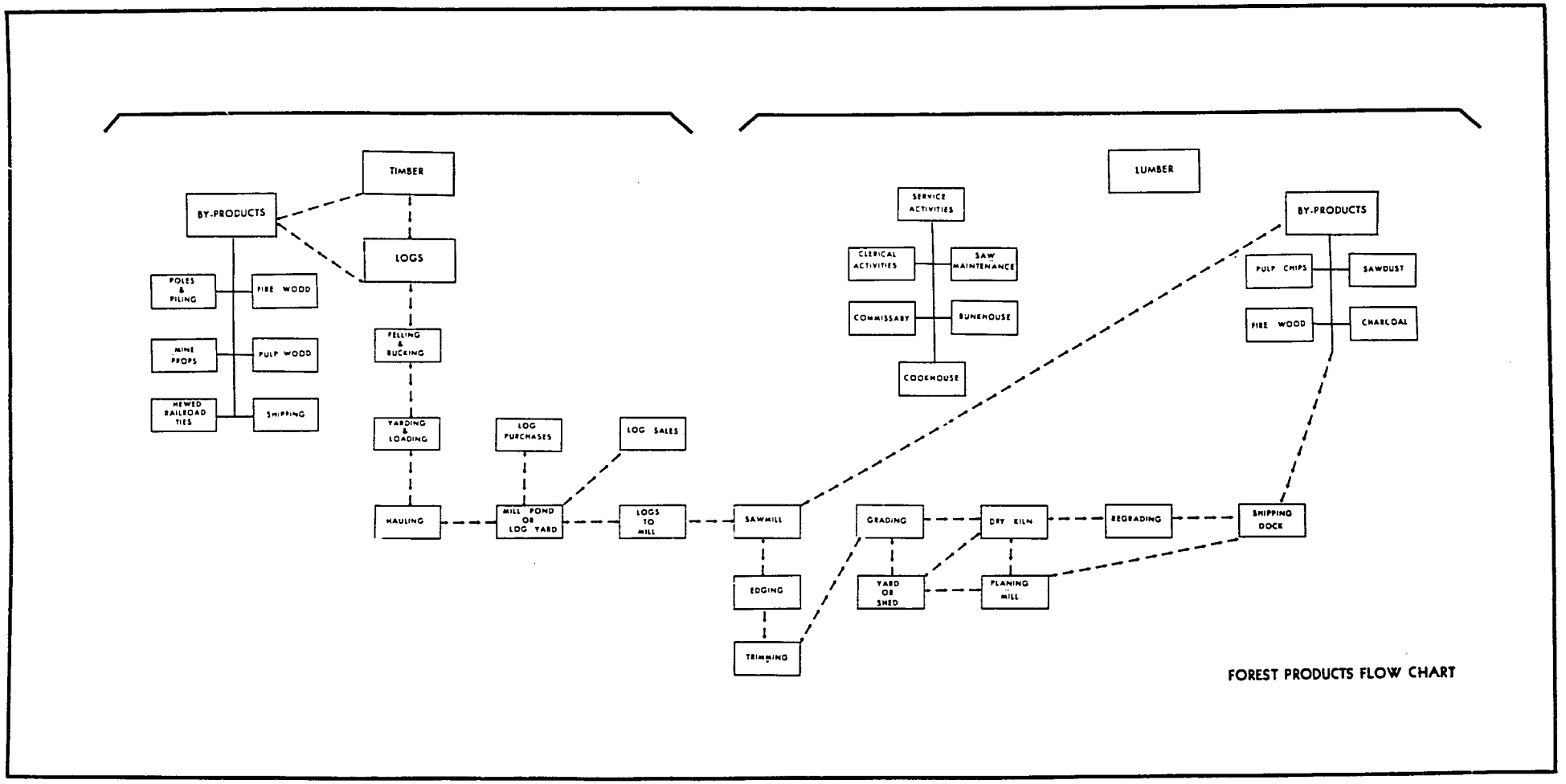
Always be sure to select a make of rig that is sturdily constructed and a layout affording ample working areas between the individual units. Keep working areas free of debris. Keep both lumber and waste flowing freely away from working areas, and whenever it appears that any part of the rig is not functioning properly, shut the machines off immediately and make suitable adjustments. Serious damage to the rig or severe accidents to workers may be prevented by following these recommendations.



TYPICAL SAWMILL LAYOUT

USING DIESEL ENGINE POWER PLANT AND INTEGRAL MECHANICAL DRIVE FOR SAWMILL, EDGER, TRIMMER AND CUT-OFF SAW

EXHIBIT D



FOREST PRODUCTS FLOW CHART

Exhibit E

With a cut of from 500,000 to 2,000,000 board feet available, even greater care should be taken to provide rig foundations which will remain serviceable throughout the cutting period, and a more serviceable shelter should be constructed. The manufacturer's recommended layout may remain the same as for a smaller cutting volume, but it might be advisable to consider extending the dimensions of the structure sufficiently to shelter a larger area to accommodate auxiliary equipment that might be subsequently purchased.

A cutting volume of this magnitude may warrant the installation of mechanical conveying equipment for lumber, sawdust, and waste, since it is generally wise to install such labor-saving equipment whenever the duration of the operation exceeds one year, and when the daily cutting volume exceeds 10,000 board feet per shift.

When the cutting reaches a volume greater than 2,000,000 board feet per year, it sometimes becomes necessary to project probable sales demands by months for the coming year in order to keep production in step with the market conditions.

At this point it might be wise to consider a layout which dispenses with integrated mechanical drives and substitute a Diesel-electric power unit with individual electric motors to drive each piece of machinery. The layout under these circumstances could be any one of a wide variety of arrangements, and flexibility would be provided to a degree that would make it possible to enlarge the operation periodically according to the stepped-up sales demands.

While the operation still remains in the small sawmill category from the standpoint of the character of machinery and equipment employed, the output of lumber may be increased, in conformity with demands, by adding to the number of machine units operated, thus avoiding the necessity of purchasing expensive high-production machinery.

The small sawmill rig operator usually competes successfully with mills using high-production equipment, chiefly because the small operator's initial investment in machinery, equipment and facilities is smaller and because he possesses a flexible plant layout which can be augmented by additional machinery if it is needed to meet increased sales demands.

BUSINESS MANAGEMENT

The profit or success of any business depends upon keeping a satisfactory margin between over-all cost and sales income - in other words, exercising sound business management.

Efficient milling of logs is not the only important factor contributing to a profitable sawmilling operation. The actual cost of converting logs into

rough lumber products approximates only about one-third of the total cost. The other two-thirds consist of log costs, sales, administrative, and general operating expenses.

A lag of several months may occur from the time an investment is made in logs and the time returns from converted products are realized. Lumber prices may not hold constant over such periods. Hence, success is greatly influenced, not only by how well the operator controls costs and adjusts the volume of production, but by how well future sales prices are anticipated.

It is impossible to obtain a formula or process for correctly evaluating future trends, but an adequate accounting system will indicate prospective market conditions and ways of controlling operating expenses to meet varying conditions. Direct costs may be controlled to keep them in line with prospective market conditions through controlling payrolls, servicing costs, stumpage and log prices, and inventories. These things are usually easier to do in a small sawmill operation than in a relatively large one. Also, fixed costs are less for small mills than for large ones.

Where the volume of business justifies the installation of a dry kiln, turnover of the better grades of wider profit margin products may be improved by reducing drying time and moisture content to improved levels. In climates where from three to six months is required to air-dry wood to from 20 percent to 30 percent moisture content, a dry kiln may be employed to reduce moisture to less than 20 percent in a matter of one to three weeks, thus stepping up the operating capital turnover rate.

There are two principal causes for failure in small sawmilling operations. They are the failure to appreciate all the costs involved, and insufficient working capital. Misconception of costs leads to uneconomic and unprofitable selling prices. Underestimating capital requirements leads to excessive and uneconomical borrowing. A prospective operator's chances for success will be greatly improved if he carefully determines his probable capital needs and always utilizes a suitable accounting system while operating.

The amount of capital required to commence and keep a business going obviously varies with the type of operation. For the small mill operator, capital requirements may be broken down into:

1. Investment in machinery and equipment.
2. Investment in stumpage and logs.
3. Probable cost of conversion and marketing.
4. Reserve for contingencies.

To determine equipment investment, the equipment purchaser must know the type of operation he is undertaking; for small mill equipment is somewhat specialized according to the products to be made, log character and size, and output volume per working shift.

The probable stumpage and log investment can be estimated by determining the customary prevailing arrangements for stumpage and log purchases and by estimating the quantity of stumpage and logs which should be bought to insure that there is always an adequate supply to keep the mill operating in full production.

The probable capital requirement to carry conversion and marketing costs may be determined by estimating the total money needed for a normal operating period, allowing sufficient time to receive payments for the merchandise produced during the period. Operators lacking an adequate accounting system are likely to underestimate their actual costs.

As has been suggested elsewhere, there are four basic functions in a sawmilling operation, and under each function there are several factors which are of managerial importance. These factors are called operating accounts. The prospective operator should engage a capable accountant to set up and operate a bookkeeping system, and he should use the figure facts which such a system will disclose as a guide in the daily operation of his business.

An excellent guide and reference book for the sawmill operator is the Small Sawmill Operator's Manual (Agriculture Handbook No. 27) written by the United States Department of Agriculture. Copies may be obtained from the Superintendent of Documents, United States Government, Washington, D.C. (65¢).

INVESTMENT AND WORKING CAPITAL REQUIREMENTS

		Estimated	Actual
Deposit to cover 90-day stumpage fees: 95¢ per Mbf log scale, 10 Mbf per day harvested		$ 855.00	
Development cost:			
Cruising and blazing:			
Operator, 8 weeks @ $150.00	1,200.00		
Assistant, 8 weeks @ $ 85.00	680.00		
Road and trail work	2,500.00		
		4,380.00	
Machinery and equipment (small and medium-sized operation)		78,000.00	
Three months payroll for operator, $150.00 per week		1,915.00	
Three months payroll for 11 assistants, $85.00 per week each		12,155.00	
Legal, accounting assistance		3,500.00	
Power, equivalent to 250 kw., 900 hours, 225,000 kw. hr.		4,500.00	
Supplies, $500.00 per month		1,500.00	
Commercial expenses:			
Sales commissions, shipping and handling costs		2,400.00	
Sundry and contingent cash requirements		3,500.00	
Investment		112,705.00	
Working capital		15,000.00	
Total investment and working capital		$ 127,705.00	

APPENDIX 1

GLOSSARY

Air drying - The practice of seasoning lumber in the open air as contrasted with seasoning it in a kiln.

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

Blue stain - A bluish or grayish discoloration of sapwood caused by the growth of certain moldlike fungi on the surface and in the interior of the piece; made possible by the same conditions that favor the growth of other fungi.

Board foot - A unit of measure in the lumber trade. A board foot is a section 12 by 12 inches in size and 1 inch thick.

Bolster - A structural part intended to afford support for logs on a sawmill carriage.

Boss dog - A dogging device on the knees of a sawmill carriage consisting of lever-controlled talons which can be brought to grip the face of a log, cant, or timber.

Box piling - A method used in piling lumber for drying by which boards of differing widths and lengths make up a course.

Bucking - Cross-cutting tree stems into logs and bolts.

Bulk pile - To pile closely, without cross strips.

Bummer - A low, two-wheeled truck for skidding logs.

Cant - A log that has been slabbed on one or more sides.

Carriage - A frame on which are mounted the headblocks, setworks, and other mechanisms for holding a log while it is being sawed, and also for advancing the log toward the saw line after a cut has been made. The carriage frame is mounted on trucks which travel on tracks, the carriage being actuated by a steam feed, a cable, or a rack-and-pinion device, which propels it back and forth past the headsaw.

Circular head saw - A circular plate having cutting teeth on the circumference and used to ripsaw logs.

Clear face - (1) In cutting hardwoods, board surface area free from defects recognized in grading hardwood lumber. (2) In a log, quadrant of log surface without blemishes indicative of causing defects in lumber.

Clutch - A coupling for connecting two working parts, permitting either to be thrown at will into or out of gear with the other, as by moving a lever.

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

Crib piling - Piling lumber to form a triangular pen with the end of a board overlapping the end of the board below. Usually each side is a single tier.

Cross alleys - Alleys in the lumber yard at right angles to main alleys to facilitate lumber movement and air flow.

Custom sawing - The sawing of lumber under contract, usually to given specifications.

Dead rolls - Rollers used for the handling of lumber, but not power-driven.

Deck - The platform in a sawmill on which logs are collected and stored before they are placed on the carriage for sawing.

Deckman - In a sawmill, one who alines logs on the deck and rolls them down for loading on the carriage.

Deck skids - Sets of timbers used to form a rollway for logs at the mill deck.

Dimension - All yard lumber except boards, strips, and timbers; that is, yard lumber 2 inches and under 5 inches thick and of any width.

Dock - An elevated structure at the rear of a sawmill on which sawed products are stored and from which they can be loaded on cars or ships by gravity.

Dog - A steel, toothlike projection that is attached to a carriage knee and usually operated by a lever. Carriage dogs are used to hold the log firmly on the carriage.

Dog board - In sawing lumber on a head saw, the last board in the log to which the carriage dogs are attached.

Dogging - Process of fixing the dogs in the wood or releasing them from it.

Dog housing - The metal frame sheltering and supporting the dog.

Double-acting setworks - A device on the carriage of a sawmill which feeds the timber to be sawed transversely at both the thrust and return stroke of the activating lever.

Double bed - The metal member supporting the slab or flitch being sawn. It is divided into two parts each of which can be independently set at a desired distance from the saw.

Down-graded - Placed in a lower grade.

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

Dump log - A mill platform on which logs are unloaded from log cars. It may be built around the edge of a pond or along the bank of a stream to aid in dumping logs into water, or it may be so built for use as a place for dry storage of logs.

Dump ramp - The platform and incline from which logs are unloaded.

Dutch oven - An extension front used with boilers burning sawdust and similar fuel. It provides greater fuel space and permits more complete combustion.

Edge - To make square-edged.

Edgings - Strips, usually discarded or burned as fuel, that are cut from the edges of boards.

Edger - A machine used in sawmills to square-edge wavy lumber and also to rip lumber. It consists of a frame supporting an arbor on which are mounted one to several circular saws, and may have feed rolls, press rolls, and transmission gear.

End rack - Lumber edge-tilted against a ridgepole to form an inverted V.

Face (log) - A quadrant of the surface of a log.

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.

Fell - To cut standing trees.

Filer - One who fits saws in a sawmill or other woodworking plant.

Fixed post - A bar or rod firmly fixed to the knee or log beam of a sawmill carriage, which supports all or part of the dog mechanism.

Flitch - A thick piece of lumber with wane on one or both edges.

Floating block - A block to hold down the log against conveyor chains, one end being pivoted above the conveyed logs by means of a shaft and the other free to float or move up and down in bearing on the top of the moving log.

Footage - Quantity of lumber expressed in board feet.

Friction wheel - A wheel or disk driving or driven by direct contact with another wheel or disk.

Gage - A standard series of sizes indicating by numbers the thickness to which saws are made. The particular series of sizes adopted by saw manufacturers is the Birmingham wire-gage one.

Gang circular - A machine having a battery of circular saws, from 22 to 26 inches in diameter, all of which are fitted to the same shaft.

Gate - The frame in which gang saws and sash saws are stretched. The frame moves up and down in vertical grooves or slides, and is actuated by a pitman attached to its base.

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

Grade - The designation of the quality of a tree, log or manufactured piece of wood.

Green - Unseasoned, wet.

Ground mill - A small sawmill placed directly upon the ground.

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

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

Guide pins - Parts of the saw-guide mechanism which actually contact the saw.

Guide plates - Metal plates fixed to synchronize with the kerf at the rear of the saw. (syn. splitter)

Guide rail - The rail that guides the movement of the sawmill carriage. May be either the rail on the saw side or the one away from the saw.

Gullet - On a saw, the rounded cavity in which sawdust accumulates and is carried from the cut.

Hardwoods - The botanical group of trees that are broadleaved. The term has no reference to the actual hardness of the wood.

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 similar device for advancing the knees toward or withdrawing them from the saw line.

Headrig - Sawing equipment used in the primary breakdown of logs.

Husk - The frame supporting the arbor and other working parts of a circular head saw.

Infeed rolls - Rolls placed ahead of certain types of saws to force the material through the saw.

Jackladder - An inclined plane with a trough up which logs are drawn into a sawmill.

Kerf - The width of cut made by a saw.

Kiln - A heated chamber for drying lumber.

Kiln drying - The process of drying wood in a kiln with the use of artificial heat.

Knee - The part of a sawmill carriage headblock that bears the carriage dogs, which hold the log being sawed. It also supports the levers used to operate both the carriage dogs and the taper set.

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

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

Log dog - A metal bracket attached at intervals to the log-haul chain to prevent slippage in logs being transported from log pond or yard level to mill deck.

Logging - The operations of felling trees, cutting them into logs, and transporting them to the sawmill.

Log rule - A table showing the estimated number of board feet of lumber that can be sawed from logs of various lengths and diameters.

Log scale - The board-foot content of logs as determined by a log rule.

Log turner - A device which is used to shove or turn logs on a sawmill carriage. Its movements are controlled by the sawyer. May be actuated by mechanical means, or by steam, air, hydraulics, or electricity. Also applied to man doing this job.

Lumber - The product of the saw and planing mill not further manufactured than by sawing, resawing, and passing lengthwise through a standard planing machine, cross-cut to length and worked.

Boards - Yard lumber less than 2 inches thick, 8 inches or more in width.

Dimension - All yard lumber except boards, strips, and timbers; that is, yard lumber 2 inches and less than 5 inches thick, and of any width.

Dressed size - The dimensions of lumber after shrinking from the green dimension and planing; often 3/8 inch less than the nominal or rough size; for example, a 2 by 4 stud actually measures 1-5/8 by 3-5/8 inches. Dressed thickness of 1-inch boards, however, may be 3/4-inch, 13/16-inch or 25/32-inch, depending on grading rules used.

Rough lumber - Lumber as it comes from the saw.

Shiplapped lumber - Lumber that is edge-dressed to make a close rabbeted or lapped joint.

Surfaced lumber - Lumber that is dressed by running it through a planer.

Yard lumber - Lumber that is less than 5 inches in thickness and is intended for general building purposes.

Lumber scale rule - A rule indicating the number of nominal surface feet contained in boards of various widths and lengths.

Main alley - A lumber-yard alley used for access and on which lumber piles front.

Miscut - Lumber having greater variation in thickness, except as to wane, between any two points than provided for in copyrighted editions of association grading rules.

Moisture content of wood - Weight of the water contained in the wood; usually expressed in percentage of the weight of the oven-dry wood.

Offsetting the carriage - The shunting of the carriage frame away from the sawline when the carriage is gigged back by a device attached to a sawmill carriage frame and also to one or more axles of the carriage trucks.

Peavy - A stout lever from 5 to 7 feet long, fitted at the larger end with a metal socket and spike and a curved steel hook that is pivoted on a bolt. Differs from a cant hook in having a pike instead of a toe ring and lip at the end.

Plain sawed - Lumber sawed parallel with the pith of the log and approximately tangent to the growth rings; that is, the rings form an angle of less than 45 degrees with the surface of the piece.

Pond slip - The extension of a mill pond to allow floating of logs to a point opposite the mill dock.

Prime mover - The initial source of motive power, the object of which is to receive and modify force and motion as supplied from some natural source, and apply them to drive other machinery.

Random width - All widths of lumber haphazardly mixed.

Refuse conveyor - An endless chain or belt traveling in a trough which transports sawmill refuse.

Resaw - A machine to cut boards, planks, slabs, or other material lengthwise into two or more pieces through their widest dimension.

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

Rip - To cut a board lengthwise, parallel to the fibers.

Sap - All the fluids in a tree, such special secretions and excretions as gum excepted.

Sapwood - The layers of wood next to the bark, usually lighter in color than the heartwood and totaling 1/2 to 3 or more inches wide, that are actively involved in the life processes of the tree.

Seasoning - Removing moisture from green wood in order to improve its serviceability.

Setshaft - The shaft on a sawmill carriage to which the pinions are fastened and which causes the knees to advance or recede as it is turned.

Setting - The process of advancing the log on the carriage the distance required to get the sawed thickness desired.

Set wheel - The wheel of the setworks attached to the setshaft, which, when turned with a lever, causes the knees to advance.

Sheathing - The structural covering, usually of boards or wallboards, placed over exterior studs or rafters of a structure.

Shipping-dry lumber - Lumber that has been partially dried to reduce weight and freight costs, but may still have a moisture content of 30 percent or more.

Shotgun feed - A long cylinder with a piston attached to the rear end of the sawmill carriage to draw the carriage back and forth. Usually actuated by steam.

Siding - Material manufactured for the special function of serving as outside covering for buildings.

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

Single-acting lever - A device on the carriage of a sawmill which feeds the timber to be sawed transversely at the thrust or the return stroke of the lever, but not at both strokes.

Skid (verb) - To drag logs out of the woods.

Skid (noun) - A horizontal timber or pole on which logs are stored or rolled.

Slab - The exterior portion of a log that is removed to get a flat face for sawing lumber.

Slash - Limbs, twigs, and other woody refuse left behind on a logging operation.

Slasher saw - A device consisting of several circular saws mounted on a shaft at intervals varying from 16 to 48 inches and used to cut slabs, edgings, and other wood refuse into lengths suitable for laths, firewood, and pulpwood, or for transportation to the refuse burner.

Softwoods - The botanical group of trees that have needle or scale-like leaves and are evergreen for the most part.

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

Sorted-length piling - The practice of placing material of a single length or of a definite series of lengths in a single pile.

Sound cutting - A hardwood cutting free from rot, pitch, shake, and wane but permitted to contain sound knots and other items listed as defects and excluded from clear-face cuttings.

Sound defect - Any defect allowed in sound cuttings, such as sound knots, sound bird pecks, stain, streaks or their equivalent, season checks not materially impairing the strength, and worm holes.

Split - A lengthwise separation of the wood, due to tearing apart of the wood cells.

Stickers - A piece of lumber that separates the different courses of lumber in a pile.

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

Straight friction feed - Feed-works mechanism entirely dependent upon friction contacts of moving parts to give motion to the sawmill carriage.

Surfaced stock - A board, plank, timber, or other sawed material one or more sides of which are planed.

Sweep - A deviation in any direction from a straight line drawn from one end of a log to the other, excluding the deviation due to taper.

Tail sawyer - One who stands directly behind the head saw in the mill and seizes slabs and boards as they come from the saw, placing them flat on rolls.

Tally - A record of the number of pieces and grades of lumber in a pile.

Taper bar - A lever attached to the knee of a sawmill carriage headblock, by means of which any knee may be placed out of alignment. It is of service when making the first cuts on swell-butted logs.

Tier - One of two or more vertical rows, one beside the other, as of boards in a pile.

Timber - Sawed material 5 inches or larger in least dimension.

Top saw - The upper of two circular saws on a head saw, both hung on the same husk.

Turning - Turning the log about on its longitudinal axis.

Twin circular - A mill that has both a right-hand and a left-hand saw; used to slab logs or to rip cants. Both saws may be so mounted as to permit altering the distance between them.

Unit - An area, equal to 12 square inches, used in determining the grade of hardwood lumber.

Wane - Bark or the lack of wood or bark, from any cause, on the edges or corners of a piece.

Warp - Any variation from a true or plane surface.

Yarding logs - The process of moving logs from mill yard to sawmill.

APPENDIX 2

LUMBER ASSOCIATIONS

American Walnut Manufacturers Association, 66 North Lake Shore Drive, Chicago 11, Illinois.

Appalachian Hardwood Manufacturers, Inc., 1015 Mercantile Library Building, 414 Walnut Street, Cincinnati, Ohio

Fine Hardwoods Association, 666 North Lake Shore Drive, Chicago 11, Illinois

Hardwood Dimension Manufacturers Association, 218 Broadway, National Bank Building, Nashville, Tennessee

Hardwood Plywood Institute, 600 South Michigan Avenue, Chicago 5, Illinois

Mahogany Association, Inc., 666 North Lake Shore Drive, Chicago 11, Illinois

Maple Flooring Manufacturers Association, 35 East Wacker Drive, Chicago 1, Illinois

National Lumber Manufacturers Association, 1319 Eighteenth Street, N. W., Washington 6, D. C.

National Oak Flooring Manufacturers Association, 814 Sterick Building, Memphis, Tennessee

Northeastern Lumber Manufacturers Association, Inc., 271 Madison Avenue, New York 16, New York

Northern Hemlock & Hardwood Manufacturers Association, Oshkosh, Wisconsin

Northern Pine Manufacturers Association, 4329 Oakland Avenue, Minneapolis, Minnesota

Southern Cypress Manufacturers Association, 2133 Kings Avenue, P. O. Box 5772, Jacksonville 7, Florida

Southern Hardwood Producers, Inc., 805 Sterick Building, Memphis, Tennessee

Southern Pine Association, National Bank of Commerce Building, New Orleans 4, Louisiana

West Coast Lumbermen's Association, 1410 Southwest Morrison Street, Portland 5, Oregon

Western Pine Association, 510 Yeon Building, Portland 4, Oregon

APPENDIX 3

LUMBER PUBLICATIONS

Alabama Lumberman, 458 South Lawrence Street, Montgomery, Alabama.

American Forests, 919 - 17th Street, Washington 6, D.C. Published by American Forestry Association.

California Lumber Merchant, 108 West 6th Street, Los Angeles 14, California.

Chain Saw Age, 8816 S.E. Foster Road, Portland 66, Oregon. Published by Conroy Publishing Corporation.

Crow's Pacific Coast Lumber Digest, 808 S.W. 15th Avenue, Portland 5, Oregon. Published by Crow Lumber Publications.

Dixie Lumberman & Forester, 317 North State Street, Jackson, Mississippi.

Forest Farmer, P.O. Box 7284, Atlanta, Georgia.

Forests & People, P.O. Box 1703, Shreveport, Louisiana. Published by Louisiana Forestry Association.

Forest Products Journal, P.O. Box 2010, University Station, Madison 5, Wisconsin. Published by Forest Products Research Society.

Gulf Coast Lumberman, South Coast Life Building, Houston 1, Texas.

Hoosier Board and Brick, Guaranty Building, Indianapolis 4, Indiana. Published by Indiana Lumber and Builders' Supply Association.

Iowa Lumber & Building Material Dealer, 1013-4th Avenue, South, Minneapolis 4, Minnesota. Published by Iowa Retail Lumbermen's Association.

Directory & Buyers' Guide, 1013 - 4th Avenue, South, Minneapolis 4, Minnesota. Published by Iowa Retail Lumbermen's Association.

IRLDA News, Wesley Temple Building, Minneapolis 3, Minnesota. Published by Independent Retail Lumber Dealers' Association.

Journal of Forestry, Mills Building, Washington 6, D.C. Published by Society of American Foresters.

Lake States Timber Digest, Lyceum Building, Duluth 2, Minnesota. Published by Cooper Publishing Company.

Lumberland, Grand Central Terminal, New York 17, New York. Published by New York Lumber Trade Association.

The Lumberman, 71 Columbia Street, Seattle 4, Washington. Published by Miller Freeman Publications.

Lumberman's Handbook & Directory, 71 Columbia Street, Seattle 4, Washington.

Lumber Merchant, Trust Building, Lincoln 8, Nebraska. Published by Nebraska Lumber Merchants Association.

Mississippi Valley Lumberman, Lumber Exchange, Minneapolis 1, Minnesota.

New York Lumber Trade Journal, Ramsey, New Jersey.

Northeastern Logger, Old Forge, New York. Published by Northeastern Logging Association.

Northwestern Lumber & Building Material Dealer, 1013 - 4th Avenue, South, Minneapolis 4, Minnesota.

Retail Lumberman, R. A. Long Building, Kansas City 6, Missouri.

Southern Lumber Journal and Building Material Dealer, P. O. Box 448, Jacksonville 1, Florida.

Southern Lumberman, 917 Berryhill Street, Nashville 3, Tennessee. Published by J. H. Baird Publishing Company.

Timberman, The, 519 S. W. Park Avenue, Portland 5, Oregon.

Timber Operator, Maritime Building, Seattle 4, Washington.

Western Forest Industries Review, 309 S. W. 4th Avenue, Portland 4, Oregon. Published by Western Forest Industries Association.

APPENDIX 4

EXCERPTS FROM PUBLISHED ARTICLES WORTHY OF CONSIDERATION

Better equipment and methods of manufacture; better grading and yarding; better knowledge of business management - all result in better lumber which brings a better grade yield from logs and better values and profits.

Installation of safety devices and material handling equipment has reduced accident hazards and labor cost substantially.

Over 1,000,000,000 railroad ties are in use in the United States. Life about 18 years. About 3,000 ties per mile of railroad. No satisfactory substitute found for wood ties.

Few manufacturing plants depend so completely on the judgment of the worker as does a sawmill. Therefore, a proprietor should spend most of his time properly training and supervising the manual workers.

Formally logs were dragged through forests by elephants, ox teams and horses. Today crawler tractors, donkey engines and steel cables do this work faster and at less cost without damage to logs and accidents to workers.

One acre of logs piled five feet high contains about 300,000 board feet. One acre of pond area contains about 155,000 board feet.

Lumber requires more man-hours of labor in relation to its value than almost any other major industrial product. That is why it is advisable to utilize modern means of material handling and why a proprietor should devote the time and effort necessary to properly train and supervise his workmen.

For the period 1929 through 1953 all firms engaged in sawmilling in the United States averaged a ratio of net profit after taxes to invested capital of 2.35 percent. (United States Bureau of Internal Revenue)

Freshly cut logs, unless stored in water, are subject to rapid deterioration in many climates because of fungi, disease or too rapid drying. Logs should be sawed into lumber soon after harvesting where these conditions are encountered.

In America, during 1939 the percentage of tree utilization was about 30 percent. By 1953, utilization was increased to almost 70 percent. More and profitable uses have been developed for utilizing wood waste.

More effort is being expended to cut better lumber and to upgrade the cut. More power, better tools, better made machinery have resulted in an improved product and substantially lower labor and operating costs.

APPENDIX 5

FILMS AND FILMSTRIPS

FALLING TIMBER
16 millimeter motion picture: sound: black and white: 20 minutes: estimated price $60

West Coast Lumberman's Association
1410 S. W. Morrison Street
Portland 5, Oregon

An excellent presentation of methods and procedures in felling large timber with the use of power saws and hand tools. Emphasis on safety in forest operations.

HARVESTING WESTERN PINES
16 millimeter motion picture: sound: black and white: 30 minutes: estimated price $90

Western Pine Association
Yeon Building
Portland, Oregon

This film shows general logging operations in the western pine forests of the United States.

LUMBER FOR HOMES
16 millimeter motion picture: sound: black and white: 21 minutes: released 1950: estimated price $65

West Coast Lumberman's Association
1410 S. W. Morrison Street
Portland 5, Oregon

This film shows lumber in the forests, mills, and being used in the building of homes.

LUMBERING
16 millimeter motion picture: sound: black and white: 10 minutes: released 1938: price $30

Edited Picture System, Inc.
165 West 46th Street
New York 19, New York

This film gives an overview of methods of lumbering from the cutting of the trees to the marketing.

LUMBERING IN THE PACIFIC NORTHWEST
16 millimeter motion picture: sound: black and white: 10 minutes: released 1945: estimated price $30

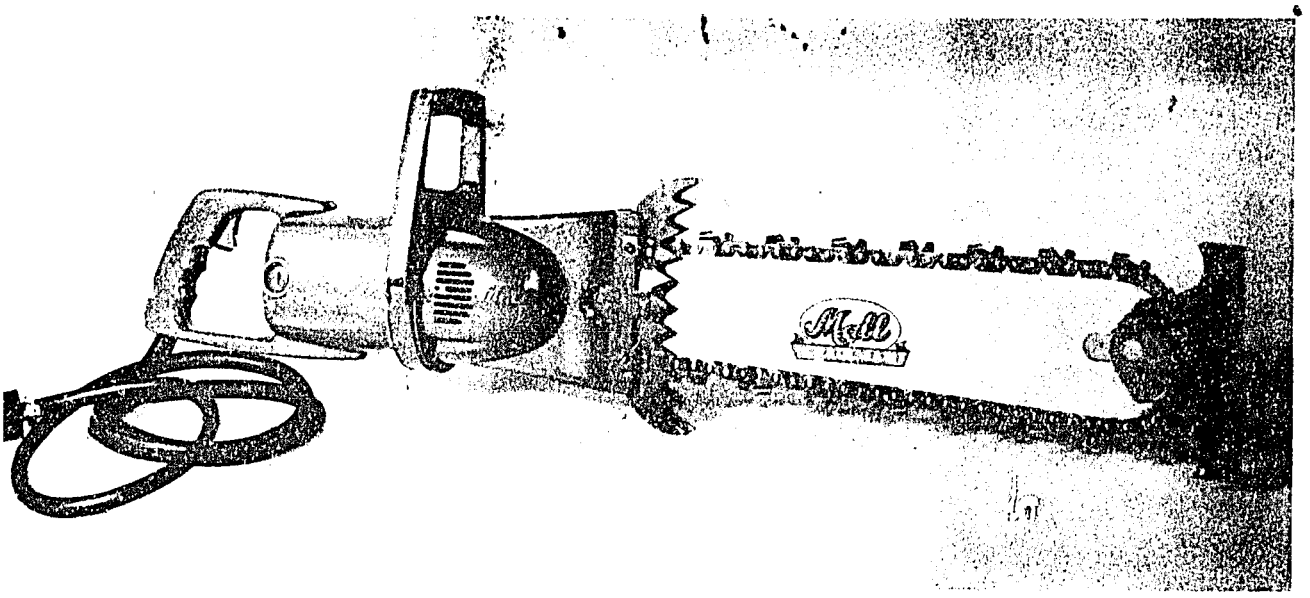
National Film Board of Canada
1270 Avenue of the Americas
New York 20, New York

This film shows the logging industry from felling trees to finished lumber.

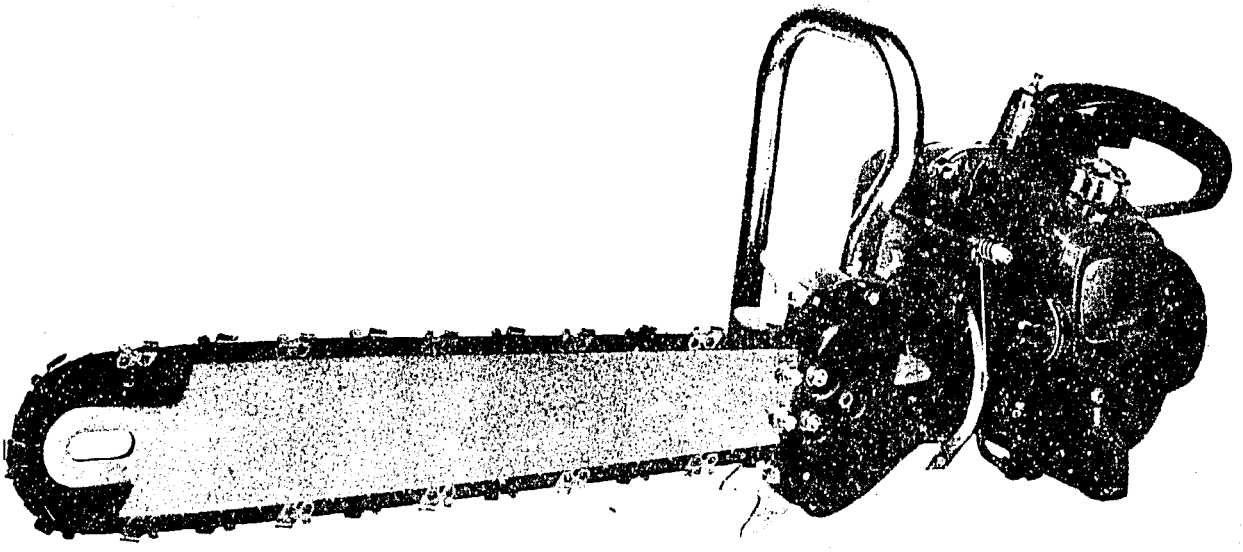
SAWMILL SAFETY
35 millimeter filmstrip: sound: black and white: 119 frames: 17 minutes: estimated price $30

National Safety Council
Film Service Bureau
20 North Wacker Drive
Chicago 6, Illinois

This filmstrip depicts sawmill operations with emphasis on safety.



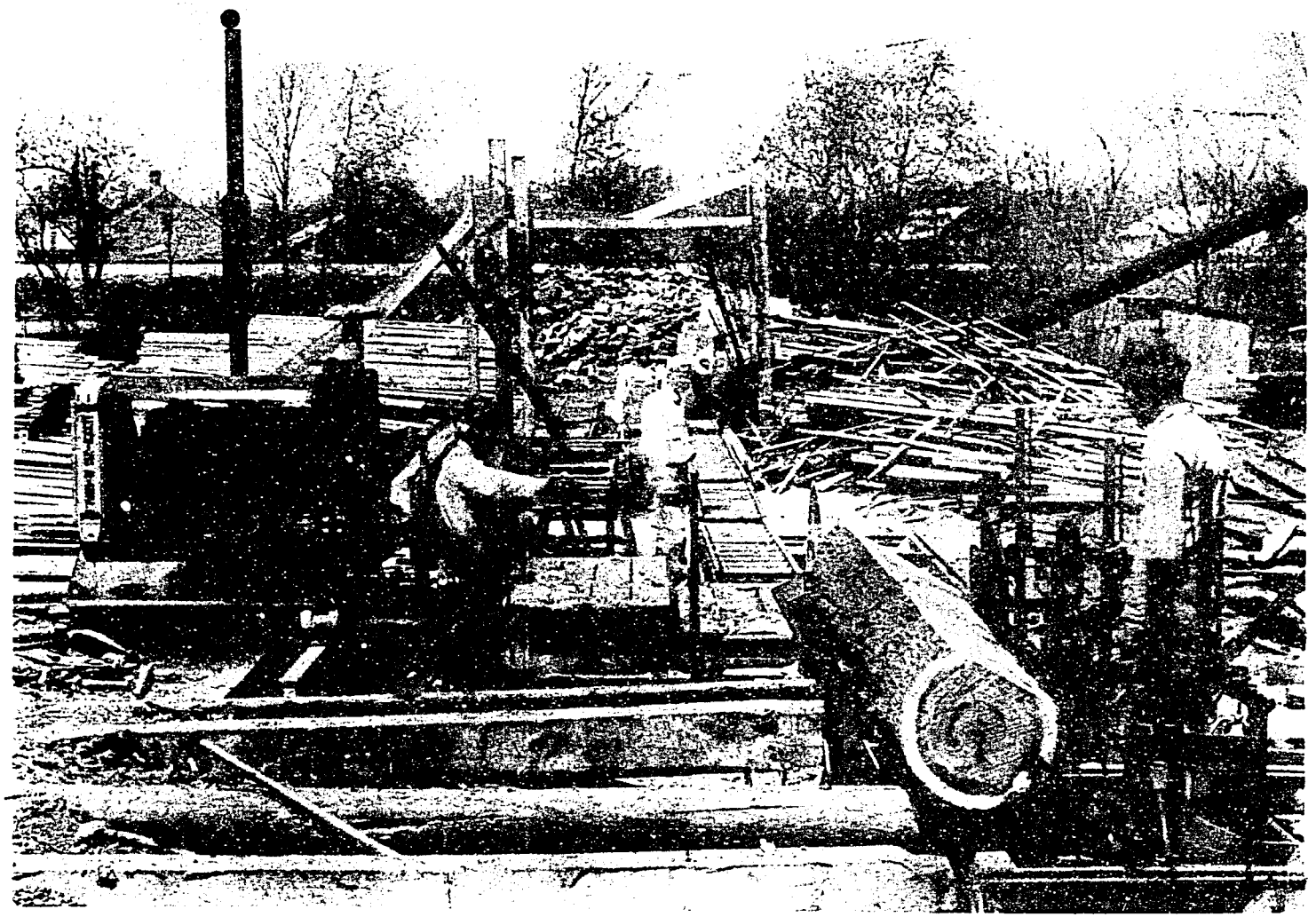
ILLUSTRATING ELECTRIC POWERED CHAIN SAW



ILLUSTRATING GASOLINE-POWERED CHAIN SAW

FIGURE 1.

Courtesy of Mall Tool Company
Chicago, Illinois



ILLUSTRATING CIRCULAR SAWMILL WITH LOG
TURNER IN OPERATION

FIGURE 2.

Courtesy of Corley Manufacturing Company
Chattanooga, Tennessee

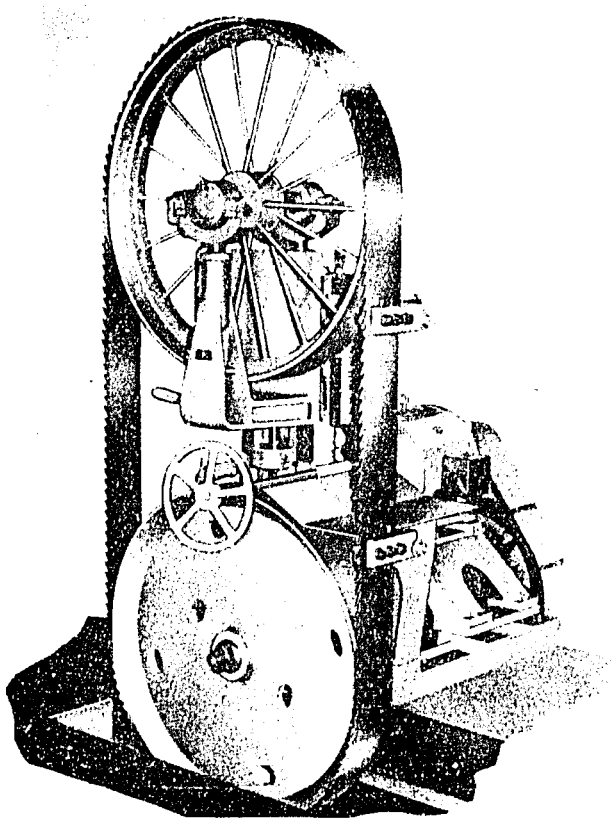


FIGURE 3. 54-INCH BAND SAW SUITABLE TO REQUIREMENTS OF SMALL OPERATOR

Courtesy of American Saw Mill Machinery Co.

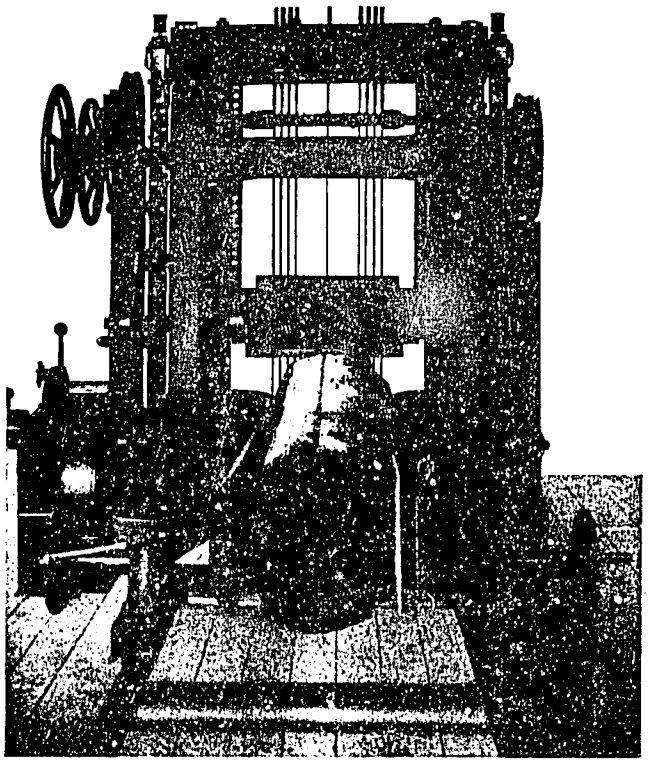
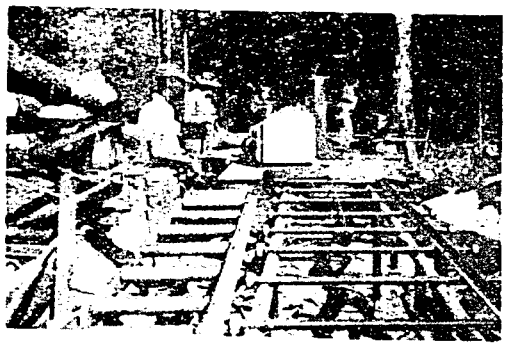
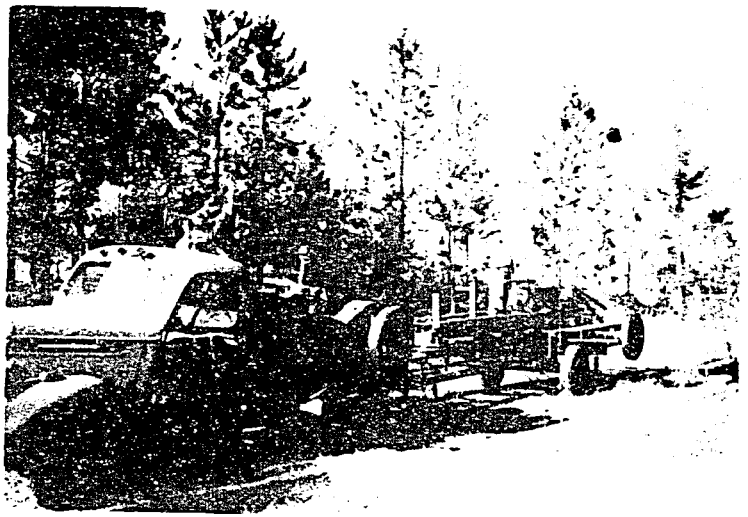
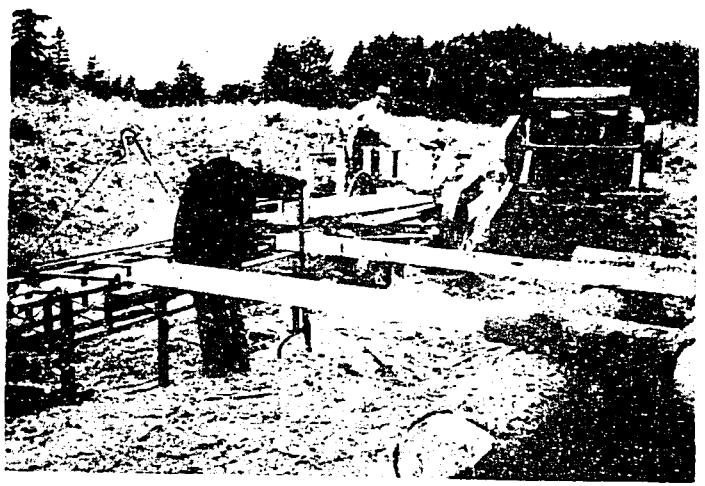


FIGURE 4. SASH GANG SAW

Courtesy of Branyan & Peterson, Inc.
Memphis, Tennessee







ILLUSTRATING MOBILE SAWMILL BEING TRANSPORTED AND OPERATED

FIGURE 5.

Courtesy of Jackson Lumber Harvester, Inc.
Brewton, Alabama

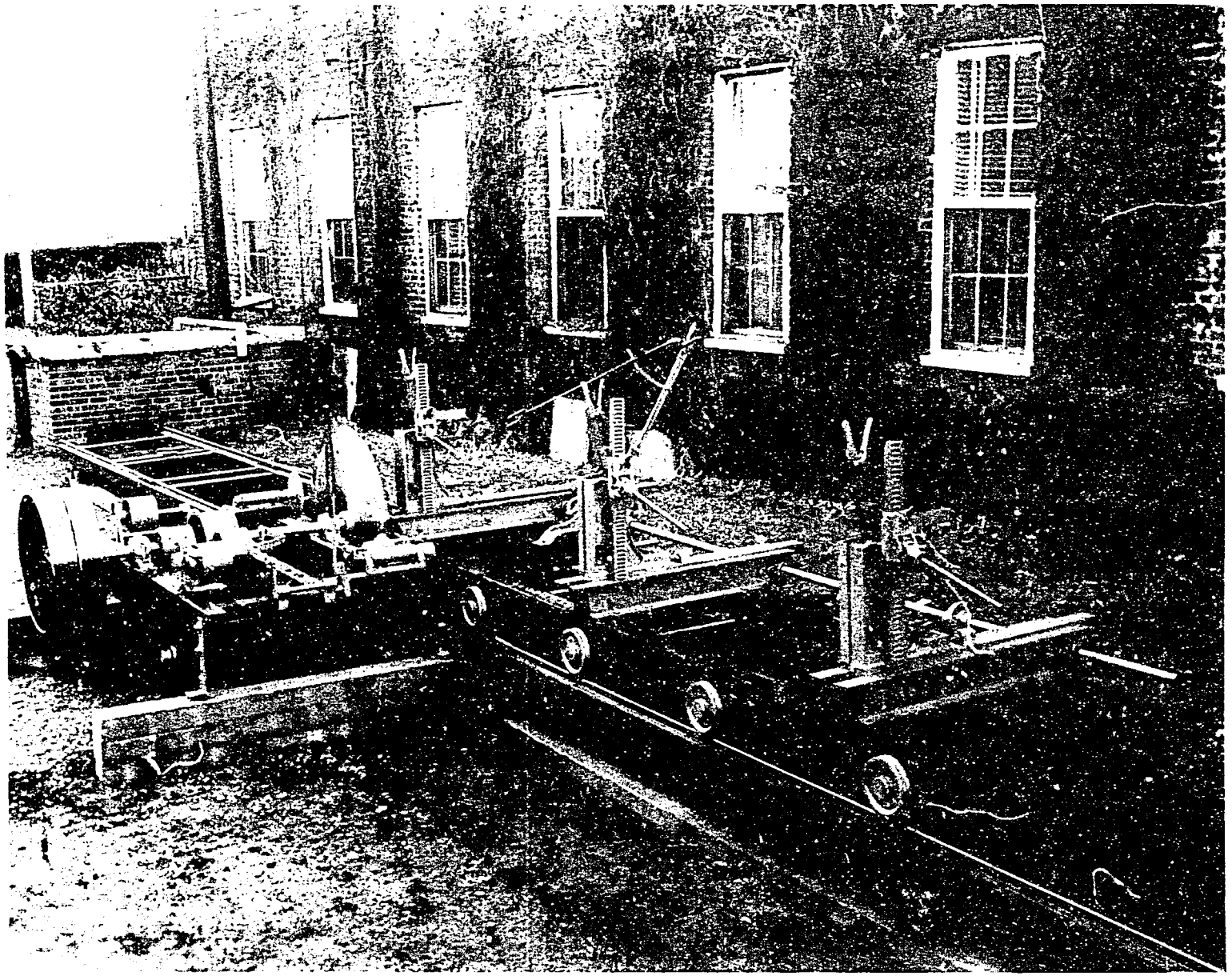


FIGURE 6. SHOWING CARRIAGE IN RELATION TO HUSK. DOGGING DONE ON GROUND.

Courtesy of American Saw Mill Machinery Co.
Corinth, Mississippi

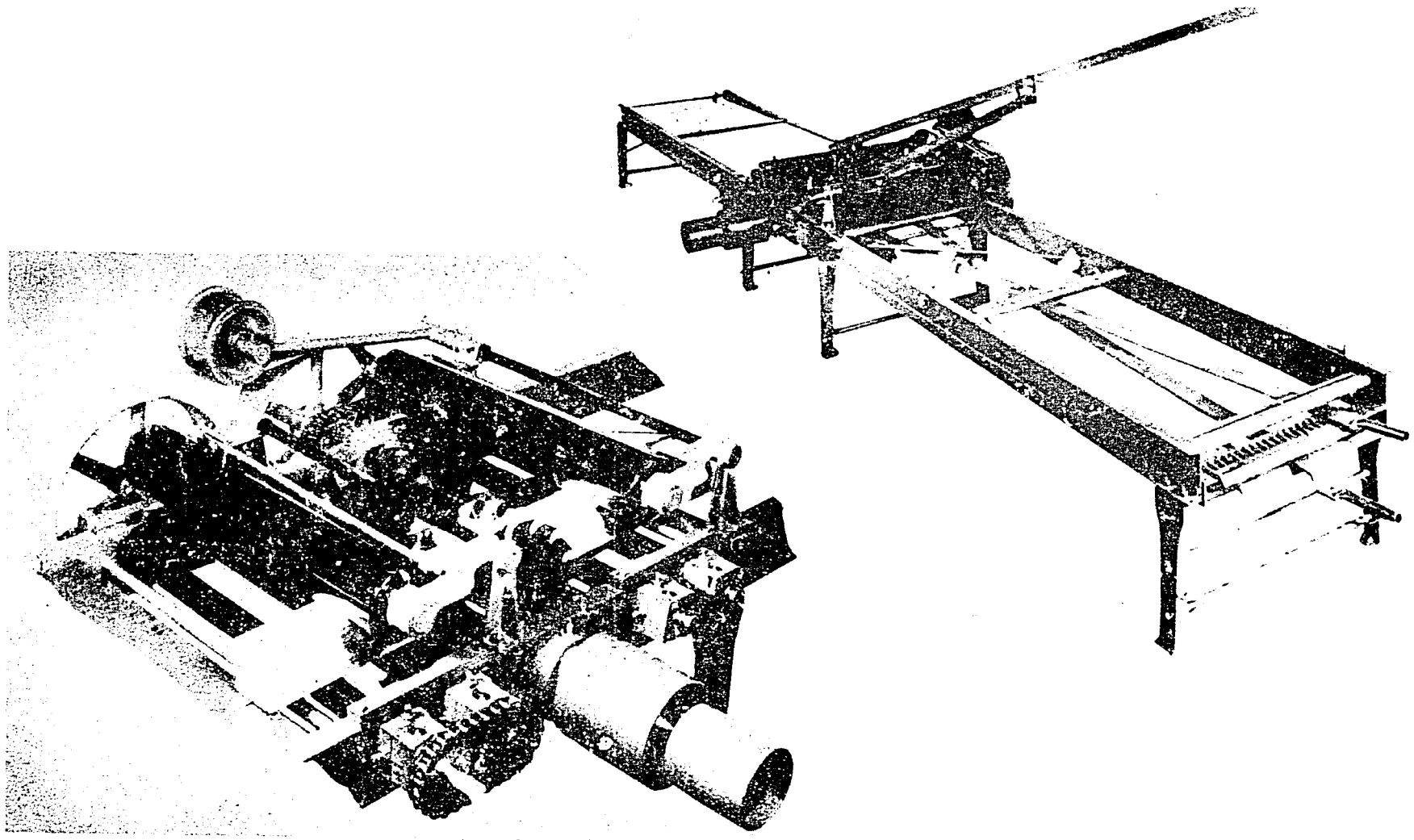
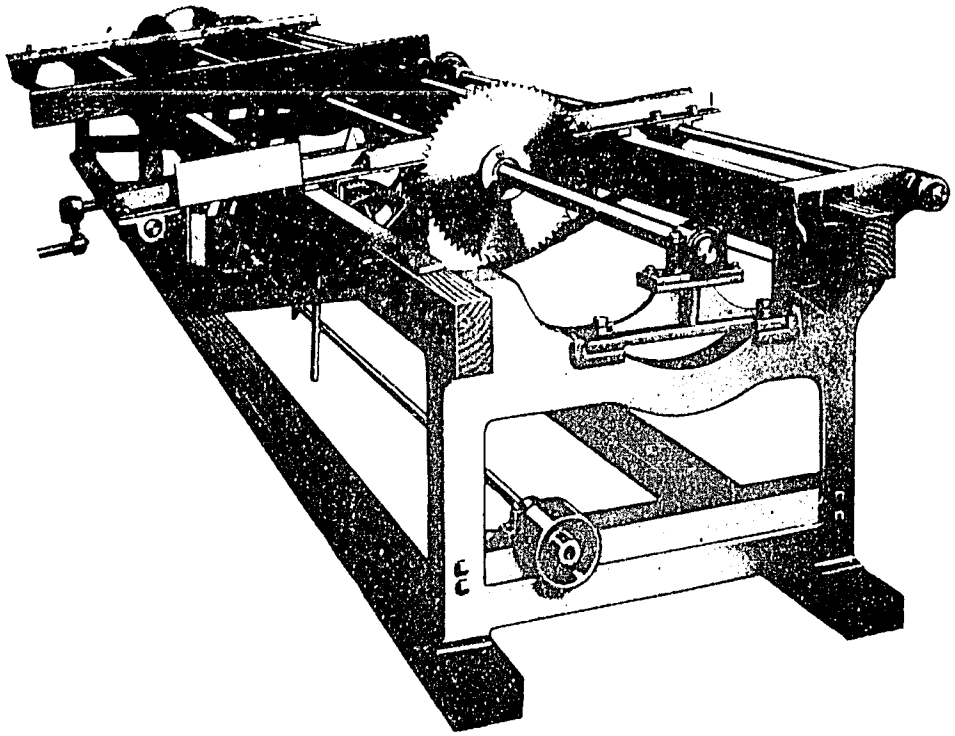


FIGURE 7. ILLUSTRATING MULTIPLE SAW EDGER

Courtesy of Corley Manufacturing Company,
Chattanooga, Tennessee



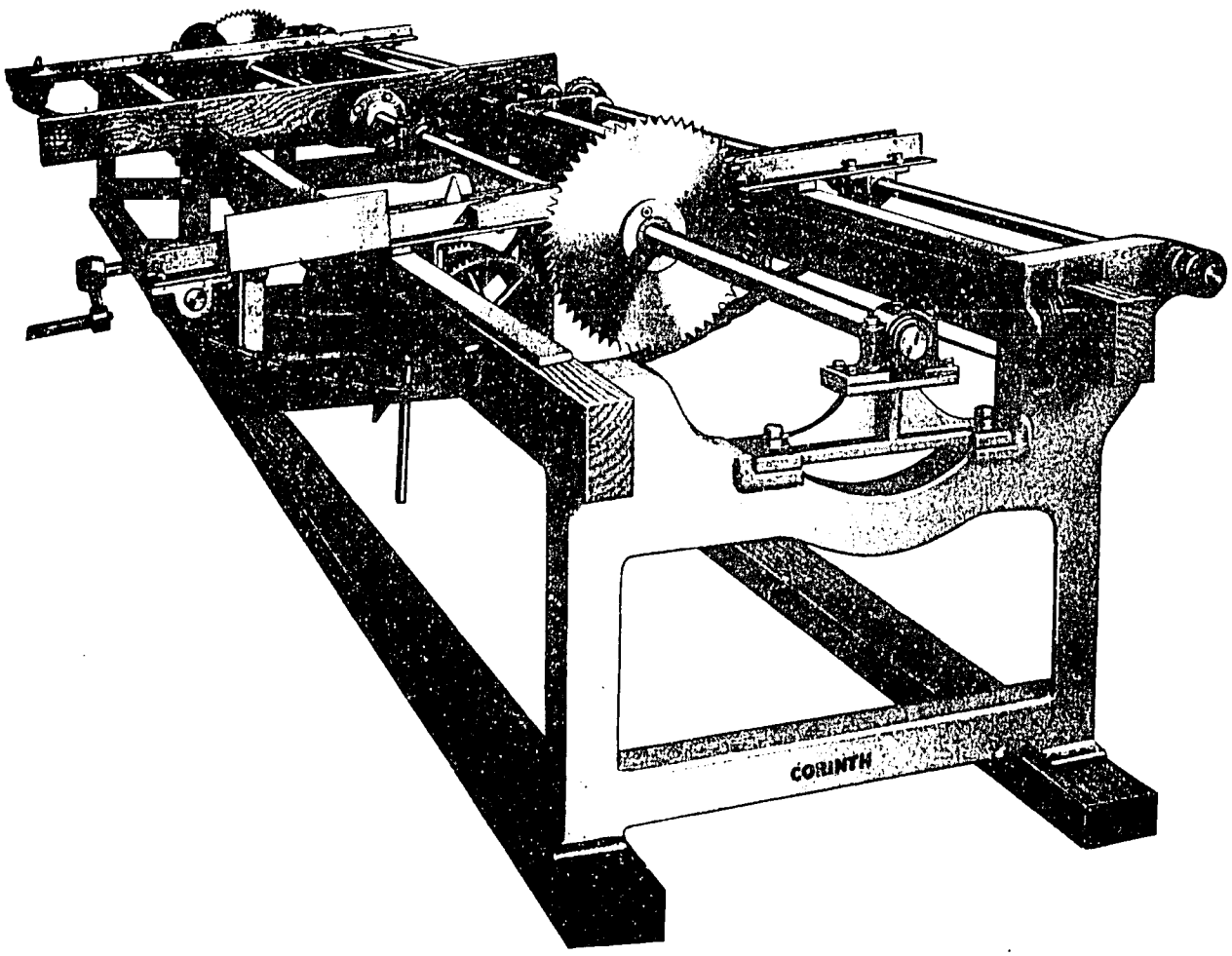


FIGURE 8. TRIMMERS

Courtesy of American Saw Mill Machinery Co.
Corinth, Mississippi