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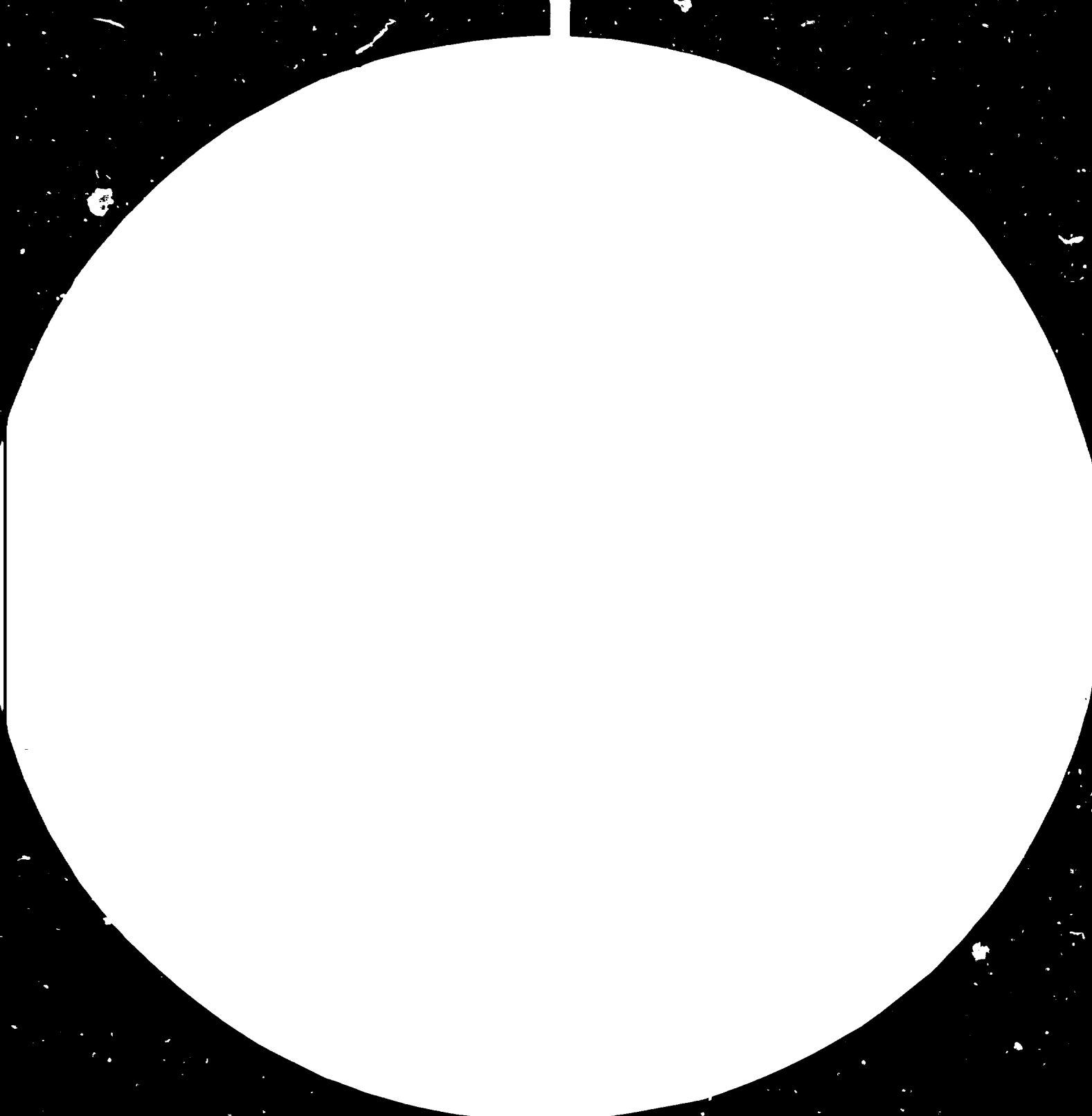
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SOME CONSIDERATIONS FOR PLANNING SAWMILLS FOR TROPICAL LOGS 1/

by

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Introduction

Due to their characteristically large diameters, ranging mostly from 60 to 180 cm, and exceptionally from 50 to 60 and/or 180 to 200 cm, tropical logs are usually sawn using log bandsaws and log band resaws. All these machines must be designed for the special purpose of sawing tropical logs.

We distinguish two types of log bandsaws for tropical logs:

- a) horizontal bandsaw; and
- b) vertical bandsaw.

The horizontal log bandsaw has a lesser capacity and is mostly used as an auxiliary machine for cutting flitches and installed in front of the veneering machine. This machine is equipped with a simple type of log carriage, with less mechanization for loading the logs on the carriage. The same applies also to the off-loading of sawn boards. The sawing proceeds in the horizontal direction and boards are piled on the top of the log and need to be taken off intermittently either manually or by means of a vacuum hoist.

Although this machine is robust and seems to be less suitable for mechanization, in certain conditions, it may nevertheless be selected as a machine for sawing logs into boards due to its lower price and simple maintenance of the log carriage.

The horizontal log bandsaws are supplied in various sizes with pulleys having diameters from 1200 mm to 1800 mm.

In practice, the vertical log bandsaw is used especially for the breakdown of tropical logs. It may be used in several ways.

The vertical log bandsaw can work as an independent machine. If it is equipped with some auxiliary devices described in the subsequent text, it may operate as an independent sawmill.



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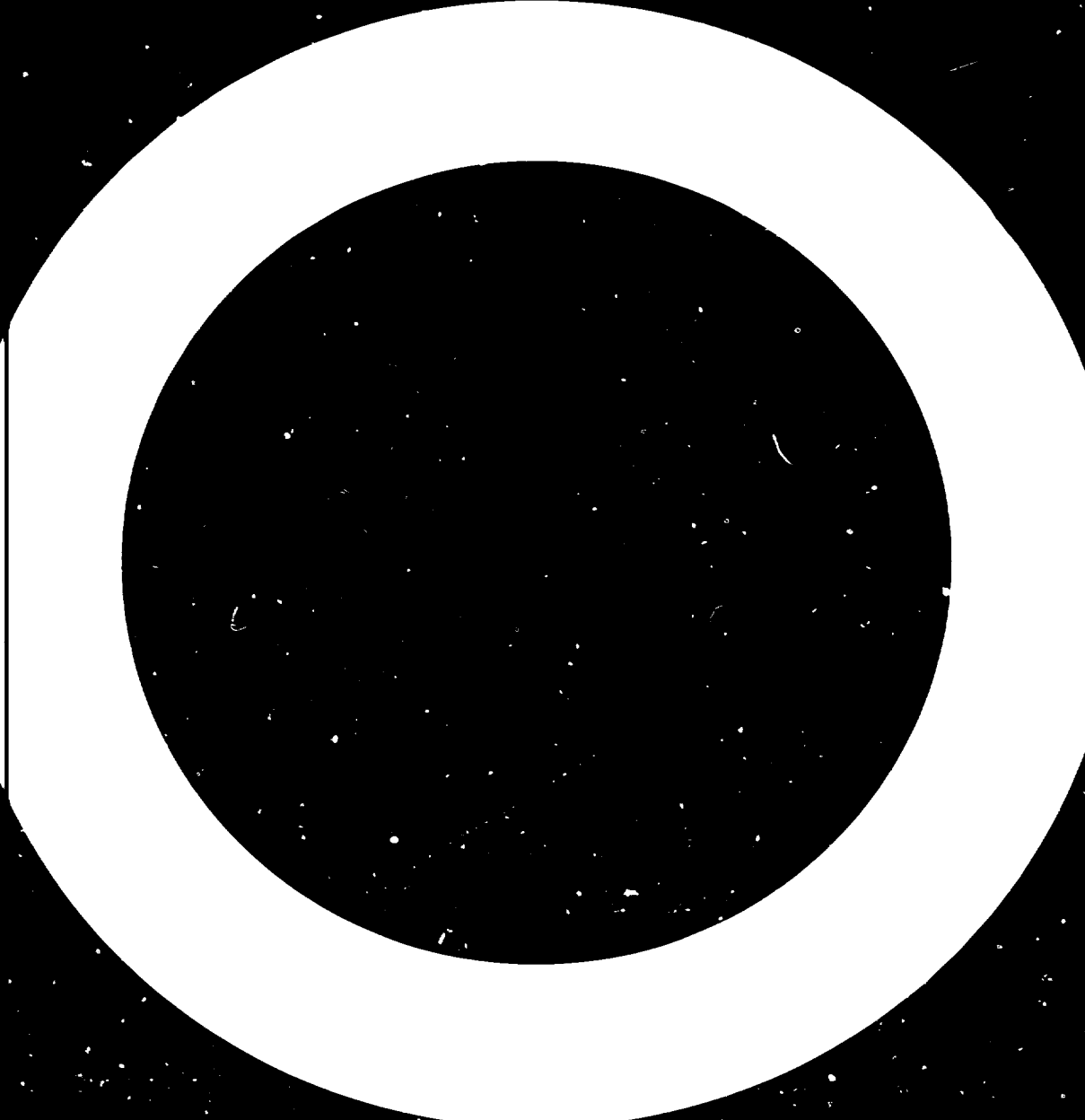
SOME CONSIDERATIONS FOR PLANNING SAWMILLS FOR TROPICAL LOGS

Corrigendum

Page 12

The formula should read

$$E_s = \frac{T \times v \times D^2 \times \pi \times k_1 \times k_2}{n_c \times 4}$$



Because of its vertical construction, this machine is suitable for inclusion in a continuous mechanized line. Therefore, this machine is used with success in mechanized sawmills for the large-scale processing of greater log quantities. Let us give some examples:

- (a) In case the log bandsaw is the only basic machine connected with other secondary machines by the conveying equipment it represents an independently working sawmill.
- (b) The capacity of the vertical log bandsaw can be increased by adding a band resaw. Such a combination requires the mechanization of the conveying equipment. In a combined sawmill of this kind, the sawing method needs to be adapted to the operation of the band resaw. This means that each log requires an individual cutting pattern, i.e. each cut must be determined individually.
- (c) If there are two main vertical log bandsaws in a sawmill, this serves for sawing larger quantities of various wood species. It is based on an advantageous and flexible technological concept.
- (d) For sawing very large quantities of logs, mechanized sawmills are built, housing two log bandsaws and one resaw. They are connected with each other and to other secondary machines, thus forming a system of a mechanized sawmilling installation.

Apart from the above-mentioned combinations of the basic machines, there are also other alternatives of selecting and placing the machines.

It is necessary to mention that comprehensive analyses of raw materials available and of the production programme of sawn timber are prerequisites for the correct selection of the most suitable basic machine and the equipment layout. It is necessary to decide upon each type of sawmill individually. This statement is confirmed by the fact that no two identical sawmills can be found worldwide.

1. Points to be taken into consideration in the selection of the basic machine.

Due to their big dimensions, tropical logs cannot be sawn by any other machine than the log bandsaw. The analysis of the quantity and dimensions of the logs available is a prerequisite for the selection of the appropriate bandsaw. Data of this analysis can also be used when the capacity of other sawmilling equipment has to be determined.

Data of this analysis are shown in the table hereunder:

Log diameter (cm)	Annual quantity (m ³)	Average volume of logs (m ³)	Number of logs
up to 60	--	--	--
60 - 70	182	1.33	137
70 - 80	729	1.77	412
80 - 90	1.541	2.27	679
90 - 100	3.487	2.84	1.228
100 - 110	5.653	3.46	1.634
110 - 120	5.636	4.15	1.358
120 - 130	6.028	4.91	1.228
130 - 140	7.854	5.72	499
140 - 150	330	6.60	50
150 and above	--	--	--
	26.440		7.225

Wood species: red (hard), white (soft)

Diameter of logs: minimum 60 cm, maximum 150 cm.

Length of logs: minimum 200 cm, maximum 600 cm.

Dimensions of an average log: diameter 107,90 cm, length 400 cm, volume 3,695 m³.

Size of the bandsaw headrig

The selection of the bandsaw headrig will depend on the ranges of log diameters and the required output. The size of the pulley affects the width

and thickness of the saw blade which is fitted between both pulleys. The parameters of the saw blades in their turn affect the machine's output.

Machines equipped with bigger pulleys are provided with wider and thicker saw blades which are suitable for greater tensions and greater log feed speeds.

The table below shows the ranges of thickness and width of saw blades with regard to various sizes of pulleys:

Size of pulley (mm)	thickness of saw blade (mm)	width of saw blade (mm)	
1100	1,1	110	120
1200	1,2	140	
1300	1,3	150	
1400	1,47	181	206,4
1600	1,65	231,8	260,4
1800	1,8	250	
2100	2,0	300	
2400	2,3	320	
2700	2,6	350	
3000	2,9	380	

The maximum possible cutting height obtainable is of great importance in selecting the size of the headrig. There are headrigs providing for instance a cutting height of 160 cm. These headrigs are selected when numerous logs of large diameters are to be sawn and no band resaw has been installed. Then, even the biggest logs can be sawn without being turned on the log carriage. Yet, we must take into account that the saw blades of these machines are subject to greater vibrations that can hardly be avoided even though blade guides are used. The vibrations of the saw blade affect the accuracy of sawing and the quality of the board surface respectively.

Should it result from the analysis of log diameters that there are but few extremely large logs, a machine with smaller cutting height may be selected, i.e. a machine for a smaller maximum cut. In this case, the method of sawing

must be modified, so that logs are turned on the log carriage during sawing. The required turning of logs increases the losses of effective operation time and leads to a decrease in machine output. This woodworking method should only be applied when the sawmill is equipped with a band resaw.

Log carriage

The bandsaw consists of a headrig with two driven pulleys and a log carriage. The log carriage represents a very important part of the machine, for it affects the machine output. The log carriage can be equipped with several headblocks and dogs. This equipment can be operated manually, electro-mechanically, hydraulically or pneumatically.

The adjustment of thickness to which boards are to be sawn is also operated manually, electro-mechanically, hydraulically or pneumatically.

While selecting the carriage equipment and the level of its mechanization, the requirements of the machine capacity with regard to the logs available and the possibility of the equipment maintenance must be considered. The carriage equipment is subject to heavy wear and is sensitive to defects. Therefore, it is of great importance that a skilled mechanic is available who would be in charge of the repair of pneumatic and hydraulic devices.

Prior to selecting the log carriage, its length and speed must be determined. The length of the log carriage is determined on the basis of the data about the length of the logs available. A longer carriage than necessary is more expensive, requires much more space and consequently more energy, etc. For this reason, the length of the log carriage should not be determined by the longest log. The ranges of length that prevail should be stated so that the size of the log carriage complies with the prevailing length of logs, as determined.

Generally, the bandsaws selected for the log breakdown are oversized in order to lessen the load and diminish the wear during operation as well as to keep the maintenance costs at a minimum so as to secure the longevity of the installation. Though the oversized machines are more expensive, the costs for their maintenance are lower.

While selecting machinery for sawmills in developing countries, an additional rule should be considered: due to the great distance of the machine manufacturers from the sites where their machines are installed, the simplest methods of equipment operation should be chosen. Unless extreme machine outputs are required, manual and electro-mechanically operated log carriages and thickness adjustments should be preferred to the pneumatic or hydraulically operated equipment.

Log carriage speed

The speed of the log carriage, especially the reverse speed, affects the machine's output. The log carriage speed should therefore preferably be established for each machine individually. For sawing logs of smaller diameters, the maximum admissible carriage speed may be selected. On the other hand, the sawing of heavy logs with large diameters requires slower log carriage movement.

The carriage drive proceeds continuously at the speed range of 0 to 120 m/minute. For the breakdown of tropical logs, the carriage speed may be even lower attaining only up to 70 m/min. The carriage usually moves by means of a steel rope which is rolled on to two drums alternatively and is equipped with a hydraulic electromotor.

Auxiliary devices to the bandsaw

The following auxiliary devices pertaining to the bandsaw are required for rational and professional sawing:

- log cleaner and log debarker;
- loader-turner arms;
- pusher arms;
- arms for off-loading the boards onto the conveyor;
- light-device to indicate the cutting line;
- circular saws for cutting logs lengthwise;
- devices for lifting and stacking of boards;
- headrig with a chain saw for sawing too large logs into two.

Auxiliary devices for cleaning and debarking of logs

Mud, sand, and bark generally need to be removed from logs to be sawn on the log bandsaw. Otherwise, they would damage the saw's teeth and affect their longevity. In sawmills with smaller capacity, the peripheric parts of logs are hand-cleaned by brooms, brushes or metal scrapers.

In mechanized mills, in which large investments have been made, log debarking machines are installed in front of log headrigs in order to secure constant operation. There are several types of debarking machines for tropical logs. Their operation is based on mechanical scraping the bark off the rotating and moving log. Therefore comprehensive conveying facilities are required for securing an even transport of logs to the debarking machine and from the debarking machine to the log bandsaw headrig.

Auxiliary devices for log turning

There are various turning devices for turning logs on the carriage. They are used to set the log into the right position for the first cut and to turn the already sawn log for further sawing.

The simplest device of this kind is the bridge crane with the pulley provided with an electromotor drive. Logs are slinged, transferred, fed to, and even turned on the log carriage by means of the pulley. If the bridge crane is equipped with an electrodrive it can be hand-controlled by a switch fitted to and travelling with the pulley and/or it can be operated from the central control unit.

In mechanized sawmills where cross conveyors are utilized to convey logs to the log carriage, the rising and lowering of logs is carried out by hydraulically or pneumatically driven log turners. Log turners facilitate the working operations of loading and turning logs on the log carriage considerably. As this device is rather robust, it affects the life span of the log carriage as well as the accuracy of sawing. Log turners are operated from the central control unit.

Turning chain arms are also used as a modern device for log turning. These are operated from the central control unit as well.

Pushing - loading arms

Hydraulic pushing arms are used in mechanized sawmills for pushing logs onto the carriage and to the headblocks. They are operated from the central control unit.

Arms for off-loading of boards

Special arms, supplied with electro-mechanical or hydraulic drive, are used for off-loading the already sawn boards onto the board conveyor. They prevent boards from falling onto the conveyor and thus prevent both the damage of the board and of the conveyor.

Light device

In standard sawmills, the central control unit for the log bandsaw and auxiliary equipment is located between the log carriage and the headrig. In mechanized sawmills, the central control unit is removed from the position adjacent to the headrig and is placed at the feed end. In this case, a light device is used in order to indicate the direction of the saw blade, thus enabling better control for the adjustment of individual cuts. Modern devices use the laser beam and generate a sufficient concentration of red light so that the cutting line can be seen on the log in daylight.

Circular saw for longitudinal cutting

If logs of large diameters pass through the bandsaw, the boards produced are also large and cause quite a lot of trouble while travelling on the conveyors. For cutting wide boards into narrower ones, a special machine can be used. It should be placed in front of the bandsaw headrig at the log carriage.

The machine consists of a vertical headrig with one or two mobile circular saws that can be shifted on the vertical axle. These circular saws cut the

log to the depth corresponding to the thickness of the board being sawn. As soon as the log has passed through the bandsaw, there are already two or more boards sawn from the log.

Purpose of this machine:

- (a) The machine equipped with one circular saw is intended to: 1. saw one wide board into two narrower boards, 2. edge one side of the board.
- (b) The machine equipped with two circular saws is intended to: 1. edge the board on both sides, 2. cut out the centre of the board, and 3. cut a wide board into several narrow boards.

The combination of the log bandsaw and the headrig with mobile vertical circular saws can be applied with success for sawing logs with internal tensions. The previous cutting lengthwise liberates wood tensions and thus prevents cracking and bending of logs during the sawing by the bandsaw blade.

Auxiliary devices for board lifting and stacking

In less mechanized sawmills, vacuum hoists are installed in order to facilitate the off-loading of boards. The vacuum hoist is intended to lift boards off the log carriage, raise them and stack them. The device is vacuum operated. It consists of a drive motor, a vacuum pump, a suction plate to be pressed on to the board surface, and an electrically driven holding mechanism. There are several types of vacuum hoists which are suitable for the work on both horizontal and vertical bandsaws. It can also be used in the wood yards (storage areas). The vacuum hoist can be mounted on a mobile bridge construction enabling it to operate over a large square space, or it can be fitted to a rotary console arm for operation over circular areas.

In the storage of sawn timber, a vacuum hoist is usually fitted to the mobile portal construction. The latter is equipped with rubber wheels running on rails.

There are also various sizes of hoists with respect to the weight that is to be lifted and the shape of suction plates.

Headrig with chain saw

In sawmills where log bandsaws with small cutting heights are installed, problems arise in sawing logs having too large diameters. This disadvantage can be successfully overcome by using a chain saw fitted on the headrig. The chain saw is intended for longitudinal sawing of the largest logs. In this case, the headrig is placed over the log, and the chain saw is adjusted to the required sawing height, so that the log can be sawn lengthwise into two parts. The headrig and the chain saw are portable, therefore they can be set into operation at any place in the wood yard.

Both halves of the log are then conveyed into the sawmill and fed to the log bandsaw.

2. How to calculate and measure the capacity of the log bandsaw

The rate of production and yield depends on several parameters, but mostly on the output actually achieved by the machine. Therefore, we must be capable of estimating and measuring the capacity of any machine, including the log bandsaw.

Prior to the purchase of the machine, its technical capacity (i.e. the maximum output that can be achieved under normal operation conditions) must be determined.

We must be capable of calculating and measuring the production capacity of the machine in operation, i.e. the actual output achieved by the machine in the given production conditions must be established.

The log bandsaw differs quite a lot from other machines for log breakdown. Due to the more complicated construction of the log bandsaw, several exacting working operations are required. Consequently, there are numerous parameters affecting the machine's capacity, and having a complex impact on its output.

The parameters influencing the machine capacity are subdivided into: technological, organizational and technical parameters.

- (a) The technological parameters depend on: 1. the kind, dimensions, quality and prior preparation of the raw materials; 2. the method of processing, i.e. method of sawing, purpose of machining, desired quality of the machined surface; and 3. the speed of machining to be calculated based on the number of cuts on the log and the feed speed of the carriage.
- (b) The organizational parameters influence: 1. the work organization, i.e. number of working days per year, number of shifts per day, number of hours per shift; 2. operation time yield, i.e. the actual utilization of the time available per shift and working day; and 3. improvement of the working conditions, appropriate personnel policy, promotion of working experience, work standardization, production control.
- (c) The technical parameters include the parameters depending on: 1. the machine characteristics, i.e. type, size and speed of the saw blade; and 2. the characteristics of the auxiliary and complementary equipment to the basic machine, such as: log turners, off-loading arms for boards, etc.

The theoretical formula for the calculation of the capacity of a log bandsaw within a shift involving all the above mentioned parameters, affecting the machine output, is as follows:

$$E_s = \frac{T \times v \times D^2}{n_c \times 4} \times k_1 \times k_2$$

- E_s - capacity of the log bandsaw per shift (m^3 of logs)
- T - duration of a shift without break (min.)
- v - average log feed speed (m/min)
- D - average log diameter (m)
- n_c - average number of cuts per log
- k_1 - coefficient of the machine operation time covering the time lost for the machine preparation, turning, loading and feeding the log to the machine, reverse drive of the log carriage, other losses when the saw blade does not operate.
theoretical value 0,2 - 0,3
- k_2 - shift time coefficient including the time lost in changing the saw blade, cleaning and lubricating the machine and other downtime occurring in the course of machine operation.
theoretical value 0,9

The theoretical formula applied for the calculation of the annual log bandsaw output is as follows:

$$E_a = E_s \cdot n_s \times n_{wd} \times k_a$$

E_a	annual machine capacity (m^3 logs)
E_s	machine capacity (m^3 /shift)
n_s	number of shifts per day
n_{wd}	number of working days per year
k_a	coefficient of the shift yield per year including the downtime due to shortage of raw materials, machine overhaul, delays due to weather, shortage of energy, etc.
	theoretical value applying European conditions 0,9 - 1,0
	Theoretical value applying the conditions in developing countries 0,75 - 1,0

The theoretical formula outlined for the calculation of the log bandsaw output within one shift has proven to be reliable, and is thus quite useful in practice. It involves all the parameters affecting the machine output, and is, therefore, suitable for the constant follow-up of the current production. By constantly checking and comparing the values of the parameters of the formula, we can easily state, at any moment during the production, which of these parameters (technological, technical, organizational) have been the cause for a lowering of production.

Another great advantage that results from both formulas is the calculation of the bandsaw's capacity. Both formulas can be used for the calculation of the capacity of a mechanized bandsaw production line as well, provided that there are no bottlenecks in the mechanized production line following the basic machine (i.e. the log headrig), so that the operation of the log headrig is not restrained by other machines, conveying equipment or sorting of the boards sawn.

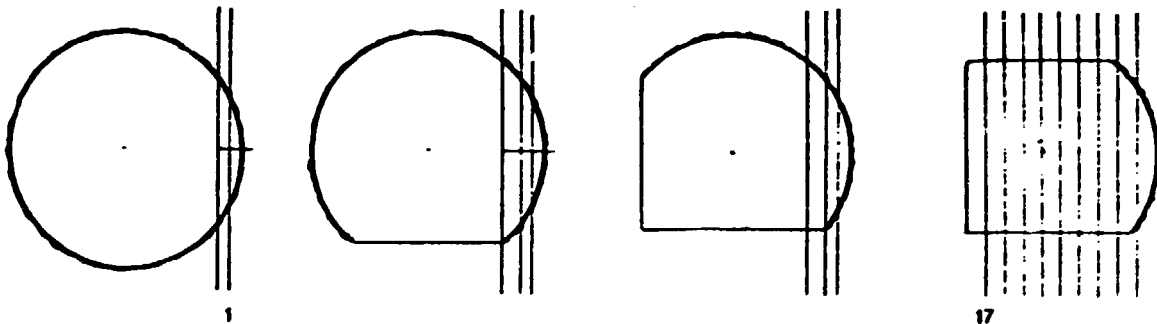
In the following text, an example is given of how to establish the production parameters of a log bandsaw located in Africa.

All data displayed in the table below represent data measured and registered in the field.

Machine: log bandsaw; size of pulleys: 1800 mm; log carriage speed: 0-80m/min.

Within a working shift 15 Saperli logs of a diameter 60 - 132 cm, and a length of 2,6 - 5,5 m have been sawn.

Method of sawing



Recorded on 7 December 1982

Log Nr.	Length (m)	Diame-ter(cm)	Volume (m ³)	Log pro-cessing time	Effective working time (time during which log was being sawn)(min)	Number of cuts	Average log feed speed (m/min)
1	5,50	80	2,765	46	11,60	15	7,1
2	5,50	90	3,499	20	12,20	15	6,7
3	4,70	95	3,331	20	7,98	15	8,8
4	3,40	85	1,929	22	3,88	10	8,5
5	4,00	62	1,208	10	4,00	11	11,0
6	4,00	65	1,327	11	4,00	10	10,0
7	2,70	132	3,695	32	9,31	24	6,9
8	4,90	81	2,523	30	6,00	11	8,9
9	3,80	80	1,909	15	5,30	14	10,0
10	4,60	119	5,113	25	11,80	20	8,2
11	5,10	112	5,021	12	12,88	21	8,3
12	3,80	105	3,289	23	10,10	19	7,1
13	4,50	122	4,431	25	7,40	22	13,3
14	2,60	130	3,449	23	8,20	23	7,3
15	2,60	118	2,841	24	9,30	20	5,6
Total			46,330	338	123,95	250	
Average log	4,11	97,83	3,088	22,53	8,26	17	8,51

- NOTE:
- log processing time covers the period of time from the moment one log has been fed to the carriage till the moment the next one is fed to the carriage.
 - effective working (technological) time represents the sum of times when the saw blade was in operation.
 - average log feed speed in m/min is calculated on the basis of the sum of all the lengths of cuts on the log and the technological time required for cutting the respective lengths.
 - machine time coefficient $k_1 = \frac{123,95}{338} = 0,365$
 - shift time coefficient $k_2 = \frac{338}{450} = 0,75$

The next table allows the comparison of the parameters established in the sawmill and their respective theoretical values.

Capacity		Achieved value	Theoretical value	Difference value
T	Duration of a shift without break in min	450	450	--
v	Average speed of the log in m/min	8,51	17,0	- 8,49
n _c	Average number of cuts per log	17	17	0
D	Average diameter of the log in m	0,9783	0,9783	0
k ₁	Machine time coefficient	0,365	0,30	+ 0,065
k ₂	shift time coefficient	0,75	0,90	- 0,15
E _s	Capacity of the log bandsaw within a shift in m ³	46,330	91,330	-45,000

Calculation of the machine capacity within a shift:

$$E_s = \frac{T \times v \times D^2 \sqrt{\pi}}{n_c \times 4} \times k_1 \times k_2$$

Theoretical value:

$$E_s = \frac{450 \times 17 \times 0,9783^2 \times 3,14 \times 0,3 \times 0,9}{17 \times 4} = 91,330 \text{ m}^3 \text{ of logs}$$

Achieved value:

$$E_s = \frac{450 \times 8,51 \times 0,9783^2 \times 3,14 \times 0,365 \times 0,75}{17 \times 4} = 46,330 \text{ m}^3 \text{ of logs}$$

The results of this capacity calculation is that there is a considerable difference between the achieved machine output and the theoretically possible one. The difference amounts to 45 m³ per shift, i.e. 49.3 percent.

The reasons for the lack of the expected output can be found in the comparative table of production parameters. It appears quite clearly that there are considerable differences in the shift time coefficient (k_2) and in average log feed speed (v). The size of the negative value in the table shows quite clearly that the low machine output is mainly caused by the slow log feed speed.

A quick glance at the bandsaw blade was sufficient to find out that neither the preparation nor the shape of the saw tooth matched the operation's requirements.

In order to attain and/or approach the installed machine capacity:

- another shape of saw tooth must be selected and the sharpening and maintenance of the saw blades must be improved
- the work organization in the sawmill must be improved.

Of course, other less complicated methods of bandsaw capacity calculation can be applied, yet, they do not involve the analysis of the technical, technological and organizational parameters which influence the machine's output.

The machine's capacity can be determined rather quickly using some less complicated methods, however with less accuracy, by estimating the:

- shift time coefficient k_2
- effective working time on the machine;
- time required for sawing a log of an average diameter
- volume of an average log.

The elements constitute the formula:

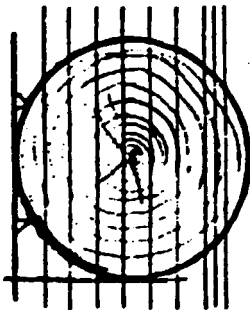
$$E_s = \frac{T \times k_2 \times Q}{t}$$

- E_s - capacity of the log bandsaw per shift (m^3 of logs)
- T - duration of the shift without a break (min)
- k_2 - shift time coefficient
- Q - volume of the average log (m^3)
- t - time required for sawing the average log (min.)

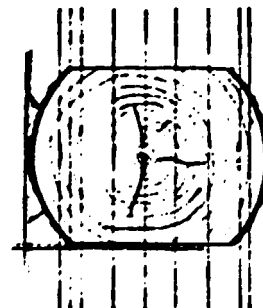
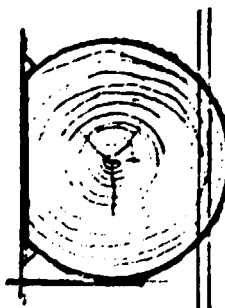
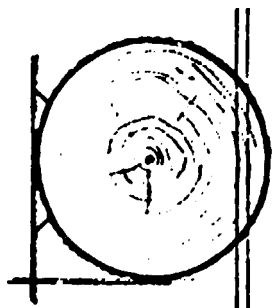
3. Some examples of methods for sawing tropical logs

Some theoretical schemes for log sawing are given hereunder. It must however be pointed out that these are but theoretical outlines of sawing methods that very often need to be combined in practice.

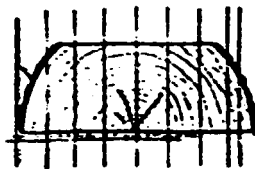
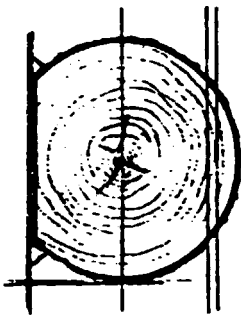
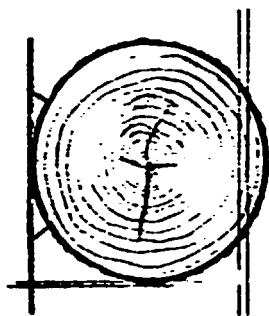
Examples A, B, D, and D hereunder display the simplest methods of sawing smaller logs with homogeneous wood structure devoid of any major defects.



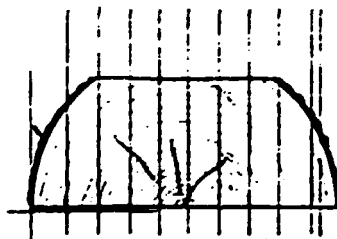
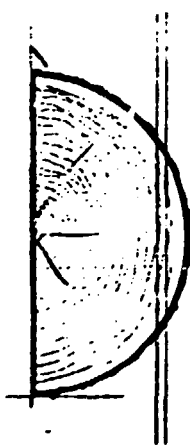
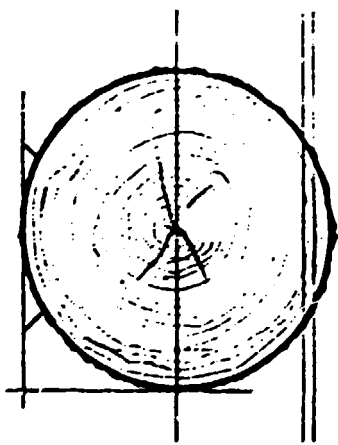
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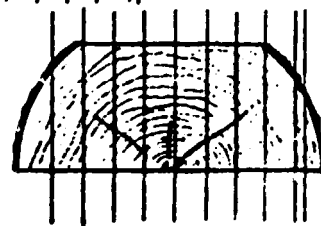
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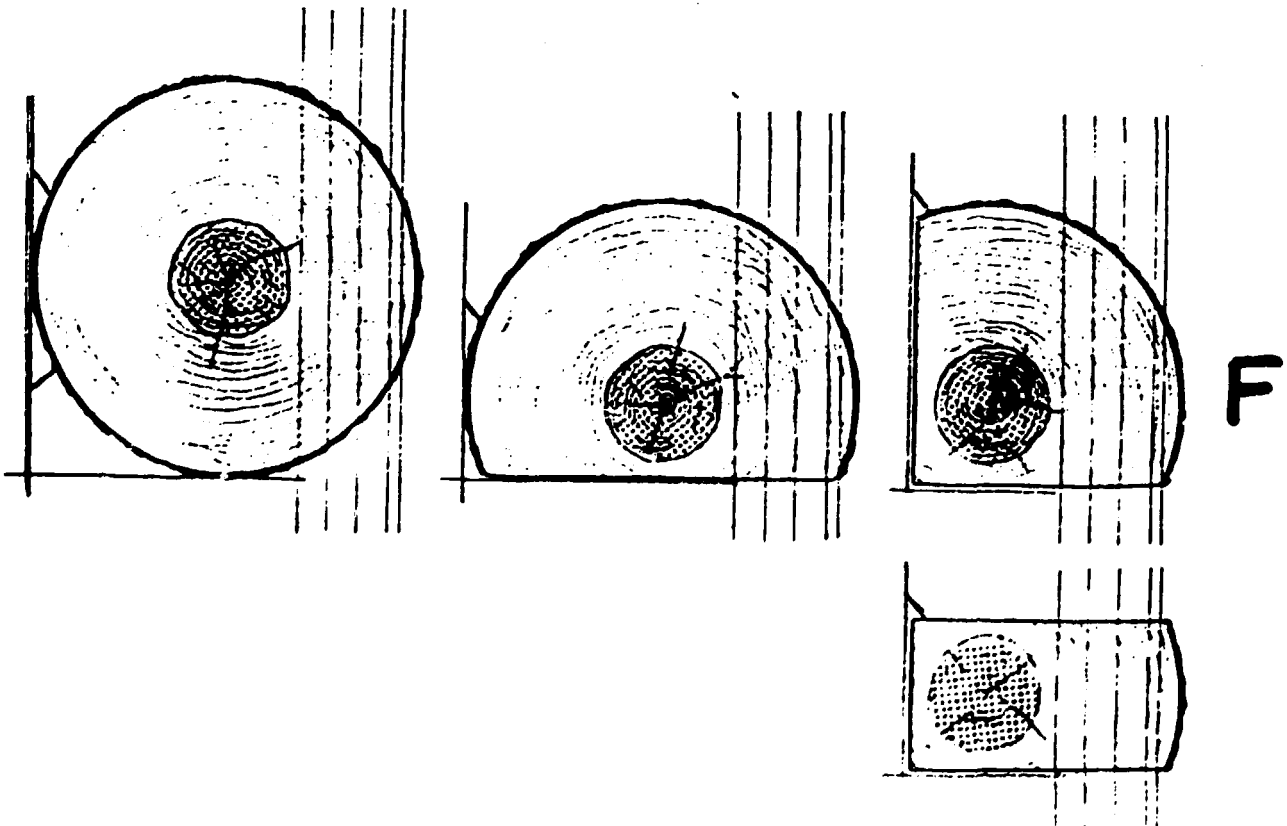
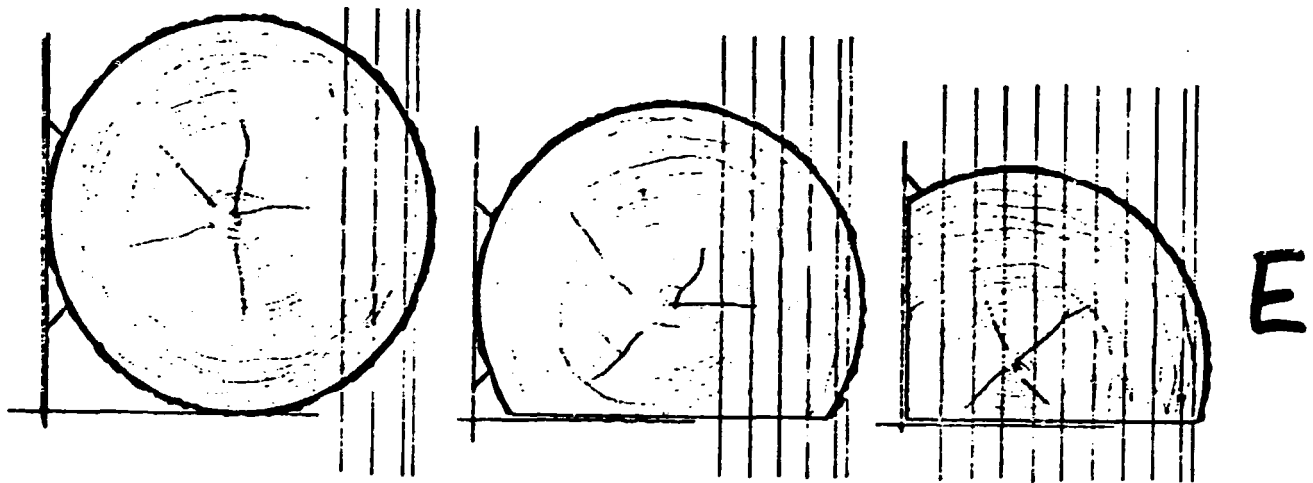
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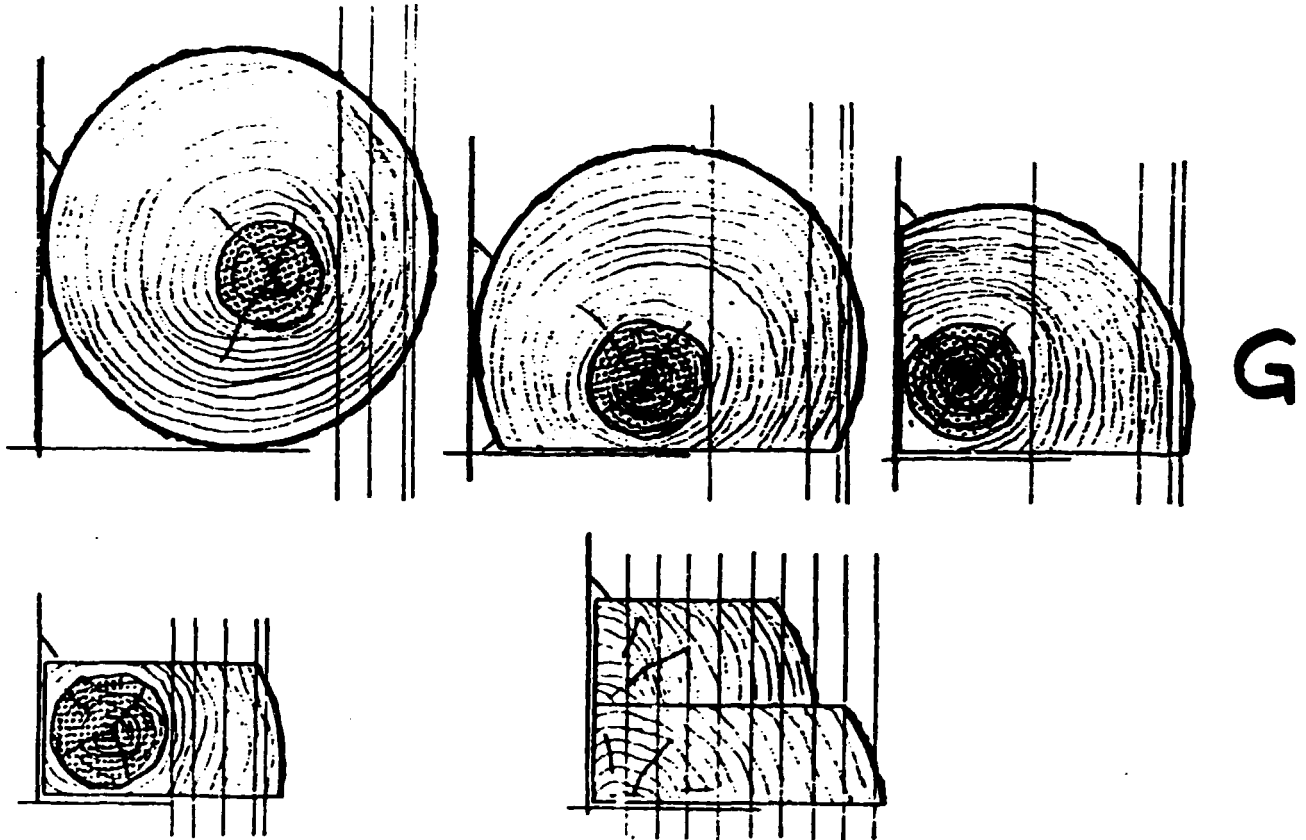
D



Example E hereunder shows the method of sawing logs of large diameters with homogeneous wood structure devoid of any major defects. Example F (also hereunder) can be suitable for sawing logs of large diameters with defective centers due to rot or ringshake. Such a case requires several operations for turning the log on the carriage in order to make use of the peripheral parts of the log. These are usually serious defects, and the log center is wasted so the log yield is therefore very small.



Example G shows the method of sawing logs with defective parts, in the form of rot or ringshake, lying away from the log's center. The method of sawing logs with eccentric defects permits however to achieve slightly better yields.

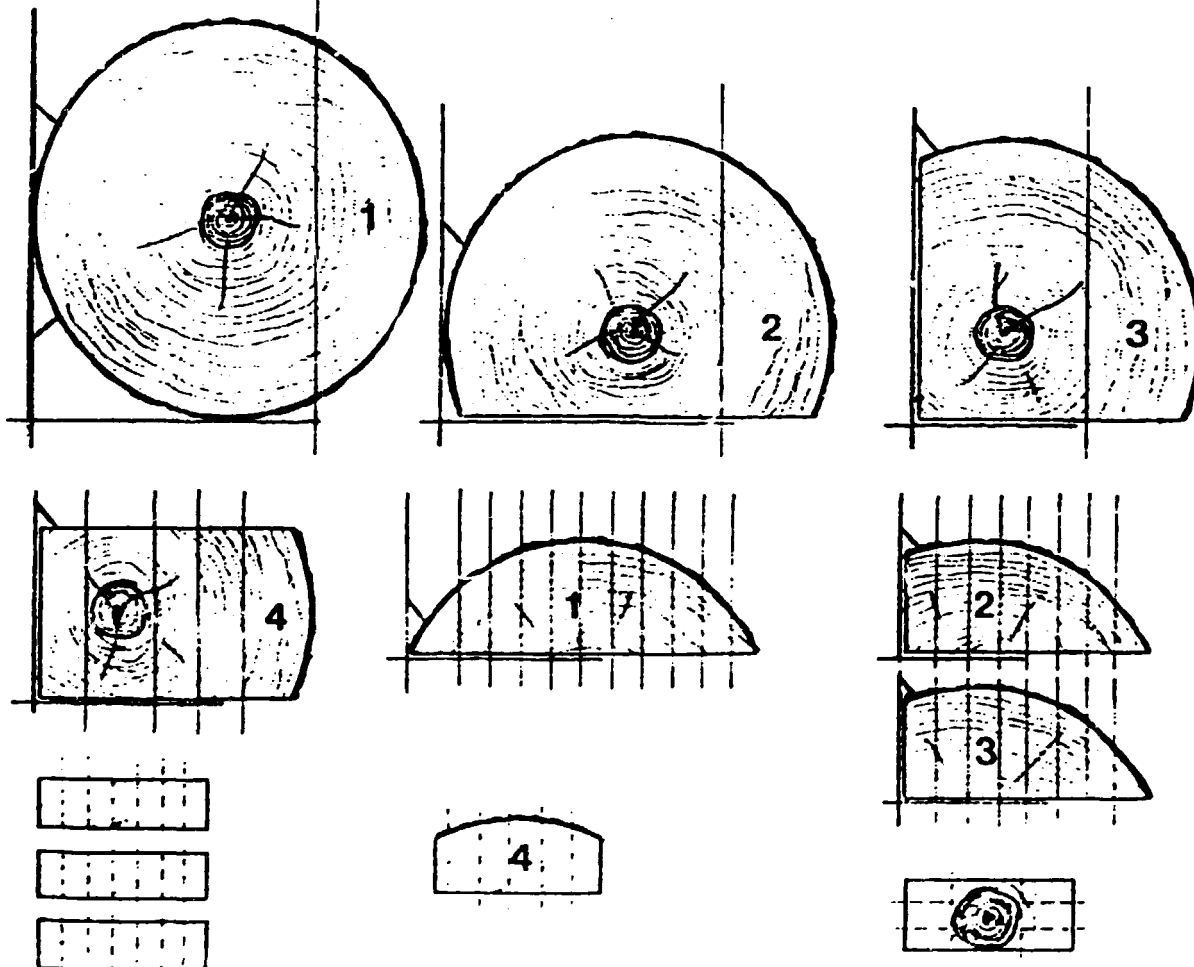


The methods of sawing according to the examples C, D, and G require equipment that must be installed behind the bandsaw headrig. This equipment is intended to take off thick flitches, store and refeeding them to the log carriages.

This equipment consists of:

- hydraulic off-loading arms to remove boards from the vertical position and place them horizontally.
- lifting cross conveyor to take off the flitches, and later on, to reload them on to the carriage.
- hoist for raising and stacking the flitches in case the operation is according to example G.

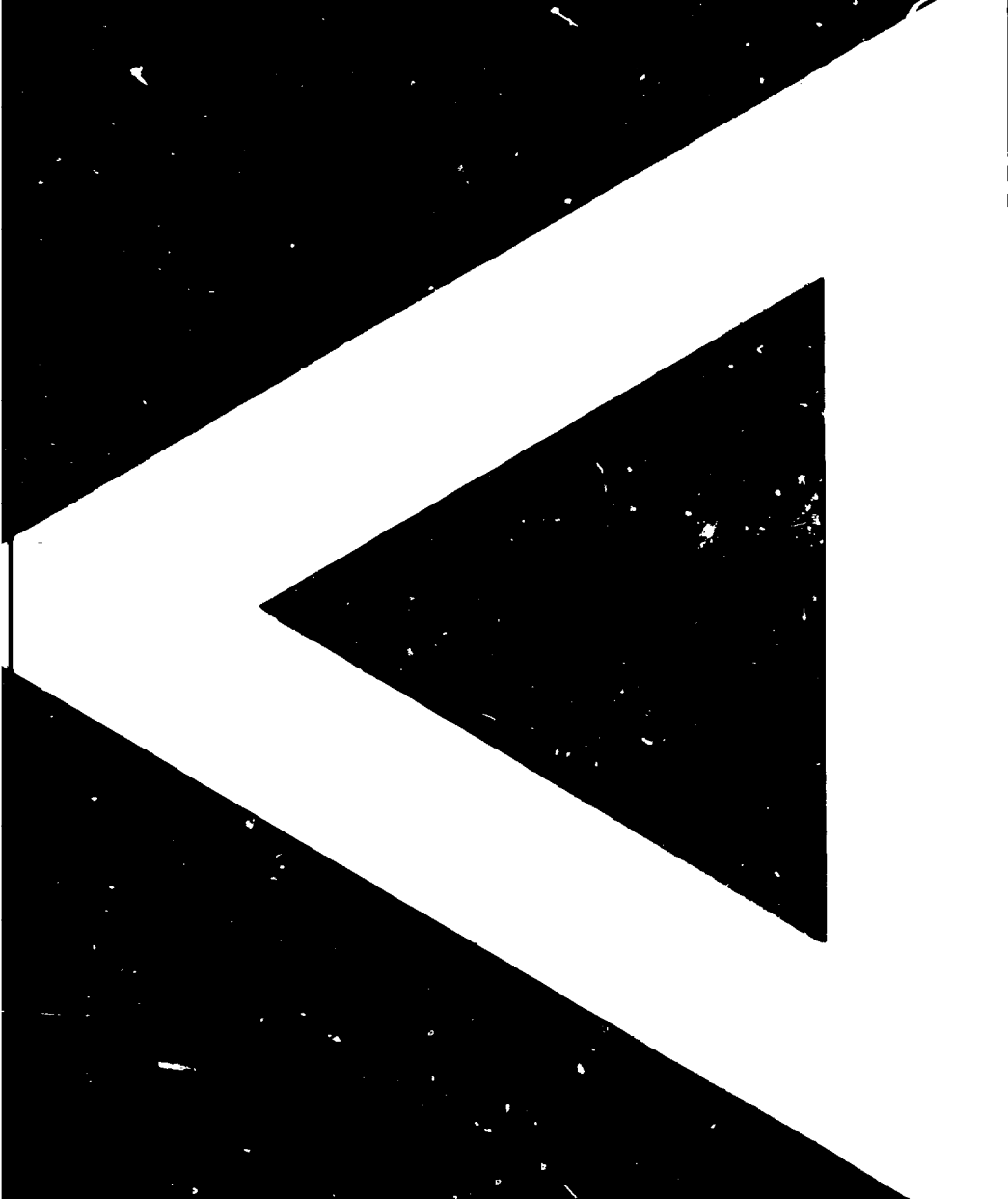
Example H hereunder is applied for sawing logs of the highest quality from valuable wood species. This method is used when most logs should be sawn radially in order to release (eliminate) the internal wood tensions, thus obtaining wood devoid of tensions, and subject only to minimum bending and shrinking during drying and subsequent machining.

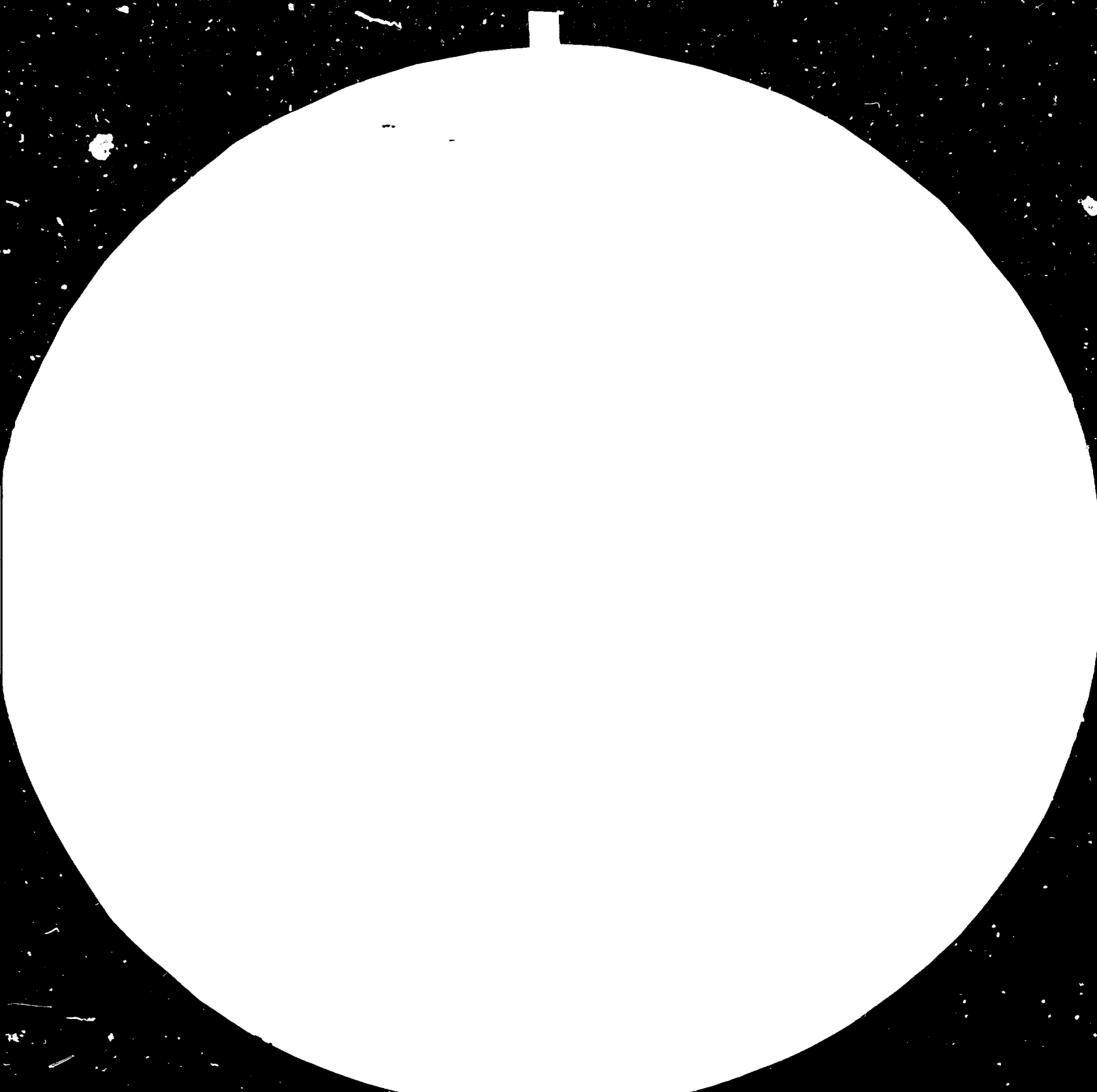


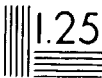
For the log breakdown according to example H, a band resaw must be installed. This method of sawing is rather expensive and takes a lot of time. Therefore, it is suitable only for machining valuable wood species. It might be also used on explicit demand, being of course adequately better paid.

As is shown by these examples, the sawing of tropical logs cannot be carried out without turning the logs on the carriage. There are several reasons for the log turning on the carriage during the log breakdown. This operation is aimed at:

- reducing the width of boards.
- rational cutting of defective logs;
- radial cutting of logs in order to obtain boards with wood devoid of any tensions.







2.8 2.5

2.2

2.0

1.8

Resolution Test Chart (NBS 1963-A) (ANSI Z39-18)

Resolution Test Chart (NBS 1963-A) (ANSI Z39-18)



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SOME CONSIDERATIONS FOR PLANNING SAWMILLS FOR TROPICAL LOGS

Addendum *

by

Z. Petric **

* The views expressed in this document are those of the author and do not necessarily reflect the views of the secretariat of UNIDO. This paper was reproduced without formal editing.

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INTRODUCTION

A wide range of important factors have to be considered when planning a sawmill in the tropics. These factors can be grouped under two headings:

- factors related to the plant's location;
- factors related to the equipment selection.

The former vary so much from case to case that they cannot be covered in such a paper.

The scope of this paper is to give a picture of sawmill equipment for the tropics by presenting the various alternatives for machinery needed with options ranging from simple to operate to sophisticated, so as to facilitate the selection.

There are additional points that need to be analyzed before any decision on equipment selection can be taken. These are:

- (a) Different tropical wood species vary in their characteristics. Variances in log diameter and length, wood structure and density are factors related to the raw material that influence the required degree of flexibility of the sawmill equipment best suited and their technical characteristics such as feed speed, motor power, rpm, construction details and size.
- (b) Different options of available machinery and equipment have each varying capacity ranges. One of the first parameters that should be determined is the daily and yearly volume of log throughput. This requires a detailed analysis of the sources of raw material supply and the characteristics of the domestic and export markets.
- (c) Developing countries frequently face a high rate of unemployment, shortage of competent technical personnel and middle-management, and, poor or non-existent support services for industry. These factors play a very important role in the successful running of a sawmill. When deciding on the degree of mechanization and the level of sophistication, a thorough consideration should be given to the above factors.

LOG HANDLING EQUIPMENT

(a) Portal cranes:

A portal crane as seen in fig. 1 hereunder can be used for unloading logs, stacking them in storage and transporting them to the sawmill. The portal crane enables the stacking of logs to much greater height than can a wheeled loader, and is therefore suitable for operation in logyards with limited storage surface. The maintenance of portal cranes is quite simple, but the prevention of corrosion in the littoral and tropical regions is rather expensive.

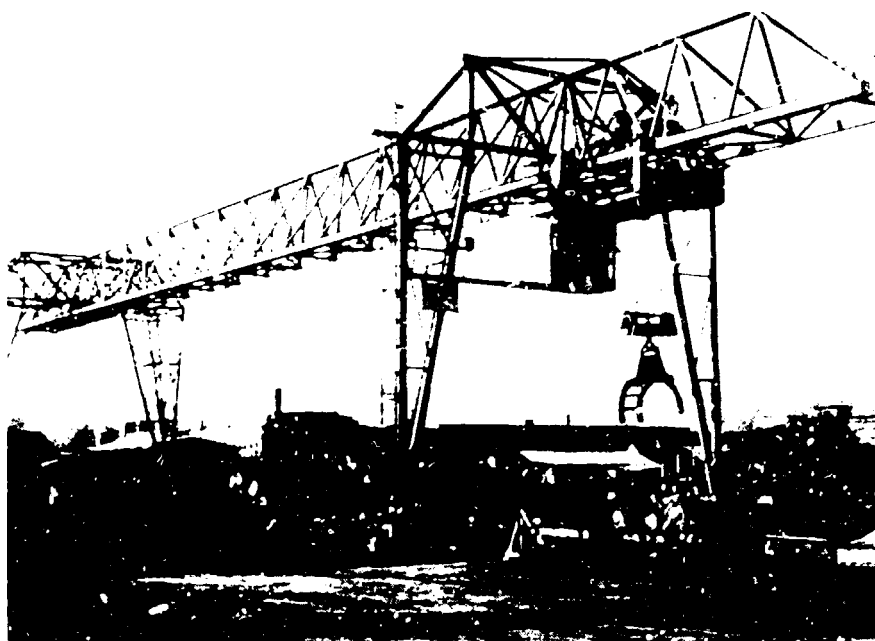


Fig. 1: portal crane.

A portal crane consists of rails, a metal construction, a mechanism for driving the metal construction, a drive mechanism for shifting the lifting mechanism along the construction, a lifting mechanism, a cabin and hydraulic grips (grabber) (see fig. 2 hereunder).

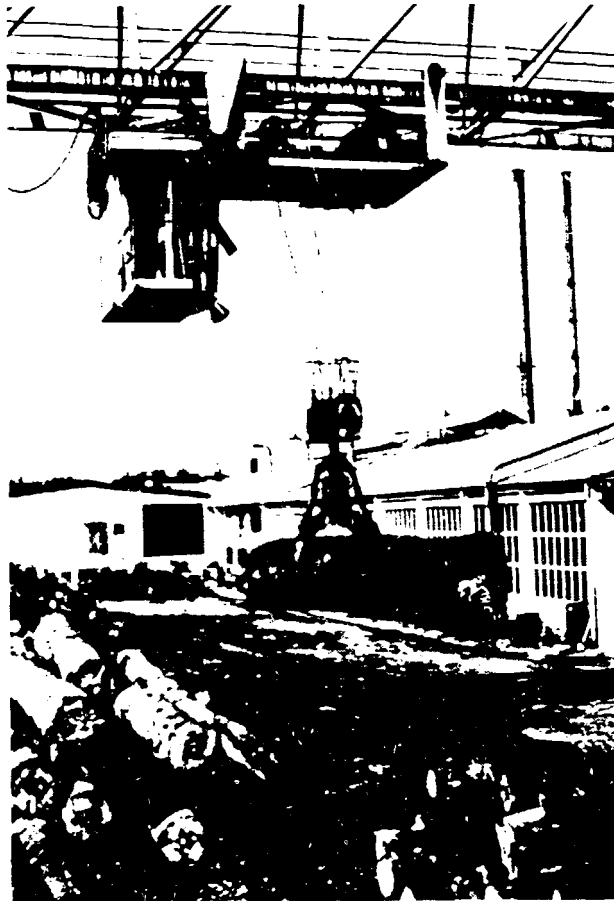


Fig. 2: Cabin, grabber, drive and lifting mechanisms of a portal frame.

The load can be moved in the horizontal, vertical and transverse directions. Mechanical grips or wire cable sling can be used instead of the hydraulic grips (grabber).

The operating zone of the portal crane is limited by the length of the rails, and the span between the mobile towers supporting the beam. The construction can be extended on both sides by means of cantilevered consoles. The usual span ranges from 40 to 70 m, with the console extending up to 15 m on either side.

The grips holding with the load can be rotated around its axle.

The central remote control system for all the functions of the crane is located in the cabin. The capacity of the crane usually ranges for 10 to 12 tons.

(b) Bridge cranes:

A bridge crane of smaller span is especially suitable for the transport of logs from the logyard into the sawing hall and placing the logs onto the machine as well as for operation in production halls (fig. 3).



Fig. 3: A bridge crane

Bridge cranes consist of the supporting framework, a mechanism for driving the construction, a driving mechanism for shifting the lifting mechanism along the construction, a lifting mechanism, grips, wire cable slings and dogs for fixing the log.

The bridge crane is controlled by means of a control panel (fig. 4) which hangs from the crane's superstructure. The operator holds the control panel and through it controls all the operations of the bridge crane. The operator follows the load and can also assist in positioning the load manually.



Fig. 4: Control panel of a bridge crane.

LOG BUCKING EQUIPMENT

(a) Portable chain saws:

Logs can be cut-to-size manually by using an electric- or petrol driven chain saw or by a fixed electric-driven chain saw. The manual bucking and cutting to size is mostly done in the logyards outside the sawmill or veneer plant. This method is the most commonly used, being both simple and cheap.

(b) Stationary chain saws:

A stationary chain saw is used for resawing and cutting to size in large scale woodworking plants, where regular log feeding times are required. In this case, a log travels from the longitudinal conveyor to the chain saw and is then sawn by the chain saw. The cut log is then conveyed by the longitudinal conveyor into the sawmill.

Fig. 5 clearly shows a stationary chain saw and the control unit for the longitudinal conveyor system, the operator, the arms for fixing the log to be sawn and the belt conveyor for transporting the log ends (trimmings) and sawdust.

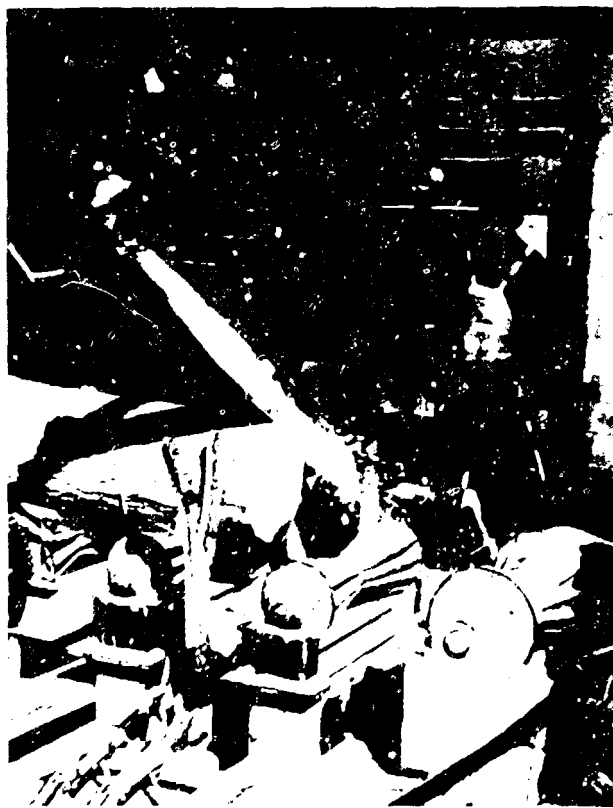


Fig. 5: A stationary chain saw.

After the cross-cutting, the log arms are lowered and the chain conveyor is activated to remove the log from the saw and advance the next one.

DEBARKING EQUIPMENT

Before being processed on any woodworking machine, logs must first be debarked and cleaned, i.e. sand, mud and stones must be removed. The cleaning can be performed by:

(a) Manual portable equipment:

Electrically operated hand-held flat scrapers or barkers can be successfully used at low throughput mills (fig. 6). Their rotating spindles are equipped with replaceable milling knives. These knives can be resharpened when dull, or replaced when broken.



Fig. 6: An electrically operated portable scraper debarker.

(b) Mechanized stationary machines:

Mechanized stationary debarking machines differ according to whether they are to be used for coniferous or deciduous logs. Fig. 7 shows the debarking machine which is usually used for debarking tropical logs. This machine consists of:

- the conveyor allowing the log to rotate during the debarking;
- the frame with an arm, on which a rotating plane head is fixed;
- the control cabin, housing the central control panel, to control all machine functions and the conveying equipment;
- devices for removing bark by pneumatic extraction or by means of a belt conveyor.



Fig. 7: A mechanized stationary debarking machine

This machine incorporates a device for rotating the log while the control panel and the arm as well as the spindle move along the rotating log (fig.8). There is another type of machine with the control panel, arm and the spindle fastened onto it whereas the mobile carriage with the device for rotating the logs moves along the milling spindle.

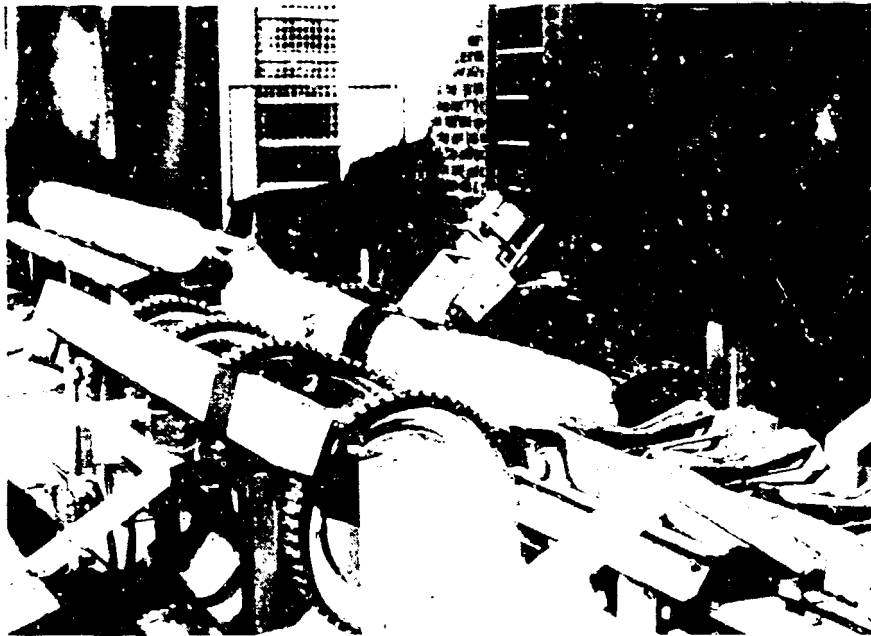


Fig. 8: Rotating device for debarkers.

The milling spindle consists of several rotating discs that are equipped with milling knives (fig. 9). These knives can be replaced or sharpened and reused.

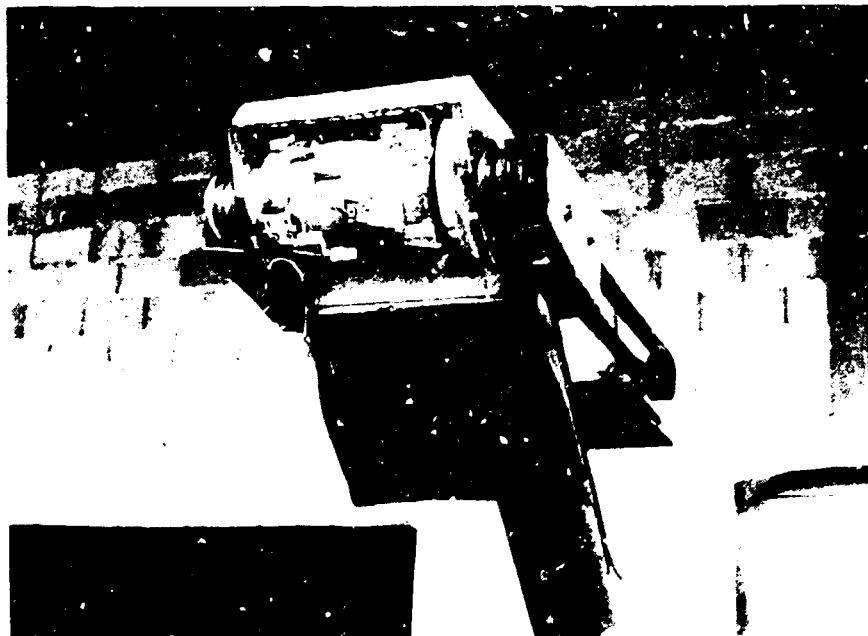


Fig. 9: Milling spindle.

The debarking machines using cutterheads have the advantage of regulating the cutterhead pressure on the log surface. The cutterhead operates relatively gently when debarking the log and more roughly when chopping up knots. By using these machines, it is possible to rectify any irregular form of a log so as to make it more cylindrical.

Mechanized debarking of logs requires also mechanized transport. Longitudinal conveyors enable the debarking of the log while it is being transported to the sawing hall. These machines are located in front of the sawing hall.

LOG BAND SAWS

Several types of log band saws exist. These differ with regard to the position of the saw:

(a) Portable horizontal band saws:

Portable band saws are those saws that can be placed on an even ground without having to be fastened onto a foundation (fig. 10).

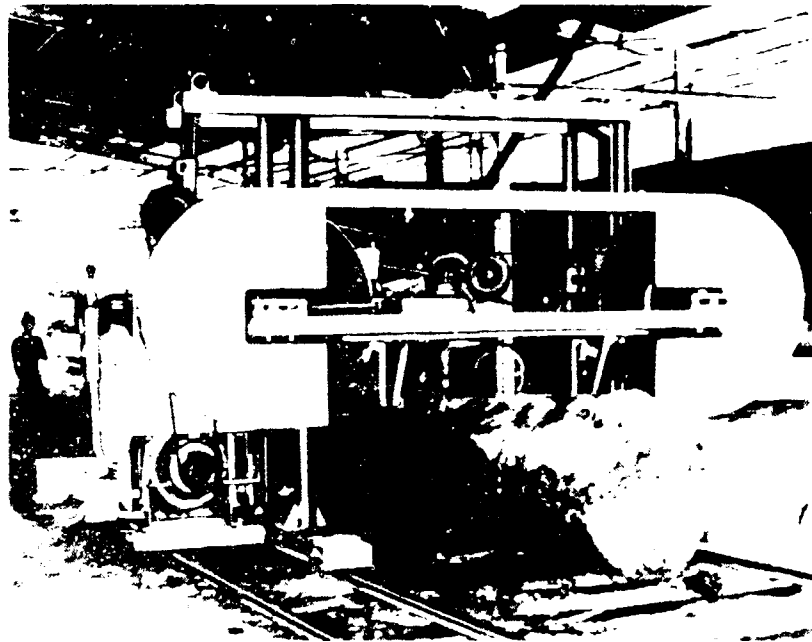


Fig. 10: Portable horizontal band saw.

These saws are suitable for erection near the forest or near the raw material source. As soon as all the logs have been sawn, the band saw can be dismantled and transferred to another location.

The log is fixed on a stable frame. The headrig (incorporating the two pulleys) is equipped with wheels, and runs on rails. The band saw blade runs between the two pulleys and saws the log while the machine moves slowly on the rails. The main feature of these machines is that they are not expensive and are portable. Because of the low accuracy of sawing they can be only used for sawing logs into boards which are later used as building material. These machines are usually provided with two petrol engines, one for the pulley drive and another for the machine drive.

(b) Fixed horizontal band saws:

Fixed horizontal band saws (fig. 11) for log breakdown are used for sawing logs with extremely large diameters, or those that are very long. The work on the horizontal band saw can be mechanized by installing simple devices such as a bridge crane for hoisting both logs and boards or a vacuum hoist for boards. This type of machine is mainly intended for sawing smaller quantities of logs or for machining logs that are later processed in the veneer plant. In principle, the headrig of the fixed horizontal band saw is placed on a foundation and supported on two sides. Between the columns of the headrig under the saw blade there are rails on which the feed carriage runs. This machine is much more stable than that of the portable band saw. Both the machine and the saw blade are subject to less vibrations. Though the machine is electrically driven, most mechanical functions are hydraulically operated. The board thickness is adjusted by raising or lowering the frame with the pulleys and the saw blade respectively. This is operated hydraulically.

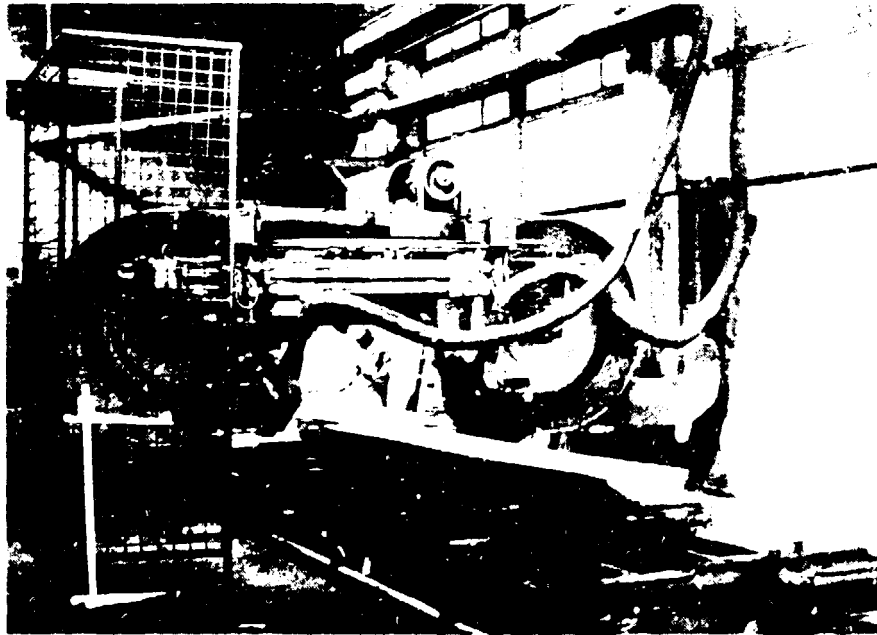


Fig. 11: A fixed horizontal band saw.

(c) Vertical band saws:

A characteristic of vertical band saws is that they are provided with a foundation on which the headrig is fixed. This headrig is carrying two pulleys which are fitted one above the other. The feed carriage, moving forwards and backwards on rails, is an integral part of the machine. Due to this construction, the vertical log band saw can be mechanized efficiently. As these are machines of the highest capacity, they are consequently the most used, and are installed in practically every sawmill for tropical logs.

Fig. 12 shows a simple vertical band saw for the log breakdown, where the machine and the feed carriage are manually operated. The spanning of saw blades, the log and feed carriage speed etc. are manually operated. The simple mechanical carriage drive is shown under the rails.

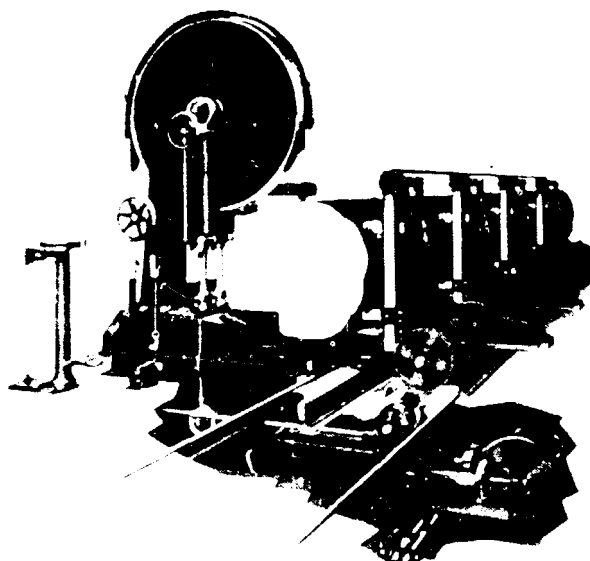


Fig. 12: A simple manually operated vertical band saw.

Fig. 13 displays a large log band saw for the breakdown of tropical logs. The pulleys have a diameter of 1800 mm and is therefore suitable for sawing logs of up to 180 cm in diameter.

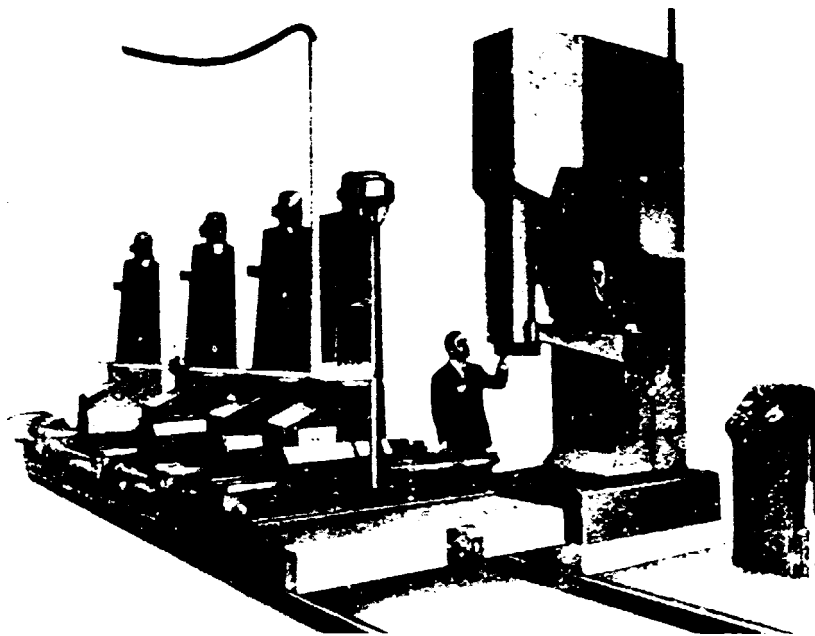


Fig. 13: Large log band saw with carriage (electro-mechanic adjustments).

A special feature of the feed carriage in fig. 13 is that the adjustment of the log feed and the board thickness is operated electro-mechanically. The controls for the machine and the feed carriage are located in a control panel which can be located up to about 7 m away from the machine.

Fig. 14 shows a bigger log band saw for the breakdown of tropical logs. The construction of the feed carriage permits the log feed and board thickness adjustment to be operated pneumatically. On the right side of the picture is the casing housing the electric equipment pertaining to the machine.

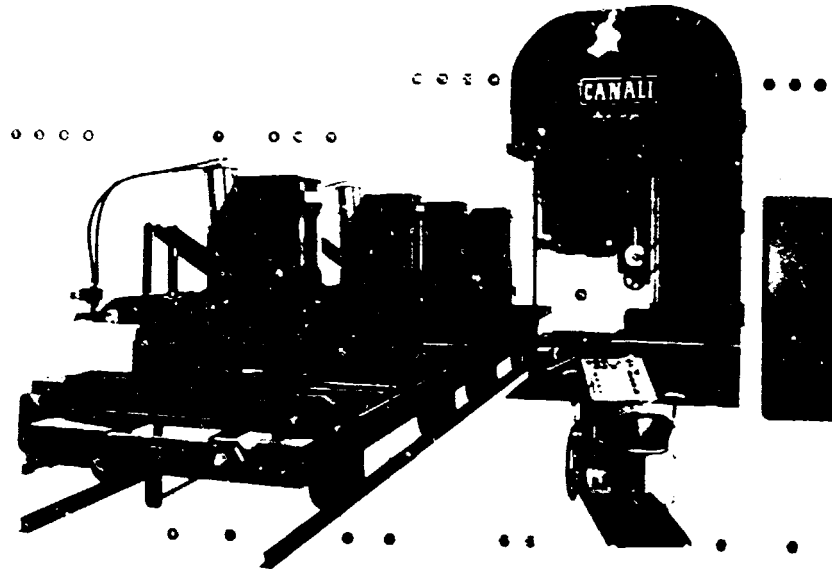


Fig. 14: Large log band saw (pneumatic adjustments).

Fig. 15 shows a bigger band saw for the breakdown of tropical logs. The particular feature of its feed carriage is that the log feed and thickness adjustment are hydraulically operated.

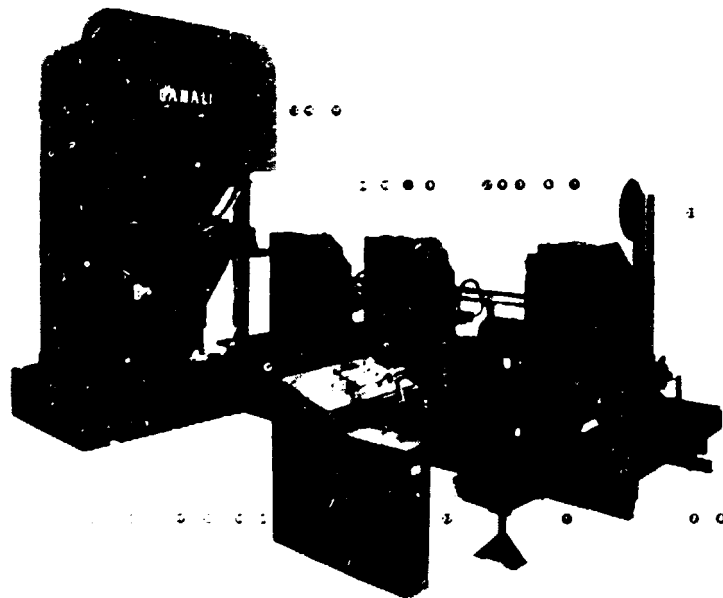


Fig. 15: Large log band saw (hydraulic adjustments).

Fig. 16 shows an extremely robust type of a log band saw for tropical logs, with an extremely heavy log feed carriage for the largest diameter logs. This machine has been designed for operation in a fully mechanized sawmill. Furthermore, it is designed for very large capacities. The control panel enables the electronic thickness adjustment and the programming of the thickness adjustment.

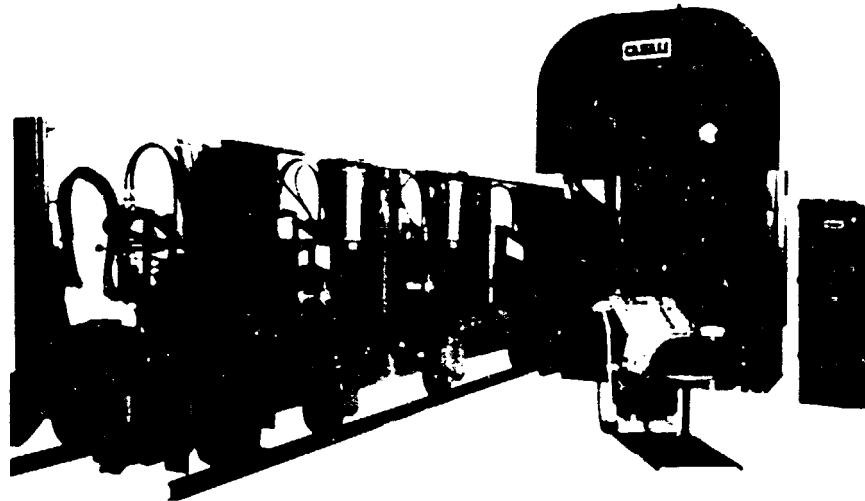


Fig. 16: Heavy-duty log band saw and carriage for largest diameter logs (with electronic programmable adjustments).

(d) Vertical band resaws:

Fig. 17 shows a band resaw which is usually not found in sawmills for tropical logs. It may be installed in a mechanized sawmill, to saw thick boards into two thinner ones by a central cut. Modern band resaws for central cutting exist which saw automatically, without any operator. In this case, a rather sophisticated system of conveyors has to be used.

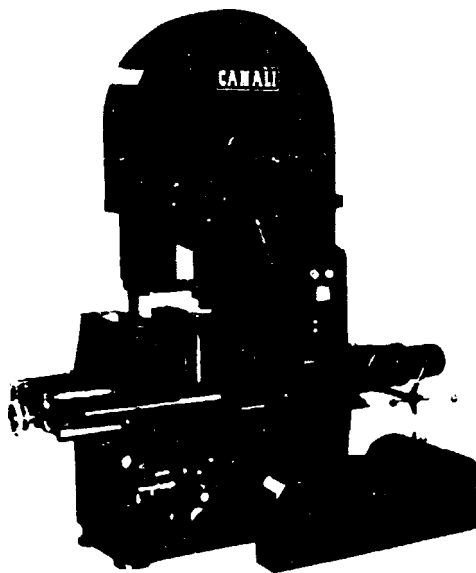


Fig. 17: A vertical band resaw.

AUXILIARY DEVICES ASSOCIATED WITH BAND SAWS

There are various auxiliary devices associated with band saws which facilitate the handling of logs during the breakdown on the band saws:

(a) Log carriages:

Log carriages differ by their weight, their feed speed, the way the log feed and the way the board thickness is adjusted. Fig. 18 shows a lighter log carriage with manually operated working functions, such as dogging gears and hand setworks.

Fig. 19 shows the top and the bottom dogs that are individually adjustable. Both dogs are pushed into the log by the long hand lever.

The control lever, the drive assembly, the turn pulley and the pressure assembly (which is sometimes replaced by a hydraulic assembly) are the essential units of a log carriage (fig. 20).

The drive assembly for a large and heavy log carriage consists of a strong steel frame which carries a hydraulic motor, reduction chain drives, a wire rope drum, a flexible coupling, roller chains and a wire cable connected to the carriage (fig. 21).



Fig. 18: A manually operated log carriage.

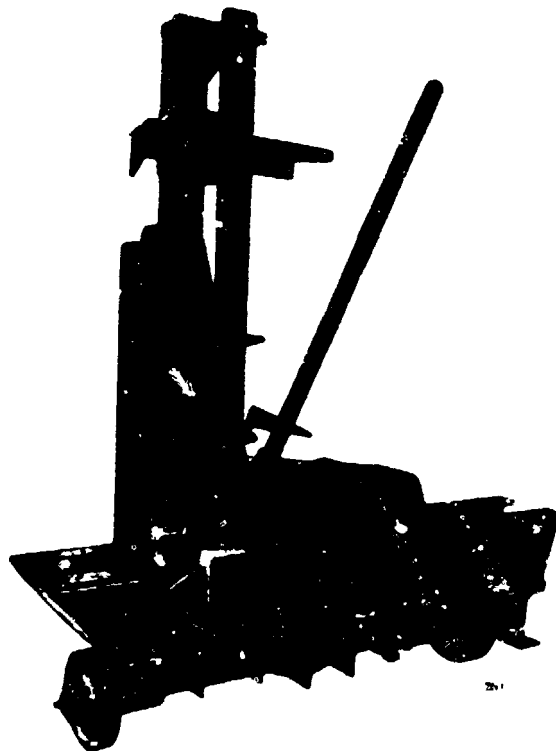


Fig. 19: Portion of a log carriage showing manually operated clamping dogs.

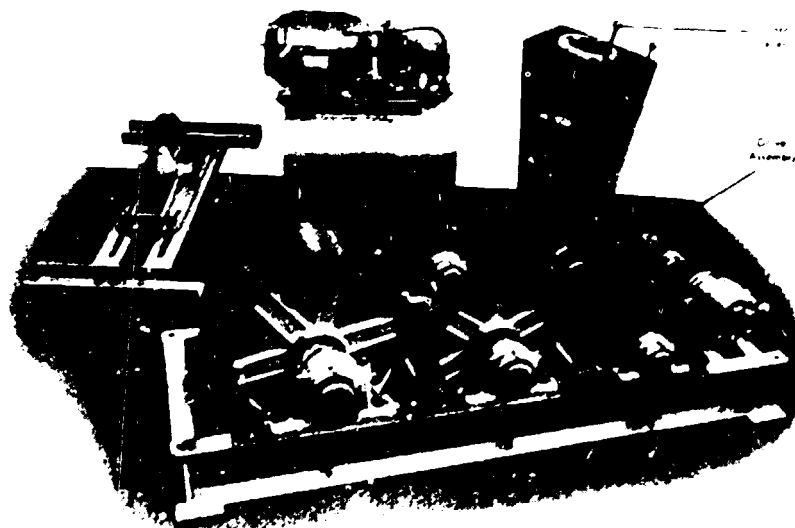


Fig. 20: Essential operating units of a log carriage.

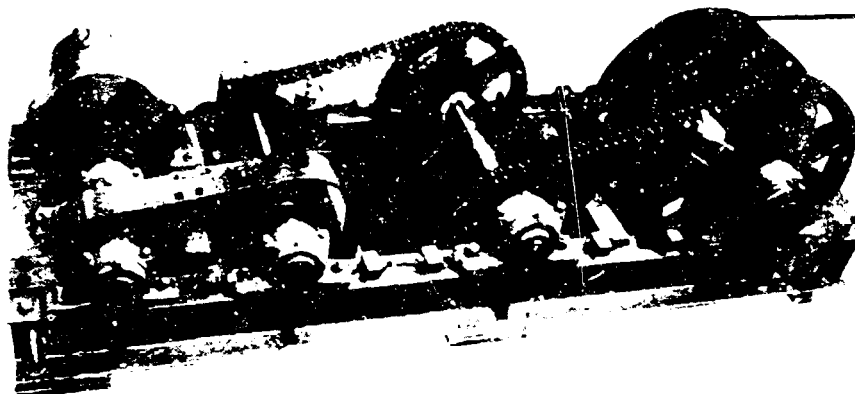


Fig. 21: Drive assembly of a log carriage.

(b) Pusher arms:

Pusher arms are used to transfer the logs from the driven cross conveyors onto the log carriages.

Fig. 22 shows log pusher arms. On the right side is the cross conveyor by means of which the log has been transported to the feed carriage. The log is then pushed onto the carriage by two hydraulically operated pusher arms.



Fig. 22: Log pusher arms and log turner.

(c) Log turners:

While positioning the log on the carriage the crookedness, ring shakes, rot and knots present should be taken into consideration. The first cut in the log affects the yield obtained from the entire log.

As soon as the log has been pushed onto the log carriage, it must be turned by the log turner into the right position for the subsequent breakdown.

An example of earlier type standard log turners can be seen also in Fig. 22, where it is combined with the pusher arms.

Fig. 23 shows a more modern type of the log loader turner. Two or three horizontal and vertical raising arms are fitted into the feed carriage. The chain runs along these arms in both directions (crosswise for the horizontal arms and up and down for the vertical arms). While the horizontal arms are rotating upwards and the chains are running, the log starts turning.



Fig. 23: A modern log loader cum turner.

Chain log turners can turn logs on the carriage with very small increments. Therefore they are much better than the standard loader-turners. This type of log turner is suitable for turning logs with both large and small diameters, flitches, slabs and thick boards.

(d) Loading arms:

Loading arms (fig. 24) are used to lift logs and flitches from the mechanized cross conveyor onto the carriage.

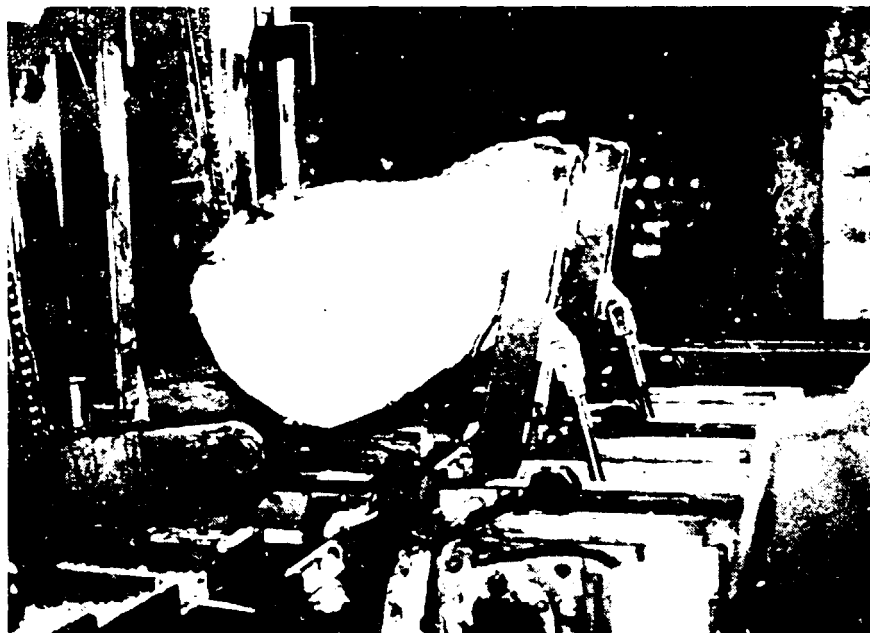


Fig. 24: A loading arm.

(e) Off loading arms:

When sawing on vertical band saws, each board falls from the log onto the longitudinal conveyor. In order to prevent the board from damaging itself, especially from breaking, off loading arms are increasingly being used to alleviate the fall and prevent damages (fig. 25). Heavy flitches also can be loaded off the carriage and put onto the conveyor without any damages (fig. 26).

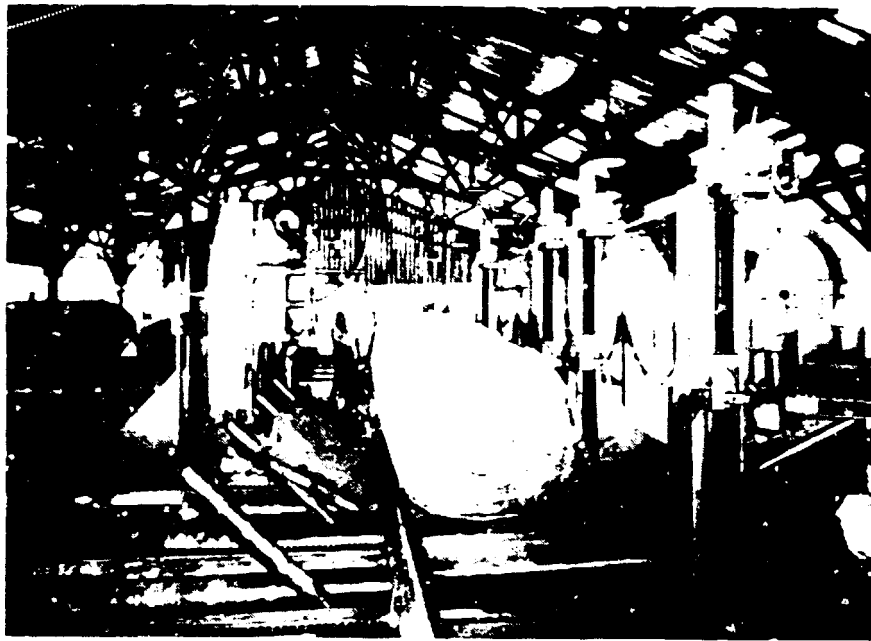


Fig. 25: An off-loading arm handling a sawn board.

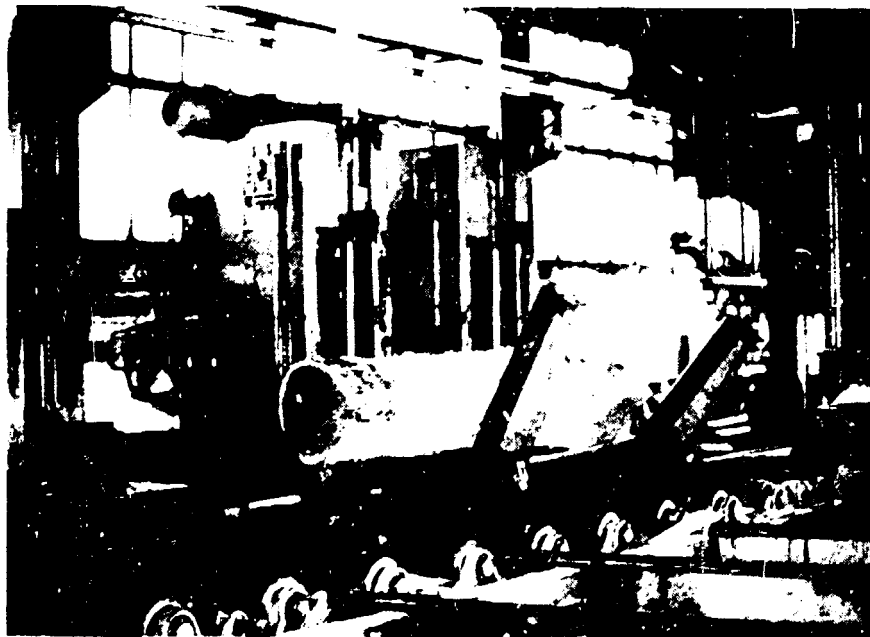


Fig. 26: An off-loading arm handling a flitch.

(f) Controls:

Controls enable remote control of all operations. The control panel must be placed so that the operator can see the log as well as all parts of the machine when the machine is in operation. In practice, there are two locations of the control panel: either at the head rig or at the feed end. The location at the headrig allows a better log yield; but it is dangerous in case of rupture of saw blade. In view of this, controls for motors, carriages, conveyors and other auxiliary equipment should be carefully placed, both from the point of view of convenience to the operators, both in the starting up and in normal production and from the safety point of view, where operators might be injured or conveyors, carriages, sawing equipment or the timber being sawn might be damaged if they cannot be stopped quickly in an emergency. It is logical to use combinations of automatic and manual starting and stopping devices, with manual overriding control in some cases.

Fig. 27 shows a control gear for a typical older type 'one-man' band mill consisting of the control panel with electric setworks, with the setting pointer and switches for all devices at the headrig, on the log carriage and the auxiliary devices.



Fig. 27: Typical older type control panel.

Modern control panels look different. They are provided with more switches for setting the programmed thickness. There are also electronic devices for the adjustment of the thickness etc. Nowadays, control panels are housed in closed cabins so as to protect the operator against noise and dust. Fig. 28 shows an example of a modern control panel with a comfortable chair allowing a quick control of the machine and the auxiliary devices.

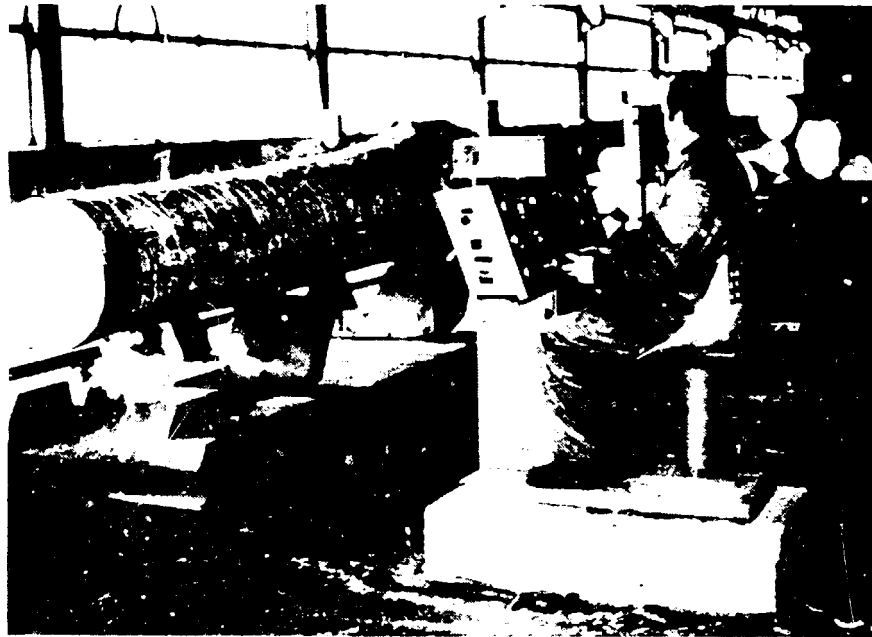


Fig. 28: A modern control panel.

(g) Single circular saws:

Circular saws that are installed in front of log band saws are intended for longitudinal sawing of logs. They operate efficiently in a combination with a vertical and a horizontal band saw. Fig. 29 shows a single blade circular saw used for:

- cutting a wide board into two narrower boards,
- edging a board.

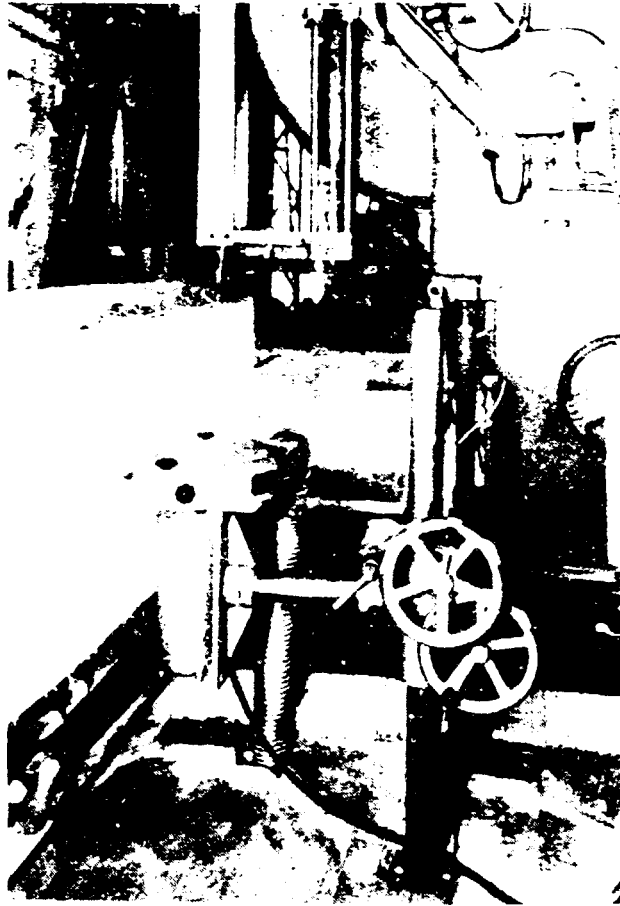


Fig. 29: Single circular saw.

(h) Double circular saws:

Fig. 30 shows a system of two circular saws for the longitudinal sawing of boards. Each blade of the circular saw can be moved hydraulically to the desired position. In this way, the width of any board can be adjusted individually, according to the requirements. Double circular saws for longitudinal sawing are suitable for:

- simultaneous edging of a board (on both sides),
- cutting out the center of a wide board (fig. 31)
- cutting a wide board into three narrower ones,
- edging a board on one side and halving it at the same time (fig. 32).

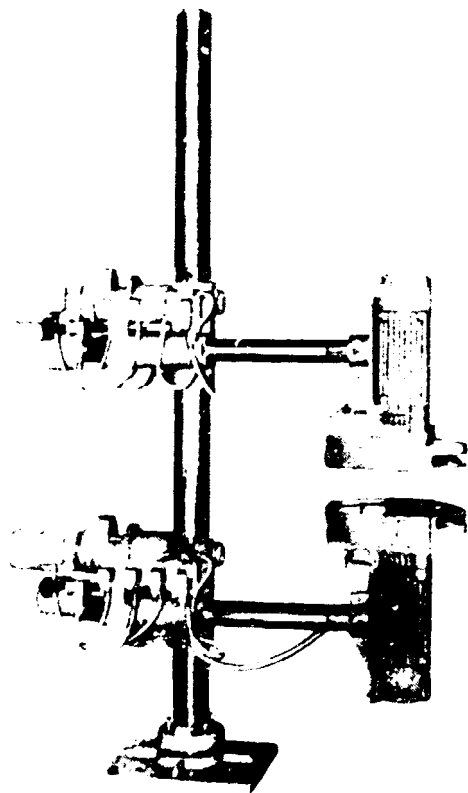


Fig. 30: Double circular saw for longitudinal sawing (ripping)



Fig. 31: Double circular saw cutting the centre of a wide board.

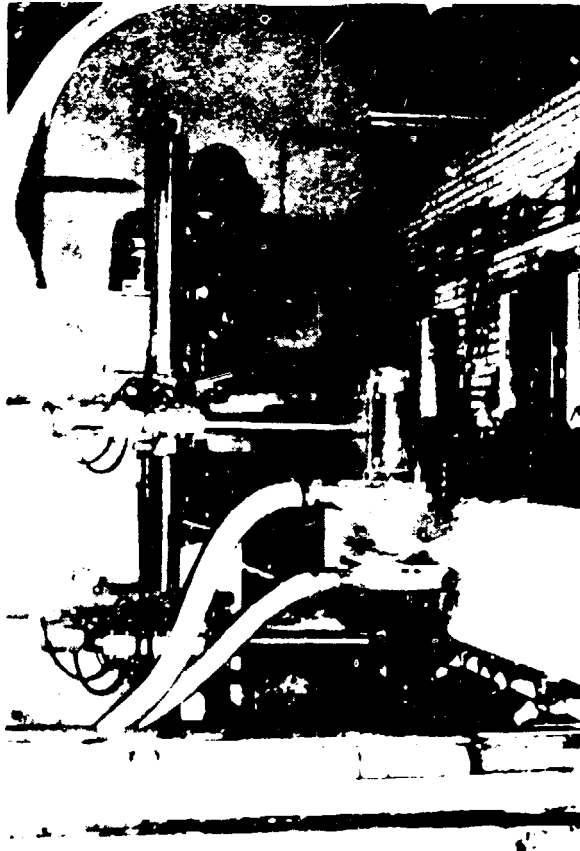


Fig. 32: A double circular saw edging and halving a board.

(i) Multiblade Circular Saw:

Multiblade circular saws can be successfully used for longitudinal sawing (ripping) on both vertical and horizontal band saws. One, two or even several saws can operate efficiently. Fig. 33 (a) shows two circular saws that are edging a board as it is being sawn from a log; while Fig. 33 (b) shows how several circular saws can be used for sawing a board lengthwise into narrower pieces.



Fig. 33: Multiple circular saws for (a) edging and (b) ripping.

(j) Vacuum hoist on horizontal band saws:

The characteristic feature of the horizontal band saw is that the board, which has been sawn does not fall from the log but remains lying on it. As the log is lying on the feed carriage it is rather difficult to take the board away, especially in case of a large diameter. Fig. 34 shows clearly that the off-loading of the board using a vacuum hoist proceeds quite simply.

A vacuum hoist can also be mounted onto a bridge crane. The bridge crane enables the movement of the hoist lengthwise and crosswise. This means that the operation zone of the hoist depends on the length of the rails and on the span of the crane's bridge construction.

Fig. 35 shows the off-loading of a board from a large diameter log, and from quite a considerable height. Manual off-loading of the board from this height would be quite problematic. A vacuum hoist can be used also for cleaning sawdust from the board's surface (fig. 36).



Fig. 34: A vacuum hoist used on a horizontal band saw.

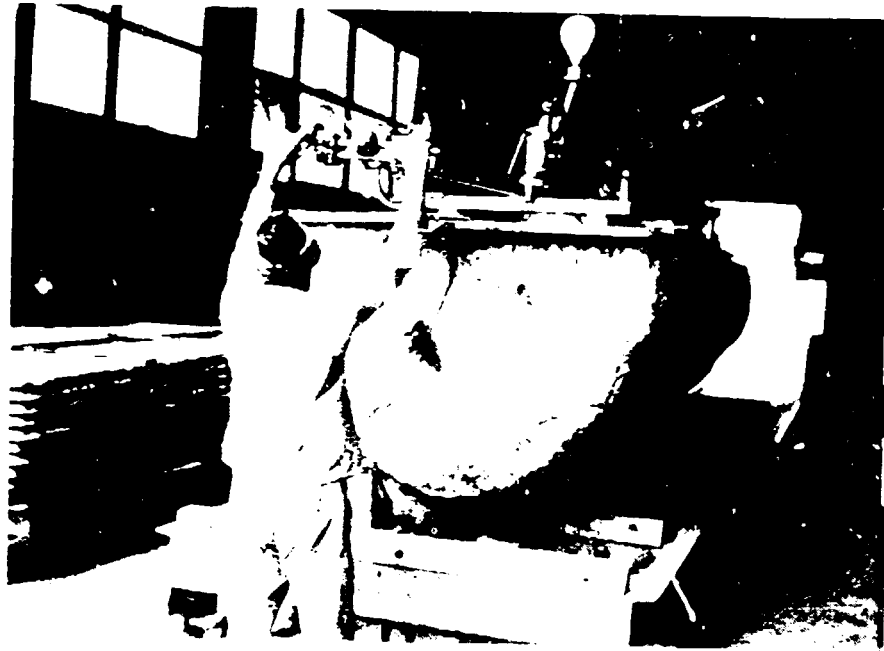


Fig. 35: Off-loading a board from a large diameter log using a vacuum hoist.

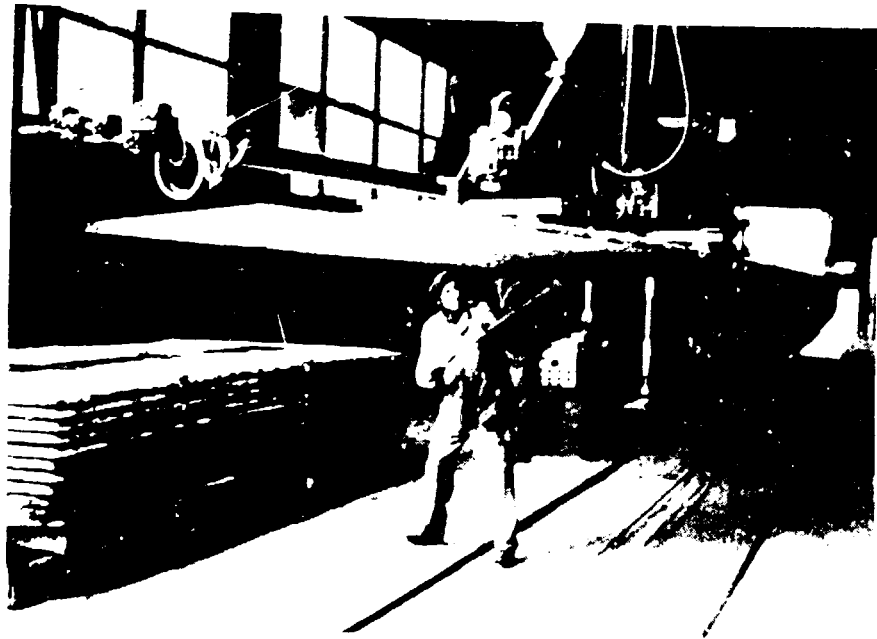


Fig. 36: Cleaning the underside of a board being held by a vacuum hoist.

(k) Vacuum hoist on vertical band saws:

Fig. 37 shows a pneumatic hoist off-loading boards from a vertical band saw. After the sawblade has advanced more than half of the length, the operator nears the hoist to the board and presses the suction plate onto the board's surface. For this purpose, the hoist is provided with an additional device which permits the turning of the suction plate by 90° . After it has been separated from the log, the board is carried and stacked onto the stack.

With vacuum hoists, it is also possible to handle two parallel lying boards at a time. On a vertical band saw, which is additionally equipped with a circular saw for the longitudinal sawing of boards, two boards are always sawn from the log simultaneously. The removal of both boards from the vertical position, their shifting by 90° , and their stacking does not cause any problem if the hoist is properly placed.

The hoist in Fig. 36 hangs from a rotating console. These types of hoists operate in a circular area with a radius of 6m. This type of hoist is called a console vacuum hoist.



Fig. 37: Console vacuum hoist used on a vertical band saw.

FRAME SAWS

Tropical logs of smaller diameter can be sawn either on log band saws and resaws or on frame saws. There is a great difference between sawing a log on a band saw and a frame saw. The log band saw saws the log into individual boards with one saw blade in such a way that the log can be turned in order to change the thickness of the boards and improve the quality eliminating defects.

In sawing on a frame saw, the log passes through the frame, into which many blades (up to 20 blades) can be fixed. When passing through the machine, the log is being sawn simultaneously into several boards without having any possibility to alter either the thickness or the quality of the board which is being sawn from the log.

Fig. 38 represents schematically the sawing of a log on a frame saw. The top of the picture shows one of the saw blades that is fastened into the frame. The frame, with the blades fitted into it, reciprocates in the vertical direction.

The bottom of the picture shows all the saws that are fitted into the frame and the kerfs - in other words, how the boards are being sawn from the log.

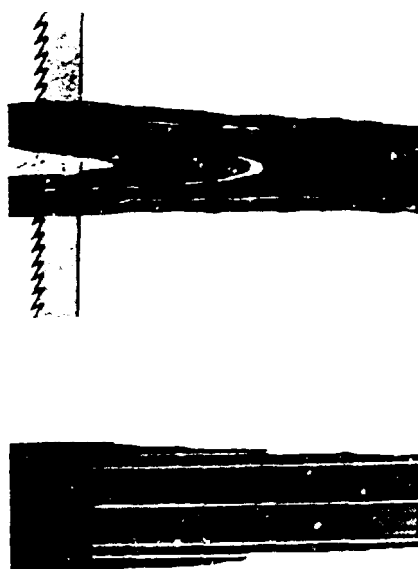


Fig. 38: Schematic representation of sawing a log on a frame saw.

Fig. 39 shows the out-feed end of a frame saw sawing a tropical log. Only half of a log is being sawn. As the frame has a limited width and height it cannot saw thicker logs. Therefore it is necessary that the larger size

logs are first sawn into two halves on a log band saw and then passed for further sawing on the frame saw. This photograph shows that all the boards are being sawn simultaneously.



Fig. 39: Out-feed end of a frame saw.

A frame saw consists of the following parts (see fig. 40):

- a sturdy cast-iron body,
- a flywheel,
- a crankshaft,
- a frame with fitted saw blades,
- devices for pushing the log through the machine,
- a drive motor geared to rotate the flywheel,
- carriages for log in-feed into the frame saw.
- carriages at the out-feed end of the frame saw.

The frame saw has been developed from the simple machine with mechanical log transport and manual machine control, via machines with electric log transport and machine control, to modern machines with hydraulically operated log transport and remote machine control.

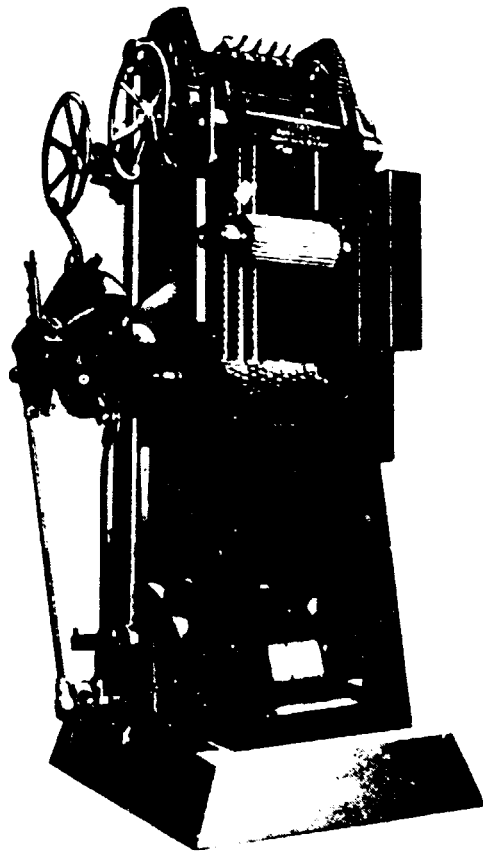


Fig. 40: A frame saw.

Fig. 41 shows a simple machine which consists of the following parts: a body, a flywheel, a crankshaft, a frame, and, in the foreground, a mechanical log transport device with manual machine control.

The conveying device is on the right side of the frame saw. It ensures the motion of the log through the machine. Logs are loaded on the feed carriage on the left side of the machine. Afterwards, the carriage is advanced towards the machine. After having passed through the machine, the log is fastened onto the out-feed carriage. Boards remain clamped by the carriage until all the log has been sawn. Then the carriage is unclamped and the boards are removed sidewise. This type of machine runs with a rather low number of revolutions, and, consequently has a low throughput.

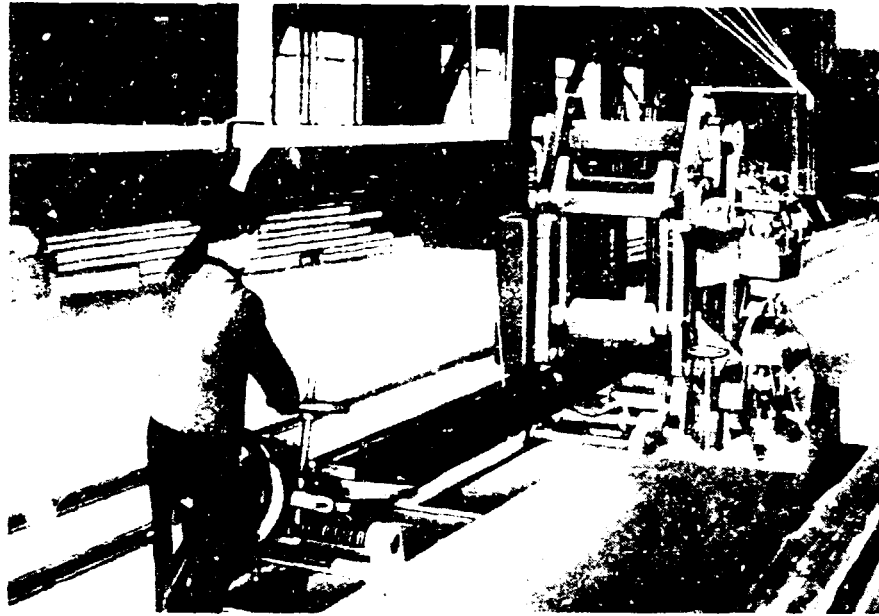


Fig. 41: A simple frame saw.

A frame saw with a smaller frame as shown in fig. 42 is particularly suitable for cutting smaller and shorter logs. It is provided with hand control to operate all the functions of the machine. There is a hydraulic device intended for moving the dented pressing rolls which serve for the advancement of the logs. A driven swinging chute which accepts and screens sawdust and feeds it into the exhausting device can be seen at the bottom. It separates also thicker splinters from the sawdust.

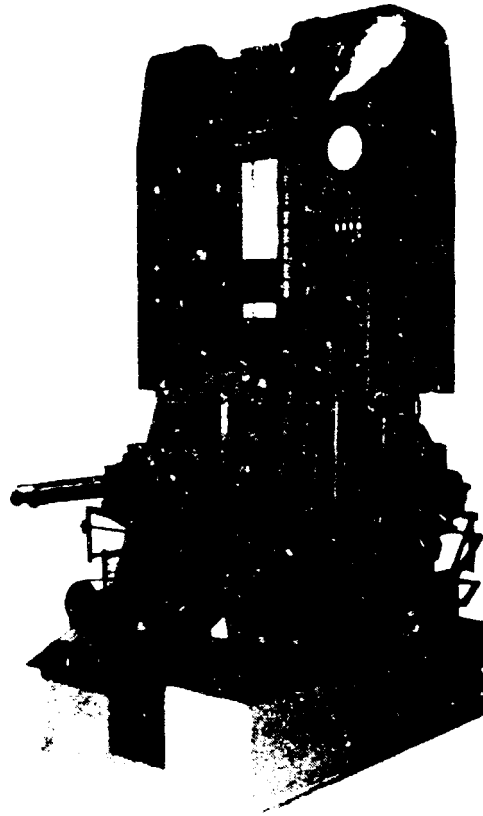


Fig. 42: A frame saw with a smaller frame.

Fig. 43 shows a frame saw with a larger frame for cutting larger diameter logs. It is a more modern machine, being equipped with hydraulically operated rolls. All the devices on the machine are operated electro-mechanically. It has remote controls for the machine's operation (the operator does not stand at the machine): he is sitting on a carriage or in a control cabin, from where he supervises and controls the machine's operation. All the devices on the machine are provided with shields or protected with sheet metal casings. This is a modern machine with a large capacity (up to 20,000 m³ of coniferous logs per annum).

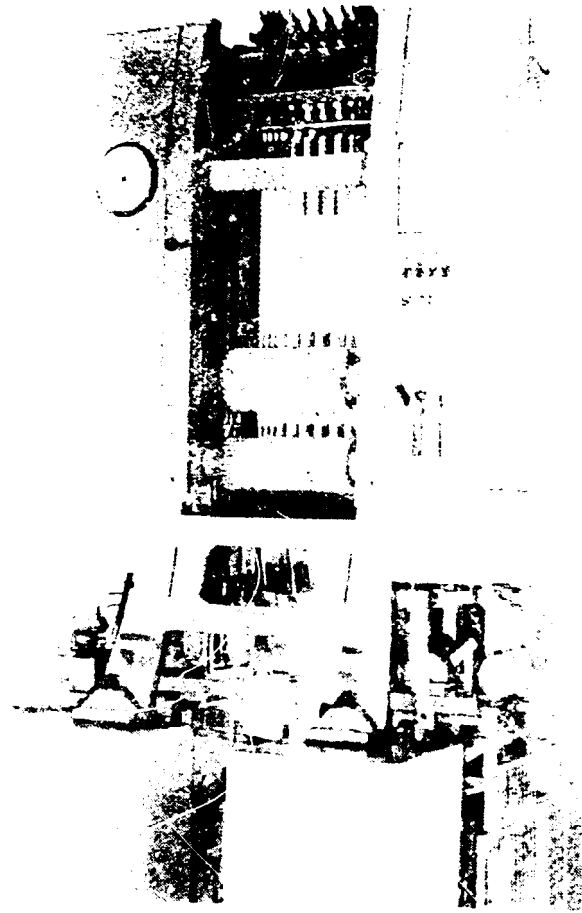


Fig. 43: A large frame saw.

AUXILIARY EQUIPMENT ASSOCIATED WITH FRAME SAWS

The most important auxiliary equipment associated with frame saws are the in-feed and out-feed carriages, stand-by carriages and control panels.

The following figures show various in-feed carriages and stand-by carriages. A combination of an in-feed and stand-by carriage in front of the machine serves for fastening, turning, adjusting and fixing the log prior to the actual sawing.

The out-feed carriage and the stand-by carriage behind the machine serve for fastening and fixing the boards of the already sawn log. While being sawn, the log is travelling through the machine, and is driven by the rollers.

Fig. 44 shows carriages for manual clamping of logs. This is the simplest carriage that had been developed for the use on frame saws. It is still being used efficiently in sawmills for sawing smaller quantities of logs. One carriage moves on rails in front of the machine to feed in the logs whereas the other one is on rails at the out-feed end to clamp the already sawn boards.

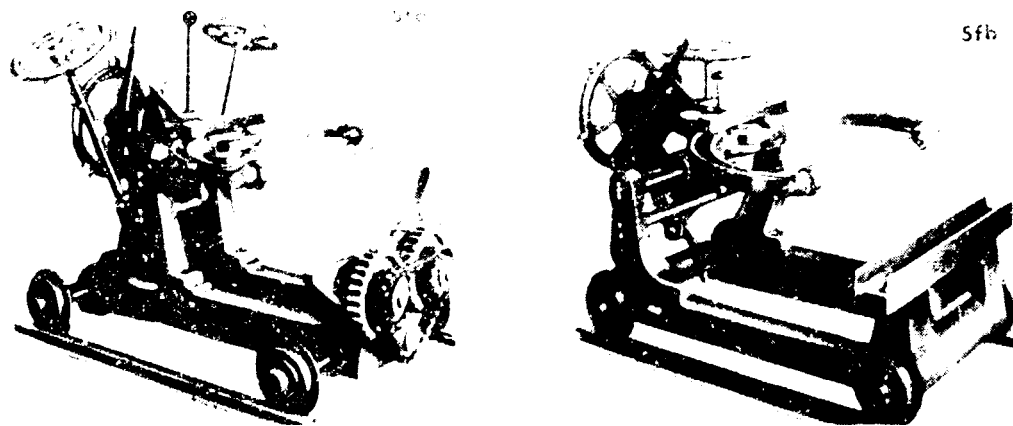


Fig. 44: Manual feed carriages for frame saws.

(a) In-feed carriage, (b) Out-feed carriage.

A stand-by carriage, with a special device for shifting and/or centering the log before it is fed into the frame saw is necessary to ensure a smooth operation. Such a stand-by carriage is shown in Fig. 45.

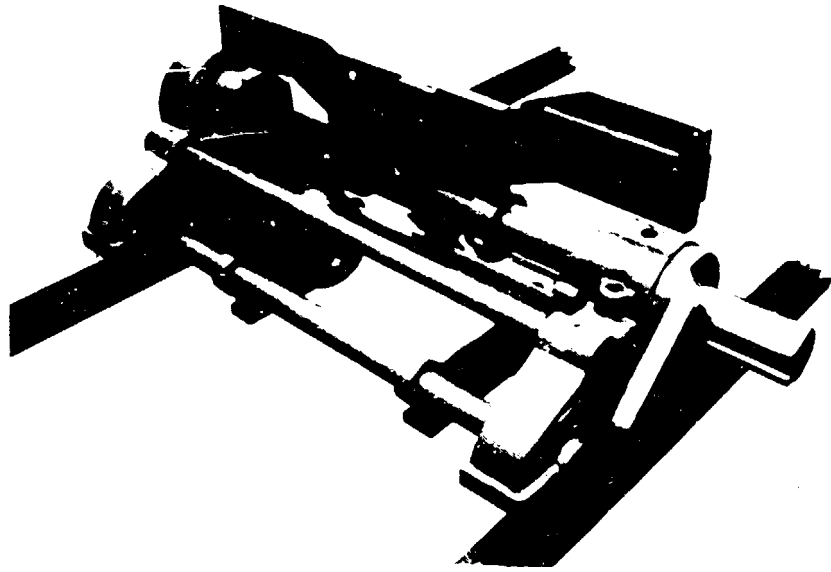


Fig. 45: A stand-by carriage.

All the above are manually operated feed carriages, which means that there must always be a worker standing by the carriage and operating it manually. When the carriage advances, the worker has to follow it. This is hard work and time consuming. Consequently, machines with manually operated carriages fail to achieve high capacity.

In order to increase the capacity of frame saws, mechanized and automotive carriages have been developed. Fig. 46 shows a mechanized carriage in which the worker is sitting and riding on the carriage. By simply pressing the corresponding switch, the worker is in a position to control all the devices on the carriage, as well as to control remotely the devices on the frame saw. All the devices are driven electro-mechanically.

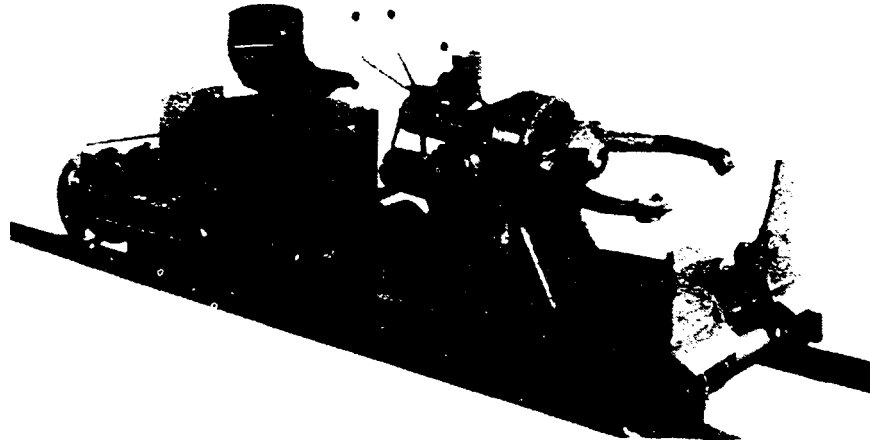


Fig. 46: A mechanized carriage for frame saws.

Latest carriages for frame saws are usually provided with a central control panel that enables the operator to command and control the carriage and the whole machine while sitting comfortably on the carriage (fig. 47). However, in sawmills where the logs sawn have large diameters and are heavier in weight, a great deal of vibration can be felt. Because of vibrations, generated by the alternative movement of the frame saw carriages on which the operators were riding became less desirable. Therefore, remotely controlled carriages were developed. They are controlled from the control cabin. The worker in the control cabin is protected against noise. He can operate remotely the whole process of sawing logs into boards. Fig. 48 shows the in-feed carriage and the control cabin as seen from the machine.

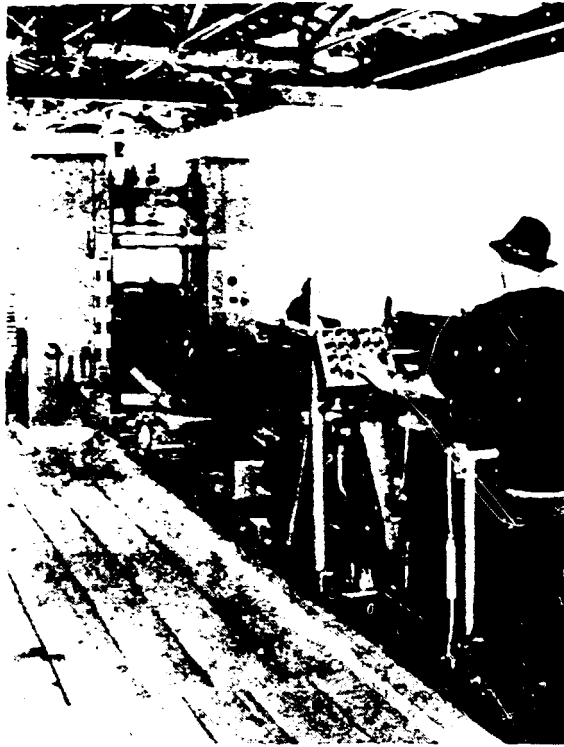


Fig. 47: Modern in-feed carriage for frame saws.

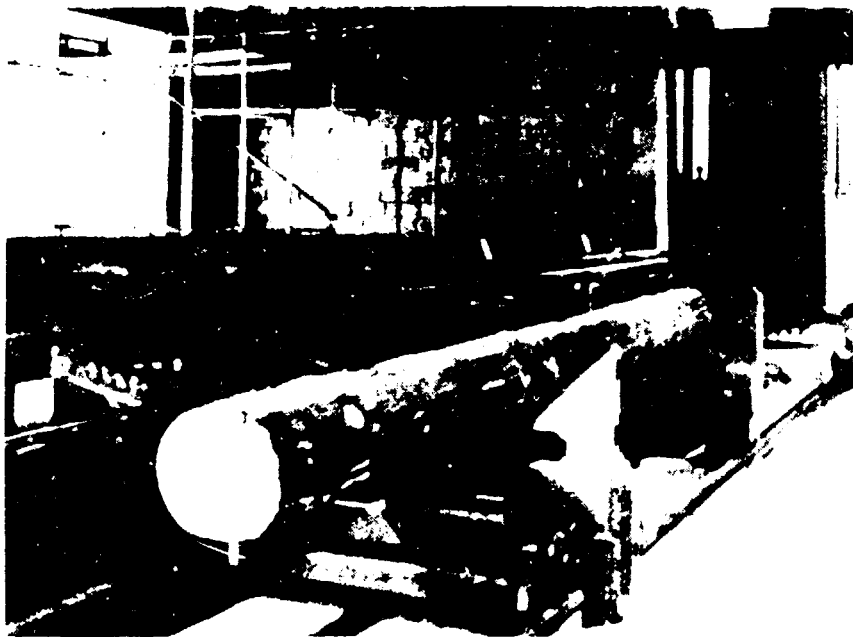


Fig. 48: A remotely controlled carriage and its control cabin.

The clear view an operator has while sitting in the control cabin is shown in Fig. 49. The basic goal of introducing remotely controlled carriages is to create working conditions that enable both the worker and the machine to work faster and more efficiently. Remotely controlled carriages are being used with machines that saw up to 100 m^3 of logs per 8 hour shift.

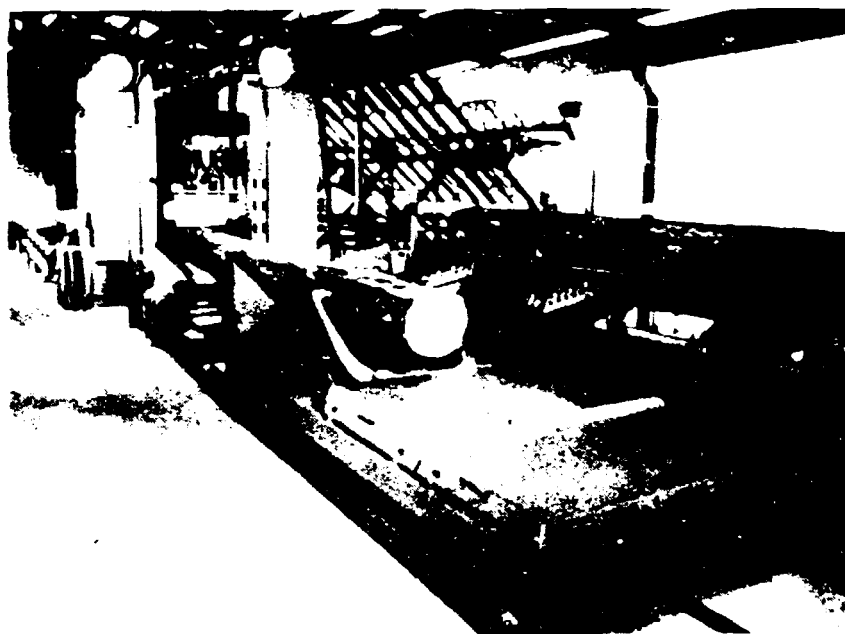


Fig. 49: Frame saw and remotely controlled carriage as seen from the control cabin.

Due to the utilization of remotely controlled carriages, the speed of sawing on the frame saws increased to such an extent that the conventional carriages behind the frame saw - intended for taking off the boards - could not cope with the increased output any more. Therefore a device for taking off boards has been developed. It consists of horizontal driven rolls, of two vertical driven rolls and of two partition plates (fig. 50). The device for taking off boards is installed at the out-feed end of the frame saw.

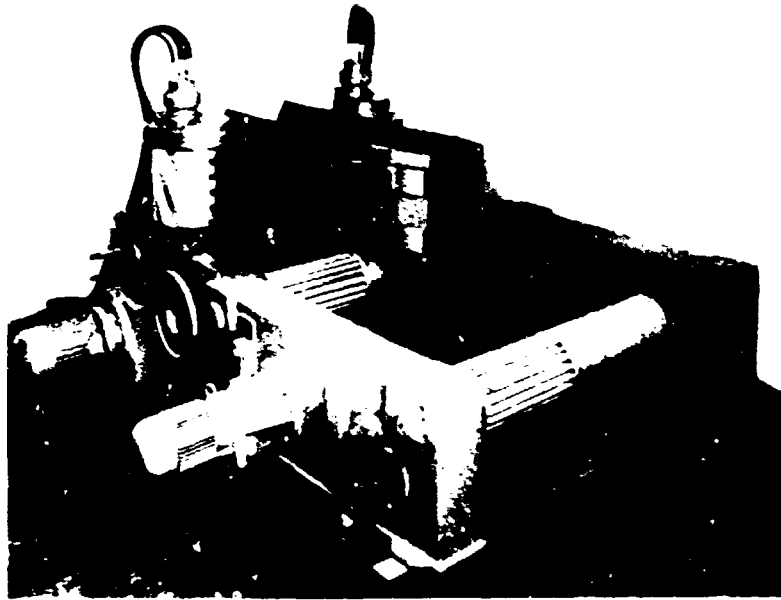


Fig. 50: Modern out-feed device.

Fig. 51 shows the out-feed device during operation. While the boards are passing through this device, the side boards are first pushed by means of vertical rolls onto the longitudinal conveyor. The central boards or fitches remain between both partition plates. The latter are transferred by the taking-off device to the longitudinal conveyor as soon as the frame saw has started to saw another log.



Fig. 51: Modern out-feed device in operation.

CHIPPER CANTERS

This is a relatively new technique in log processing. Chipper canters are now being used in combination with frame saws, band saws or circular saws. The main characteristic of these machines is that they are milling (chipping) the sides of the logs, so that chips are produced instead of slabs. A chipper canter's knives are shown in fig. 52; while fig. 53 shows a chipper canter operating in combination with a frame saw.

Fig. 54 shows schematically a combined operation of cutters of these two machines. While the chipper canter shapes both sides of the log, the frame saw saws the flitch thus formed into boards. Through such a combination of machines it is possible to achieve an extremely high throughput. Therefore it is advisable that this combination of machines be used only in fully mechanized sawmills which can sell the chips to pulp mills and/or particle board mills.

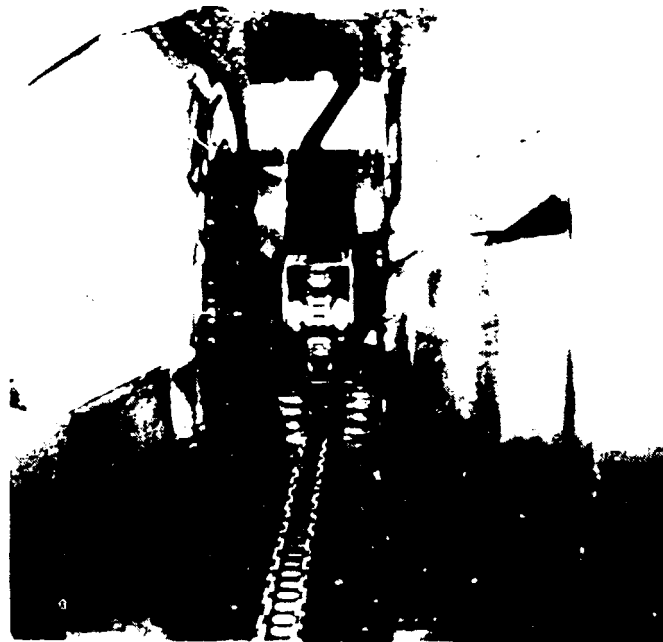


Fig. 52: A chipper canter's knives.



Fig. 53: A chipper-canter operating in combination with a frame saw.

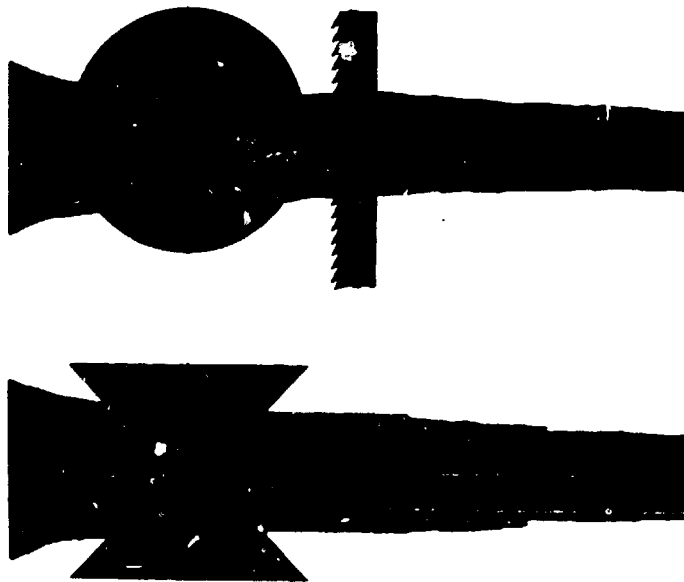


Fig. 54: Schematic representation of a chipper-canter/frame saw combination.

SECONDARY MACHINES

Aside from the primary machines that are installed in the sawmills, such as log band saws and frame saws, which saw logs into boards, there are also the so-called secondary machines: cross-cutters and edgers.

(a) Cross-cutting circular saws:

A cross-cutting machine with a circular saw is used for cross-cutting of boards and adjusting the length of the board. By pressing a switch, the circular saw blade, which is normally hidden under the table, rises above it and, rotating around its axle, saws the board crosswise.

Fig. 55 shows how an under-table circular saw is integrated into a system of conveyors. On the left side is a silhouette of a worker who stands by the machine and operates it. He positions the board by hand, then he starts the machine and saws the board crosswise.

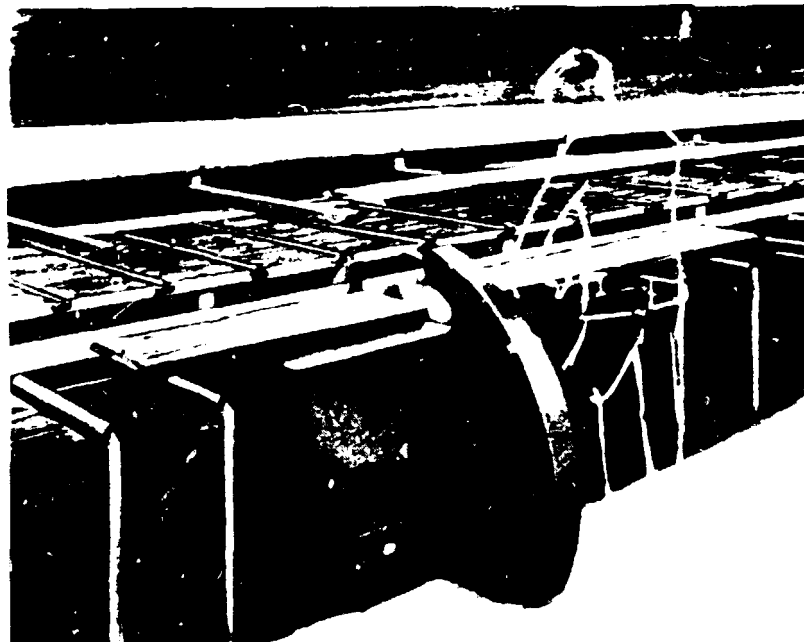


Fig. 55: An under-table circular cross cut saw.

The shield above the machine prevents the worker from approaching the machine too closely or from putting a hand into the machine. Despite these measures, these are the most dangerous machines in a sawmill.

(b) Multi-blade circular saws:

The other secondary machine encountered in a sawmill is a multi-blade circular saw. It is used for longitudinal cutting, i.e. edging of boards. There are one, two or more fixed blades and one, two or more adjustable blades fixed onto the axis of the edger. This enables the worker to adjust the position of the movable saw blades before edging every individual board, so that each board is edged at the desired place. This machine serves for edging boards, sawing wide boards into narrow ones and for sawing boards to laths.

Fig. 56 shows a conventional type. If used for sawing small quantities of wood, then it is operated by two workers. While one worker is feeding the unedged boards into the machine, the other one is taking the boards already edged off the machine.

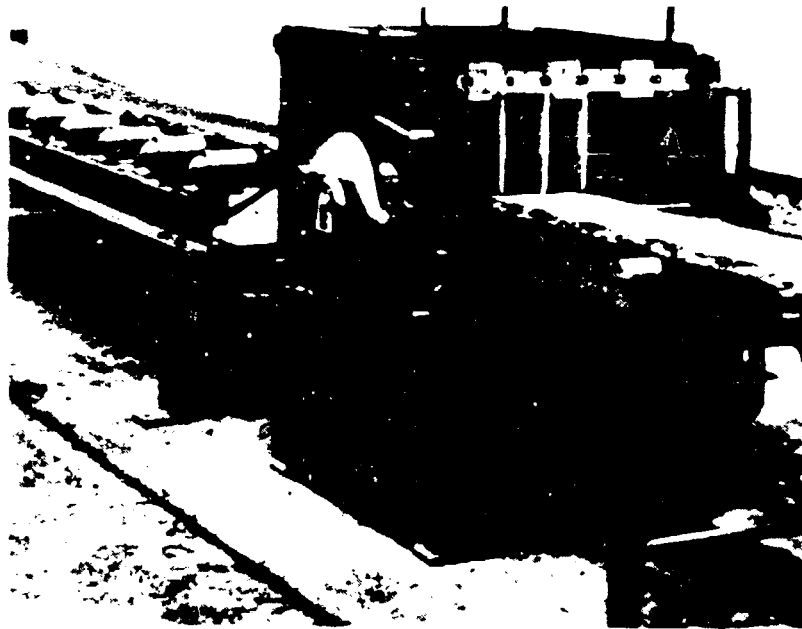


Fig. 56: A multi-blade circular saw used for edging.

The machine shown in the above figure is equipped with a conveyor and is operated by one worker.

A more modern machine is shown in fig. 57. Though the boards are fed into the machine by hand, all the machine operations are controlled remotely. On the left side is the control panel with switches. This is a high-efficiency edging machine with a capacity of up to 15 boards per minute. Boards can be sawn at feed speeds of up to 60 metres per minute.

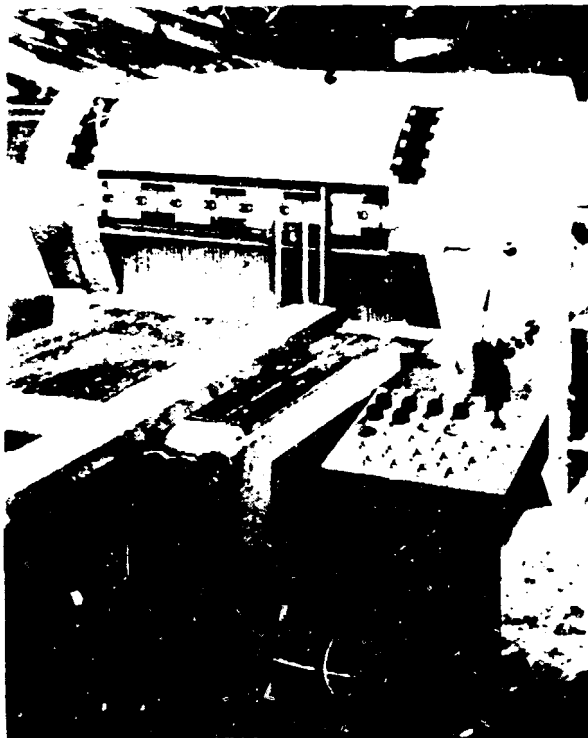


Fig. 57: Modern high capacity multi-blade circular saw.

Fig. 58 represents the most modern high-efficiency board edging automat. The capacity of the machine is so high that the machine cannot be operated manually any more. It is capable of edging more than 20 boards per minute at a speed ranging from 90 to 120 metres per minute. Therefore, a rather sophisticated system of conveying devices is installed in front of the edging automat. It feeds individual boards into the machine at a constant rate. Prior to being fed into the machine, boards are centered and the position of the saw blades is automatically adjusted to the minimum width of each individual board.

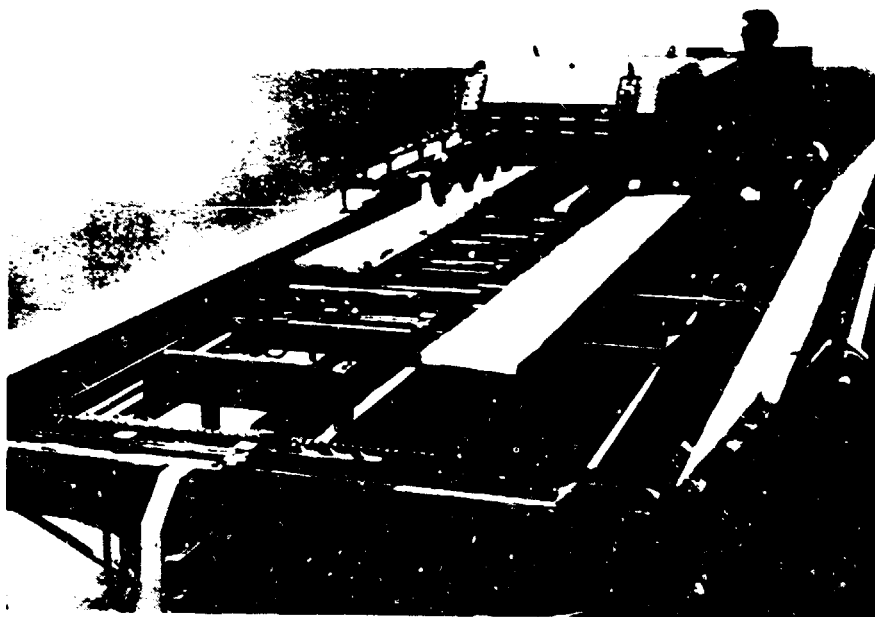


Fig. 58: An edging automat.

LIFTING AND STACKING EQUIPMENT FOR SAWN BOARDS

Boards that have been sawn from tropical logs are usually very wide, thick and heavy. Manual handling is therefore rather labour intensive and very slow. Vacuum hoists are therefore being used, since they are very suitable for lifting, carrying and stacking heavy boards. These vacuum hoists are electro-pneumatically operated and consist of the following parts:

- suction plate,
- vacuum set with an electric motor,
- hoist operated by an electric motor,
- control lever with a control switch,
- guide rail along which the hoist is moving,
- drive mechanism for moving the hoist along the guide rail.

Fig. 59 shows a lifting device: its frame with the suction plate and the cup for holding the suction plate onto the board.

There are several types of vacuum hoists, which are used for the following operations:

- off-loading of boards from a horizontal band saw,
- off-loading of boards from a vertical band saw,
- off-loading of boards from a frame saw,
- stacking of boards onto pallets,
- shifting of boards from one stack to another.

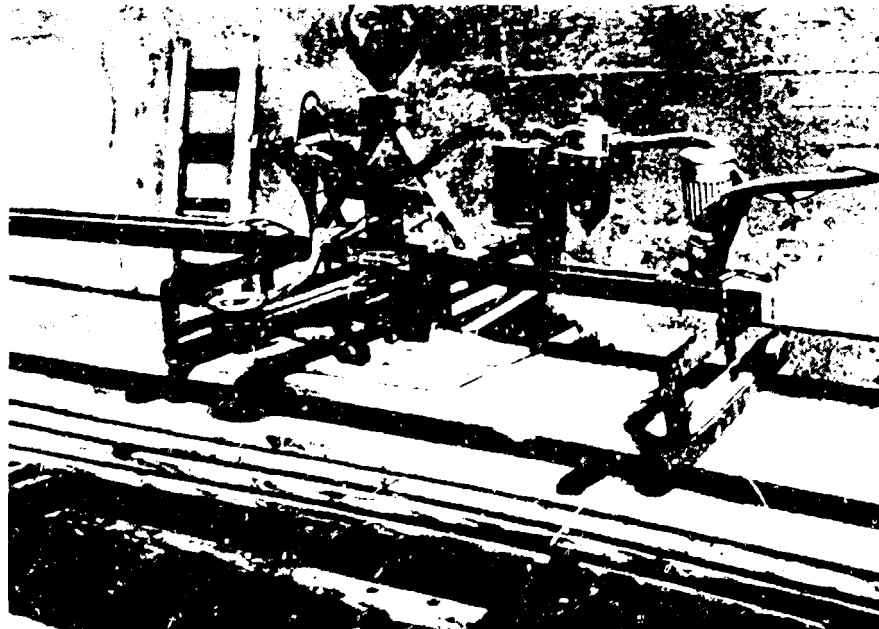


Fig. 59: A typical vacuum hoist.

(a) Vacuum hoist for lifting and stacking boards:

This device (fig. 60) is operated by one worker who is standing at the hoist control lever which incorporates the control switch. The operator moves to the board he wants to lift, lowers the lifting device down to the board, and, by means of the control switch, presses the suction plate onto the board surface. The board is then lifted by the electric motor. The operator directs the lifting device (and the board) to the desired place. The control lever and the control switch are sufficiently distant from the lifting device so that the operator can work safely. The control of the lifting device is fairly simple. Nevertheless, this type of lifting device is less appropriate for use in larger sawmills because it operates rather slowly.

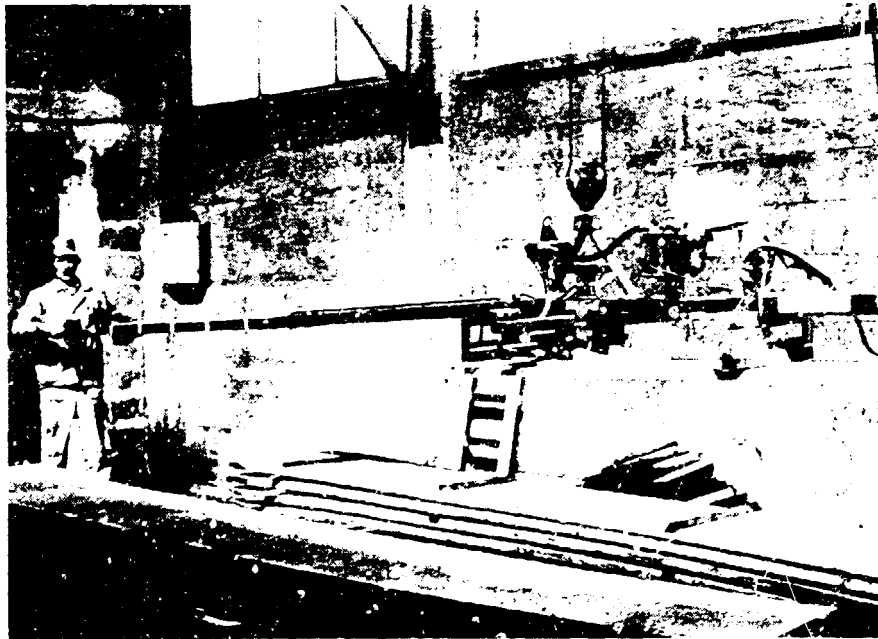


Fig. 60: A vacuum hoist operated by one worker.

(b) Vacuum hoist in warehouses:

A vacuum hoist can also be efficiently used in the storage of sawnwood and in the rooms where the boards are sorted and graded prior to dispatching. Only one worker is needed for shifting boards from the board stack when the boards must be measured prior to delivery. Two workers are in charge of measuring the boards and keeping records (fig. 61).

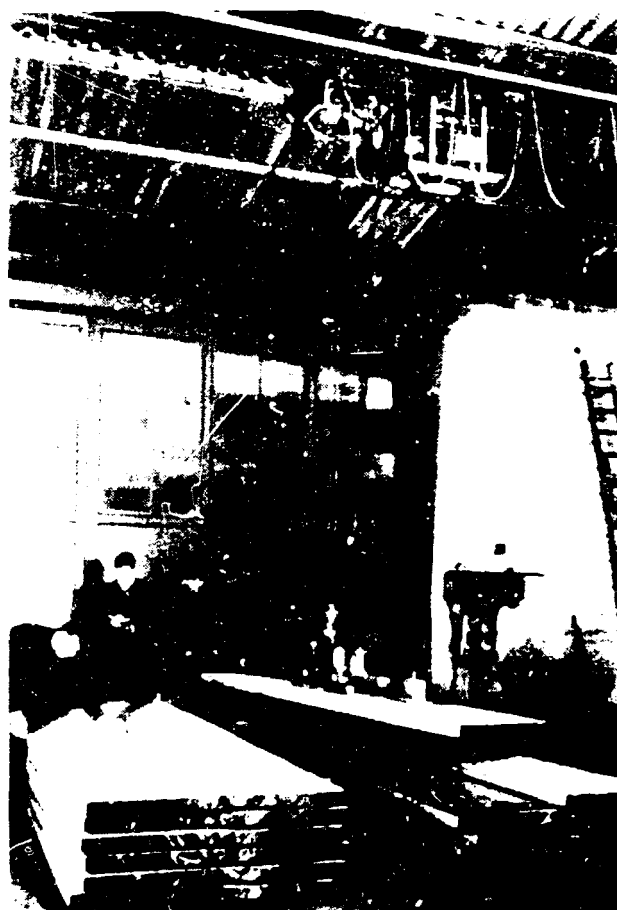


Fig. 61: Vacuum hoist used in a warehouse.

(c) Vacuum hoist in open woodyards:

Vacuum hoists that are intended for operation in open woodyards are fitted onto smaller portal cranes. The latter are mobile (they are equipped with wheels). The vacuum hoists are used for stacking boards onto pallets or for shifting boards that have already been measured and classified (fig. 62).



Fig. 62: Vacuum hoist used on an open wood yard.

CONCLUSION

The figures compiled in this document represent a review of the woodworking machines available for sawmills. They range from the simplest machines with a very low capacity to sophisticated high capacity machines. It should be underlined that many of these machines cannot yet be used in most developing countries, for the capacity requirements in these countries are not sufficiently high. For this reason, and because of maintenance problems, the simplest machines should be considered.

In order to avoid any mistake when selecting the woodworking machines it is absolutely necessary first to analyze the raw materials available. Once the availability and the characteristics of raw materials have been determined, then it is possible to determine which is the most suitable woodworking machine.

