regarding communication circuits.

IV-5-2 Utilization of Drum Scanner

(1) Use of drum-scanner

A drum-scanner is the equipment to decompose air-photograph, drawings, etc. into 3-colours in order to store the digital values of the density of 3-colours in magnetic tape or floppy disk. By means of processing these digital data through computer, the image processing becomes available, so when remote-sensing data of air-photograph, etc., are used, the classification of forest types, etc. can be possible by the analysis of the strengths of spectral reflection, recorded on photos. However, as its subjects are image data, the use of colour-display equipment for image ascertainment is essential, hence the high resolution display equipment of micro-computer PC 9801 is used for this purpose.

This system is composed of a drum-scan densito-meter, magnetic tape equipment, and a complete set of PC 9801.

(2) Drum-scan densito-meter

This equipment can read out the density information of photos or drawings, with following features.

a) It can choose any of six sampling pitches of 25 μm, 50 μm, 100 μm, 200 μm, 500 μm, and 1000 μm.

b) Its measuring aparture may choose any size of 25 μm square-100 μm square continuously (but usually it is made identical as the sampling pitch).

c) The rotating speed of a drum can be choosen out of 4 stages of 1, 2, 5 and 10 r.p.s., but the use of as slow as practicable speed is recommended.

d) The density of 3-colours can be measured simultaneously.

e) The measurement of reflection strength as well as transmission strength is possible.

(3) Control panel of drum-scanner

a) Power switch

Switch in the power source. A lamp is lit when power is switched in.

b) ONLINE switch

This is switched on when the data transcription onto the magnetic tape equipment are ready. While on line procedure, neither the manual movement of the optical head nor the reset in axis-direction is practicable. A lamp is lit while on-line procedure.

c) DRUM RUN Switch

This makes the drum rotate. A lamp is lit while the drum is rotating.

d) DRUM STOP Swtich

This stops the drum rotation. A lamp is lit while the drum is stopping.

e) DRUM SPEED Selector

This sets up the rotating speed of the drum. It selects any one out of 1, 2, 5, 10 r.p.s.

f) SAMPLING PITCH Selector

This sets up the sampling pitch, selecting any one out of 25, 50, 100, 200, 500 and 1000 μm. The sampling pitch is of same size for the rotating direction and the axial direction, both.

g) STOP Switch (→)

This determines the measurement finishing position in the axial direction. It sets up at any of 000-300mm. When the optical head is manually operated, the delivery in the axial direction is stopped when the head arrived at the position set by this switch.

h) RESET Swtich

This resets the location counter of the optional head in the axial direction. Invalid while ON LINE procedure

i) START Switch (↓)

This designates the measurement start point in the rotating direction. Set at 000-400m.

j) STOP Switch (↓)

This designates the measurement end point in the rotating direction. Set at 000-400 mm. However, must exceed the value at previous i) value.

k) ← and → Switches

This is for operating the optical head manually while off-line (i.e. ON-LINE lamp is not lit).

l) READY Indicator

A lamp is lit when the rotation of the drum is started and the auto-zero operation (original point ascertainment) is completed. Then, when on line is set, "READY" signal is output to the magnetic tape equipment, so the actual connection with magnetic tape is practised.

m) READY ENABL Indicator

A lamp is lit, when the optical head is within a range set up by g), h), i) and j).

n) ADDRESS Display (↔)

This expresses the measurement position in the axial direction, indicating 0-300.00. This is cleared by h) RESET switch while off-line.

o) ADDRESS Display (↓)

This expresses the measurement position in the rotating direction, indicating 0-500.00, but with the range of measurement of 0-400 mm.

p) DENSITY DISPLAY

This is the monitoring display of the measured density.

q) DISPLAY CH SELECTOR

This selects a colour channel to be displayed on p) DENSITY DISPLAY (no concern with the transmission of magnetic tape).

r) REFLECTION/TRANSMISSION Switch

This selects the reflection measurement (such as film) as well as the transmission measurement (photo-print or paper).

s) Aprature dial

The dial sets on the measurement aparture size. This indicates the length of a side of the squar aparture in μm. This dial located in the cover of the equipment. The value of size normally is identical with that of the sampling pitch.

(4) Precautions on handling of drum scan densito-meter

When a drum-scanner is moved, or after a certain length of unused periods, the adjustment on the optical system of the equipment may be necessitated. The adjustment shall be performed in accordance with the manufacturer's manual. At first, the adjustment of the light measurement system, and then the unification of the light axis in the light measurement system shall be conducted.

Though the life of lamps lasts more than 600 hours, it is recommended to turn off electricity, if not required, for extended life. When a bulb is replaced, insert it to the bottom of a socket completely, otherwise, uneveness at light source may be caused. By the way, the lamp should not be touched with hand in any case. The part touched with hand should be throughly wiped with alcohol, otherwise the bulb may be devitrified. Further, a bulb should be replaced with the one designated in the manual provided by a manufacturer.

(5) Magnetic tape system

This system consists of a magnetic tape control unit and magnetic tape. In the function, the data transmitted from the drum-scan densito-meter are stored in the file of BIP, BIL or BSQ type, with the selectable record density of 1600 BPI (PE) or 800 BPI (NRZI).

The control unit adopts the micro-processor Z80, with the buffer memory of 64K, capable of processing 8 bits par a pixel, maximum 7 bands. By means of the connection with the drum scanner, data in mono-chrome, red, green or red can be recorded. It is recommended for the details of the system to refer the manual by the manufacturer.

(6) PC 9801

DRUMSCO is a programme that controls the drum-scanner by microcomputor PC9801, and collects and displays the digital data decomposed in 3 colours by a drum-scanner. (The programme title stored in 5-inch floppy disk is "drmsc.4ch").

The signal cables, A1 and A2, are connected with the interface at the side of PC 9801, this programme is executed, after the data at the drum-scanner is set up and the range of data reading, the reading pitch, etc. are set up.

The content of processing by this programme is input of image data from the drum-scanner, save of input data into a disk, loading of data saved in a disk, display of input image data, printing of image data on a line-printer. As for each procedure, refer "DRUMSCO operation manual".

The maximum number of image elements to be processed by PC 9801 is 65536, in normal case, (256 horizontal image elements) x (256 vertical image elements).

(7) Operation procedure of drum-scanner

The operating procedure is shown inthe flow diagram (Fig. IV-62). The explanatory drawing concerning parameters in the range of data measurement is also shown in Fig. IV-63. The file form of magnetic tape is indicated in Fig. IV-64.

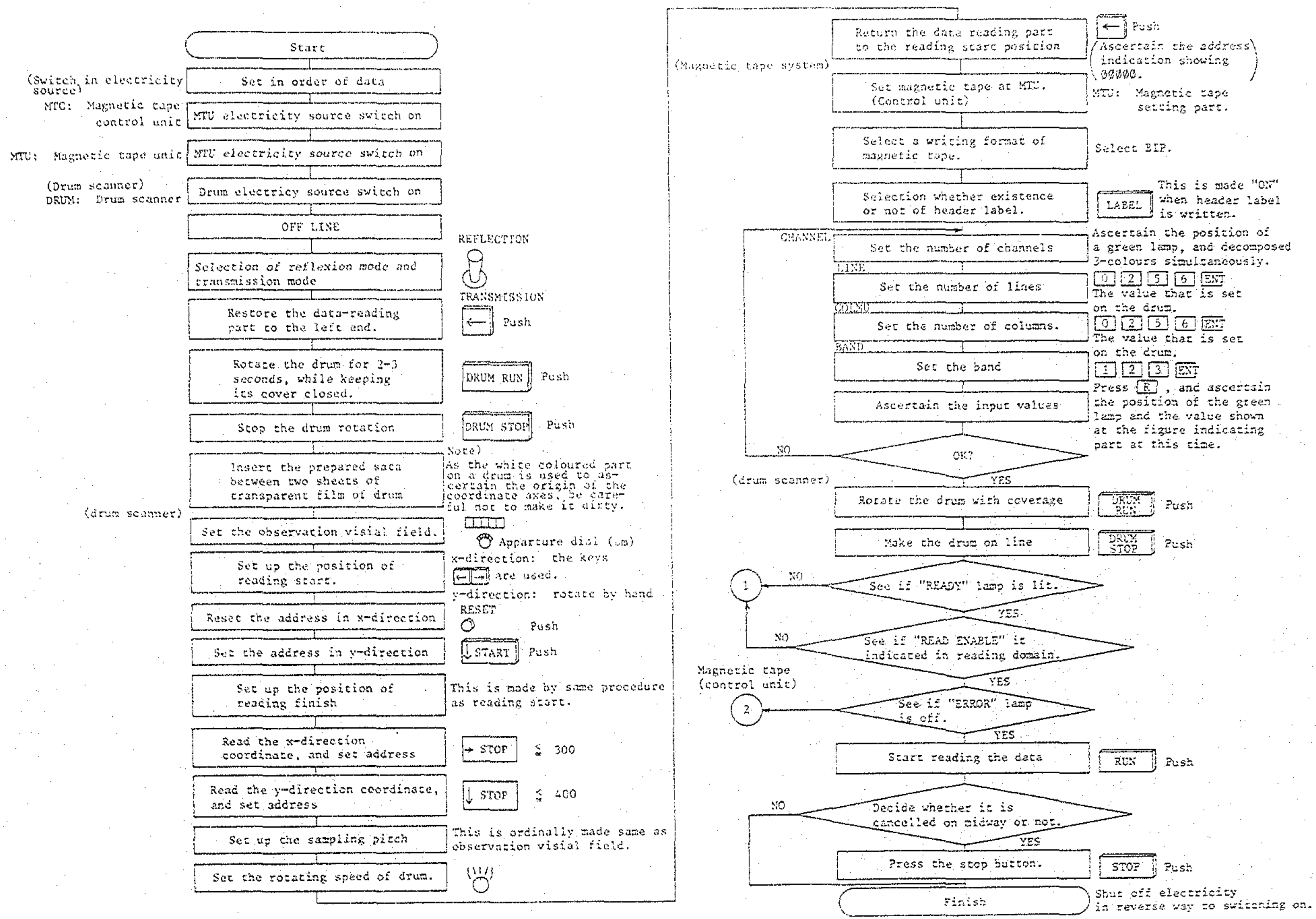
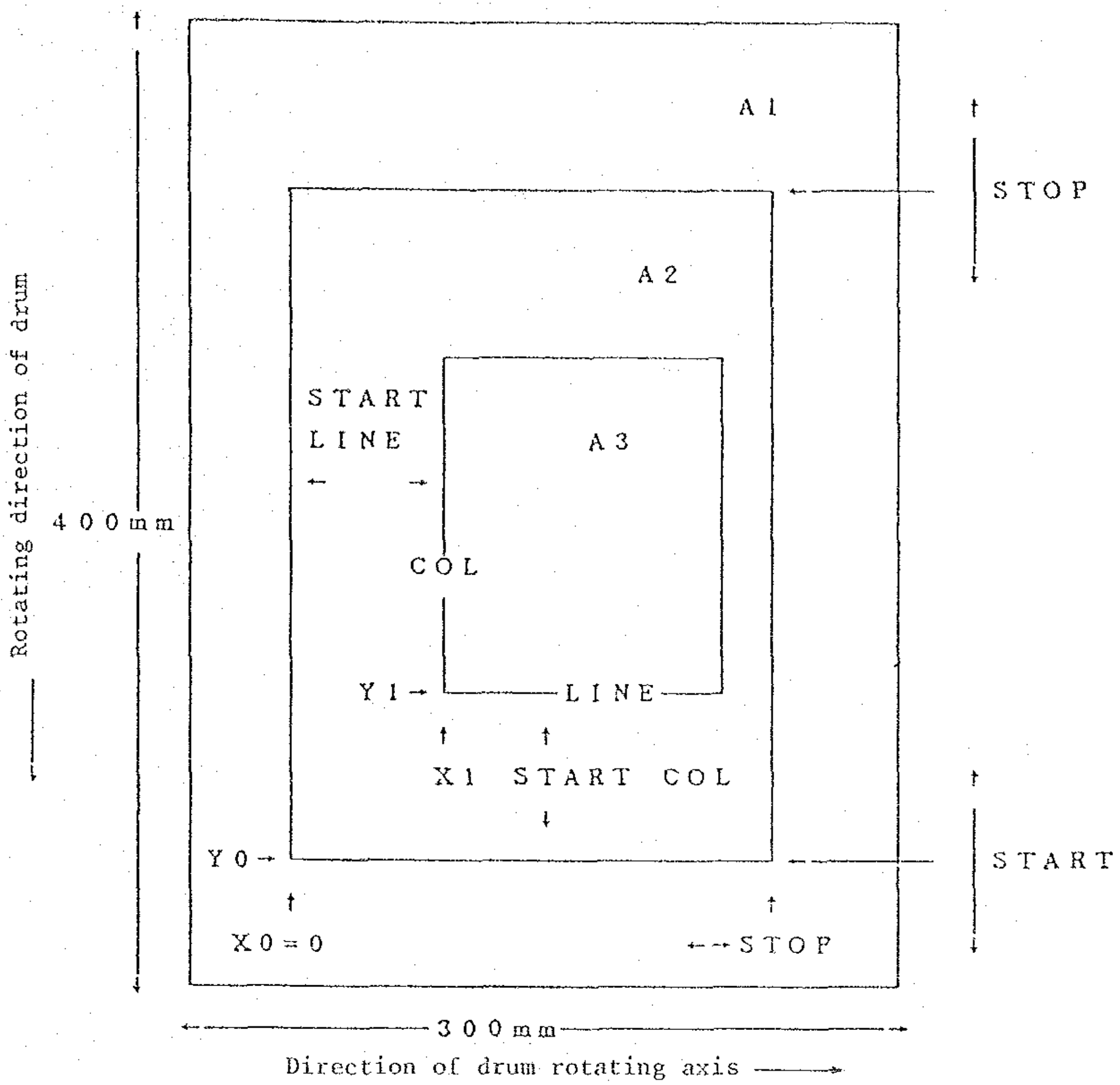


Fig. IV-62 Using procedure of drum scanner



A1: Effective range of measurement of drum scanner

A2: Range of measurement set for a drum scanner

A3: Range of record on MT

$$A1 \geqq A2 \geqq A3$$

Generally, $A1 > A2 = A3$

When XO = X1, START LINE = 1

When YO = Y1, START COL = 1

Fig. IV-63 Range of measurement and parameters

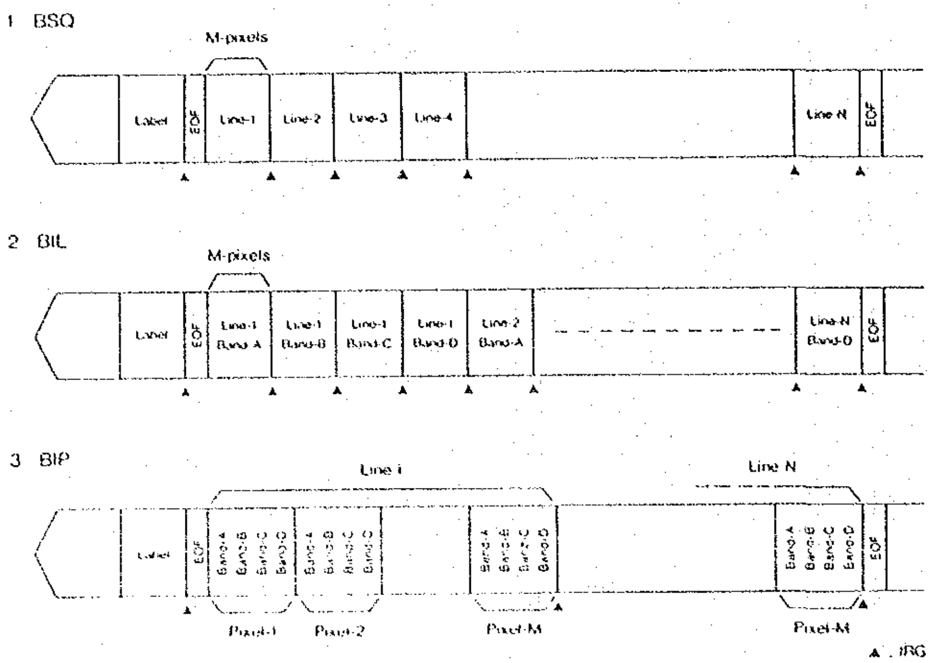


Fig. IV-64 Form of magnetic tape

V. Studies on Techniques for Small Diameter Timber Processing

Photo V-1 Installation work for sawmill machineries

Photo V-2 Saw filing for circular saw

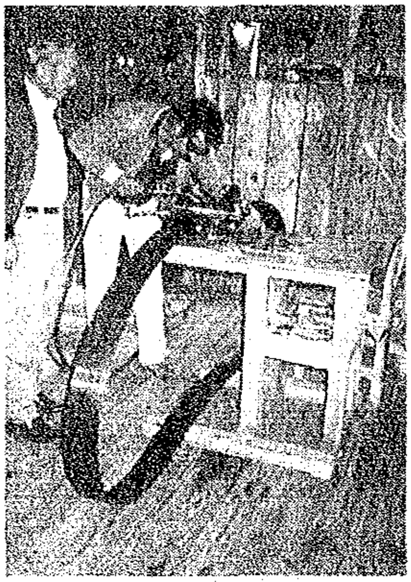


Photo V-3 Band saw welding

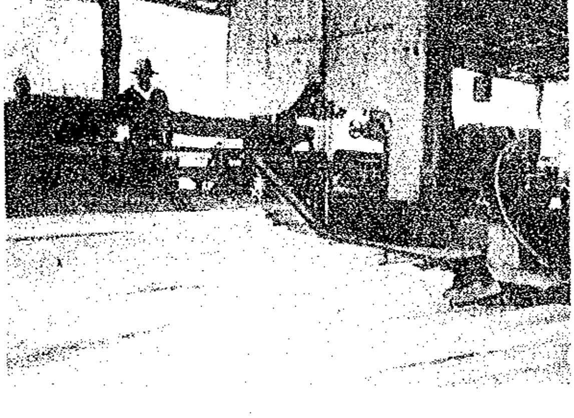


Photo V-4 Twin bandmill

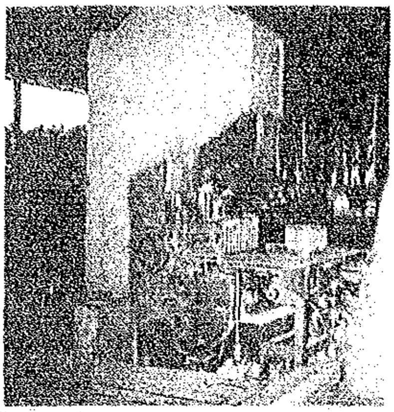


Photo V-5 Table band resaw

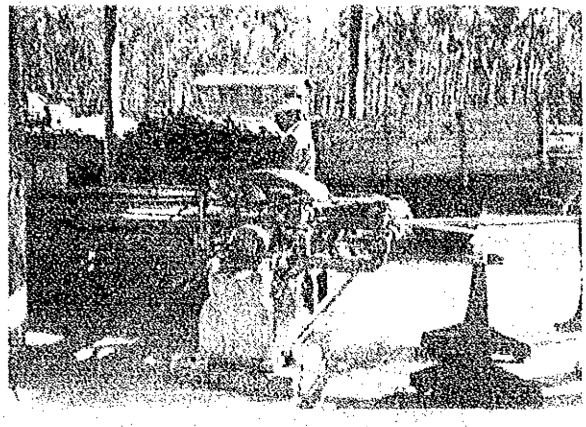


Photo V-6 Double edger

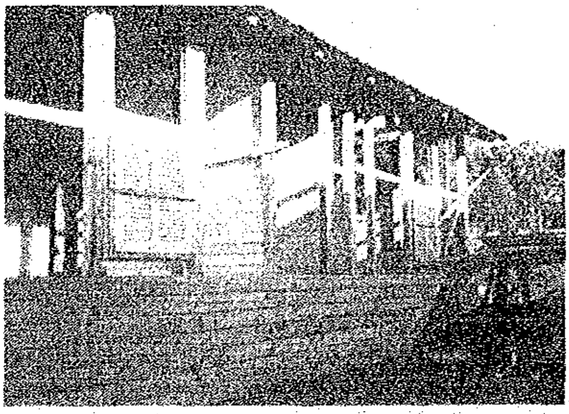


Photo V-7 Prefabricated living house by utilization of small-size logs

Photo V-8 Prefabricated living house by utilization of small-size logs

V. Studies on Techniques for Small Diameter Timber Processing

V-1 Improving Techniques for Small-Diameter Timber Processing

Introduction

The position of sawmilling of small-diameter logs will be explained in the project which aims at establishing techniques for studying appropriate controlling techniques for headwaters forest.

The state of São Paulo was a country of forest in 1850s, as much as 82% of its area being covered with trees. However, a large part of the land was suitable as farms and pastures in terms of topography, climate, and soil; and the forests were cleared on a large scale for agriculture and cattle farming before felling of forest was legally controlled. The area of natural forest was reduced to 8.2% within 80 years. Thus many of the rivers lost even their headwaters forest, except those on the eastern coast mountain range; and problems of soil erosion and water pollution were brought about. In order that forests be restored in the district for soil and water conservation, positive afforestation must be resorted to, and positive subsidizing of afforestation was started. As afforestation plan was advanced with such intention, utilization of small diameter logs has been subject for research as a matter of course.

Supply of small-diamter logs has been started from those artificial forests afforested since 1950s. If the logs are utilized effectively as products of a higher value than pulp wood and charcoal material for iron and steel manufacture, it will be a great success not only in achieving the policy of afforestation to expand forest area but also in soil and water conservation.

The cooperation project was meant for coping with said situation by research and technical advances in lumber manufacturing.

Studies on sawmilling small-diameter logs were scheduled to be advanced by Forestry Institute in the future, and emphasis was laid at the moment on transference of techniques for sawmilling and saw filing. A foundation for future development of research was laid. The duty of specialists despatched to Brazil for a short period was to install machines for saw filing and sawmill machinery with performances at the very spearhead and to transfer techniques of their handling and operation.

The achievements explained in the present paragraph were extended in

Manduri Experiment Station located about 320 km to the west of São Paulo City. Pine forest of about 20 years of age of mostly Elliottii Pine is growing in the Station, and sawmilling has been operated. A forest for collecting turpentine, a forest product marked to be highly cash-making, is located.

The machines operating in Manduri Experiment Station were centered by a twin circular sawmill machine; but sawmill machinery with a twin band mill as the center were introduced andinstalled in a newly built sawmill that was built by Forestry Institute. Transference of techniques for operation of machines and sawmilling was carried out. As a result, yield of sawn timber was enhanced and the production efficiency was improved; and transference of techniques concerning the novel set of machines was completed. As to the techniques for saw filling, the techniques for smooth operation of the sawmill machinery were fully acquired by the Brazilian crew.

The newest techniques and the method of wood working and utilization of small-diameter logs in Manduri Experiment Station were marked by sawmilling industries in the neighborhood, and spreading effect of transference is started as is shown by requests for transference to the plants of band saw filing techniques. Supplementary system has been born on the side of Forestry Institute, who are requested for the transference, where engineers of experiment station understand the basic theory of saw filing and the workers acquire the skill. Thus the basis for smooth advancement of the enterprise and diffusion of the techniques of band saw filing, etc. into sawmills in the state of São Paulo has been established, we believe.

V-1-1 Improving Saw Filing Techniques

(1) Conventional saw filing and working (conditions before the project)

Techniques for saw filing of circular saw blades and band saw blades did exist before the project was started. However, a large difference was found in the techniques among sawmilling industries. For example, Shiffer Ltd. that is one of the largest sawmill machinery manufacturer on South American Continent, is on a nearly equal technical level as high as that of so-called "band saw filing". On the other hand, the saw filing in sawmills in the vicinity of Manduri Experiment Station shows that saw filing techniques such as band saw joining (oxygen-acetylene welding) and stellite welding are not diffused into them yet.

There were a bandmill (blade of 2 inches or smaller width) and circular sawmill machines in Manduri Experiment Station. Under the large difference in the technical level of saw filing, the conventional operation of saw filing was such that a simple grinder made of an electric motor and grind wheel was used for simple grinding of saw teeth only for both of the circular saw and band saw blade. There was a lack of techniques for band saw filing except grinding.

(2) Saw filing machine

① Circular saw filing machine

(a) Carbide tips brazing machine

In order to enhance machinability of circular saw, carbide tips are brazed on the blade.

(b) Hard alloy grinding machine

The hard alloy grinding machine enables the whole treatment of carbide tipped circular saw blade. The machine can grind the cutting face, the clearance face and side of the carbide tips.

② Band saw filing machine

(a) Set of welding machine

The set of welding machine consists of an oxygen-acetylene welder and stellite welding machine.

Oxygen ated acetylene welding is necessary for end joining and repairing operation for crack of band saw blade. Stellite welding machine welds stellite on the blade, forms it under pressure while it is red hot.

(b) Band saw grinding machine

Band saw grinding machine is used in tooth style shaping operation and tooth grinding operation of saw blade of 3 to 8 inches width. It can give the blade any shape of tooth as required and can grind teeth of different pitch by changing feed cam for moving saw blade or grind wheel, or by adjusting the set angle of grind wheel etc.

(c) Automatic side grinder

The automatic side grinder grinds the both sides of tooth after stellite welding so that the edges of bent out teeth are aligned on a straight line.

(d) Band saw stretcher

Tensioning is one of the most important of the band saw filing operations, and it requires a delicate skill. First, the band saw levelling is treated on a surface plate attached to give it a level finish. Next operation is tensioning and back crowning by means of turning rollers arranged at the top and bottom of the rolling machine.

(e) Tools for band saw setting

The swage set is usually used because of the higher cutting performance than spring set. Swage, shaper and clamp stand are used for working blade for swage set.

(3) Guiding item and object

① Basic theory of saw filing

In order that the saw filing techniques take root and that future technical problems be solved, engineers responsible in technical field, must understand the theory of saw filing correctly and establish a system for guiding workers. Therefore, the basic theory of saw filing was explained for the engineers. For workers, practical skill was explained with some theory, so that they can acquire "techniques" without merely depending on knack and experience.

② Circular saw filing

Carbide tipped circular saw has a circular blade brazing with cemented carbide tips for a longer life. Tip is made of a hard alloy of tungsten carbide. A circular saw has been used, but they had lack of techniques for carbide tipped saw brazing. Therefore, emphasis was laid on guiding them for carbide tips brazing techniques and sharpening techniques so that circular saw filing techniques be established.

③ Band saw filing

Transference of techniques was carried out so that techniques for a consistent operation of band saw filing will take root.

It is difficult to explain the grade of band saw filing to the learners of techniques. Therefore, the blade was used on the machine for test sawmilling; and the problems of saw filing were explained in relation to the finish on the swan timber.

(4) Transference of techniques

① Circular saw filing

(a) Carbide tips brazing

Cemented carbide tipps is brazed on a circular saw and cutting performance of the saw is enhanced and time of performance is prolonged. The treatment is effective in sawmilling hard sawlogs.

(b) Grinding carbide tipped circular saw

In addition to grinding of the cutting face of teeth, that had been operated by them, the clearance face and sides of teeth were ground so that the cutting performance is enhanced. Any of the faces can be ground by adjustment of hard alloy grinding machine.

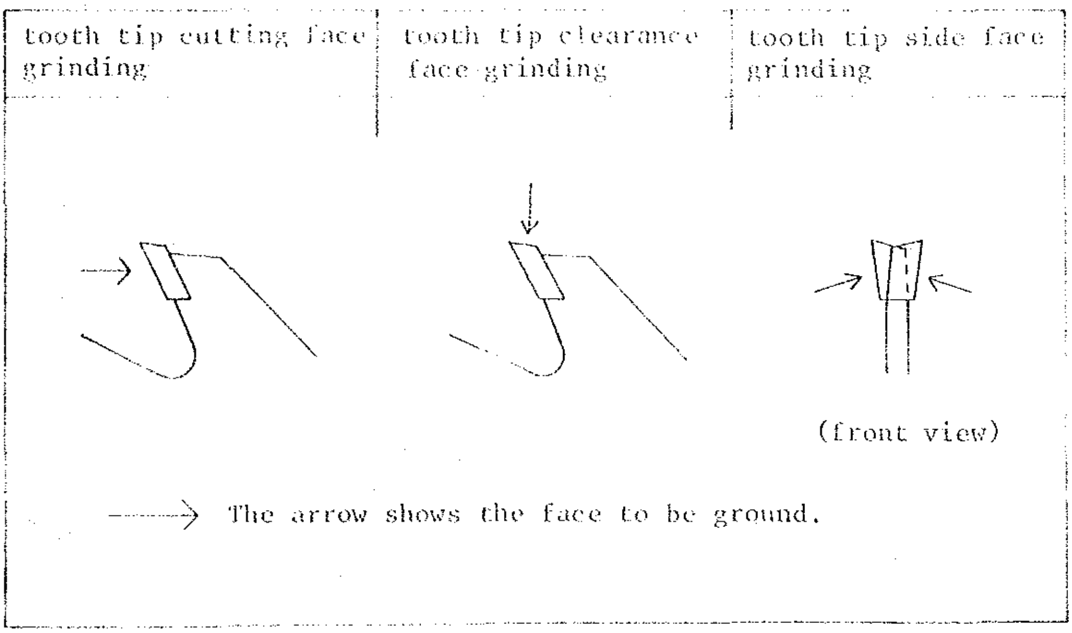


Fig. V-1 Grinding carbide tipped circular saw

Table V-1 Circular saw filing

Name of operation	Conventional techniques	Transferred techniques	Machine
Tensioning	●		
Circular saw setting (spring set)	●		
Carbide tips brazing		○	Carbide tipped saw welding machine
Tipped saw grinding			
cutting face	●	○	Hard alloy grinding machine
clearance face		○	
side		○	

Legend: ● Conventional techniques

○ Transferred techniques

② Band saw setting filing

(a) Operating procedure and importance of operation

The band saw blade is made of a carbon tool steel or low-alloy tool steel containing nickel, chromium, etc. In addition to those for carbon tool steel. In order to file a band saw into a sharpness of a good-cutting tool and give it performances to stand a long run of operation, several stages of operation are required as shown in Table V-2.

Any of the stages of band saw filing is important, but the following items are especially important.

- levelling of saw blade
- proper setting
- proper tooth shape
- proper tensioning and back crowning

Table V-2 Procedures for band saw filing

Order	Name of operation	Content of operation	Machines
	Tooth punching operation	Tooth punching of band saw	
1	Welding	Band saw cutting Oxygen welding of band saw into endless loop	Cutting machine A set of oxygen-acetylen welding apparatus
2	Levelling	Flatness finishing at weld Levelling for the whole blade	Hand grinder Surface plate, Band saw stretcher ruler
3	Tooth shaping	Adjusting band saw sharpener	Automatic saw sharpener
4	Tensioning	Tensioning Back crowning	Band saw stretcher, ruler
5	Saw setting	Swage setting	Swage, shaper, clamp bed
6	Stellite welding	Stellite welding	Stellite welding machine Stellite rod
7	Grinding	Tooth tip finishing grinding Tooth side grinding	Automatic saw sharpener Automatic side grinder machine

In purchasing band saw blade, it is usual to get one manufactured by tooth punching by an automatic machine.

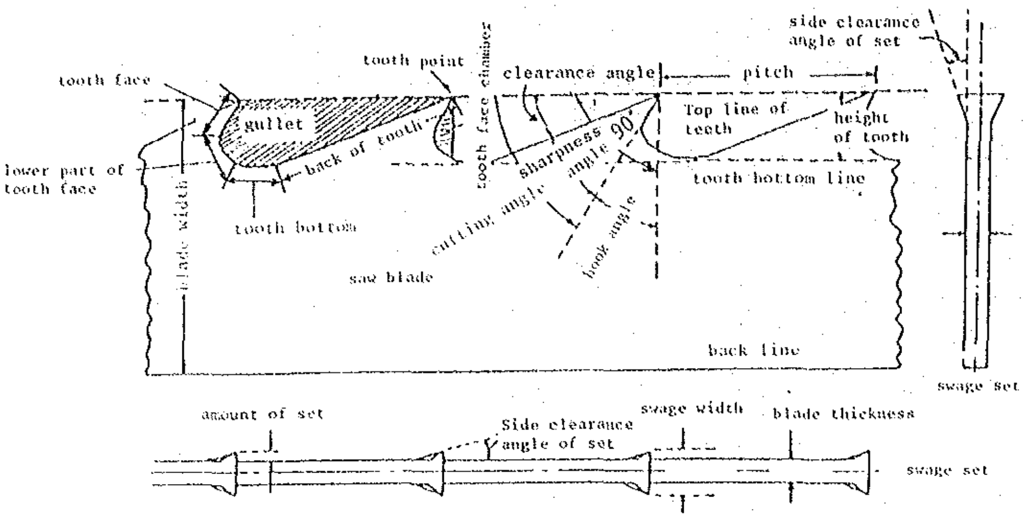


Fig. V-2 Nomenclature of band saw

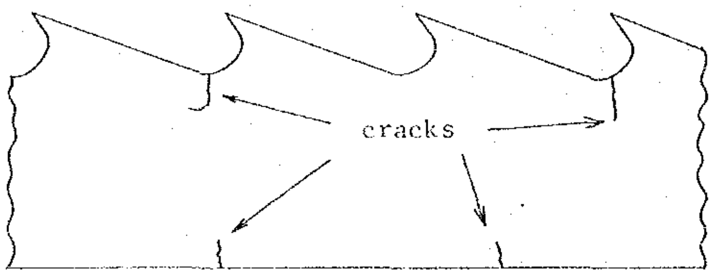


Fig. V-3 Cracks formed on band saw blade

In addition, skill in following operations are also important.

- tensioning (levelling, tensioning, back crowning)
- end joining of saw blade
- stellite welding

(b) End joining of band saw blade

Band saw blade is cut into required length and both ends are joined into an endless band. Oxygen ated acetylene welding is now commonly operated. A shorter time is required for the method than for brazing, besides the strength of weld part being superior. Oxygen ated acetylene welding enables one to repair small damage (crack etc.) on the tooth or saw blade that is difficult to repair by brazing.

(c) Tensioning

ⓐ Levelling

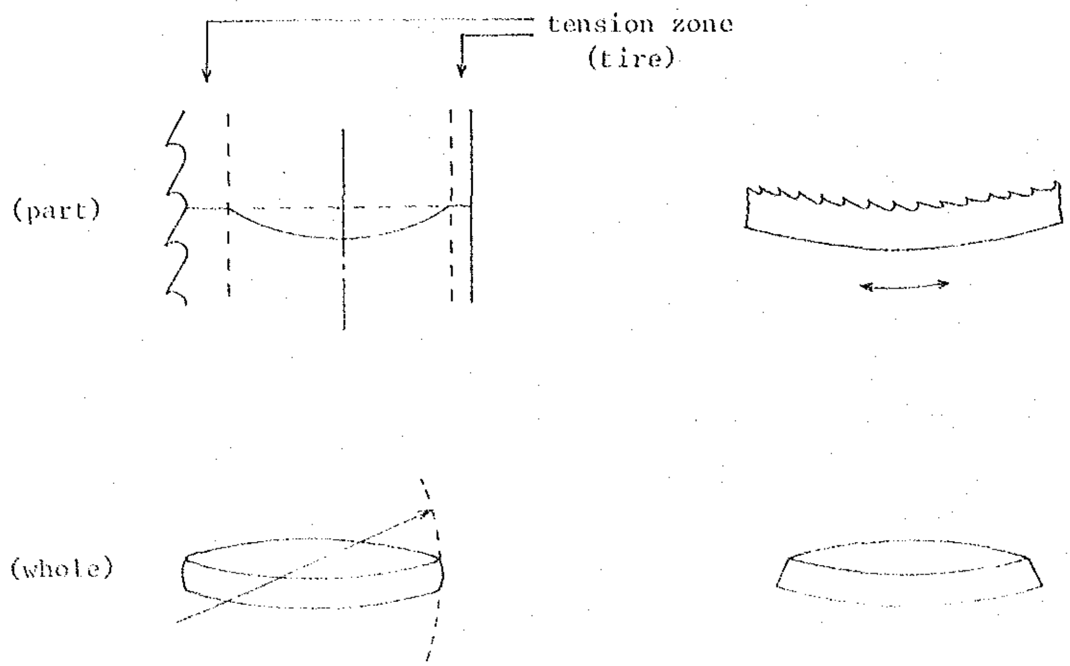
Levelling is given to the blade so that local strain is removed and a blade of good planeness, free from elongation, shrinkage, distortion, etc., is obtained. A slight strain at the weld, saw blade, or tooth root causes distortion of blade by the thermal expansion during sawing and leads to bending in kerf. Levelling is thus an important operation but is time-consuming, and much patience is required for the saw filler.

The part by welding is levelled by a hand grinder, hammer, etc., and defects of the saw blade is investigated on the surface plate attached to the unit by means of a straight edge to be corrected by the band saw stretcher, hammer, etc.

ⓑ Tensioning and Back crowning

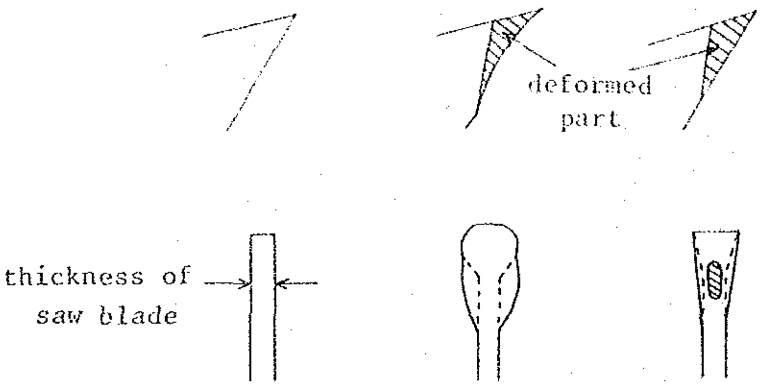
Band saw blade is stretched in the direction of length so that the tension is the largest at the center, and smaller at the sides; and the tension is adjusted to the tension gauge.

Tensioning is operated for prevention of bending of saw blade at the front or back edge by thermal expansion during sawing that causes deflection of teeth by the feed force of the machine and leads to bending in sawing direction. Tensioning is also for enhancing running stability of the



band saw blade after tensioning, band saw blade after back crowning

Fig. V-4 Shapes of band saw tensioned and backed



before setting | after swage working | after shaper finishing and grinding

Fig. V-5 Swage setting

band saw blade.

The front edge of band saw blade bends by thermal expansion during sawing, and this can cause deflection in the kerf. Therefore, the back of the saw blade is elongated in advance by band saw stretcher. The amount of elongation in back crowning is adjusted to meet the back gauge. This enhances running stability of the band saw.

ⓒ Grinding tooth

Tooth style is formed by the automatic saw sharpener where the movement of a cam moves the grind wheel up and down and that of the other cam feeds band saw blade and the grind wheel for the teeth is fixed on the machine inclined. Therefore, teeth of various style can be formed by changing the hoisting cam, feeding cam, grind wheel, and grind angle. Saw filer must be fully trained in the skill for adjusting automatic saw sharpener and operation in order that he can form teeth of the specified style.

ⓓ Saw setting

The spring set has been used long since, and it has an advantage of smaller cutting resistance, but the swage set is generally used these days because of an excellent cutting performance. Swage set consists of two steps of works, swage work and shaper finish, the former making the form of swage by changing the form of tooth and the latter making all of the teeth into uniform size and shape.

ⓔ Stellite welding

Casting alloy (stellite) is welded on the tooth point in order to give longer operating time expectancy of band saw. Stellite is an alloy consisting mostly of cobalt, chromium, and tungsten, and its hardness is lost but slightly even at 600°C: and this gives it a high resistence to wear. A band saw can continue to be operated from 2 hours without treatment to 1/2 to a day after treatment. Sawmilling of hard saw log (eucalyptus, for example), resin-rich wood, and other difficulty sawing wood can be facilitated by the treatment.

Band saw can be grinded 7 to 8 times without saw setting and stellite welding.

ⓕ Grinding

Saw teeth are grinded in the order of take face, tooth back and tooth side. The automatic saw sharpener and automatic side grinder are adjusted so that the teeth are ground in proper tooth angle and that saw setting width is adjusted uniformly. Too large speed of feeding saw teeth and lowering grind wheel causes poor sharpness of cutting edge, and adjustment is important.

Band saw blade is inspected in regrinding. Condition of saw setting, crack, tensioning, etc. are examined for every blade. Regrinding is given after confirmation of absence of the troubles.

ⓖ New saw setting working

When the swages of band saw teeth dwindle and using limit is reched, the saw blade is revived by giving a new saw setting. The dwingled swages are gound off, levelling, tensioning, back crowning, and other disorders on the blade are corrected. Then saw setting, and stellite brazing are worked, and saw teeth are ground.

③ Defects on band saw and sawn product caused by inappropriate saw filing

(a) Inappropriate band saw filing and its cause

ⓐ Offset saw setting

- The center of grinder is misaligned
- The tooth sways in grinding.
- Poor adjustment of swage.
- Poor adjustment of shaper.

ⓑ Irregular saw setting

- Defect in swage or swage operation.

Table V-3 Band saw filing

Name of operation	Conventional techniques	Transferred techniques	Machines
End joining	● (brazing)	○ (Welding)	Set of oxygen-acetylene welding apparatus
Tooth style formation		○	Automatic saw sharpening machine
Tensioning			Surface plate, band saw stretcher, ruler
Levelling		○	
Tensioning		○	
Back crowning		○	
Saw setting	● (Spring set)	○ (Swage set)	Swage, shaper, clamp bed
Stellite welding		○	Stellite welding machine, Stellite rod
Grinding, Rake face	● (Spring set)	○ (Swage set)	Automatic saw sharpener
Tooth sides		○	Automatic side grinding machine

Legend: ● Conventional techniques

○ Transferred techniques

- Defect in shaper or shaper operation
- Irregular grinding by automatic saw sharpener.
- Inappropriate method in grinding

Irregular grinding of automatic saw sharpener can be caused for the following reasons:

- Faulty tip of feeding click for band saw blade
- Insufficient accuracy of copy roller of cam.
- Bearings of grinder are worn-out.
- Vibration of the base of saw sharpener
- Band saw blade support in worn.
- Insufficient holding by saw blade holder
- Poor contact between cam and copy roller
- Too much clearance on grind wheel sliding guide.
- Too much clearance around pin by deterioration
- Too much grinding at a time

ⓒ Chipping off of set out teeth

- Lug crack was formed in saw setting.
- Inappropriate operation by shaper
- Heat due to grinding took place
- Incorrect method of saw transportation

The following reasons can be cited for heat due to grinding

- Wrong selection of grind wheel
- Incorrect surface speed of grind wheel
- Too large feeding speed of saw blade in grinding (number of teeth/min.)
- Too rapid hoisting and lowering of grind wheel
- Lack of clearance for hoising cam of grinder
- Grind wheel is worn down

ⓓ Poor sharpeness of cutting edge

- Too coarse grid is used on grind wheel
- Descending speed of grind wheel too large
- Feed speed of saw blade too large in grinding (number of teeth/min)
- Incorrect tooth angle
- Insufficient grinding at the tooth

Table V-4 Change in circular saw filing

Name of operation	Conventional techniques	Transferred techniques	Present operation
Tensioning	●		●
Saw setting (spring set)	●		×
Cemente carbide tip brazing		○	○
Tipped saw grinding			
Rake face	●	○	⊙
Clearance face		○	○
Side		○	○

Legend:
- ● Conventional techniques
- ○ Transferred techniques
- ⊙ Accuracy improved by transferred techniques
- × Became unnecessary after transference of techniques

Table V-5 Change in band saw filing

Name of operation		Conventional techniques	Transferred techniques	Present operation
End joining	Brazing	●		×
	Oxygen-acetylen welding		○	○
Tooth style forming			○	○
Tensioning	Levelling		○	○
	Tensioning		○	○
	Back crowning		○	○
Saw setting	Spring set	●		×
	Swage set		○	○
Stellite welding			○	○
Grinding	Rake face	● Spring set	○ Swage set	◉
	Tooth side		○	○

Legend: ● Conventional techniques
○ Conveyed techniques
◉ Improved accuracy by conveyance of techniques
× nnecessary by conveyance of techniques

Table V-6 Saw filers

Name	Age	Former occupation
ISMAEL NUNES	40	Carpenter
ANTONIO PEREIRA DE MORAES	40	"
PEDRO MILTON MARTINS	24	Lumber sawmilling worker
SERGIO BENTO	20	"

ⓒ Irregular tensioning and back crowning

- Irregularity in the hardness of saw blade
- Band saw stretcher is causing strain.
- Stretching under misjudgement in strain and irregular tension.
- Partial tensioning and back crowning
- Feed speed of saw blade not constant.
- Stretching on the tension zones (fire) on both edges of saw blade.

(b) Causes of faulty sawing and sawn wood as brought about by band saw and solution

ⓐ Bending of kerf

- Insufficient levelling of saw blade
- Inappropriate saw setting
- Inappropriate tooth style
- Irregular or insufficient tensioning
- Irregular or insufficient back crowning
- Insufficient levelling or tensioning at the weld

ⓑ Poor surface quality of sawn timber

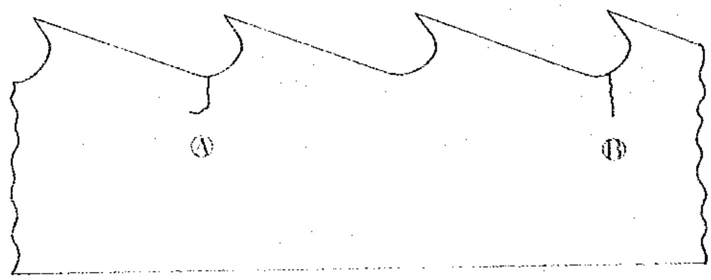
- Poor aligning in saw setting
- Poor sharpeness of cutting edge
- Easily broken saw set or broken saw set
- Deficient work of shaper, inappropriate side clearance angle of saw set
- Excessive saw setting or too large thickness of saw blade
- Excessive pitch of band saw or irregular pitch
- Case of weak tooth point or case of inappropriate cutting angle
- Faulty levelling at the weld
- Bent tooth point
- Insufficient tension at tooth side edge
- Case of levelling being operated by hammer

ⓒ Crack on the saw blade

- Hardness of saw blade is too large and saw blade is brittle.
- Saw blade thickness is too large against the diameter of band saw wheel of the bandmill.

- Improper shape of teeth, especially the roundness at the tooth bottom
- Heat due to grinding is left at the tooth root
- Excessive tensioning and back crowning
- Width of tension zones left on both edges of band saw blade is too small.
- Inappropriate finish at the weld.

The shape of crack often depends on the cause of the crack. Fig. V-6 shows the typical shapes of crack caused by the machine and saw filing respectively.



(A) The machine is to blame for the crack.

(B) Saw filing is to blame for the crack.

Fig. V-6 Shape of typical crack of band saw blade

(4) Result

Consistent techniques for carbide tipped circular saw filing were established by combination of the conventional and new techniques. Circular saw filing has been included in routine works in the experiment station.

The saw filers of the experiment station acquired the techniques for the whole operations of band saw filing process. The saw filers mastered the techniques by their practice, because the techniques are of a nature that saw filers depend very much on their sense and experience, and this made it sure that the band saw filing techniques would take root. It also ensured smooth production of lumber products by the sawmill machinery introduced by the project with twin bandmill etc. The band saw filling techniques contributes to the amount of production, quality of products, and operating cost. Manduri Experiment Station now possesses by far the superior techniques, as compared with sawmills in the viscinity, to be one of the top-class techniques not only in the state of São Paulo but in whole Brazil.

(5) Future Problems

① Circular saw filing

There are not many difficulties in circular saw filing techniques, owing to the improvement of machines for saw filing. Saw filers need just to be acustomed to the handling of the machines in order that the circular saw filing techniques be maintained. Therefore, there is a little possibility of some problem being raised in the future.

② Maintaining techniques of band saw filing

As to band saw filing, sawmilling operation in a sufficiently favorable condition will be maintained by the present techniques in the case of sawmill machinery working in good conditions and sawmilling conditions of operations being similar to those at present, in terms of diameter of saw logs, sawing speed, etc. In addition, in sawmilling operation running under stable conditions, a slight difference in saw filing does not cause noticeable trouble. However, little difference in sawmilling operation appears when the saw filing techniques reach a certain standard, and this conversely means that the saw filing techniques can be lost or forgotton without being noticed by the saw filers. Further in the case of sawmilling conditions being changed, such as saw log of a larger diameter or sawing in a larger speed, or under some disorder of the machine, modified operation is required; and the problem of lowered skill can appear strongly.

Since techniques of saw filing depend largely on sense fostered by experience, the means of maintaining the techniques are introduced from this angle. Considering the characteristics of saw filing as bodily act, it is indispensable to operate every day, securing a certain level of work constantly in the amount.

The average amount of work by a saw filer in sawmilling in Japan for regrinding, saw setting, new swage formation, etc. covers about four machines operating 5 - 7 hours a day. Speaking from the level in Japan, the capacity of saw filer in Manduri Experiment Station is larger than their actual amount of work. In other words, their amount of work is too small, even if their present situation of being in a learning stage is considered. They need a larger amount of work in order to maintain their skill. This is effective not only for maintaining their skill in saw filing but also in a wider scope of their ability.

③ Improving efficiency of saw filing

Saw filing techniques of a high accuracy has taken root by the project. Because of the saw filing techniques being a bodily act, reduction in operating hours by skill is the next subject to be achieved. According to an investigation of band saw filing operation in Japan[3], the average operating hours for a new band saw filing is 139.0 minutes by a skilled saw filer of 10-year or longer experience and 200.2 minutes by an ordinary saw filer, showing a difference of 60 minutes between skilled saw filer and ordinary saw filer. The difference was clearly shown in each of the steps of end-joining, tensioning, and stellite welding. The skill in stellite welding affected the operating hours for grinding.

It is necessary for improvement of working efficiency to set a goal to be attained, and it seems appropriate for Brazilian saw filers to set a goal for the moment at 200 minutes for saw filing of new band saw blade, that is the average by Japanese saw filers of ordinary skill. The training shall be made with emphasis on the step where a difference is shown by the skill. The fact that a new band saw blade can be worked within 140 minutes would be a further target to be remembered for their advancement.

V-1-2 Method of Improving Sawmilling Techniques

(1) Sawmilling in the Past

Sawmilling in Manduri Experiment Station is operated with logs produced in the state-owned artificial pine forest by thinning as the material. The sawing facilities owned by the station before the project was started consisted of sawmill machinery such as twin circular sawmill, crosscut saw, and table band resaw, and wood working machines such as planer, tenoning machine, borer, etc.

Sawmilling was operated in the following steps: Saw logs were treated by the twin circular sawmill into squared timber. Squared timbers were treated by the table band resaw into boards. The length of the squared timbers and boards was adjusted by the crosscut saw to meet the specification.

The features of the machines are as follows: The distance between circular blades of the twin circular sawmill (width of sawing) is set by hand, and carbide tipped circular saws are used. The maximum sawing speed is 20 m/min. The width of saw set is 9 mm, and sawing loss is large. The width of blade of table band resaw is as small as 2 inches.

The sawing yield by the machines was as law as 38% in production of squared timbers and 30% in that of boards, due to the lack of function for slab use, large kerf width, etc.; and the wood wastes were disposed of by burning, a part being used as fuel.

The sawmill machinery in the sawmills near Manduri are similar to those of the experiment station, and the sawing yield was not very much different. However, in sawmills sawing large-size logs, an band mill with auto feed cartiage has been introduced in an example, and a large difference in sawmill machinery was noticeable in Brazil.

(2) Sawmill Machinery

① Outline of new sawmill

The new sawmill was constructed next door to the existing sawmill by Forestry Institute. The new plant contains a production line with a twin bandmill as the principal machine. A plant building is about 600 m^2 area.

② Twin bandmill

Twin bandmill allows setting sawing size at any amount desired. It enables one to saw log into squared timbers and boards automatically. It also allows changing the sawing method according to the diameter of the log amount other sawing method according to the kind of sawn timbers. The feed speed can be adjusted within the range of 0 - 60 m/min by regulating the hydraulic system. The kerf width is 2 mm, and the sawing loss is small.

③ Table band resaw

The table band resaw is exclusively used for sawing slab into board. The thickness of the board can be varied within the range of 5 - 250 mm. In the case of feeding material by manpower, two workers are arranged each ahead and behind the material. However, unexperienced workers can only difficulty manage the log to saw streight; and a roller feed was fitted so that the material can be fed by a roller. The roller feed can make the sawing of slab into board product safely and regularly so that the accuracy in the thickness and operational efficiency are enhanced.

④ Double edger

Twin exclusive circular saw is used for treatment of slab and other end materials. Slab is treated for cutting the edges into boards and narrow boards. The width of product can be adjusted within the range of 75 - 330 mm.

⑤ Crosscut saw

Crosscut circular saw is exclusively used for cutting squared timbers and boards into specified length. The safety cover holds down and fixes the material during cutting, while the circular blade comes up to cut the material.

⑥ Log loader

Log loader is a loading machine of four-wheel drive type, and it can be used also as a fork-lift and power shovel by changing the attachment. Formerly, saw logs were unloaded by manpower in carrying them in. However, the unloading operation was mechanized in order to cope with the increased capacity of sawmilling by introduction of twin bandmill.

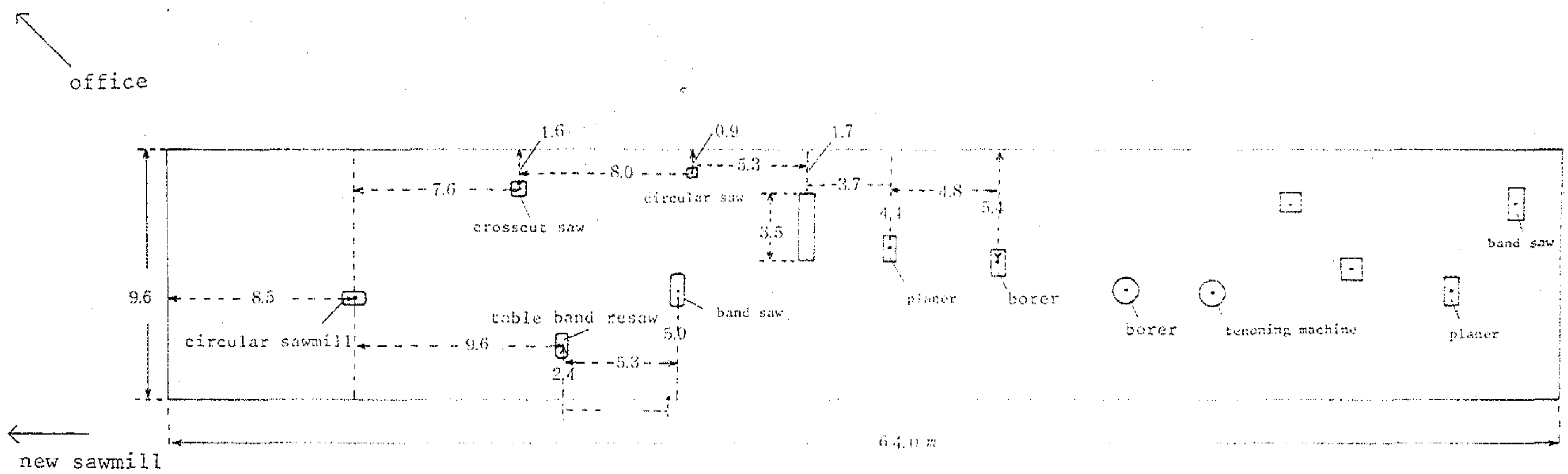


Fig. V-7 Sketch of Manduri old sawmill

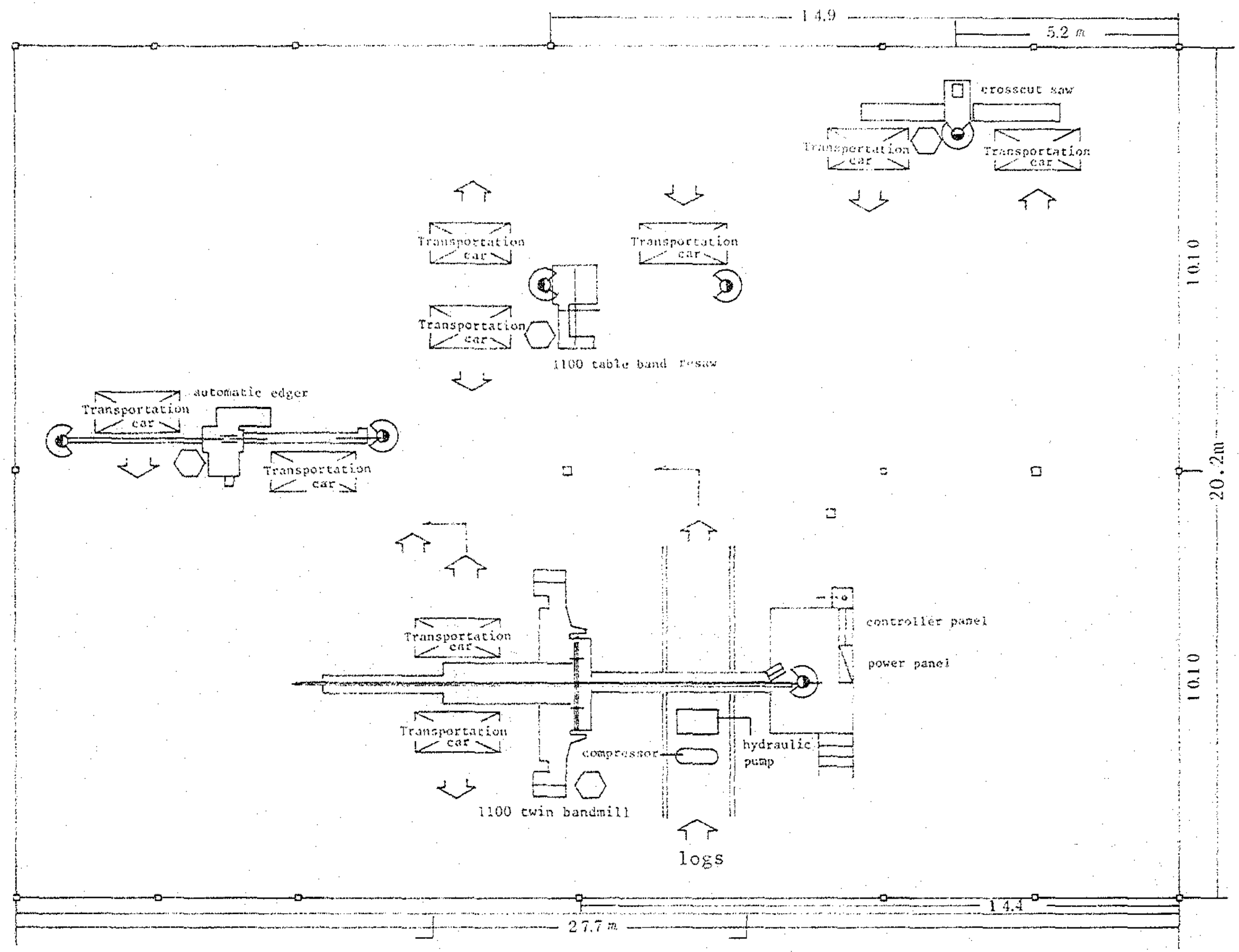


Fig. V-8 Sketch of new sawmill in Manduri

(3) Items of guidance and aims

① Operation, inspection, and maintenance of sawmill machinery

Performance and structure of sawmill machinery were explained, so that working procedures were acquired along with the method of handling and adjustment of the machinery. The machines are driven and controlled in various power systems, electric, pneumatic, and hydraulic; and understanding of the systems is necessary for inspection and maintenance in addition to understanding of the mechanical part of the machines. Thus workers shall be trained not only for handling of the machine for production but also for simple repair works.

Sawmilling is a dangerous operation to work heavy material surrounded by cutting tools. Through going understanding of the method and procedure of operation is asked of the workers for safe sawmilling.

② Sawing method

Sawing method means deciding the kinds of products to be produced from a saw log, along with the size of product, position on the material, and procedure of operation in a sawmill. Establishment of practical sawing pattern was aimed at that would suit the size of log and uses of the products. The twin bandmill has a function to decide the sawing width in advance, and techniques for setting sawing pattern on the control panel (pin board) of the machine were learned by the workers.

③ Sawmilling

The production line with the twin bandmill as the main machine has many automated steps, and it is simple to operated and enables a mass production. Operators should become fully skillful in operating the machines so that the operational efficiency be enhanced and sawn timbers of high sawing accuracy produced.

Various problems are caused in the operation owing to inappropriate maintenance of machines, saw filing works, and sawmilling operation. Problems disclose themselves concretely as faults in sawmilling operation, and the causes of the problems shall be traced from the clues. And the operators shall be trained so that they will acquire overall techniques for solution of the problems and the present techniques was designed in this line.

(4) Transference of techniques

① Sawing method

It is the object of sawing method to obtain sawn timbers from the saw log in the most advantageous manners. For this purpose, sawing method must be prepared with consideration of the following points.

- To grasp the kinds of product
- To be throughly aware of the standards of sawn timber
- To grasp the present situation and future trend of timber market
- To select the saw logs that are suitable for production of the kind of products
- To observe the kind, size, and position of the defects in the saw log and to manage and prevent ill effect on the value of the product

The following is some indices for judging advantage in sawing method. In addition, due consideration on efficiency of sawing operation is also necessary.

ⓐ Volume yield

Volume yield of product is expressed by per cent of sawn timber volume/saw log volume. Volume means wood transaction volume for the saw log as well as the sawn timber.

ⓑ Value yield

Value yield is expressed by the ratio of values, sawn timber against saw log. The value of sawn timber is that of exfactory and that of saw log cif factory. The value yield in Japan in the case of sawmilling in producing district is in the range of 1.3 - 1.4.

ⓒ Added value rate

Added value rate is the rate of processing amount against product sales amount per unit volume of material, where processing amount = product value - material price - outside order processing expense. The rate is in the range of 0.2 - 0.3 in sawmilling in producing district in Japan.

② Sawmilling

The characteristics of logs of eucalyptus and pine that are the principal kinds in artificial forests in the state of São Paulo are as follows: Eucalyptus is cut for pulp wood at the age of 6 - 7 years, but as lumber material at 10 and odd years. However, it is the short-coming of fast-growing eucalyptus that a end crack is formed. Pine is cut at the age of 15 - 25 years. It is used as pulp wood, charcoal wood for iron manufacture, box material, etc. Pine has also the short-coming of end crack formation due to fast growth when it is used as sawn timber. These two kinds of saw logs have such short-comings as saw log, and development of some means of utilization at higher added values is awaited.

The characteristics of small-size pine as subject of saw log are short-comings as follows:

- The logs are not mature and the distance between annual rings is large. This causes smaller strength and warp such as bending or distortion.
- The small-size logs give sawn timbers that are apt to turn roundish, and the yield is low.
- High bark rate, high void rate in transportation causing higher transportation cost.
- Low added value of sawn timber leading to low profitability.

③ Principal technical problems in sawmilling and their causes

If the production activity is not satisfactory, the mechanical maintenance, saw filing, sawmilling techniques, etc. must be examined collectively. Low efficiency in sawmill is generally caused by inappropriate arrangement and/or selection of machines, unbalance among production capacities of machines, poor means and capacity of transportation between machines, inadequate capacity of sawmilling machinery, etc. Other causes will be given as follows including the case of using bandmill with carriage type.

(a) Poor efficiency of sawing operation

- Poor performance of bandmill
- The machine has a limited power output.
- The feed speed is not appropriate for the saw log.
- The quality and diameter of saw logs are divergent.
- The bark is not removed.
- Difficult sawing pattern.
- Unskilled sawmilling techniques.

(b) Bending in sawing

- Inappropriate angle between the main machine and the rails
- Wear at the periphery of band saw wheel
  - Overrunning of upper band saw wheel
  - Band saw blade of small width alone being used.
  - Insufficient tensile force of band saw blade.
  - Incorrect quality of band saw wheel.
  - Wear at the front margin of band saw wheel (upper and lower)
  - Incorrect fitting of sweep blade on band saw wheel
- Deflection of material sending rail or its base
  - Soft ground or insufficient foundation work
  - Poor water drainage
  - Incorrect position of rail base or bolts on concrete base
  - Fault in rail itself.

In the case of bandmill with carriage using wooden base,

- A gap between wooden base and base concrete.

- Wrong joint of wooden base, wrong retaining, wrong position of rail joint.
- Poor accuracy in linearity of vee-faced rail
- Insufficient accuracy in level of the rails in the direction of width.

- Wear of rail and wheel of carriage
  - Wrong direction in driving carriage.
  - Carriage wheel not on flat rail completely.
  - Poor quality of rail
- Distortion of carriage axle
  - Axle too thin
  - No wood turning device on carriage
  - Rail of concrete anchor type
  - Steel frame being used for carriage
  - Head block being attached right above axle
- Fault in carriage offset
- Tension weight being too light (also causes saw crack)
- Large distortion of upper and lower saw wheel (causing saw crack)
- Fault in saw guide (apt to cause distortion in saw blade)
- Inactivity in band saw straining device (causes saw crack)
  - Wear of push rod and knife edge
  - Wrong position of weight lever attaching
  - Weight lever contacting with band saw straining device
  - Poor rotating of ball bearing for upper wheel
  - Faulty position and method of supporting rod
- Too large distance between axles of band saw wheel
- Revolution speed of main machine not matching the kind of saw log.
- Band saw protruding too much.

- Depending on the quality of saw logs (too much warp in reaction wood)
- Wrong way of sawing
- Unskillful saw filing (cf the paragraph for band saw filing techniques)

(c) Saw blade easily cracked

- The band saw blade too hard and brittle
- The blade is too thick against the diameter of band saw wheel. A blade thickness of about 1/1,000 of the diameter is usually used.
- Axles of upper and lower band saw wheel are twisted.
- Working of band saw straining device not sensitive enough.
  - Case of push rod and knife edge being worn or not acute enough
  - Weight lever or weight is contacting the main machine or safety cover.
  - Rotating of ball bearing for upper wheel not smooth at the support.
  - Structural defect in band saw straining device.
  - Inappropriate tension of weight lever
  - Saw dust being caught by rod support
- Excessive weight of tension weight
- Bearing of band saw wheel is worn.
  - Too much inclination of band saw wheel.
  - Too fast revolution of saw blade
  - Inappropriate lubricating oil and poor lubrication
  - Impact being given or vibration
  - Biased center of gravity of band saw wheel
  - Wrong mounting position of band saw wheel.
  - Over loading of tension weight
  - Too much tension on belt

- Too much vibration on main machine
  - Revolution too fast
  - Loose nut on bolt connecting the machine with the foundation
  - Insufficient rigidity of the main machine
  - Defect in band saw wheel support
  - Wearing of bearing of band saw wheel, etc.
  - Loose spall guide
  - Poor finish of saw wheel, poor accuracy and balance
- Larger protrustion of band saw from the lower band saw sheel than from upper wheel
- Imperfect sweep blade of band saw wheel.
- Insufficient accuracy in side and periphery of band saw wheel
- Wear of band saw wheel front margin.
- Clamping of saw guide plug too tight.
- Saw guide and band saw blade not parallel to each other
- Wear of lower sweep blade of band saw wheel
- Too long idle running of bandmill or sawing hours of band saw.
- Inappropriate number of revolution against saw blade thickness.
- Inappropriate saw filing (cf. paragraph for band saw filing techniques)

(d) Poor surface of quality sawn timber

- Irregular saw setting
- Easy breaking of teeth by saw set
- Poor sharpeness of cutting edge
- Too large amount of set, or in the case of thick saw blade
- Too large pitch or irregular pitch
- Teeth shape causing weak tooth style

- Insufficient output of main machine
- Too much vibration on main machine
- Poor saw filing (cf. paragraph for band saw filing techniques)

(e) Usable time of band saw is short.

- Saw blade runs too fast or too slow.
- Deviation in kerf line by incorrect the rails or band saw wheel is 1.0 mm or larger.
- Soil or bark adhering on the saw logs
- Insufficient straining force
- Difficult kind of saw log for sawmilling
- Saw of poor sharpeness used.
- Improper saw set
- Using saw blade is thin.
- A saw blade is used on purpose whose leveling and saw setting is adjusted to one-side set in order to prevent deviation of kerf line.
- Incorrect saw filing (cf. the paragraph for band saw filing techniques)
  - Poor levelling
  - Case of insufficient or irregular tensioning or back crowning
  - Case of sharpness angle being acute
  - Tooth style is such that saw dust is difficultly discharged.

(f) Poor rectangularity of product

- Inaccurate rectangularity between saw blade and sliding surface of head block.
- Saw blade is not correctly parallel to saw guide.
- Poor adjustment of saw guide plug.
- Bending of frame of carriage or the rails.

- Saw blade is not perpendicular to table bed or ruler.

(g) Band saw is apt to recede during sawmilling.

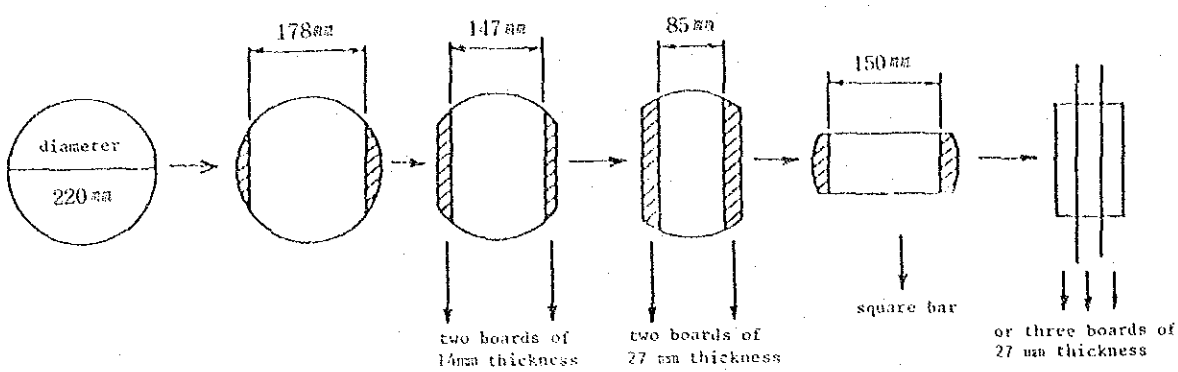
- Peripheral surface of band saw wheel is not at right angle.
- Side surface of lower band saw wheel is vertical or inclined forward.
- Back crowning or tensioning is excessive or insufficient.
- Straining of band saw insufficient.
- Refuse removing device of band saw wheel not appropriate.
- Upper and lower band saw wheels distorted.
- Poor levelling for band saw.
- Band saw of poor cutting sharpness being used.
- Inappropriate saw setting.
- Angle between main machine and the rails too large.
- Deviation of kerf line by bending of the rails etc.
- Saw width is too small and material width too large.
- Power output of main machine inadequate.
- Depends on the property of saw log (reaction wood, etc.)

(5) Result

Forestry Institute has been producing sawn timber for construction of houses. It is necessary to establish sawing method for producing timber suitable for the method of house construction with consideration of the performance of the sawmill machinery. Two kinds of sawing pattern were established by the engineer of the experiment station based on their experience to be operated by the twin bandmill. (Fig. V-9) More suitable sawing pattern can be applied to the saw log depending on the size.

The workers learned operation procedure and adjustment of the sawmill machinery thoroughly. In the case of sawmilling with twin bandmill, manual handling of material in addition to the mechanical handling, such as log loading, positioning, set work, unloading, etc. are operated smoothly and operating time was reduced. Thus the workers are now skillful with sawmilling operation, including operation of machines, and a system was established that can be called a production line of a sawmill. In other words, a group of workers were acquired who have mastered operating sawmill machinery, and the mill is ready for a mass production. The products from sawmilling of small size logs of thinning etc. are low in added value because of the limited field of use, and

1. Case of pine log of about 22 cm diameter



2. case of pine log of about 19 cm diameter

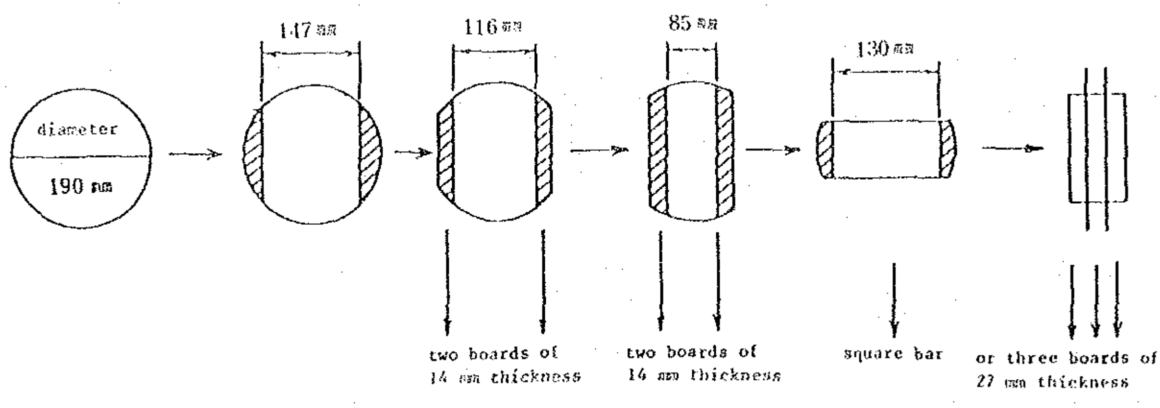


Fig. V-9 Sawing pattern for pine log

there is no other means of profitable operation than mass production. Therefore, the readiness for mass production thus established can be called a large advanced towards effective utilization of the small size logs.

Inspection and maintenance of machines are now operated smoothly, and workers understand the machines pretty well. The workers are now skillful in operation and understand the structure of machines so well that they can add some partial improvement on the machines by their ideas. The clamp for fixing saw log on the carriage of twin bandmill was improved as a result. This remodeling enables sure and easy fixing of saw log on the carriage and handling of material was improved. The structure in the remodeled part is shown in Fig. V-10 and Fig. V-11.

(5) Sawing yield and operational efficiency

Sawing yield and operational efficiency before and after the project are compared referring to the report 3), 4) by Forestry Institute along with productivity of old and new sawmill machinery.

Sawing yield is expressed in percentage of product volume against the volume of raw material logs. The volume means here the volume of wood obtained by specified method of calculation for the material and products. The volume is the present report was calculated by the Brazilian method: a mean diameter method or a conversion method from stacked volume is used. As an index of production capacity of a sawmill as a whole, log consumption per PS of sawmill machinery, log consumption per kwh of power consumed, etc. are used. Log consumption per worker of the plant is often used as an index of efficiency of sawing operation. However, in the case of a large difference in the performances of machines, it is not a suitable index of efficiency of sawing operation. We, therefore, use log consumption and product volume per operating hour of sawmill machinery (m^3/hr) as indices of operational efficiency.

Operational efficiency by the conventional sawmill machinery with twin circular sawmill as the main machine was 3.10 m^3/hr logs consumed and 1.37 m^3/hr of product produced, and the sawing yield was 44.3%. The same for sample A and B by the new facilities with twin bandmill as the main machine was 3.67 m^3/hr, 3.25 m^3/hr log consumption and 2.02 m^3/hr, 2.00 m^3/hr product, with sawing yield of 55.1% and 61.5 %. Comparison of the test result by the new facilities with that of the old ones shows that log consumption increased by 118.4 % for samples A and B respectively with further increase in product volume by 147.4 % and 146.0 %. Sawing yield increased by 10.8 % and 17.2 %. Comparing the test results between old and new facilities, for Sample B that was similar to the logs for old facilities, the product increased by 146.0 % but log consumption increased only by 104.8 %. The sawing yield increased from 44.3 % to 61.5 % by 17.2 %. Similar result was observed in Sample A. The improved treatment of logs and higher increase of production than that of log consumption, showing a remarkable increase in productivity, is attributable to the difference in performance of sawmill machinery. (Table V-7)

The difference in performance can be summarized into the two points as follows: (a) Boards can be produced from slab. Slab were just wasted by burning, being unable to utilize them; but now they can be raw materials for board products. Thus sawing of a high advantage was adopted and the slab are utilized. (b) Kerf width was reduced, and this lowered the sawing loss. The conventional twin circular sawmill was made at 9 mm set width, and this resulted in a loss of material by 18 mm; while the twin bandmill can operated at 2 mm set width, and this lowered the loss of material to 4 mm. Reduction in the amount of saw dust means an increase in the possible volume of logs for utilization.

The effect of the size of logs on the operational efficiency was discussed from Table V-8. The volume yield for sample A was 55.1 %, going up by 10.8 %, which is smaller than that of sample B at 61.5 %. However, operational efficiency of sample A is higher than that of sample B, showing that sawing of logs of a larger size is of advantage to that of smaller size. In the case of sample B of a smaller size, volume yield was raised by managing sawing pattern, but products of lower quality were produced in a large amount as shown in Table V-9. Logs of larger size is of advantage also in terms of quality of products. Yield of products from logs of a smaller diameter can be improved by managing the sawing pattern, but logs of a larger diameter are of advantage in terms of operational efficiency and quality of products.

To sum up, it was proved, as suggested by the case of sample B, profitability of sawmilling can be improved by a mass production with enhanced yield and operational efficiency.

Desenho esquematico das peças A original
e a peça adaptada, montadas no conjunto.

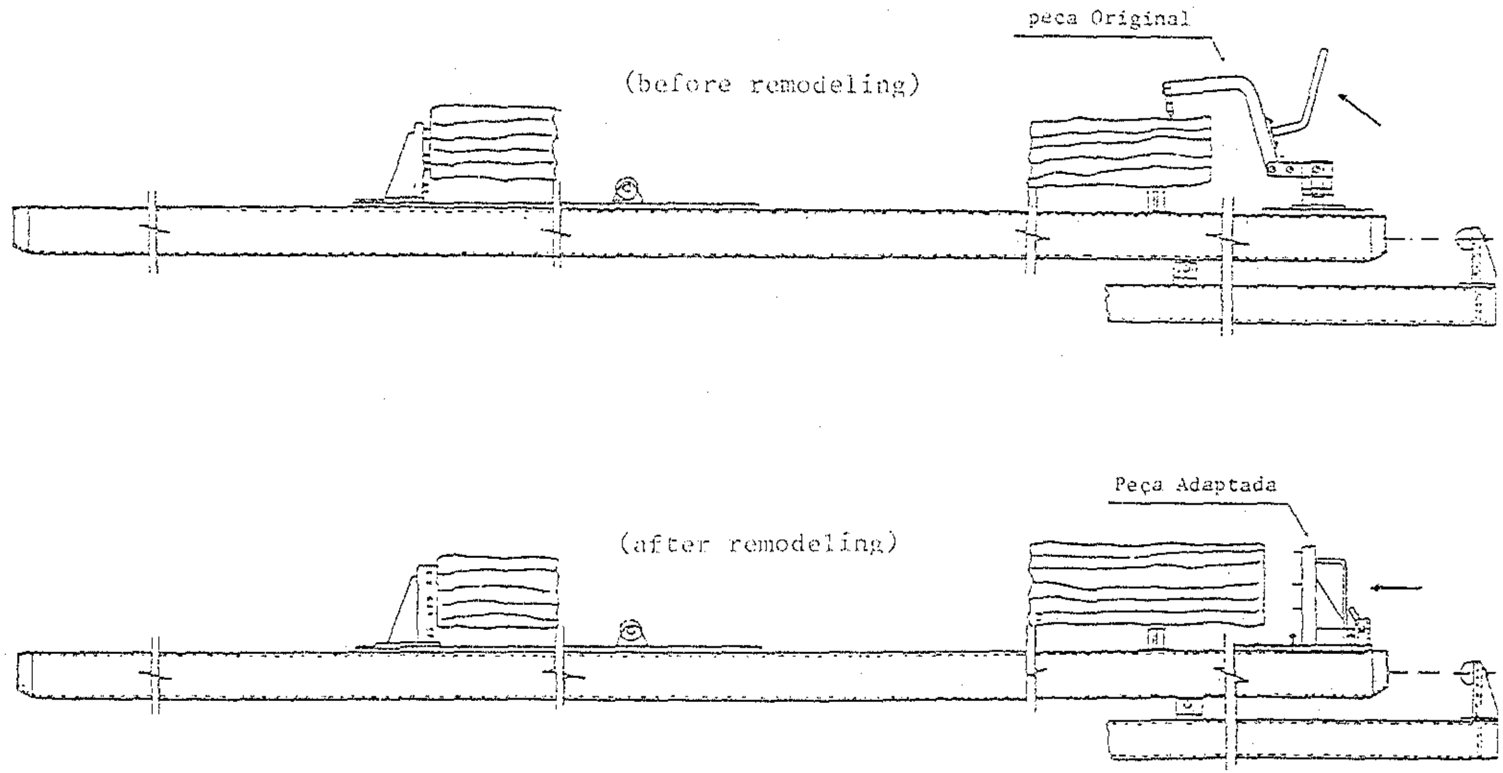


Fig. V-10 Remodeling clamp for fixing log
(twin band mill)

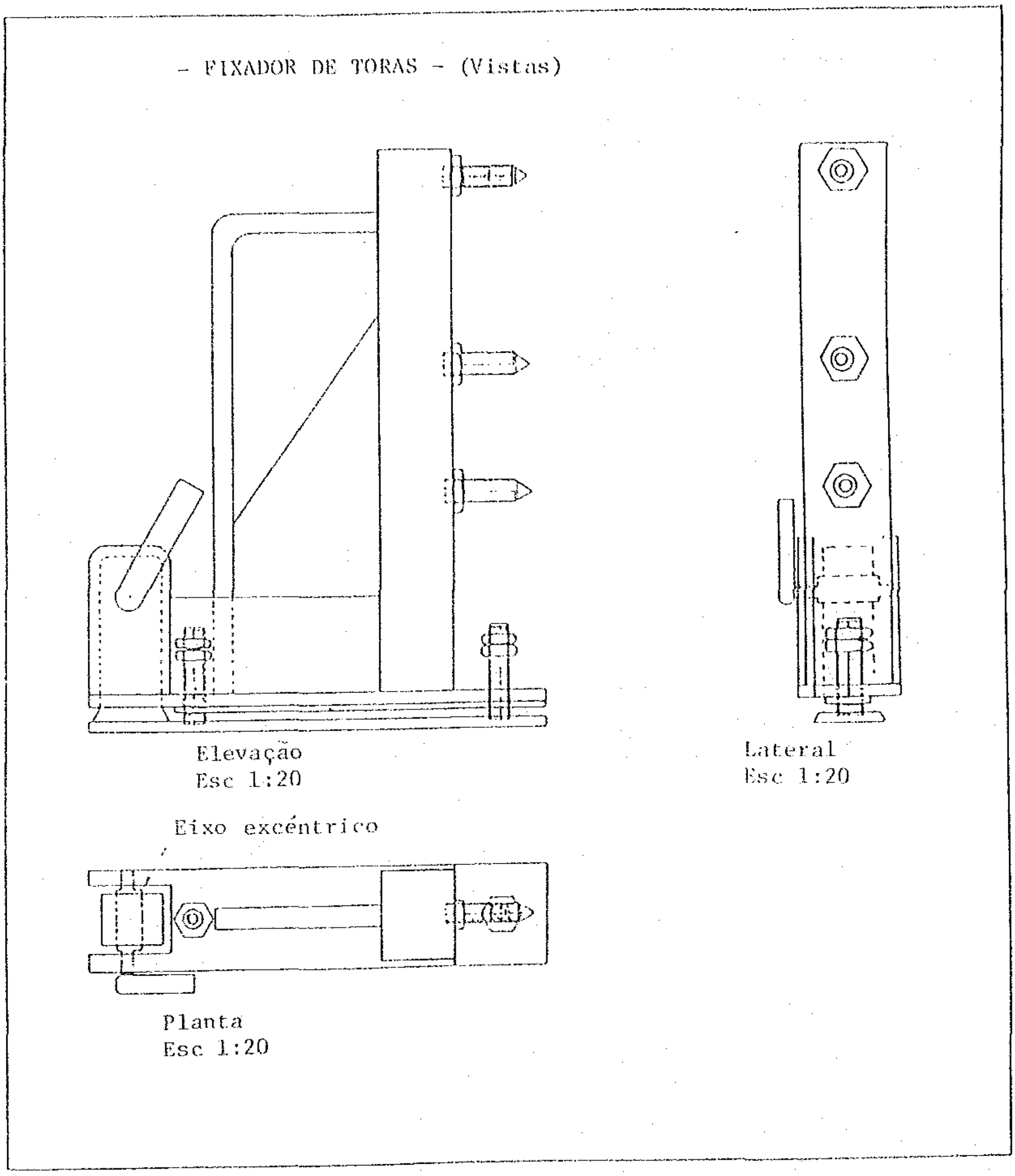


Fig. V-11 Structure of clamp (remodeled) for fixing log

Table V-7 Efficiency and yield by new and old sawmill machinery

Item \ Data		Old sawmill machinery	New sawmill machinery	
			Sample A	Sample B
Number of sample logs		346	33	40
Age of tree		22	23	22
Length of log		3.3 m	3.07 m	3.07 m
Average top end diameter		16 cm	19.3 cm	16.5 cm
Average center diameter		-	21 cm	18 cm
Efficiency	Log volume/hr	3.10 m^3/hr	3.67 m^3/hr	3.25 m^3/hr
	product volume/hr	1.37 m^3/hr	2.02 m^3/hr	2.00 m^3/hr
	" /man day	-	1.57 m^3	1.39 m^3
Volume-yield		44.3 %	55.1 %	61.5 %
Saw dust/sawlog volume		-	9.7 %	8.4 %

Table V-8 Efficiency and yield for various diameters

Item		Sample A	Sample B
Forest condition	Kind of tree	Elliottii pine	Elliottii pine
	Age	23 years	23 years
	Number of times of thinning	5	4
Sawlogs	Number of logs	33	49
	Length	3.07 m	3.07 m
	Average top end diameter	19.3 cm	16.5 cm
	Average bottom end diameter	23.4 cm	18.7 cm
	Average center diameter	21.0 cm	17.9 cm
	Log volume (free from bark)	3.673 m	3.788 m
Sawmilling	Product volume	2.022 m	2.329 m
	Sawing time	60 min.	70 min.
	Efficiency: log volume/hr	3.673 m^3/hr	3.246 m^3/hr
	Efficiency: product volume/hr	2.022 m^3/hr	1.997 m^3/hr
	Efficiency: product volume /man day	1.57 m^3	1.39 m^3
	Volume-yield	55.1 %	61.5 %
	Saw dust/sawlog volume	9.7 %	8.4 %

Table V-9 Amount of production by size of product

Size of boards	Sample A		Sample B	
	Number	Volume	Number	Volume
cm		m^3		m^3
8.5 × 1.4 × 307	55 (21)	0.2009	88 (38)	0.3214
8.5 × 2.9 × 307	3	0.0227	7 (4)	0.0529
11.0 × 1.4 × 307	37	0.1749	26 (4)	0.1229
11.0 × 2.9 × 307	12	0.1175	60 (5)	0.5876
13.0 × 2.9 × 307	24	0.2778	48 (2)	0.5555
15.0 × 2.9 × 307	84	1.1218	48	0.6410
18.0 × 2.9 × 307	—	—	3	0.0481
20.0 × 2.9 × 307	6	1.1068	—	—
Total	221 (21)	2.0224	280 (53)	2.3294

Note: Figures in ( ) show the amount of second class products.

(6) Future outlook

Sawmilling is operated in Manduri Experiment Station using pine logs obtained by thinning as the saw log. Most of the logs available are of a small diameter at present, but medium sized logs are expected in the future even though they are products of thinning, for the trees grow pretty fast. In addition, the cutting age for pine trees is generally 25 years in and around São Paulo, and cutting time for the pine forest in the experiment station is approaching; and medium sized (40 - 60 cm diameter) logs will be used as material in the sawmill. The present sawmill machinery there is not suitable for an efficient treatment of medium sized logs, and suitable machines must be introduced. Further, secondary working of the lumber shall desirably be examined for enhancing the added value of the products. Equipments for treating wood refuses and end materials, that have been wasted, seems to be necessary.

(7) Future Problem

① Opening up new uses

Sufficient experience has not been accumulated for utilization of lumber from artificial forest of coniferous trees. Therefore, it seem the largest subject to expand the market for the product by development of new uses. Forestry Institute has developed wooden prefabricated houses made of pine obtained by thinning, prepared a manual for construction, and are trying to diffuse them. The method of construction was adopted for house owned publicly of the campos do Jordan city with success. (Fig. V-12, 13) However, the growth in demand is not very large, and more ideas in design seems to be necessary for making the house more attractive. For example, external appearance can be given more attention so that the residents may feel more pleasant. Development of use for sawn timber as building timbers other than those for prefabricated houses seems necessary so that more demand is created. Developing new use for the edge wood, odd wood, and saw dust, that are not utilized at present, is another item to be considered in view of effective utilization of forest resources.

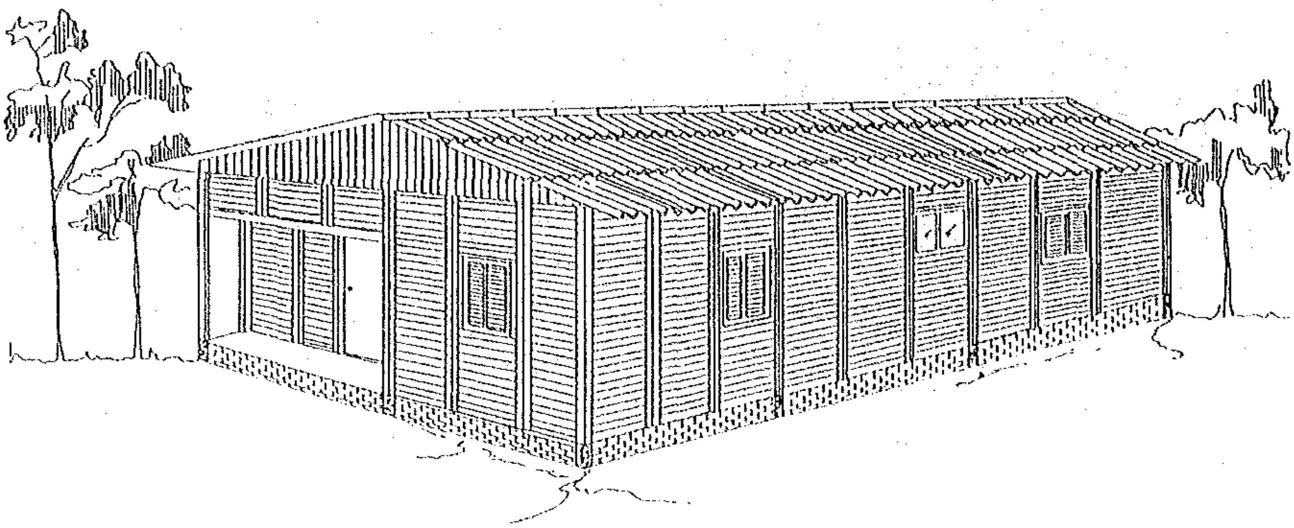


Fig. V-12 Wooden prefabricated living house (sketch)

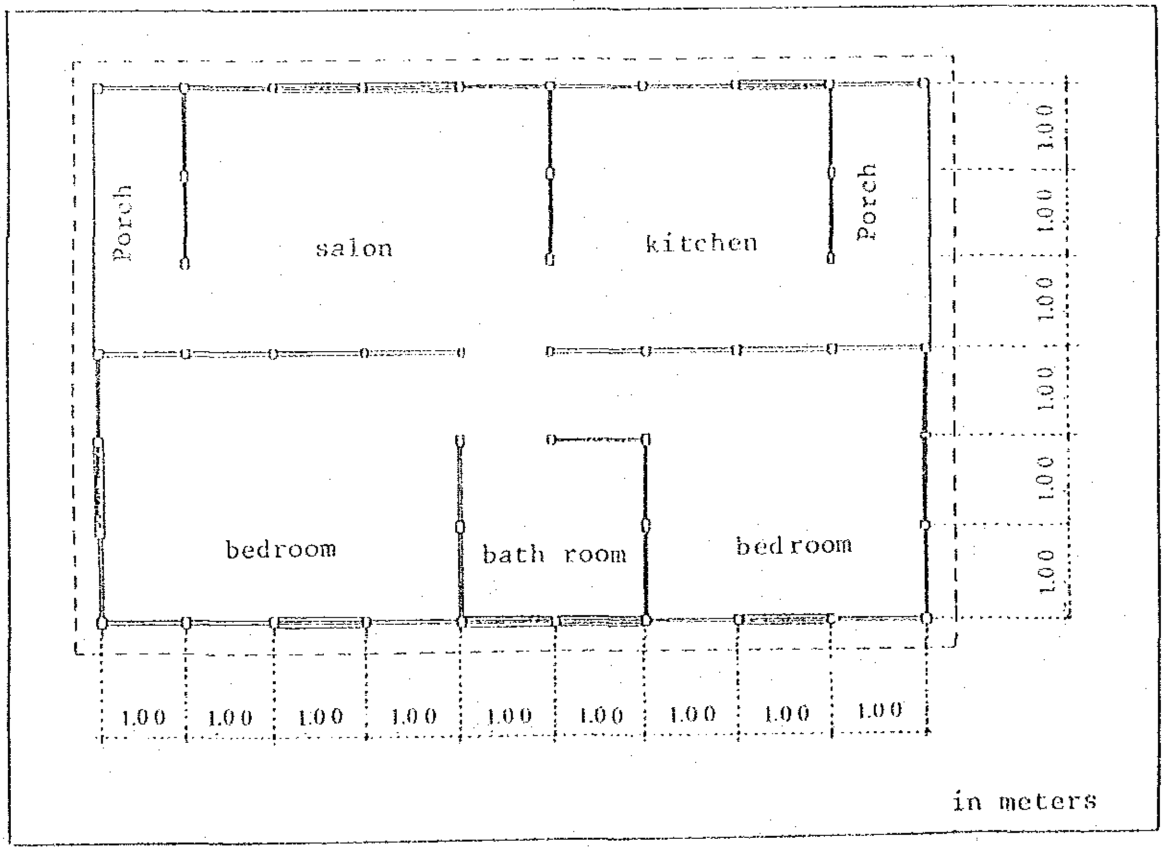


Fig. V-12 Wooden prefabricated house (sketch)

② Maintenance

Everyday maintenance is important for the sawmill machinery in order that they can fully exhibit their production capacity. It is necessary for a high operational efficiency to secure the route of obtaining parts, to keep those parts of high consumption in stock, and to check the condition of stockpile so that the part can be changed promptly when it is out of order and can continue operation smoothly. For a smooth management of the business, it is indispensable to organize a crew of fixed personnel for maintenance and train them for a sufficient knowledge and techniques.

③ Safety in operation

Operators and assistants in the experiment station are not in charge of a specific machine. This can be appraised in view of their willingness to learn new techniques. However, sawmilling operation is one of the high rate of labor accidents among various industries. Therefore, it seems necessary to fix the duty of operators and assistants to some extent. Organizing a group of workers for everyone of the machines may be one of the ways. By fixing the duty of operators, productivity will be further enhanced by their improved skill.

V-1-3 Summary

A sawmill with twin bandmill as its main machine for treating small-sized sawlogs was constructed by the project. All of the techniques have already taken root as those of the Forestry Institute of the state of São Paulo; operating procedures of the machines, sawmilling techniques such as sawing method, and saw filing techniques for circular saw and band saw. These techniques for sawmilling and saw filing should diffuse from the Forestry Institute not only to whole of the state of São Paulo but also all over Brazil for improving the technical standard. For this purpose, saw filing techniques for band saw was taught in the sawmills near the experiment station as the first step. For diffusion of the saw filing techniques, it is necessary to show various effects of the new techniques on the business concretely.

(1) Data for the amount of saw logs, sawn timber, power consumption, etc. concerning sawmill by Forestry Institute shall be recorded and accumulated

as basic data. Cost control and other production control shall be established based on these data.

(2) In order to demonstrate the effectiveness of the new techniques, the difference in productivity between those by new and conventional techniques must be grasped quantitatively. For example, it is desirable to express the difference in sawing yield, operational efficiency, and added value of the products, caused by the difference in the size of saw logs and sawmilling conditions such as sawing pattern, by actual data.

Furthermore, integration of actual studies enables the administrative organ to give private sawmilling industry suitable advices and guidance.

(3) As it is expected that many medium size logs will be included among saw logs harvested in the Manduri Experiment Station, it seems necessary to add sawmill machinery for the medium size sawlogs to the existing one for small size sawlogs. It is also necessary to install machines for secondary working of sawn timbers for a higher added value of the product and chipper for effective utilization of wood waste, so that a comprehensive production organization be established.

(4) Studies on the wood strength, wood physics, and other fundamental properties, analysis of factors affecting the quality of timber, and elucidation of the characteristics of wood differing by the kinds of trees planted must be advanced. Studies also on techniques of wood processing such as cutting, wood working, wood drying, and wood preservation must be advanced. For advancing the studies, it is necessary constantly to collect new data and analyze them. It is also necessary to maintain the techniques at good skill for carrying out experiments at a certain level for collection of these data. For example, in order to make theoretical experiment on cutting and sawmilling, assistance by technicians who can actually operate saw filing and sawmilling are essential. The expected goal of this field to be the basis of future development of research can thus be regarded achieved, and its further contribution to development of research by Forestry Institute is expected.

V-1 Literature

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Photo V-9 Entrance of newly opened Planted Chemistry Laboratory of Forestry Institute

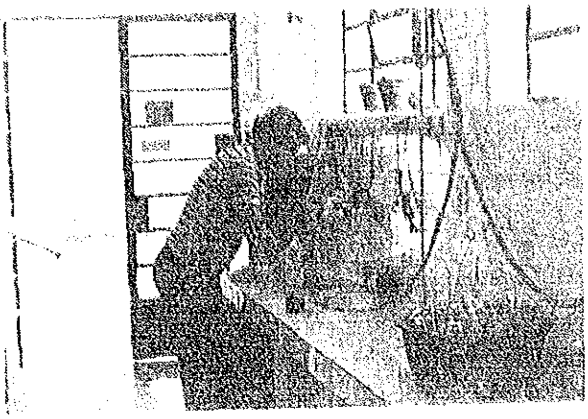


Photo V-10 Ditto interior

Photo V-11 Ditto central bench (northern side)

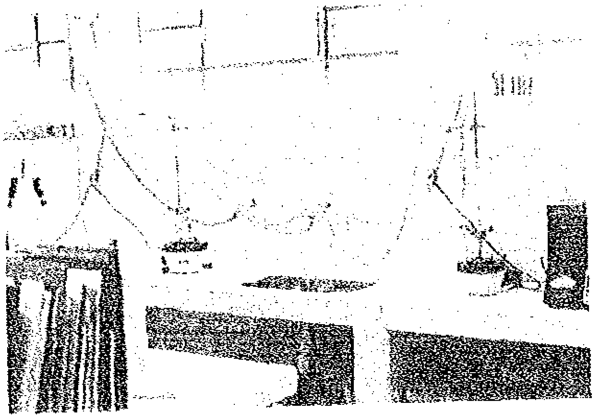


Photo V-12 Ditto side bench (essential oil testing apparatus)

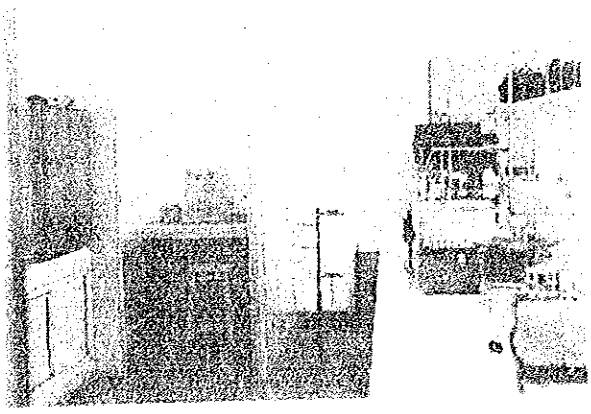


Photo V-13 Ditto central bench (southern side) and balance room

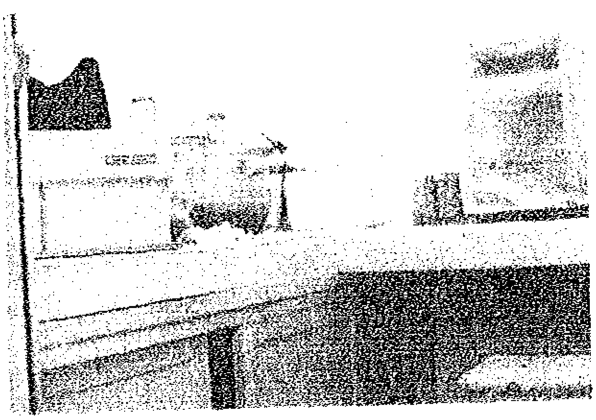


Photo V-14 Inside balance room (UV cabinet to the left)

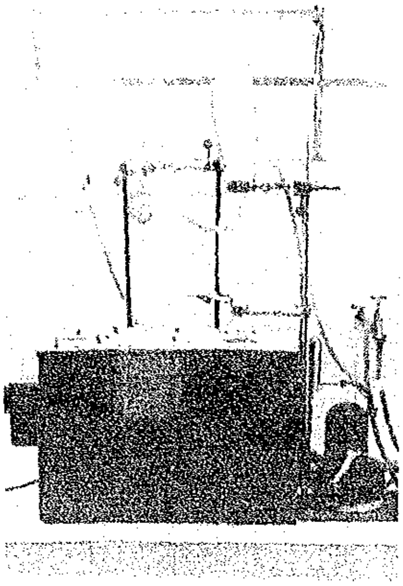


Photo V-15 ditto side bench
(Soxhlet extraction apparatus)

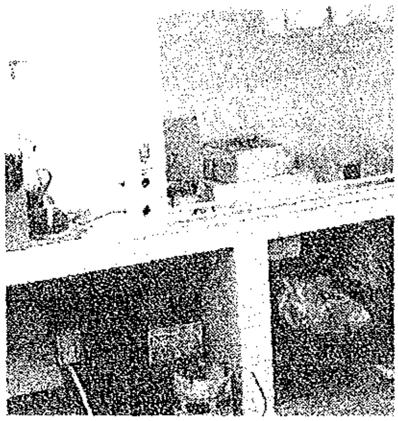


Photo V-16 ditto draft chamber

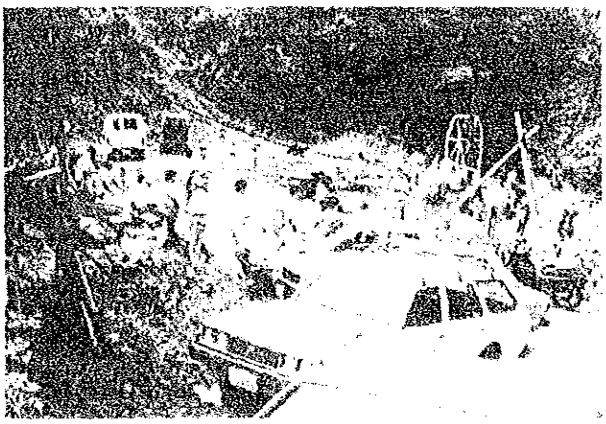


Photo V-17 Collecting coniferous leaf
oil in forest in Okutama, Tokyo

Photo V-19 ditto wood vinegar
collecting apparatus

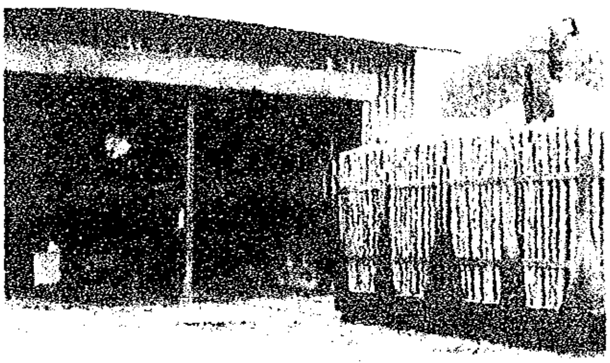


Photo V-18 Japanese larch thinning log
charcoal manufacturing plant
in Shimokawa-cho, Hokkaido

V-2 Chemical Method of Small Diameter Wood Utilization

Introduction

Brazilian counterpart visited Japan to study "Techniques for chemical analysis of wood extract and wood carbonization by-products for their utilization" as a part of the research project. The study included chemical analysis of extracts from trees and by-product of wood carbonization for their utilization; and method of preparing sample, method of extraction, separation and identification of constituents by chromatography, determination by various analytical instruments, and method of analysis for hiba (*Thujopsis dolabrata var. hondae*) leaf oil, hiba wood extract, and distillates from wood carbonization of 11 genera 20 species growing in Brazil, hiba, karamatsu (Japanese larch), mangrove, wheat straw, bamboo grass, and sugi ogalite were studied. In addition, a Japanese specialist was despatched to Brazil for a short time; and he installed chemical instruments provided with followed by adjustment, and gave advices on the method of their handling, on future arrangement of chemical laboratory, and on the method of research.

V-2-1 Study in Japan

(1) Policy of studying

Emphasis was laid on learning the techniques for chemical analysis of extracts from various parts of trees growing in the state of São Paulo into various constituents and of wood tar from carbonization of wood (mostly gas chromatography for phenols), so that the study would be useful in chemical analysis operation in Forestry Institute of São Paulo. As the subjects of inspection by the Brazilian counterpart, laboratories and plants were selected so that the inspection would be useful in grasping the actual conditions of chemical utilization of waste wood and its development in Japan.

(2) Items of Study

1. Collection and determination of coniferous leaf essential oil and wood essential oil.
2. Wood extractives: preparation of sample, method of extraction, separation into constituents, method of analysis by various instruments.

3. Wood carbonization distillate: sample preparation, gas chromatography of phenols in wood tar.

4. Field study (collection of coniferous leaf oil in forest, inspection and studying in principal laboratories for testing and studying forest products and forest products fuel manufacturing plants)

(3) Items of study and outline of contents

① Collection and determination of coniferous leaf essential oil and wood essential oil

Essential oil was collected and determined from Aomori Hiba (*Thujopsis dolabrata var. hondae*) leaves and wood powder. Essential oil testing apparatus in conformity with the Japanese Pharmacopoeia was used. The content of essential oil was 0.6 ml/100 g leaves (55 % moisture) = 1.3 ml/100 g oven-dry leaves, 1.2 ml/96 g wood powder (10 % moisture) = 1.3 ml/100 g oven-dry wood powder.

Two sets of the type of essential oil testing apparatus Photo V-12 are used in the plant chemical laboratory of Forestry Institute for determination of essential oil in eucalyptus leaves and others.

② Wood extract composition: Method of preparing sample, method of extraction, method of separating constituents, method of analysis by various instruments.

It was desirable to use samples of Brazilian trees, but they were not available. And lumber of Aomori Hiba was sliced by a disc type planer and ground into powder by a mixer, the resultant powder sample was extracted by hexane, ether, acetone, and methyl alcohol successively in a Soxhlet extractor, and the amounts of successively extracted substances were determined. The extracts were successively treated by thin layer chromatography, and the target constituent was separated and refined by fractionating silica gel thin layer chromatography and by silica gel column chromatography, and NMR spectrum of fractionated constituents was taken.

③ Wood carbonization distillate: Sample preparation, gas chromatography for phenols in wood tar*

Wood tars shown in Table V-11, that were prepared from plants of 11 genera 20 species in the small experimental dry distillation furnace in Tupi Experiment Station of Forestry Institute, were fractionated into three fractions, a low boiling fraction (b.p. below 180°C), a high boiling fraction (b.p.180°C to 230°C), and distillation residue (pitch), by distillation under atmospheric pressure. The high boiling distillate was further separated by usual process into strongly acidic part, phenols, and neutral part (Fig. V-16, 17) and the composition of the phenol part was examined by gas chromatography (Fig. V-18, 19). Wood tars from most of the plants contained 40 - 70 % pitch, but that of *Tapirira guianensis* 1.6 % and *Xylopia aromatica* 85.3 %. The amount of successor distillate was mostly 10 - 30 %, but that of *Tapirira guianensis* about 40 %. Phenols occupied mostly about 5 % of the tar but those of *T. guianensis, Xylopia aromatica,* and *Eucalyptus pilularis* 1 % or less. The composition of the phenols showed little difference in Xylenols between the kinds of trees, but a large difference was noticed in phenol, guaiacol, cresol, and p-, m-cresol. The largest and smallest contents are as follows:

phenol: *Q. grandiflora* 36.0 %, *E. pilularis* 0.8 %
guaiacol: *X. aromatica* 19.0 %, *E. punctata* 6.8 %
cresol: *E. pilularis* 19.3 %, *E. punctata* 7.1 %
p-, m-cresol: *V. tucanorum* 16.1 %, *Q. grandiflora* 6.1 %

Compositions of phenols were investigated for wheat straw, bamboo grass, sugi oralite, and mangrove, and it was revealed that the composition of phenols from wood tar of mangrove was similar to that of Brazilian trees but that of ogalite was lower in 2.6 - diMeO-phenol, that of wheat straw higher in the same (29.0 %) but lower in guaiacol (1 % or less) and 4-Et guaiacol not detected. That of bamboo grass contained much 2,6-diMeO phenol (35.5 %) (Fig. V-20 - 23).

* The result of this tests was presented at the 35th Annual Meeting of the Japan Wood Research Society in Tokyo, April, 1985.

④ Field study (collecting coniferous leaf oil in forest, inspecting and studying at principal forest products research institutes and forest products fuel manufacturing plants in Japan)

Inspection and studying at institutes and plants were conducted for

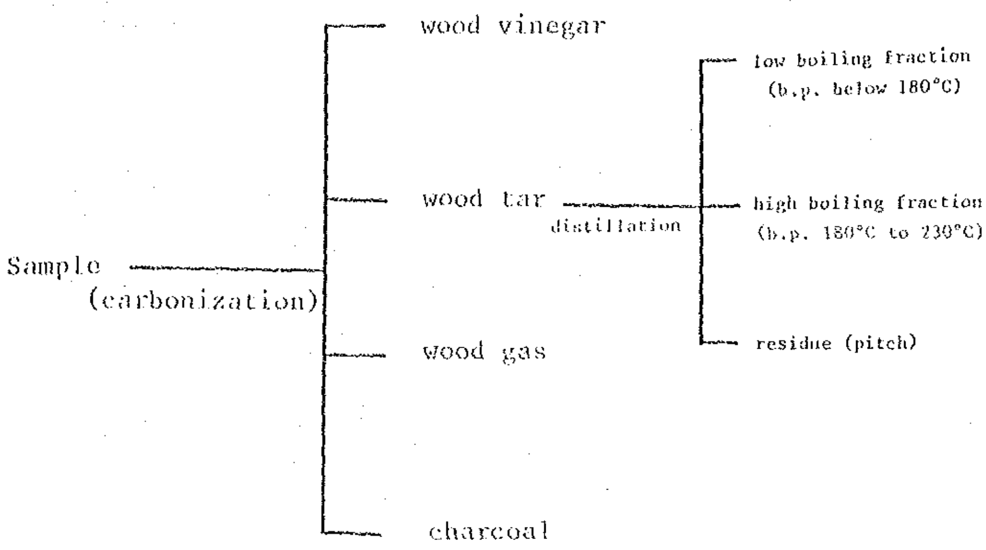
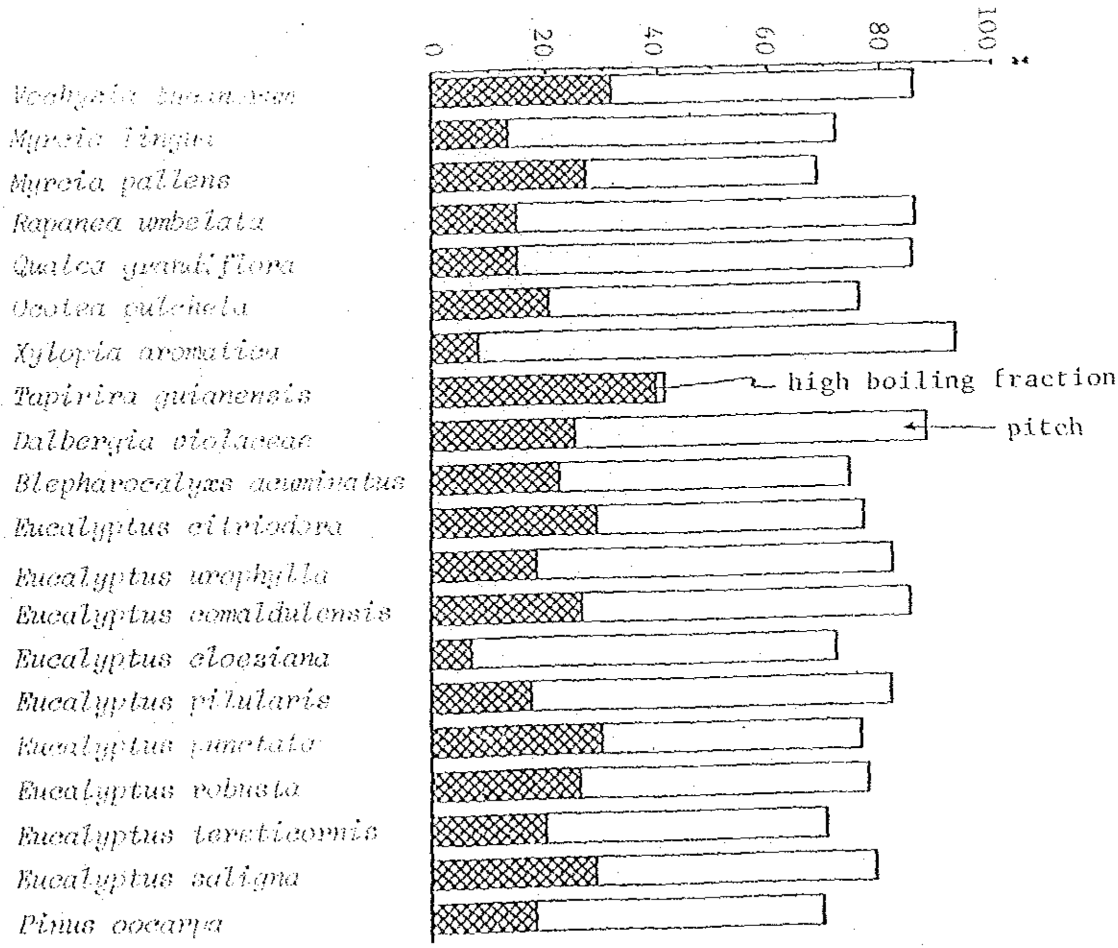


Fig. V-14 Carbonization product



Components of the wood tar from the trees in Brasil

Fig. V-15 Fractionation by distillation of wood tar under atmospheric pressure

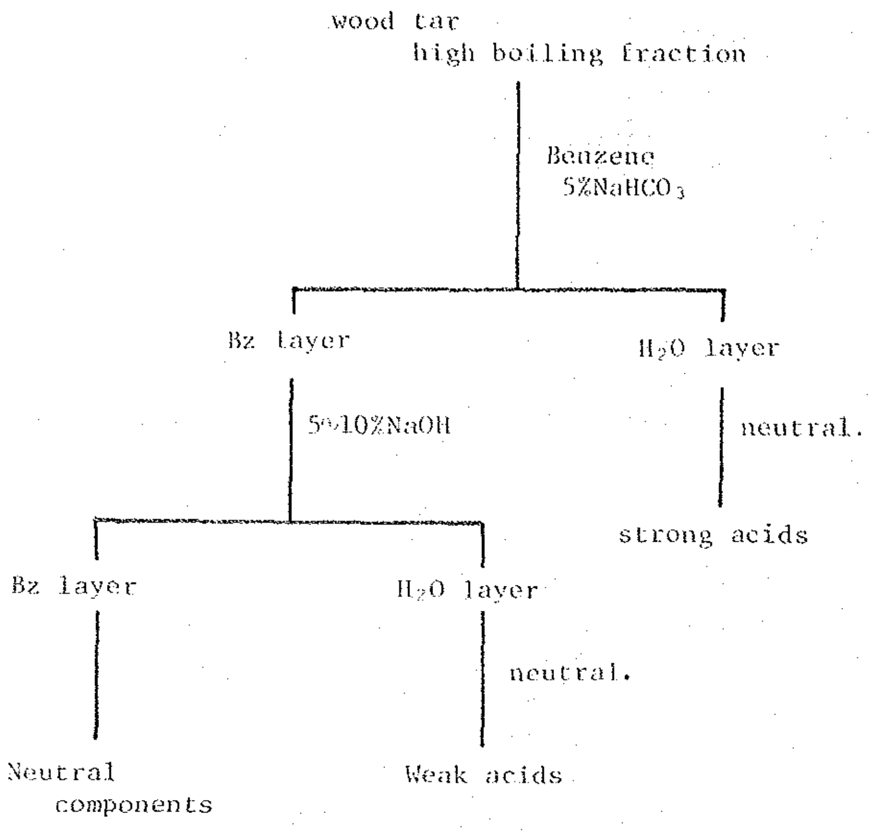
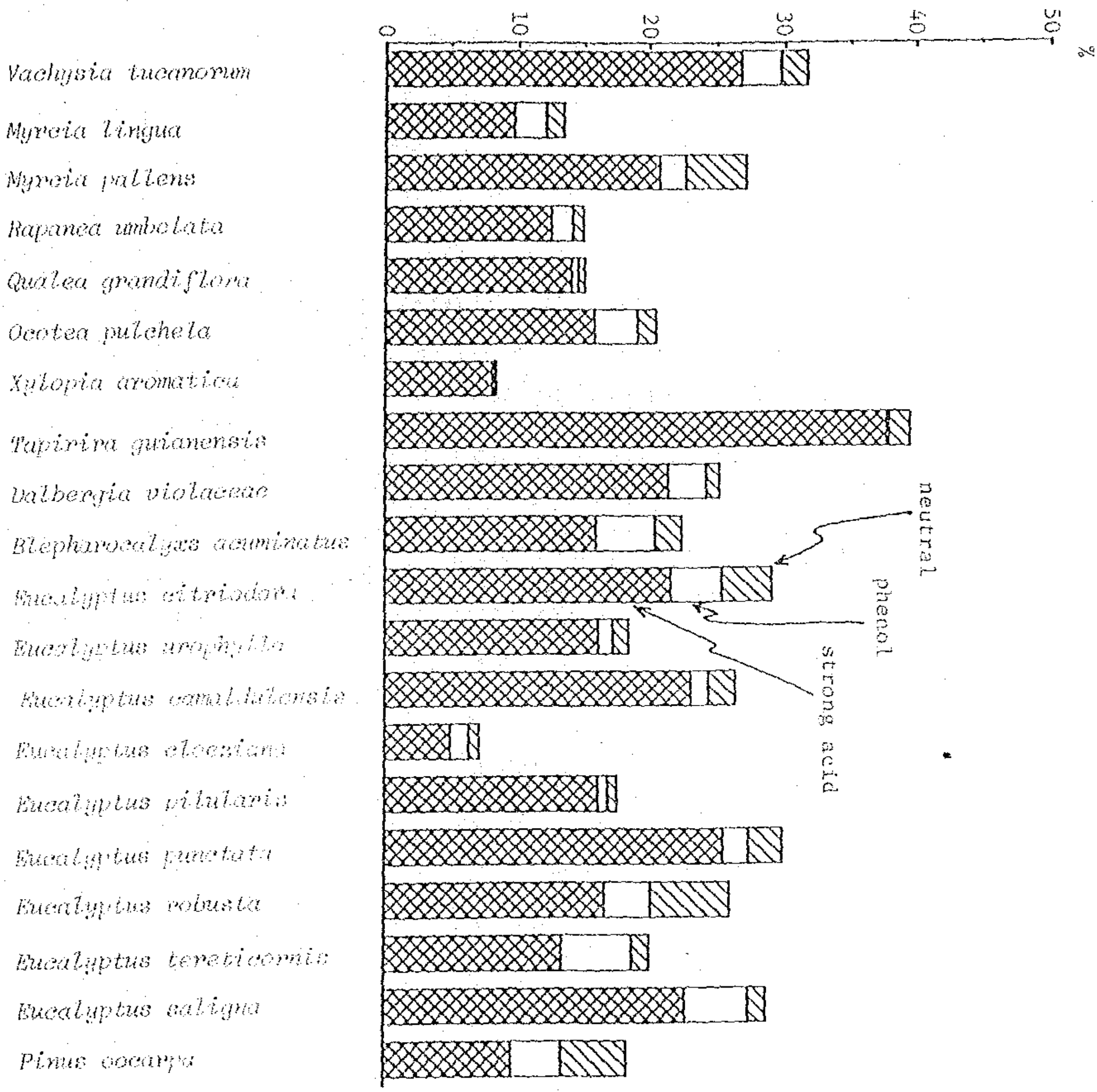
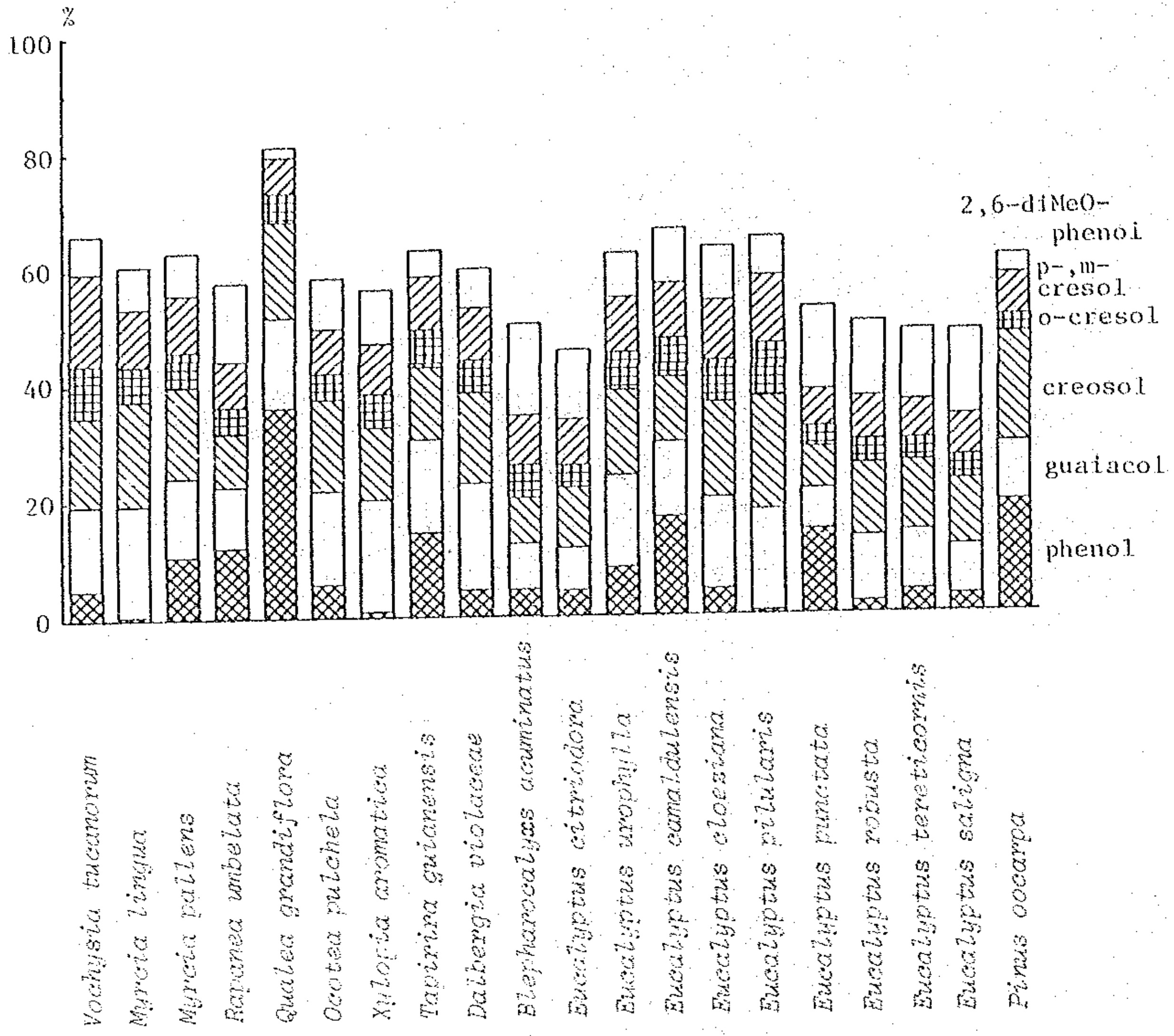


Fig. V-16 Fracionation of high boiling fraction of wood tar



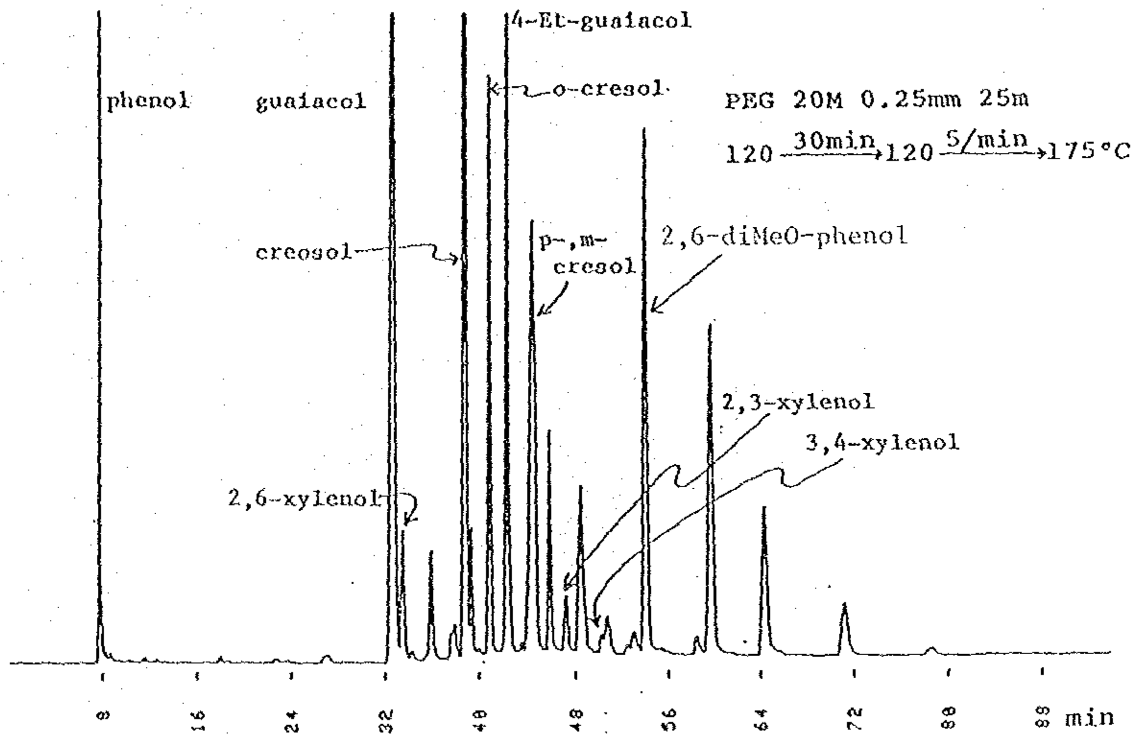
High boiling fraction of the wood tar from the trees in Brasil

Fig. V-17 Proportions of strong acids, phenols, and neutrals in the high boiling distillate of wood tar



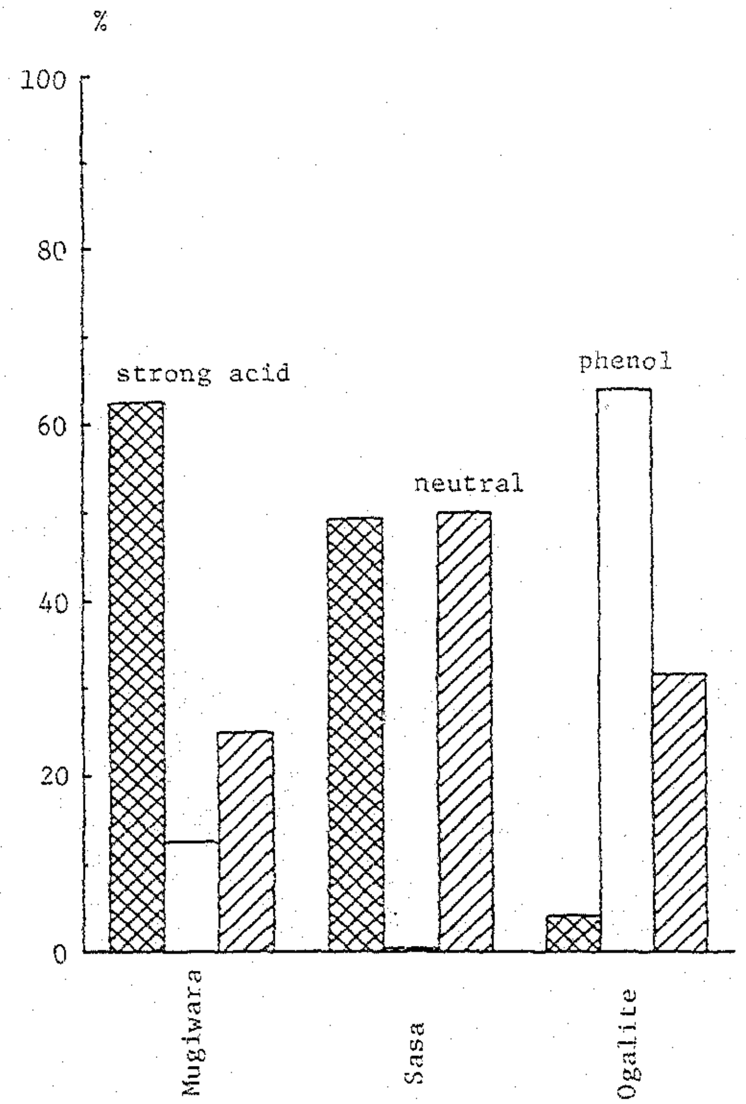
Phenols of the wood tar from the trees in Brasil

Fig. V-18 Analysis of wood tar into phenols by gas chromatography



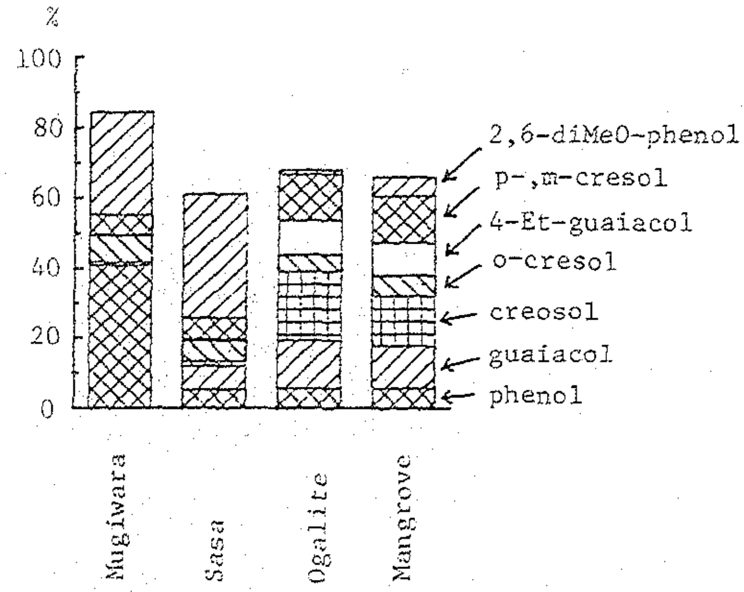
Phenols in the wood tar of *Eucalyptus cloeziana.*

Fig. V-19 Gas chromatogram of phenols in the wood tar of *Eucalyptus cloeziana*



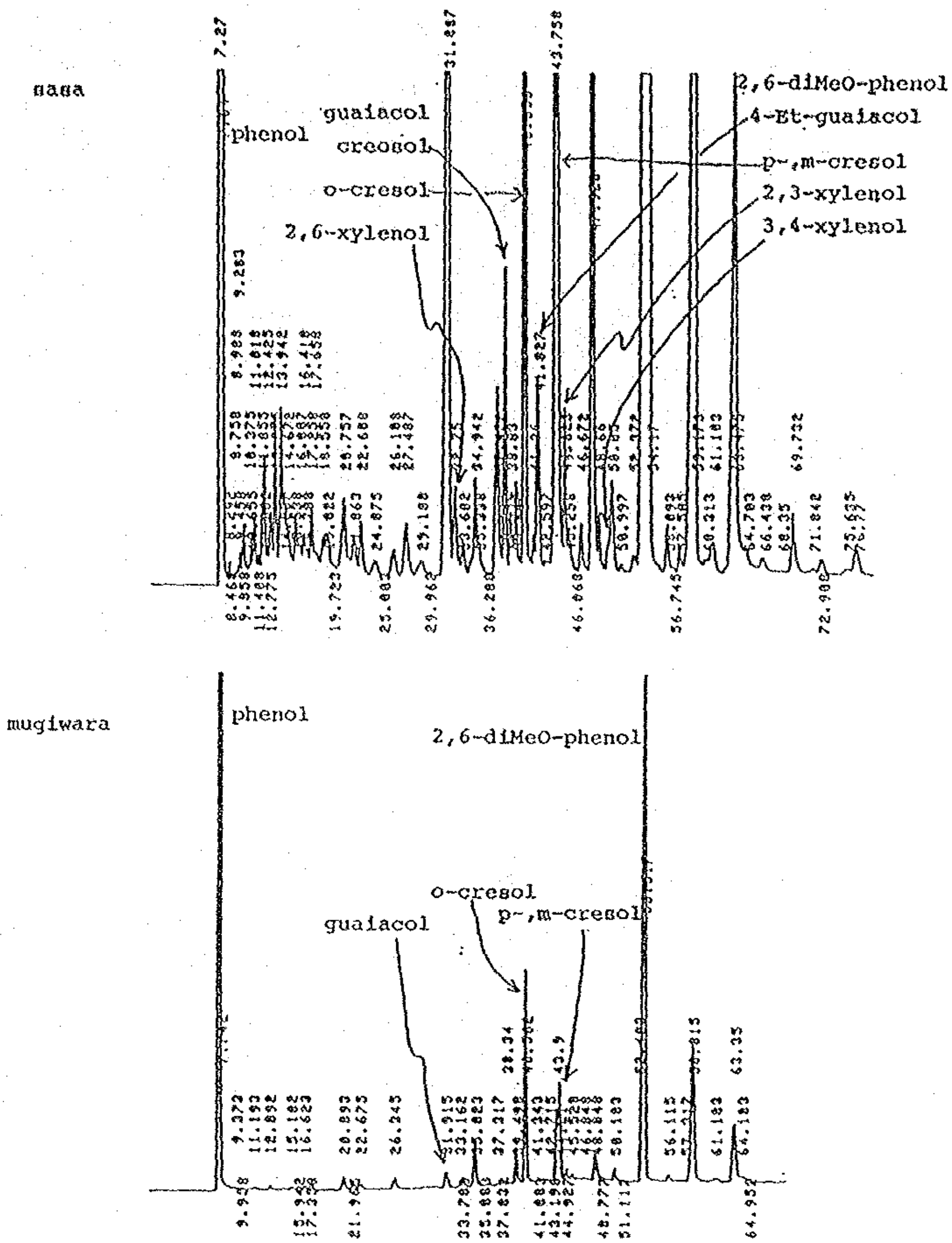
High boiling fraction of the tar of mugiwara, sasa and ogalite

Fig. V-20 Acidic, neutral, and phenolic fractions of high boiling distillate from tar of wheat straw, bamboo straw and ogalite.



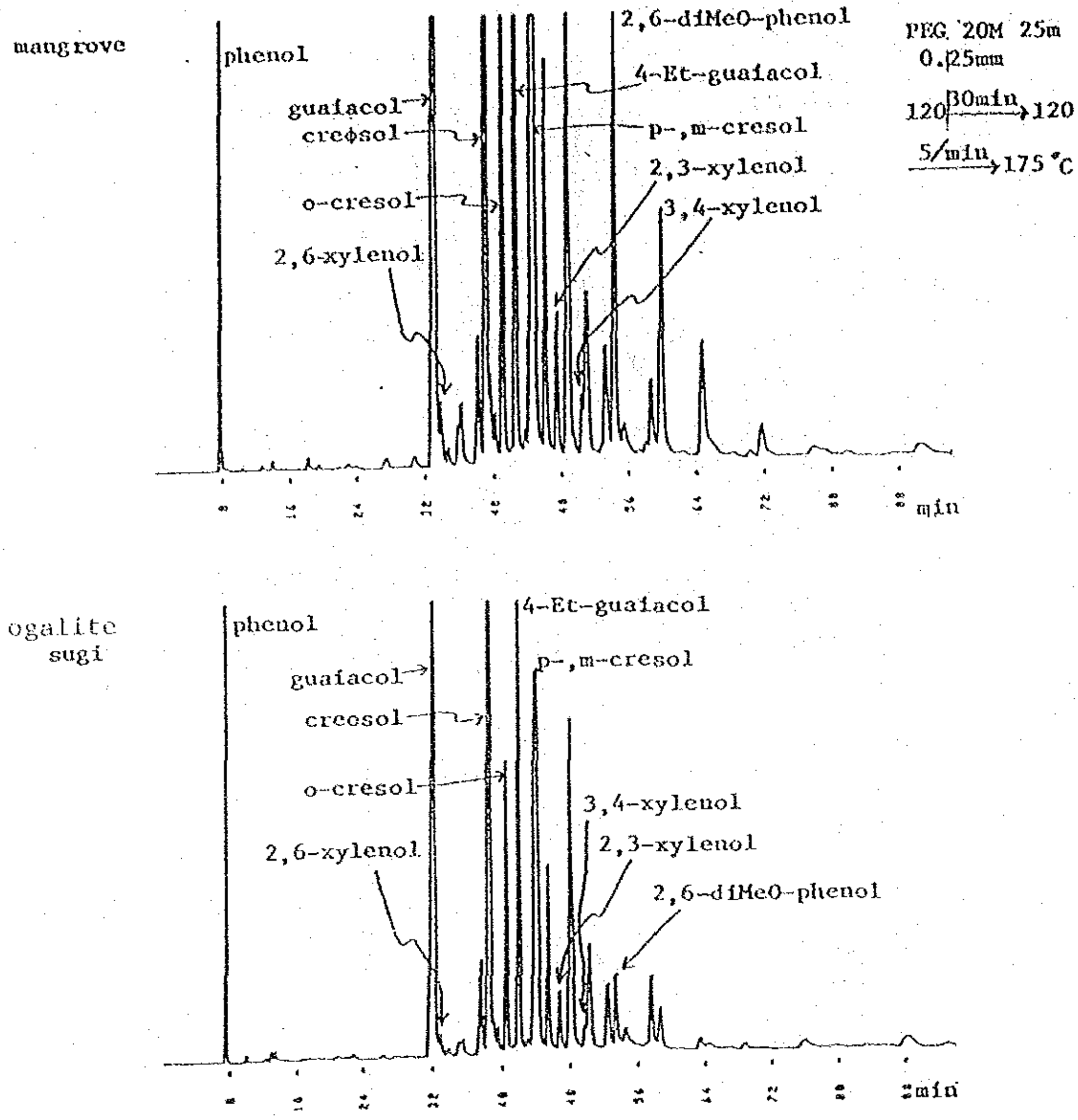
Phenols of the tar from mugiwara, sasa, ogalite and mangrove

Fig. V-21 Fractionating analysis of phenol fraction of tar from wheat straw, bamboo grass, ogalite, and mangrove by gas chromatography



Phenols in the tars of sasa and mugiwara.
PEG 20M 25m 0.25mm 120 $\xrightarrow{30min}$ 120 $\xrightarrow{5/min}$ 175°C

Fig. V-22 Gas chromatogram for phenols from tar of bamboo grass and wheat straw



Phenols in the wood tars of mangrove and ogalite(sugi).

Fig. V-23 Gas chromatogram of phenols from tar of mangrove and sugi ogalite effective understanding of the conditions of developing chemical utilization of small diameter wood and waste wood in Japan as follows:

Okutama Forest: Exercise for collection of coniferous leaf oil in forest using a movable apparatus for collecting coniferous leaf oil (Photo V-17).

Chiyoda Experimental Site: Chacoal kiln inspected.

Hokkaido University, Agricultural Department: Forest Products Research facilities inspected.

Hokkaido Forest Products Research Institute: Thinning lumber utilization techniques inspected.

Shimokawa Forest Owners' Association: Charcoal manufacturing plant from Japanese larch thinning logs inspected (Photo V-18, 19).

Asakawa Experimental Forest: Investigation of suitable site for collection of coniferous leaf oil, Inspecting of charcoal testing ground.

Shioyacho, Tochigi Prefecture, Japan Forest Products Fuel K.K.: Charcoal plant, Imaichi pellet plant, Kanuma hemp pith carbonization plant, Tochigi Prefecture Forestry Center: Forestry and forest products facilities inspected.

Forestry and Forest Products Research Institute, Kyushu Branch Station: Eucalyptus nursery inspected.

Kyushu University, Agricultural Department: Forest Products Research facilities inspected.

Harima Kasei, Kakogawa Plant, Central Research Laboratory: Pine resin facilities inspected.

Kyoto University, Agricultural Department, Wood Research Institute: Forest Products Research facilities inspected.

Nara Carbonization K.K.: Carbonization plant inspected.

V-2-2 Result of Research Cooperation

Our short-term specialist engaged in installation and adjustment of chemical instruments in the chemical laboratories in August, 1985; and he had a chance to see the facilities of the laboratories.

Forestry Institute is advancing tests as regards composition of extracts from Brazilian trees, including essential oil composition, and of wood vinegar. The analytical techniques acquired by the project and experience of inspecting facilities for utilization of waste wood, along with machines provided with, will undoubtedly be a useful help in promoting testing and research by Forestry Institute in the future

Conclusion

An independent chemical laboratory was established at the same time of return of the trainee scientist. This could be regarded as a manifestation of the large expectation on the chemical department by Forestry Institute. We hope that further enrichment of internal facilities and testing apparatus will be considered by the Institute.

Development of chemical utilization of small diameter wood is an important item of research in various fields. The research project is going to be closed by the end of this fiscal year, but we hope that the result of the research project will ripen more fruitfully by continued exchange of information between counterparts in Japan and Brazil.

Table V-10 Composition of wood tar from trees growing in Brazil

	Wood tar			High-boiling fraction		
	Low-boiling fraction	High-boiling fraction	Pitch	Strongly acidic part	Phenol part	Neutral part
Vachysia tucanorum	14.2	31.7	54.2	26.8	2.9	2.0
Myrcia lingua	27.9	13.4	58.7	9.7	2.4	1.3
Myrcia pallens	31.2	27.2	41.6	20.8	1.9	4.5
Rapanea umbelata	13.7	14.9	71.4	12.5	1.6	0.8
Qualea grandiflora	14.2	15.0	70.8	14.0	0.5	0.5
Ocotea pulchela	23.7	20.5	55.9	15.8	3.3	1.4
Xylopia aromatica	6.3	8.4	85.3	8.1	0.2	0.1
Tapirira guianensis	58.8	39.6	1.6	37.8	0.2	1.6
Dalbergia violaceae	11.7	25.2	63.1	21.4	2.8	1.0
Blepharocalyxs acuminatus	25.4	22.4	52.2	15.9	4.5	2.0
Eucalyptus citriodora	22.8	29.1	48.1	21.6	3.8	3.7
Eucalyptus urophylla	17.7	18.1	63.9	16.1	1.1	1.2
Eucalyptus camaldulensis	14.5	26.4	59.1	23.1	1.3	2.0
Eucalyptus cloeziana	27.8	7.2	65.0	5.0	1.4	0.8
Eucalyptus pilularis	17.9	17.5	64.6	16.1	0.7	0.7
Eucalyptus punctata	23.3	29.9	46.8	25.5	1.9	2.5
Eucalyptus robusta	22.0	26.0	52.0	16.6	3.5	5.9
Eucalyptus tereticornis	29.5	20.0	50.5	13.4	5.3	1.3
Eucalyptus saligna	20.6	28.8	50.6	22.7	4.7	1.3
Pinus oocarpa	30.0	18.3	51.6	9.7	3.7	4.9

Figures show percentages based on tar weight.

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