

Sawdoctoring manual

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58



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INTRODUCTION

High quality tool maintenance means gains in raw material yield, increased productivity and products of improved quality which will command higher prices. High quality tool maintenance, whether saws or knives, requires good equipment installed in a saw shop large enough with all the lighting and other facilities necessary for it to be used to full advantage. Above all these requirements however, it requires skilled personnel, satisfied in their work who are prepared to use the equipment to its full potential. Under these circumstances economical advantages much greater than the tooling costs will arise.

The information given is based on experience of proven techniques in various countries where processing of softwoods and hardwoods is carried out. It must be emphasized however, that the full theoretical knowledge of all the above subjects will not yield satisfactory results without the requisite skills necessary to put them into practice. The need for all key personnel engaged in wood processing industries to be properly trained, and to acquire the practical ability and experience necessary to achieve and maintain maximum efficiency from the various equipment with which they are working is therefore paramount. Without this experience, the best equipment available will not produce satisfactory results and the natural forest resources of any country will not be used to full advantage.

This manual is intended to provide management, key personnel and trainees engaged in wood processing in developing countries where softwoods and/or hardwoods are being utilised with basic information.

The manual is based upon work of AB Sandvik International, Sweden, in collaboration with the FAO Forestry Department.

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CHAPTER 1 - SAWMILL TOOL ECONOMY

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1.2. Personnel and Machines

1.3. Aggregate Savings

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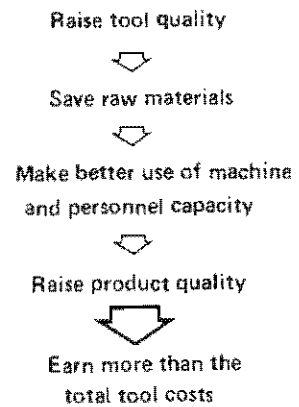
APPENDICES

- Raw-material requirements at a large sawmill
- Relationship of raw-material consumption to choice of spacer in gang-sawing

0. ABSTRACT

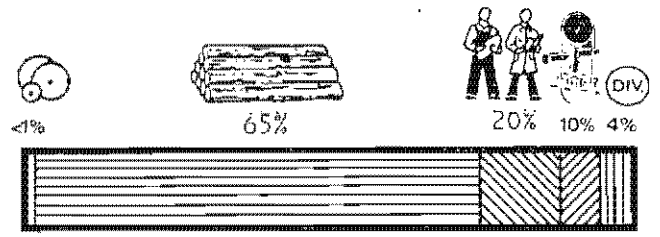
Fig. 1.0 The use of higher-quality tools, properly maintained can result in the following benefits.

1. More product output from raw material input.
2. Improved quality of product.
3. Increased production from men and machines involved.
4. Reduction in fuel or power costs relevant to volume of product.



1. COST STRUCTURE

Fig. 1.1 The cost of tools (purchase and maintenance) is comparatively small if taken relative to the total costs. The figures given as an example in Fig. 1.1 are intended as a guide by which sawmill cost structure can be calculated. Relevant to the prevailing costs of raw material, cost of labour, machines and buildings in various countries, the figures can be amended. Costs in tropical hardwood mills will be higher.



SAWMILL COST STRUCTURE

1.1. Raw Material

The largest item in the budget of sawmills is the cost of raw material, which for example may well exceed 65% of the total costs when the cost of transportation is included. It is therefore obvious that the objective must be to obtain the highest possible yield from the raw material by using the best tools in the most efficient manner. Hardwood sawmills in

developing countries must be even more concerned with this objective due to the fast diminishing resources of their natural forests.

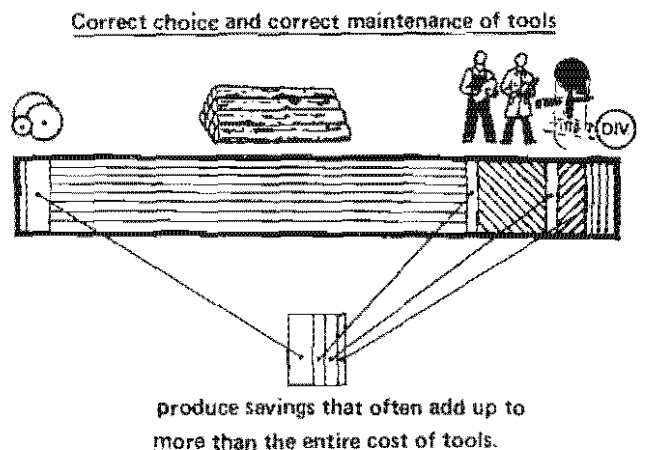
1.2. Personnel and Machines

The next largest item of costs is wages followed by machines and buildings. The machine and personnel costs will decline if we use tools that reduce the number of stoppages and malfunctions.

Planned tool and machine maintenance will reduce stoppages and lost production time. This in turn will increase product output and reduce the production cost per cubic metre of sawn timber.

1.3. Aggregate Savings

Fig. 1.2 The correct choice and maintenance of tools will often produce savings in raw materials, labour and machine time that are many times greater than the entire tool cost.



2. RAW-MATERIAL YIELD: kerf losses

Fig. 1.3 The choice of tools and the maintenance of tools have a direct effect on the raw-material yield in the form of kerf losses in rip-sawing. This must be taken to include not only the sawdust but also the margin of thickness that is added to compensate for rough surfaces and for wavy sawing.

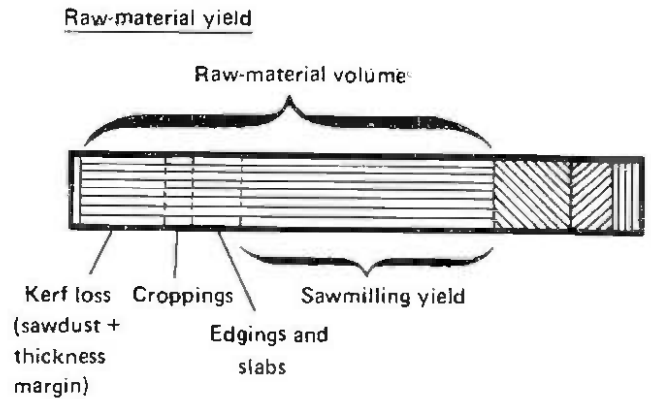


Fig. 1.4 Sawdust and thickness margin (i.e. the kerf loss) cost a lot of money in the form of unutilised raw material. Theoretically, for 25 x 100 mm of sawn timber for example, kerf losses can amount to 25%. The example is taken from a gang saw. A sound choice of tools and good tool maintenance will reduce that percentage, with savings of raw material in consequence.

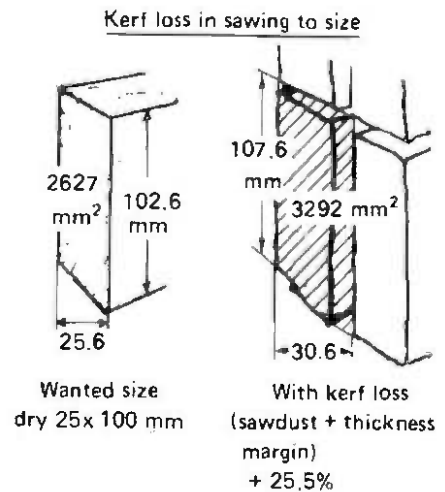


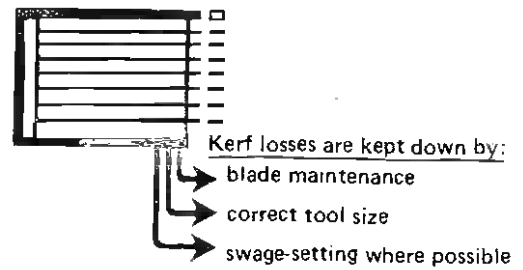
Fig. 1.5 Of the total kerf loss, the actual blade thickness seldom accounts for more than half. The use of thinner blades is very likely to lead to wavy sawing, so that it is better to look for other ways of

Kerf loss

- blade thickness seldom more than half
- thickness margin 1.0-2.5 mm

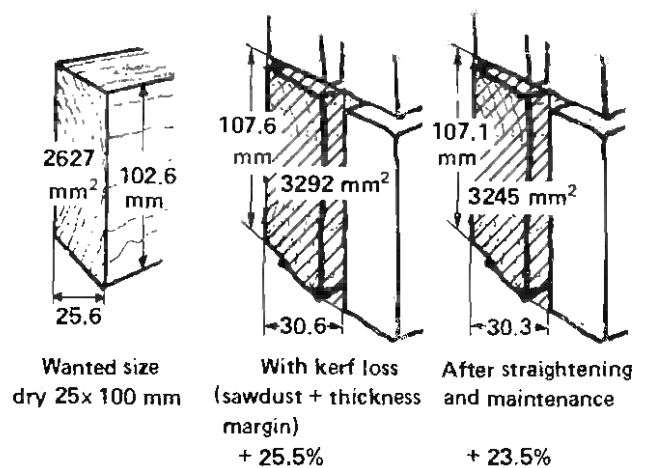
increasing yield. There are numerous ways in which we can do something about this part of the kerf loss.

Fig. 1.6 Steps can be taken to reduce kerf losses by improved saw maintenance by choosing the right size and type of tool, and by appropriate choice of spring-setting or swage-setting.



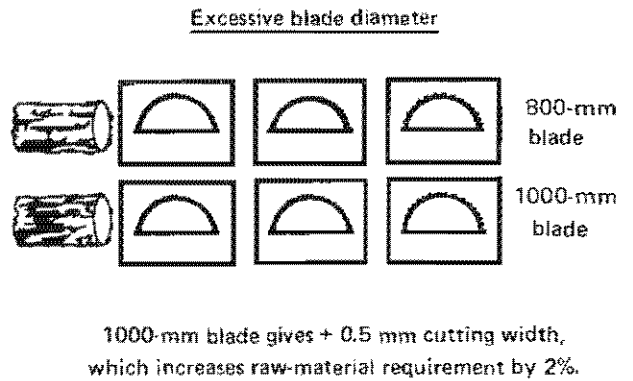
2.1. Better Tool Maintenance

Fig. 1.7 Improved maintenance of tools, which enables the thickness margin to be somewhat reduced, yields prompt savings in raw materials. If, for example, in gang-sawing, you can reduce the size of spacers the raw-material requirement declines possibly by 2%. For a typical sawmill, buying 30,000 cubic metres a year, 2% could represent an annual saving of US\$ 30,000.



2.2. Correct Diameter of Circular Saw Blade

Fig. 1.8 It is important not to choose circular saw blades with too large a diameter, particularly if the blades are carbide-tipped, since the cutting width increases with increasing blade diameter.

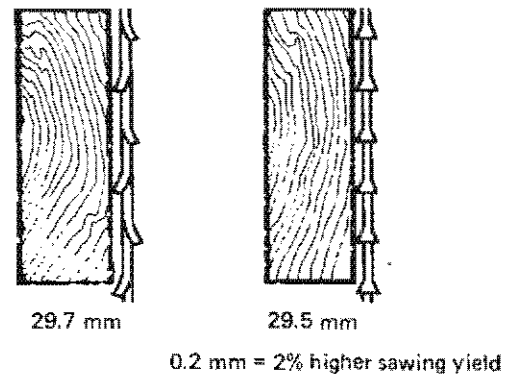


Sawing timber on a line with a 1000-mm blade where an 800-mm blade would do gives a cutting width that is 0.5 mm too big - creating a 2% unnecessary raw-material demand.

2.3. Spring-set Versus Swage-set Blades

Fig. 1.9 Going over from spring-set to swage-set blades can for example reduce the thickness margin by 0.2 mm, since the margin with respect to surface roughness can be reduced.

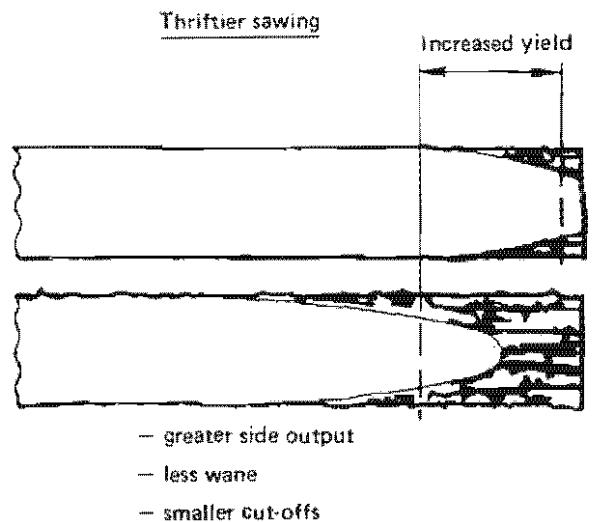
Possible gain from a switch from spring-set to swage-set blades



Too much spring- or swage-setting or uneven setting can readily lead to losses of a few tenths of a millimetre in the form of sawdust and surface - roughness margin. This highlights the importance of good blade maintenance.

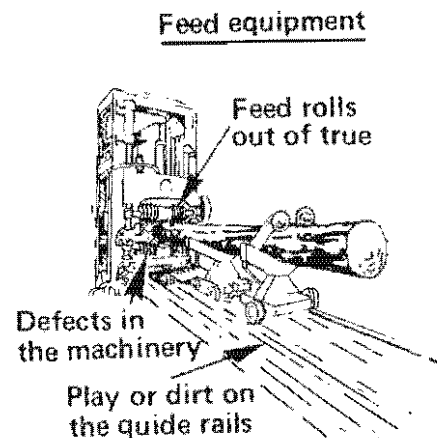
2.4. Thriftier Sawing

Fig. 1.10 Tools and tool maintenance that permit a smaller thickness margin not only produce a smaller kerf loss but also give increased output from the side slabs, less wane and smaller off cuts, since they enable the blades to be spaced more economically.



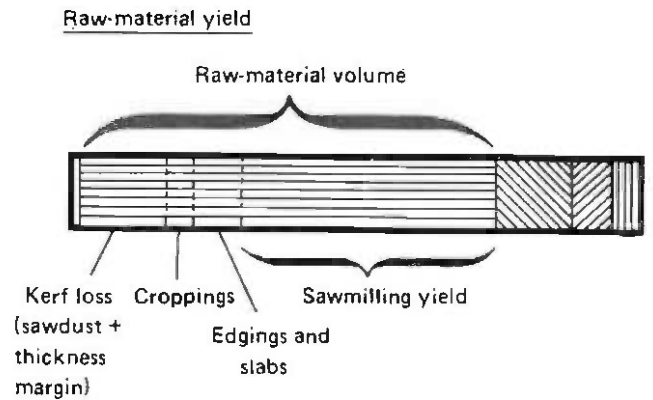
2.5. Feed Equipment

Fig. 1.11 There may be other raw-material losses besides the kerf losses. A common cause of this is wavy sawing due to faulty feed equipment, such as feed rolls that are out of true, play or dirt on the guide rails, or defects in the machinery.



2.6. Summary: Raw-material Yield

Fig. 1.12 We have now had a look at the gains in raw-material yield that result from reduced thickness margins. Better tool maintenance, correct choice of blade diameter and switching from spring-set to swage-set blades all give economically worthwhile savings. Giving the feed equipment proper maintenance reduces crooked sawing and thus will also raise raw-material savings.

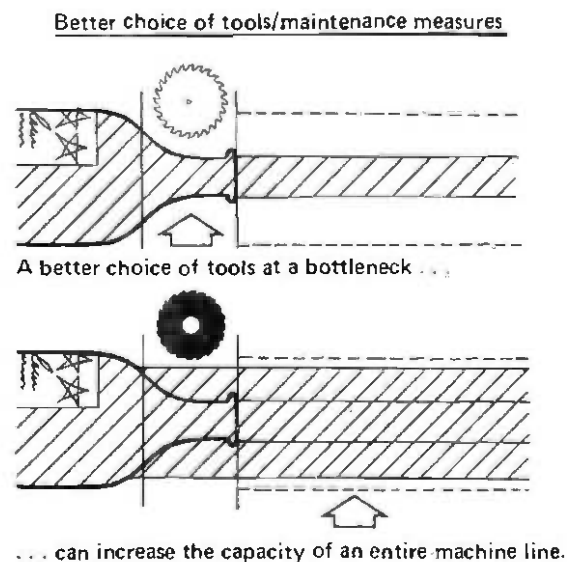


Now let's have a look at how tools can affect the costs of machines and personnel.

3. MACHINERY AND PERSONNEL COSTS

3.1. Opening up a Bottleneck

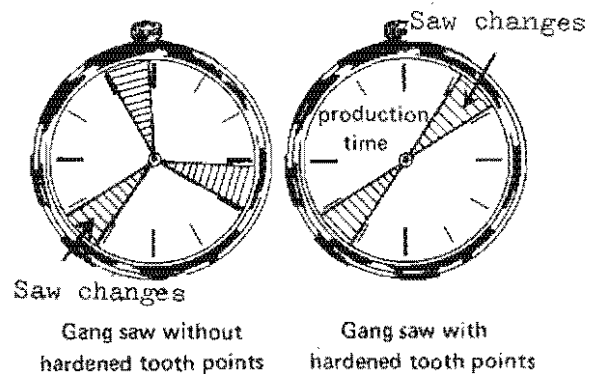
Fig. 1.13 By a better choice of tools or maintenance measures you can even raise the capacity of a whole machine line. Fewer saw changes, increased feed speed and fewer



operating snags will permit higher output if the sawing operation is a bottleneck. A common method of achieving this is to use blades with harder teeth. Let's have a look at tooth-point hardening and carbide-tipping.

3.2. Tooth-point Hardening

Fig. 1.14 An example of the gains to be made by using hardened tooth points on gang saws is that you get more effective working time by being able to change saws at longer intervals. You can also raise the machine capacity, since you no longer need to reduce the feed speed towards the end of a sawing run.



3.3. Carbide Tips

The introduction of carbide tipped circular saw blades can be considered when the standard of expertise by saw maintenance and operational personnel makes it possible for them to be used to

advantage. Without doubt they will give increase sawing time between sharpenings, particularly on abrasive timbers. At the same time the quality of the product should be greatly improved.

Fig. 1.15 However, these saws will not stand abuse in handling or operation and a high degree of skill, care and knowledge is a prerequisite to their maintenance and efficient operation.

Automation can also be considered where the production flow is sufficiently constant in size and volume to be introduced successfully. In most developing countries the general size of the sawmills, and the variety of species which are sawn limit this possibility and make the reduction of labour cost to any great extent unlikely, particularly in hardwood mills. Diminishing resources from the natural forests make the utilisation of sub standard logs a necessity in many wood processing industries in developing countries. Processing these logs

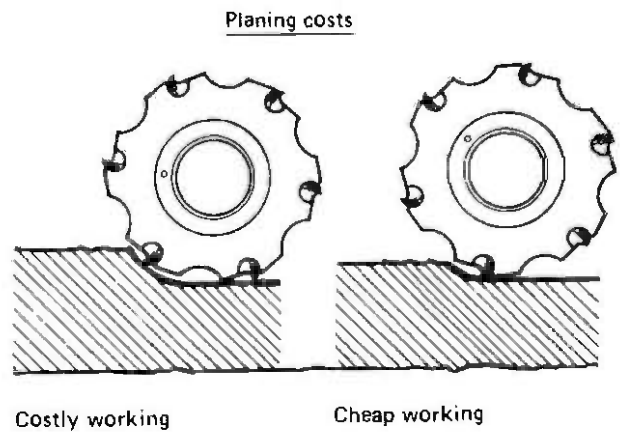
Longer running times made possible by carbide tips give

- better capacity utilisation
- scope for automation
- lower maintenance cost

is not conducive to automation and can in some cases necessitate extra labour to assist in primary conversion of logs to lumber.

3.4. Planing Costs

When the product is upgraded by planing, the thickness margins are not only a raw-material loss. They also have the effect of raising tool and energy costs in the planing mill and reducing its capacity. It's important to keep down surface roughness and crookedness by properly maintaining the sawmill's tools and machines, so as to avoid high planing costs.



3.5. Job Satisfaction

Fig. 1.17 The economic consequences of job satisfaction are hard to measure, but it is a known fact that better tools have a positive effect on personnel and on their efficiency.



Better tools = greater job satisfaction

4. PRODUCT QUALITY

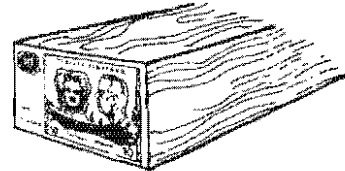
Fig. 1.18 Better designed and maintained tools have a favourable effect on production costs. Product quality, too, shows an improvement when better tools are used.

Finished products that have better surfaces or greater dimensional accuracy often command a higher price.

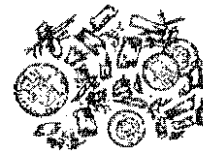
5. SAVINGS ON THE TOOL ACCOUNT

As we've already noted, tool costs are a very small proportion of a sawmill's expenditures. All savings that in any degree reduce the tool quality will be more than eaten up by losses in raw materials or production capacity.

Better choice of tools/maintenance measures



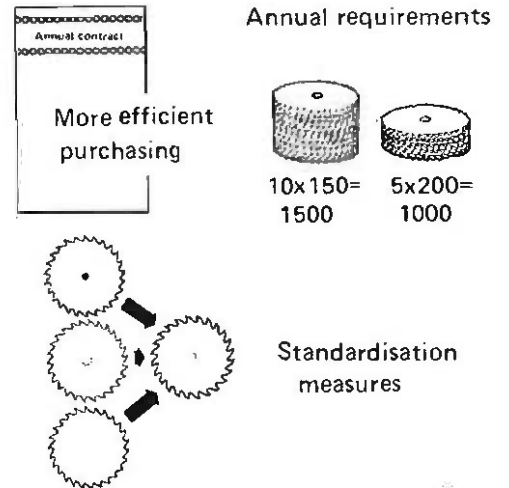
-- increase quality of finished products



-- raise value of by-product chips

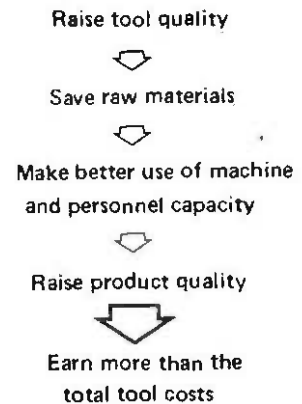
Fig. 1.19 Carbide-tipped circular saw blades are examples of a tool with a higher purchase price which by reason of its longer life actually turns out cheaper than traditional circular saws providing skilled maintenance personnel with suitable equipment for keeping them in first class working order are available.

Savings on the tool account by increased tool quality



6. SUMMARY

Fig. 1.20 The use of higher-quality tools brings about savings in raw-material consumption, better utilisation of machinery and personnel, improved capacity and product quality.



In consequence, the use of higher-quality tools can result in gains that are considerably in excess of the total tool cost.

CHAPTER 2 - ENVIRONMENTAL ASPECTS OF SAWMILL TOOLING

1. WHAT ARE THE PROBLEMS?

2. DUST

2.1. Origin of Dust in Sawmills

2.2. Measures Against Dust

3. NOISE AND VIBRATION

3.1. What Is Noise?

3.2. How Much Noise Can We Take?

3.3. The Origin of Noise in Sawmills

3.4. Measures Against Noise

3.4.1. Sound-absorbing Enclosures

3.4.2. Air Eddies

3.4.3. The Cutting Process

3.4.4. Tool Vibration

3.4.5. Vibration of the Workpiece

3.4.6. Other Machine Sounds

3.4.7. Background Noise

ENVIRONMENTAL ASPECTS OF SAWMILL TOOLING

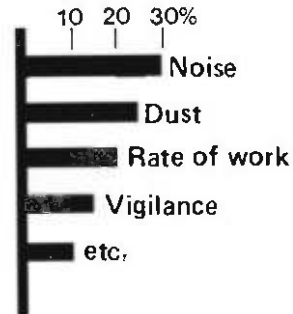
1. WHAT ARE THE PROBLEMS?

Fig. 2.1 According to various studies the most trying inconveniences to sawmill personnel at present are dust and noise. Dust, moreover, constitutes a very serious fire hazard.

Fig. 2.2 The problems of dust and noise can be somewhat reduced by placing the personnel in insulated compartments. This is a costly solution, since it calls for remote control and monitoring of the machines - besides which the reliability of electronic equipment has proved to be the weak link in dusty environments. Insulation also masks the telltale sounds and other signs of trouble in the machine that would otherwise alert the operator to tool damage or impending break-downs. A much more effective approach is to attack the dust and noise at the source, i.e. at the tool.

Stresses on sawmill personnel

Percentages reporting distress



Drawbacks of insulated compartments

- More costly control equipment
- Additional maintenance requirements
- Personal contact impeded
- Machine monitoring impeded

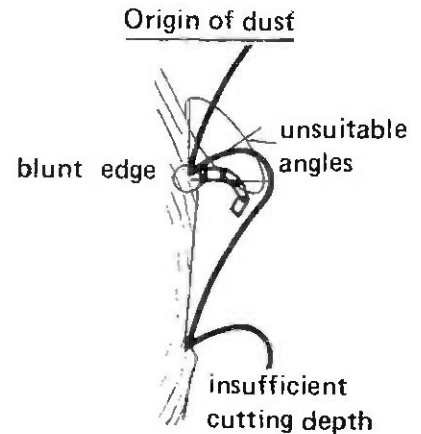
Conclusion: Tackle the problems at the source: the tool.

2. DUST

2.1. Origin of Dust in Sawmills

Fig. 2.3 Sawmill dust consists of the smallest particles among the chips produced by sawing. It arises in greatest abundance when chips are violently bent or crushed by

- 1) a blunt edge
- 2) an edge with unsuitable angles
- 3) insufficient cutting depth per edge



2.2. Measures Against Dust

Fig. 2.4 The dust problem can be alleviated by ensuring that the tools are well sharpened, have a suitable hook angle, and have the correct tooth bite per edge, and by improving the chip exhaust. The chip exhaust can be improved by changing the shape and siting of exhausts. Thus ducts should not be rigidly attached to the machines but should be connected using rubber-cloth bellows.

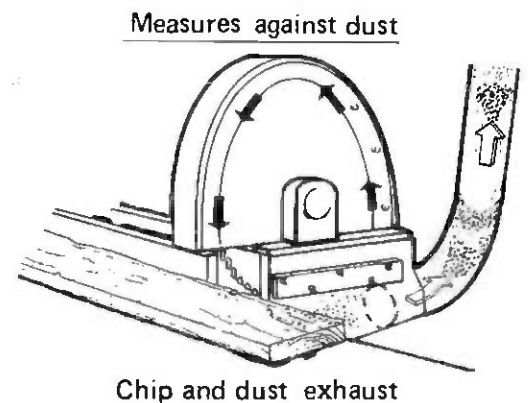


Fig. 2.5 The edge must be sharp to avoid overheating. Dust formation due to a blunt edge is especially noticeable in the chipping of dry waste.

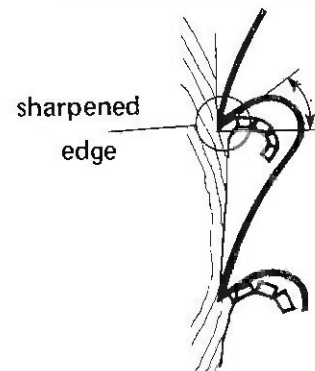
The operation of edgers is liable to produce resin vapours, which cause breathing difficulties for many people.

Sawmills in some countries cool their saws with water sprays when working on highly resinous woods.

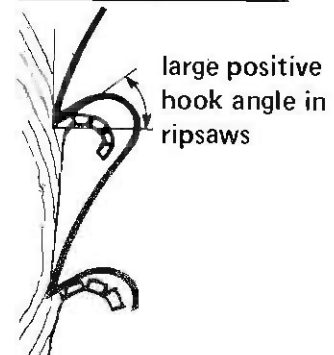
Fig. 2.6 Ripsaws should have a large positive hook angle. The pitch should be made as wide as possible without impairing surface quality.

Fig. 2.7 The correct cutting depth per edge is achieved by appropriate choice of pitch, cutting speed and feed speed. The cutting depth should be made as large as the machine power and surface requirements will permit. Cutting depths of 0.1 mm or less should be avoided.

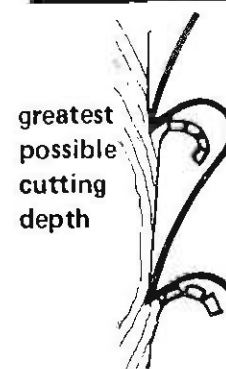
Measures against dust



Measures against dust



Measures against dust



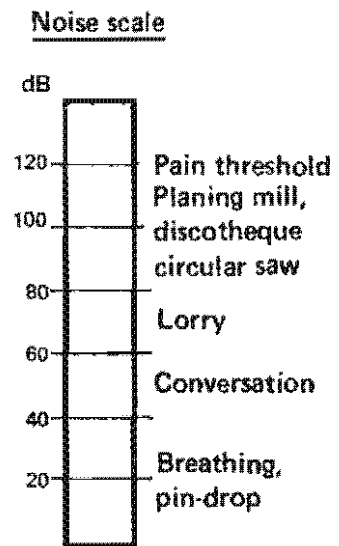
3. NOISE AND VIBRATION

3.1. What Is Noise?

Fig. 2.8 Noise is unwanted sound which can cause stress, safety hazards and permanent hearing damage.

Noise is measured in terms of the power level in watts per square metre. The ear pain threshold being about $1W/m^2$ while the faintest sound audible to a young person is one-millionth of a millionth thereof. The instruments used in noise measurement are customarily graduated in decibels (dB), which is in better accordance with human perception of loudness.

Doubling the sound intensity corresponds to an additional 3 dB, tenfolding it to an additional 10 dB. The pain threshold is 120 dB and the faintest audible sound 0 dB.



3.2. How Much Noise Can We Take?

Fig. 2.9 Human beings can take only a certain amount of noise per day without eventually suffering hearing damage. The longer the time of exposure per day, the lower the noise level must be.

This can be expressed by saying that a human being can tolerate 85 dB for eight hours, 88 dB for four hours, 91 dB for two hours, etc.

If the noise exceeds these levels, ear protectors should be used. Noise-level calculations should be regarded as a necessary requirement in the planning of buildings, and 85 dB must be taken as the maximum at permanent workplaces. When a new workplace is being prepared, 80 dB should be the accepted level. This allows some margin for unforeseen increments. In due course, machine manufacturers will be required to submit certificates showing the noise produced by their machine -

Noise limits

8 hours at 85 dB
4 hours at 88 dB
2 hours at 91 dB

90 dB

—

95 dB



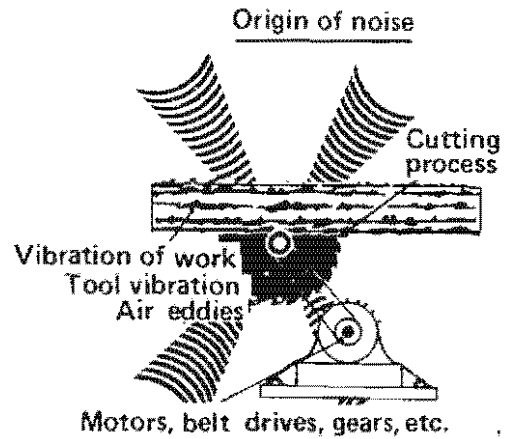
as is already the case in many countries.

3.3. The Origin of Noise in Sawmills

The noise from a saw or a planer is made up of several components:

Fig. 2.10 - Air eddies at cutting edges and tooth gullets

- Sounds generated by the cutting process
- Sounds produced by the vibration of the tool
- Sounds produced by the vibration of the work piece
- Sounds from motors, gearing, feed devices, air cylinders, chip exhausts etc.



Each of these noise components can be reduced by various measures.

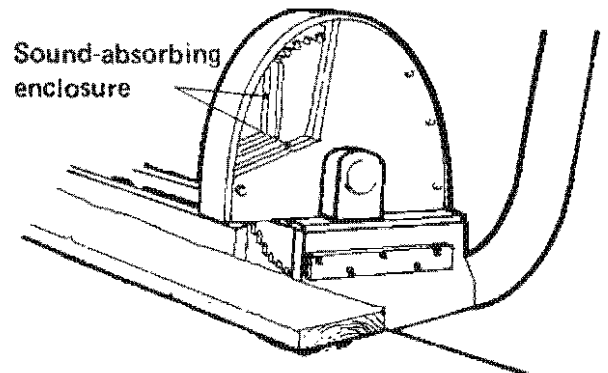
3.4. Measures Against Noise

3.4.1. Sound-absorbing Enclosures

Fig. 2.11 All types of noise are reduced by enclosing working parts.

Sound-absorbing casing material should be used, e.g. laminated sheet metal with layers of rubber asphalt glued or sprayed on. The machines should be set up on a vibration-damping base.

Measures against noise



3.4.2. Air Eddies

Fig. 2.12 The sound of the air eddies is reduced by suitable shaping of the tools, e.g. rounded-off edges, small gullets and small clearance angles in circular saw blades.

Measures against noise



Reducing the sound of the air eddies

The distance from the tool to fixed parts, e.g. the slot in the machine table, should be large from considerations of sound, though this has disadvantages in other respects.

3.4.3. The Cutting Process

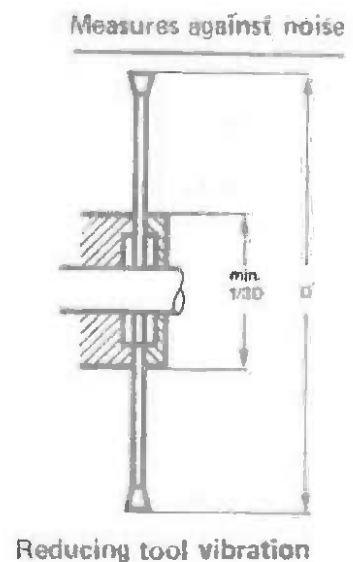
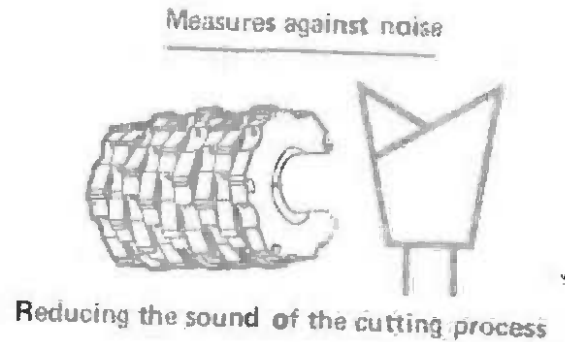
Fig. 2.13 The sound from the cutting process in planing can be reduced by using cutters with many short, staggered blades skewed or helical blades.

In sawing, you can reduce the noise of the cutting process by using bevel-ground teeth and positive hook angles. In all cases the rule holds good that well-ground edges produce less noise.

3.4.4. Tool Vibration

Fig. 2.14 Tool vibration is of very great significance, since the large flat face of a saw blade acts like the diaphragm of a loudspeaker.

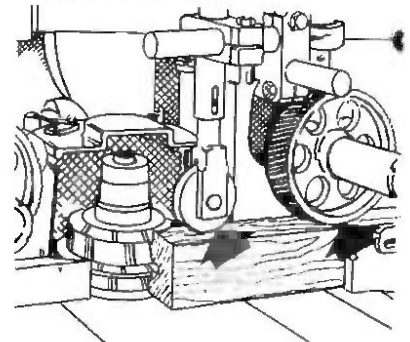
Substantial reductions of the noise produced by circular saw blades can be achieved by damping incorporated directly into the disc. An added advantage thereby gained is that a tool with less vibrations remains sharp a good deal longer.



3.4.5. Vibration of the Workpiece

Fig. 2.15 Vibration of the workpiece can be reduced by siting hold-down rolls and feed devices as close to the tool as possible. This kind of noise is most closely associated with the sawing and planing of thin material, e.g. plywood, fibreboard and panels.

Measures against noise



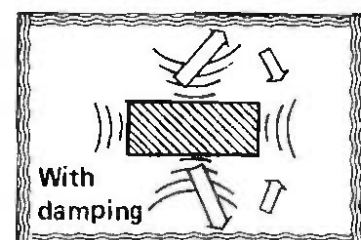
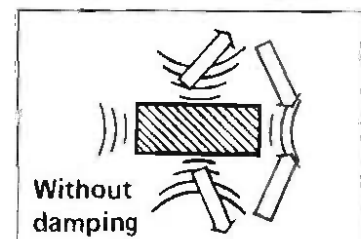
Reducing vibration in the work
Lubrication and maintenance of
the machine

3.4.6. Other Machine Sounds

Other sounds produced by machines are harder to deal with, even though maintenance and lubrication help to some extent. Usually, so much sound remains that changing to quieter tools will reduce the total noise by only 6-7 dB. even though the tool noise is reduced by 10-15 dB.

Fig. 2.16 Enclosing the machine is the solution of last resort, but in such case the walls must be sound-absorbing, clad for example with mineral wool on the inside.

Measures against noise



Enclosing the machine

A hard, sound-reflecting wall will function well as a screen or insulation between two rooms, but is useless for purposes of enclosure. The results would merely be an unchanged noise level outside and a fearful increase in noise inside.

A simpler approach is to hang up sound-damping curtains. To be effective, they must be heavy and must reach right up to ceiling.

3.4.7. Background Noise

Fig. 2.17 The background noise, that is to say the noise from machines in other parts of the room, can best be reduced by sound-absorbing ceiling material, e.g. 5-10 cm mineral wool covered with thin plastic foil so as not to collect inflammable dust. At least half the ceiling surface should be covered.

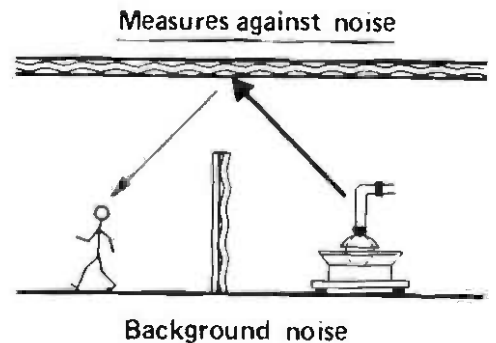
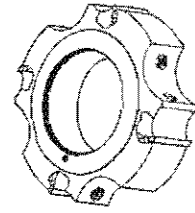


Fig. 2.18 The most economical solution to reduce noise is to use silent-running tools and to maintain them well.

However, a quiet tool must not be inferior to a conventional one in point of productivity or safety. In such cases, enclosure is preferred instead. Some indexable insert cutters embody the principle of damping at the source in their design.



Tools that attack the problem at source



CHAPTER 3 - PLANNING THE SAW SHOP IN A SAWMILL

1. IN-HOUSE SAW SHOP OR OUTSIDE SERVICE?

2. DESIGN OF THE SAW SHOP

2.1. Size

2.2. Location

2.3. Floors

2.4. Walls and Ceiling

2.5. Lighting

2.6. Electricity

2.7. Ventilation

3. THE FUNCTION OF THE SAW SHOP

3.1. Storage

3.2. Transportation

3.3. Machine Siting

4. MACHINE REQUIREMENTS FOR VARIOUS SAWS

PLANNING THE SAW SHOP IN A SAWMILL

1. IN-HOUSE SAW SHOP OF OUTSIDE SERVICE?

Fig. 3.1 Sawmills usually maintain their own facilities for servicing saws. They do so out of consideration for the frequent resharpening needed by spring-set and swage-set saw blades of all kinds - every three or four hours. If they farmed the job out to a saw servicing station they would have to arrange for the collection and delivery of blades on a daily basis. Otherwise the requisite stock of blades to maintain continuous sawing would become excessive.

Saw blades, especially bandsaw blades, are awkward things to transport. They take up a lot of

Advantages of an in-house saw shop

- number of blades in stock can be kept down
- troublesome transportation avoided
- close contact between grinder and sawyer

space and require special transport packing or hangers to prevent damage being caused to or by the sharp teeth. For this reason the transport distance must not be long, whether you do your own grinding or use an outside service.

Another argument in favour of short lines of communication is the need for close contact between the sawmill personnel and the grinder to allow for individual preferences in the matter of swage width, angles, etc.

Fig. 3.2 The main argument in favour of a central saw shop serving several sawmills is that it saves costs, since the load on machines and personnel can be spread more evenly. You can also equip such stations with more sophisticated machines, and your saw servicing is less likely to be disrupted by sickness and vacations.

Advantages of a grinding station

- more even machine loading gives lower cost
- more sophisticated machines can be used
- fewer problems due to absent grinders

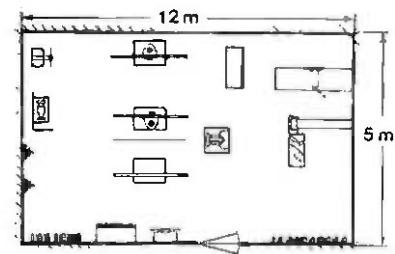
Carbide blades have such a long running time that they are usually sent away for regrinding.

2. DESIGN OF THE SAW SHOP

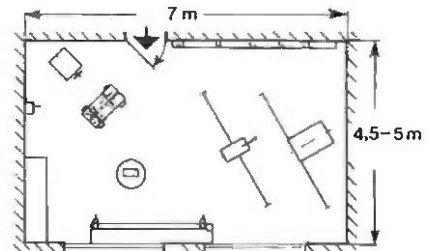
2.1. Size

Fig. 3.3 In view of the weight and size of saw blades it is important for the saw shop to be large enough. The minimum is about 30 m² for gang and circular saws, with an additional 20 m² for band-saws and 10 m² for chipper knives.

The main requirement for a multi purpose sawshop therefore is to make certain it has adequate space. Saws of any description are dangerous to personnel particularly large band or circular saws if they have be moved around in confined areas. The actual size of the sawshop in a sawmill will be dependant on the size of the



Saw shop for gang-saw mill with two or more gang-saw lines (3-4 men)



Saw shop for a smaller gang-saw mill (1 man)

saws and number of saws to be maintained. In hardwood sawmills using bandsaws (e.g. 10 m in length) the sawshop should at least be 15 m in length and 10 m wide. This will ensure sufficient floor space being available for saws awaiting maintenance when sawing abrasive timbers and more frequent saw changes are made, thus avoiding interference to circular saw and gang saw maintenance.

2.2. Location

Most convenient is to have the saw shop inside the actual sawmill. This simplifies the task of transportation.

Even so, this location must be avoided in mills that have not succeeded in damping out vibrations from gang saws or chippers. Many maintenance machines, e.g. grinding machines and tooth-point-

hardening machines, will never give optimum results in a vibrating building.

2.3. Floors

Fig. 3.4. The flooring should be soft enough not to damage tools that are bumped against it. A bare concrete floor is wholly unsuitable. Best of all is a wooden floor, either boards or industrial parquet. Metal, rubber, or plastic floors are not so good, because of the risk of grinding liquids being spilt and making them slippery. Wooden floors also have the advantage of being more sound-absorbent than other types.

2.4. Walls and Ceiling

Ceilings should be covered with sound-damping material, e.g. mineral-wool, slabs or perforated fibreboard.

The saw shop

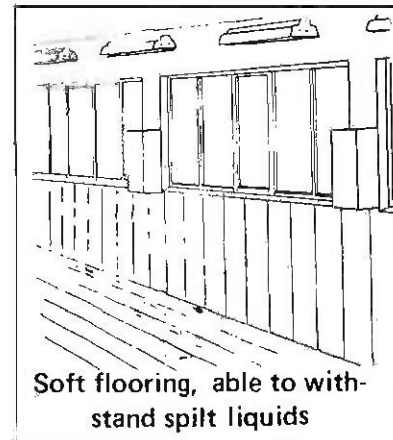
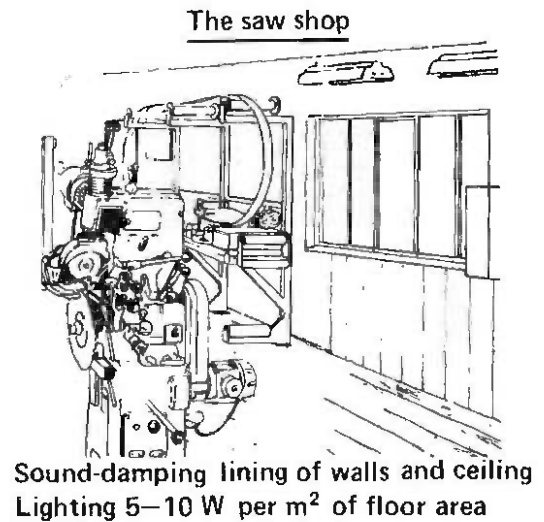


Fig. 3.5 Walls should have sound-damping properties, e.g. clad with wooden panels up to a height of 1.5 metres and perforated board above that. On no account should bare hard concrete be used without cladding. Enough of the wall area must be kept free for racking or hanging knives and saws.

2.5. Lighting

For precision work on bright metal objects, strong, diffuse lighting is needed.

Wherever possible natural lighting through translucent roofing sheets should be used to the maximum extent and all ceiling and wall areas should be painted white. This will minimise the cost of lighting during daylight hours particularly if large windows can also be used to advantage.



There should be some 5-10W of general lighting per square metre of floor area from fluorescent lamps giving an illumination of 150-300 lux available for other periods when necessary.

Additional lighting will also be needed on grinding machines and hammering benches.

2.6. Electricity

Fig. 3.6 Most machines impose normal demands on the power mains. Exceptions are tooth-point-hardening machines, which have proved to be sensitive to voltage variations and must therefore be provided with their own voltage stabiliser.

Electricity

Tooth-point-hardening machines need special treatment

Ventilation

Suction removal of dust from dry-grinding

2.7. Ventilation

Dry-grinding machines for saws call for the suction removal of grinding dust. Most saw sharpener

manufacturers supply such units for their particular machines at extra cost. Grinding dust has serious adverse effects on personnel and machines. It is most essential to ensure effective means of collection.

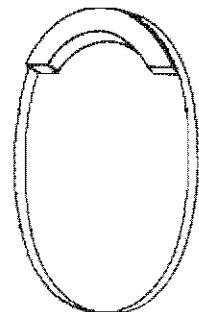
The need for air conditioning should not be overlooked for sawshops in tropical countries. A much higher standard of saw maintenance can be maintained under this condition especially in areas where humidity is very high. The possibility of weld failures or faulty brazed joints in particular are greatly reduced as there is far less likelihood of perspiration from the technician falling on to the work in progress.

3. THE FUNCTION OF SAW SHOPS

3.1. Storage

Fig. 3.7 Bandsaw blades are best stored standing in stalls, preferably tied together with loose loops.

Storage of bandsaw blades



Diameter at least 280 times the thickness

They can also be hung on the wall over semicircular formers, the diameter of which must be at least 280 times the band thickness. For the most part, therefore, plenty of headroom is needed.

Fig. 3.8 When a blade is tied into a bundle the welded joint must come on a straight portion. The teeth must be protected from damage by contact with concrete floors, other blades and so on.

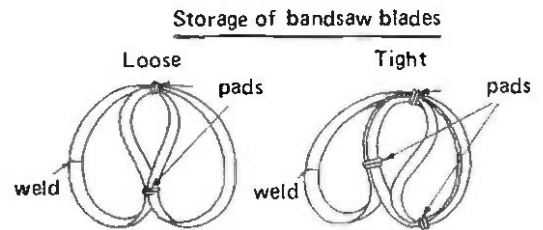
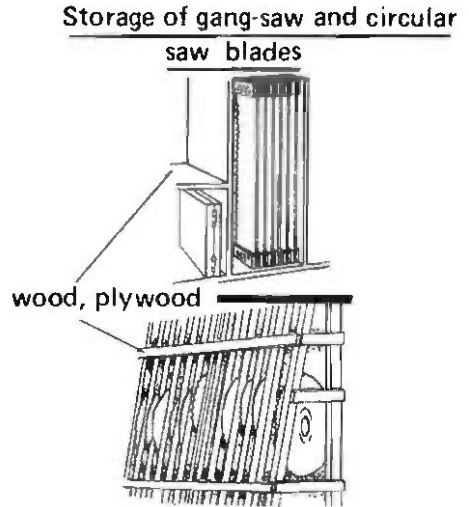


Fig. 3.9 Gang-saw blades should be stored in stalls with their teeth towards the wall. They can be arranged according to length.

Circular saw blades can be stored standing in stalls. The smaller sizes can be hung on hooks. Carbide blades should always be stored in individual containers of wood, plastic or similar material.



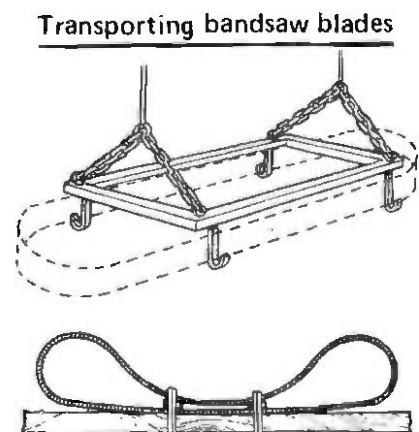
It is particularly important to see that circular saw blades are not left standing on the floor leaning against a bench, since this is bad for the saw body. Nor should they be stacked without protectors between blades, since this is liable to damage the teeth.

Chipper knives should be stored standing against a wall or lying in a wood or cardboard box. It is important not to let them slide over each other, which might damage their edges.

3.2. Transportation

Fig. 3.10 The easiest way to transport bandsaw blades is by using an overhead crane.

The lifting device should be in the form of an open frame so that the blades can easily be lowered

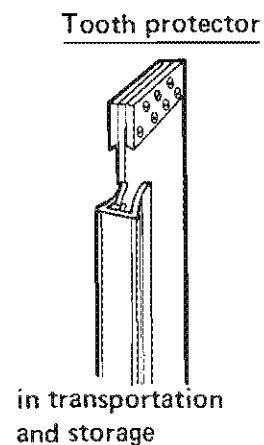


on to grinding and sawing machines. Another way of carrying a long blade is to tie it to a board. In this case the joint should be positioned against the board.

Gang-saw blades will have to be carried for the most part. The same applies to circular saw blades, though they can often be handled using a carrying hook.

Chipper knives are transported in boxes. A convenient conveyor makes a good way of handling heavy knives as long as they are properly boxed to avoid damage to the cutting edge and injury to personnel.

Fig. 3.11 To reduce the risk of damaging saws and injuring personnel the teeth of saw blades must always be fitted with protectors during transportation. Usually, it is advisable to use these protectors during storage as well.



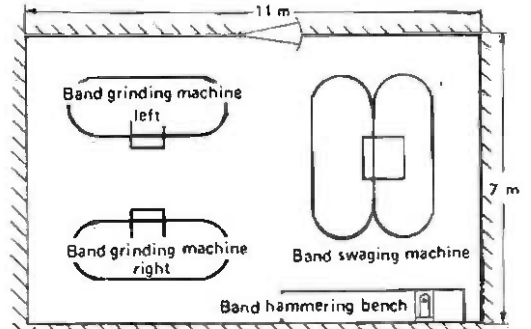
3.3. Machine Siting

Fig. 3.12 To make the operation of the saw shop easier the equipment should be grouped by type of saw, with bandsaws being serviced in one part of the room, circular saws in another.

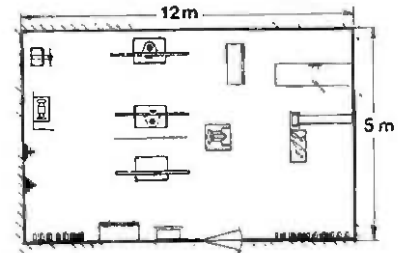
There must be separate spaces for unground and for sharpened blades.

Equipment at which the operator sits, or stands still, should preferably be sited along the walls. Automatic machines, where plenty of elbow room is needed for setting up and removing large blades, are best sited in the middle of the room.

A multipurpose sawshop is shown in 3.13.



Saw shop for multi-band saws
(right-hand and
left-hand bands)



Saw shop for gang-saw mill with
two or more saw lines (3-4 men)

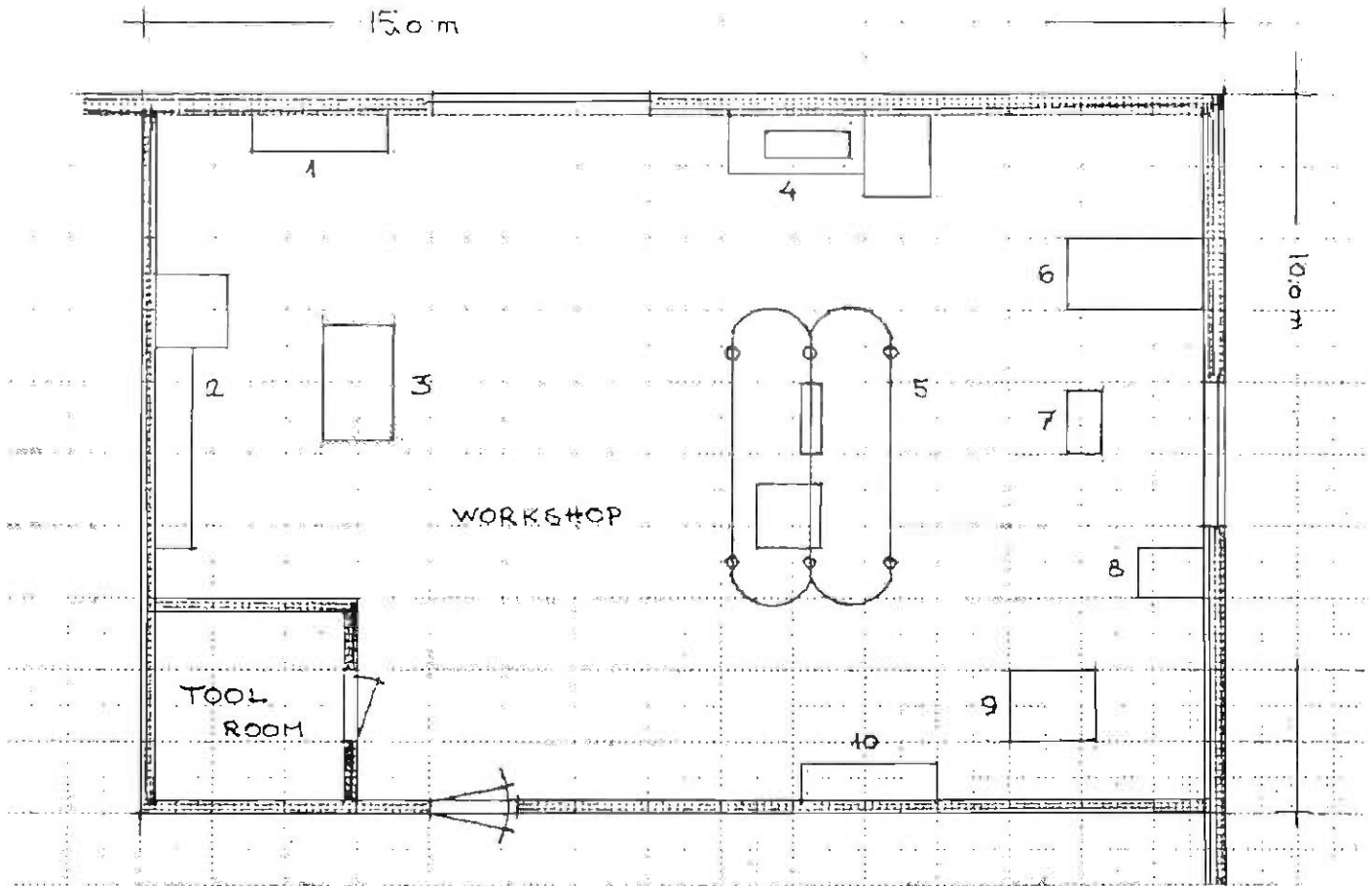
4. MACHINE REQUIREMENTS FOR VARIOUS SAWS

Gang saws	Definitely needed	Automatic grinding machine. Levelling block and stretcher roll. Crossface and doghead hammers. Backgauge, straight edge/tension gauges. Swaging and shaping equipment.
	Possibly needed	Tooth point hardening machine. Side grinder for stellite tipped teeth. Tooth press (punching machine). Shearing machine.
Bandsaws	Definitely needed	Automatic grinding machine. Levelling block and stretcher roll. Swaging and shaping equipment, welding equipment. Backgauge, straight edge/tension gauges. Crossface and doghead hammers. Shearing machine.
	Possibly needed	Tooth point hardening machine. Side grinder for stellite tipped teeth. Brazing equipment. Tooth press (punching machine).

Circular saws	Definitely needed	Hand gulleting machine. Stretcher roll and saw anvil. Twist face and doghead hammers. Straight edges. Automatic grinding machine.
	Possibly needed	Oxy/acetylene welding equipment. Side grinder for stellite tipped teeth. Swaging and shaping equipment. Tooth hardening machine.

In addition to the equipment already specified, all sawshops should be equipped with an assortment of spanners and socket wrenches in appropriate sizes necessary to carry out repairs and adjustments to the various machines. Likewise an engineers bench and vice together with a small bench grinder are standard requirements which must not be overlooked. Straight edged gauges need periodic checking to ensure the faces are not worn out of true and a long master gauge kept for this purpose is a great asset.

Fig. 3.13



COMPLETE SAWSHOP FOR BANDSAWS,
GANGSAWS AND CIRCULAR SAWS

1:100

- | | |
|-------------------------------------------------------------------------------------------------------|-------------------------------------------|
| 1. GANGSAW SWAGING CLAMP | 6. CIRCULAR SAW STRETCHER ROLL |
| 2. GANGSAW LEVELLING BLOCK AND STRETCHER ROLL | 7. CIRCULAR SAW MILL |
| 3. GANGSAW SHARPENER | 8. CIRCULAR SAW GULLETTING MACHINE |
| 4. BANDSAW LEVELLING BLOCK AND STRETCHER ROLL | 9. CIRCULAR SAW SHARPENER |
| 5. LEFT HAND AUTOMATIC BANDSAW SHARPENER WITH SWAGING CLAMP SET UP WITH SUPPORTS FOR RIGHT HAND SAWS. | 10. CIRCULAR SAW SWAGING OR SETTING CLAMP |

CHAPTER 4 - THE EDGE (of various cutting tools)

1. THE SHAPE OF THE TOOTH AND CUTTING EDGES

1.1. Related Angles

1.2. Edge Wear

1.3 Wire Edge

2. FORCES

2.1. Where?

2.2. Two Directions of Force

2.2.1. Cutting Force

2.2.2. Feed Force

2.3. Forces at Work in Circular Sawing

2.4. Forces at Work in Chipping

3. THE SIZE OF THE GULLET

4. EDGE MATERIAL

4.1. Types of Material

4.1.1. Carbon Steel: Hardening and Tempering

4.1.2. Alloy Steels

4.1.3. Carbide and Stellite

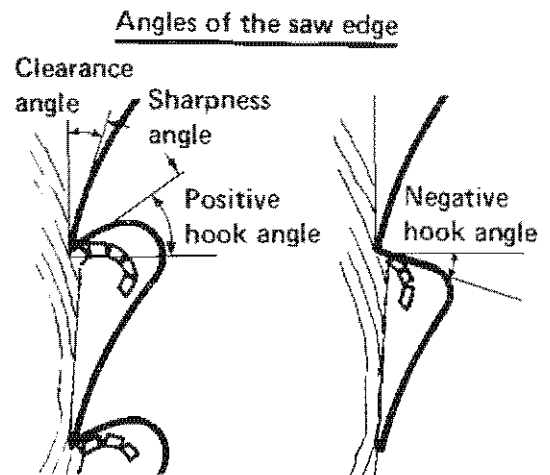
4.2. Fatigue Cracks

THE EDGE (of various cutting tools)

1. THE SHAPE OF THE TOOTH AND CUTTING EDGES

1.1. Related Angles

Fig. 4.1 The way in which the edges on knives or saws perform is decided by their angles relevant to the density of the wood being sawn, the direction of the cut being made, and the type of saw being used. i.e. ripping or cross-cutting.



- Hook angle
- Sharpness angle (on a saw blade = tooth-point angle)
- Clearance angle

In general, the edge is approximately at right angles to its direction of movement.

1.2. Edge Wear

Fig. 4.2 In reality, a cutting edge is not a completely sharp intersection of two surfaces but is more or less rounded. The roundness increases with wear. Soft edge materials generally become smooth and evenly rounded. Hard edge materials, and edges that have struck large and foreign bodies in the wood, develop an uneven, jagged rounding.

Typical radii would be 0.001 mm for a keen edge and 0.1 mm for a dull one.

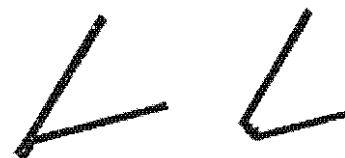
1.3. Wire Edge

Fig. 4.3 The grinding of an edge produces a "wire edge", a thin, deformed extension of the edge. It feels sharp to the touch, but breaks off at once when the tool is put to work and quickly gives way to

Worn edge (schematic)



Wire edge (schematic)



Before use

After use

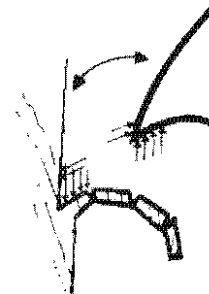
a dull edge. This wire edge must be removed by honing. A honed edge takes much longer to wear down.

2. FORCES

2.1. Where?

Fig. 4.4 When the edge cuts into wood a thrust arises in the area where the edge is in contact with the workpiece and with the chip that is just being removed. This area is from one to a few millimetres wide. The thrust against the parts of the wood is equal to the thrust against the parts of the edge, but acts in the opposite direction.

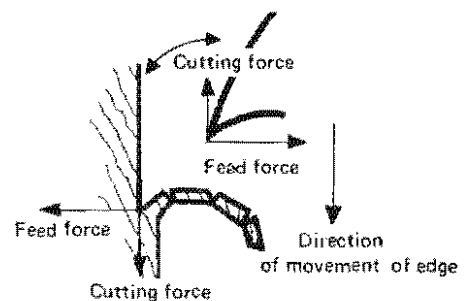
Contact face of the edge



2.2. Two Directions of Force

Fig. 4.5 For the purpose of calculating strength, motor power, etc., we can often sum up the effect of the thrust within the narrow area next to the edge in terms of two forces.

Directions of edge forces



One acts along the cut surface and is called the cutting force; the other acts at right angles thereto and is called the feed force.

2.2.1. Cutting Force

Fig. 4.6 The cutting force is spent in

- parting the chips from the work piece

- shaping the chips by bending or breaking them so that they follow the edge and are carried away

- dragging the blank or clearance surface of the tooth along the workpiece

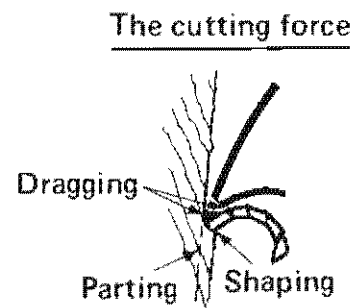
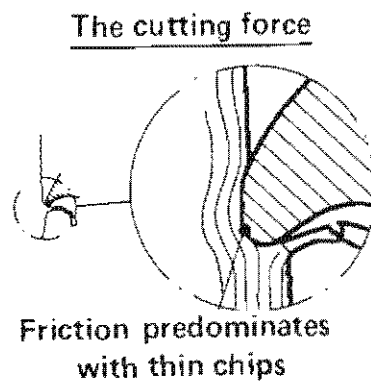


Fig. 4.7 When the chips are more than 0.1 mm thick, most of the force is spent on shaping them. If the chips are thinner than this the



aggregate forces will be only slightly less, since the effect of friction will be all the more noticeable. Besides the chip thickness, other influencing factors are

- the density of the wood and its moisture content
- the temperature of the wood
- the direction of grain of the wood
- the keenness of the edge, and
- the angles of the edge

Fig. 4.8 The cutting force becomes progressively less with hook angles up to 30 degree. Further increase in the hook angle reduces the cutting force only negligibly, but weakens the tooth.

Influence of edge angles on cutting force

Clearance angle of 10° usually keeps the friction down



hook angles above 30° reduce the cutting force only negligibly

If the clearance angle is very small the flank of the tooth will drag against the work piece producing heavy friction.

However, clearance angles of 10 degree are satisfactory, except at high feed speeds, when larger angles are called for in order to keep the friction down.

With gang-saw blades the position is somewhat different, since they have a forward inclination. The clearance angle on such blades must be put at 25 degree so that the friction will not become too great.

2.2.2. Feed Force

Fig. 4.9 Passage of the chips along the face of the edge and the thrust against the flank serve to increase the feed force. On the other hand the thrust is reduced when the chips are parted from the workpiece (provided the hook angle is positive).

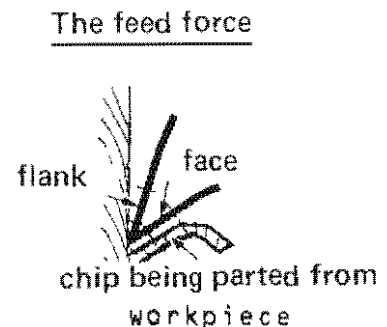
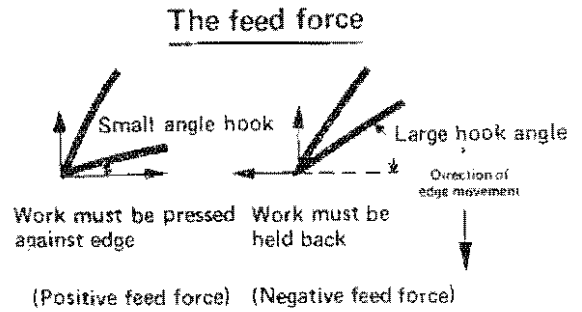


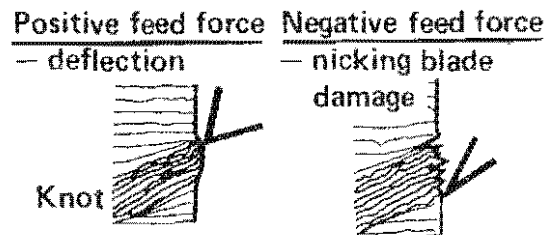
Fig. 4.10 The result will be that we have to press the workpiece against the edge if the hook angle is negative or moderately positive, up to 20-30 degree. This is referred to a positive feed force.



With greater positive angles we shall in some cases be forced to hold the workpiece back to prevent the edge from digging in and becoming self-feeding. When this happens, the feed force has gone negative.

Fig. 4.11 For safety reasons it is preferable to have a small positive feed force.

When the edge encounters a harder zone, e.g. a knot, the workpiece or the blade will then deflect a little, thereby reducing the cutting force. A negative feed force would have pulled the edge



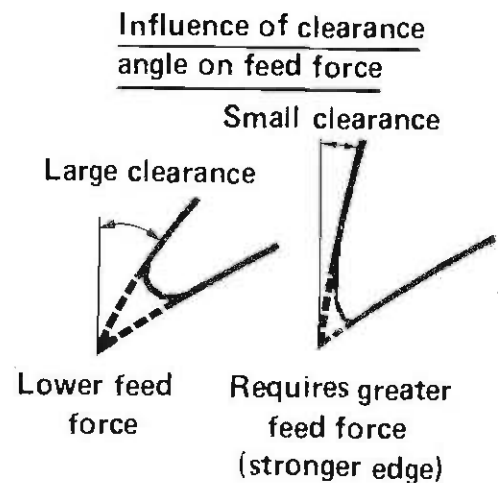
further in and overloaded it. A heavy positive feed force would be liable to throw the workpiece to the rear, normally called a kick back.

Fig. 4.12 A large clearance angle gives a somewhat lower feed force but reduces the strength of the edge and causes it to dull faster, through sheer lack of metal.

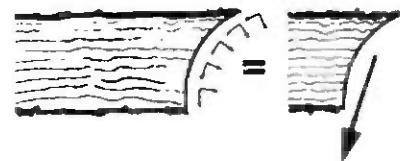
A small clearance angle gives a stronger tooth and slower wear. On the other hand it calls for greater feed force and can give trouble because of small gullets and evolution of heat.

2.3. Forces at Work in Circular Sawing

Fig. 4.13 Circular sawblades have several teeth in action simultaneously at different inclinations. It is essential to ensure that the saw teeth are uniform in height and shape. Some teeth taller than



Forces at work in circular sawing

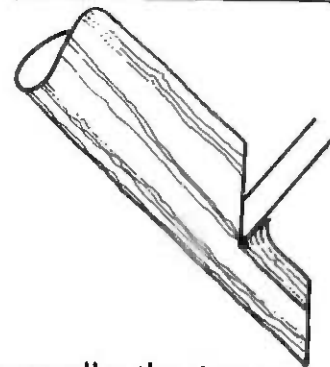


the others will create a rough surface, cause vibration on the workpiece, and varying thickness, as well as possible kick backs. Cracks and broken teeth can also result from uneven tooth height.

2.4. Forces at Work in Chipping

Fig. 4.14 In chipping operations the knife has both a shearing and a prising action. This means that before the knife has gone right through the wood it will to some extent have deformed the chip it is producing. The smaller the sharpness angle, the less will be the deformation. A normal figure is 37-38 degree. Angles below 30 degree give a weak edge that does not stay sharp very long.

Forces at work in chipping

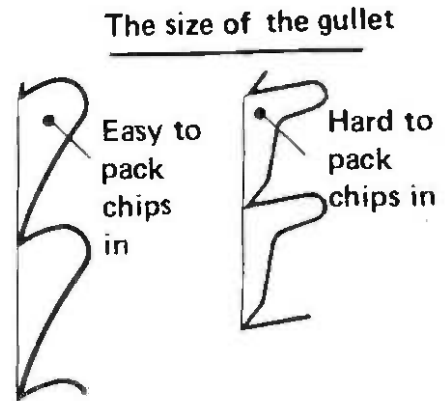


- the smaller the sharpness angle, the less the deformation of the chip
- 37-38° is normal, below 30° makes the edge too weak

3. THE SIZE OF THE GULLET

The gullets must be sufficiently large to accommodate the chip that is formed from the moment when the edge starts to bite until the

Fig. 4.15 gullet is opened just before the edge leaves the kerf. The chips take up more space than the wood they were made from - how much more will depend on the shape of the gullet. A well-rounded gullet only needs to be 1.3 times larger than the solid volume of the chip, whereas a shallow or angular gullet into which the chips cannot be packed must be twice as large or more. If the gullet is too small the chips will be packed in under heavy pressure, evidenced by a rise in both feed force and cutting force and causing the saw to labour.



4. EDGE MATERIAL

4.1. Types of Material

Fig. 4.16 - Steel is iron with a suitable carbon content and perhaps containing other alloys.

Relationships between types of material

	Steel	Stellite	Carbide
Toughness	●●		●
Durability		●	●●
Grindability	●●	●●	●
Heat resistance		●	●
Thin edge	●●	●	
Repair facility	●	●	

= "Carbide" is made up of grains of tungsten carbide or similar materials embedded in metallic cobalt.

= Stellite is an alloy of cobalt and chromium with a suitable carbon content, perhaps with some tungsten and other alloying elements.

4.1.1. Carbon Steel: Hardening and Tempering

Fig. 4.17 The most common material used in woodworking tools is carbon steel. It has a carbon content of around 0.75%. Manganese is added to increase its toughness and to counteract brittleness.

A carbon steel of this carbon content can be hardened. This is because the structure of the steel is different at high and low temperatures. The usual low-

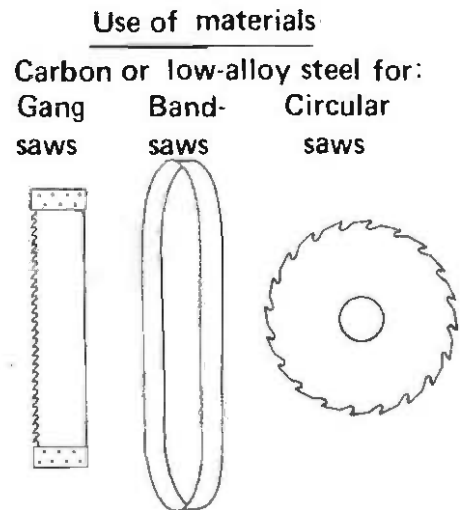
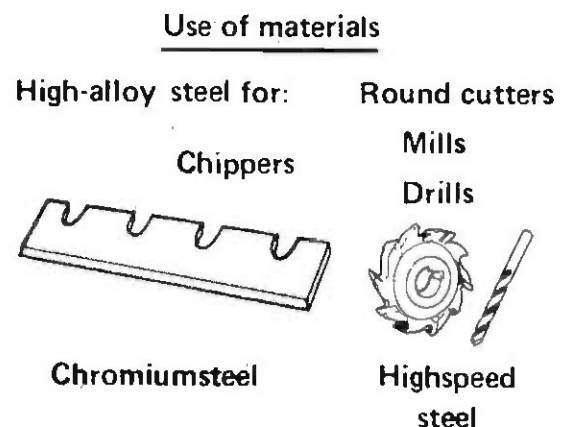
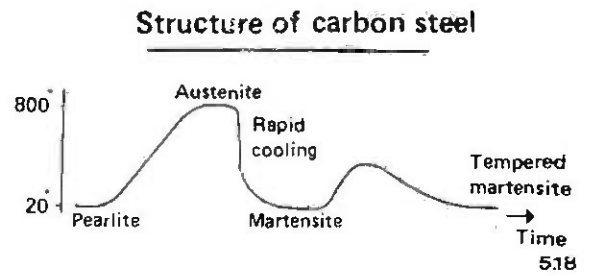


Fig. 4.18 temperature structure, pearlite, is on the soft side, but if we first heat the steel to about 800 degree C and then "quench" it, i.e. cool it rapidly, it assumes a structure known as martensite. Such steel retains some of the characteristics of the high-temperature structure and is very hard and brittle.

The steel is tempered by heating it again, though not at so high a temperature. It is then allowed to cool slowly. Some of the martensite thereupon undergoes transformation and comes to resemble pearlite. The brittleness decreases and the steel becomes tougher.

4.1.2. Alloy Steels

Fig. 4.19 Alloy steels for cutting tools contain additional elements intended to prevent tempering and softening at high working tem-

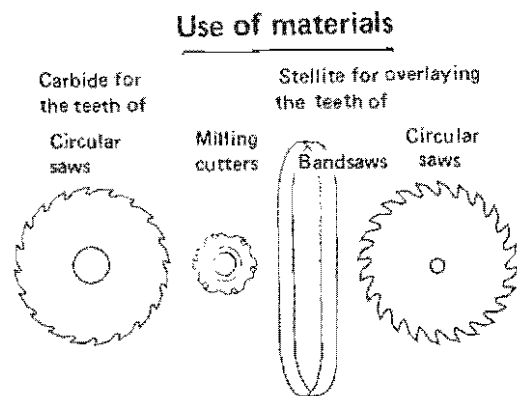


peratures. Materials in common use are chromium-steels, and high-speed steels, alloyed with tungsten, chromium and vanadium.

4.1.3. Carbide and Stellite

Fig. 4.20 Carbide does not contain any iron: it consists instead of extremely hard grains of tungsten carbide cemented together by metallic cobalt. Such cemented carbide has a much higher wear resistance than steel and can withstand high working temperatures. It is more brittle than steel and cannot be used for edges more acute than 45 degree, whereas steel can be used for edges down to 30 degree, or even less in certain cases such as veneer cutting.

By reason of its grain structure a carbide edge cannot normally be made as sharp as a newly ground steel edge. For carbide we can take the edge radius as 0.002 mm.



Stellite is a very hard-wearing but brittle alloy of chromium and cobalt containing no iron. It can be shaped only by casting or overlay welding followed by grinding.

4.2. Fatigue Cracks

Fig. 4.21 It is a well known fact that a material will break if we load it too much, but with many tools there also occurs another kind of failure which is caused by fatigue. Fatigue failures can occur if a material is subjected to a heavy, rapidly alternating load. At first, cracks appear, usually starting from a scratch or surface fissure; they grow slowly until the remaining undamaged cross-section becomes too small and fails by over-loading. If a surface is free from scratches or fissures fatigue will be delayed, but not entirely avoided.

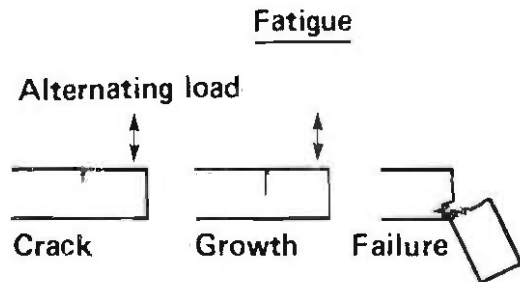


Fig. 4.22 In many cases it is difficult to avoid small fatigue cracks in saw gullets. It is therefore important to remove them during grinding before they can grow too much.

Fatigue cracks
at

- grinding scratches
- wire edges and grinding burrs
- emery-hardened zones
- hammering dents
- uneven welds

CHAPTER 5 - BANDSAWING

1. WHERE AND WHY ARE BANDSAWS USED?

2. THE MACHINE
 - 2.1. Working Direction
 - 2.2. Blade Tension
 - 2.3. Blade Speed
 - 2.4. The Pulleys
 - 2.5. The Blade Guides

3. THE BLADE
 - 3.1. Length
 - 3.2. Width
 - 3.3. Thickness

4. THE TOOTH
 - 4.1. The Pitch
 - 4.2. The Hook Angle
 - 4.3. Tooth Shape

5. OPERATING CONDITIONS
 - 5.1. The Chips
 - 5.2. The Life of the Blade: Bending Fatigue

5.3. Feed Speed

5.4. Maintenance Requirements

5.4.1. Tensioning

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5.4.3. Hardening

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6. SPECIMEN CALCULATIONS

BANDSAWING

1. WHERE AND WHY ARE BANDSAWS USED?

Bandsaws have long been used for the sawing of large-sized logs. In recent years they have also begun gaining ground at the expense of gang saws, chiefly in plants with log reducers.

The advantages of bandsaws over other types of machines are

- Fig. 5.1
- small kerf losses
 - adaptability to large log diameters and unsorted log input
 - capacity for high feed speed
 - good surface quality in the sawn timber

Advantages of the bandsaw

- small kerf losses
- applicability to large diameters and unsorted logs
- capacity for high and uniform feed speed
- good surface quality in the sawn timber

Fig. 5.2 The bandsaw also has some disadvantages as compared to other types of machine. The most important are

- high machine cost
- large space requirements for machine groups
- more elaborate blade maintenance

The most common types of bandsaw used in sawmills are:

Fig. 5.3 - the log bandsaw or headrig for repeated sawing of blocks or boards from large size logs. Such machines may have blades working vertically or horizontally.

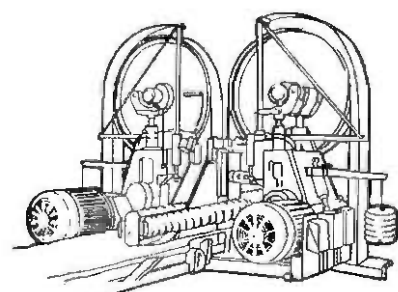
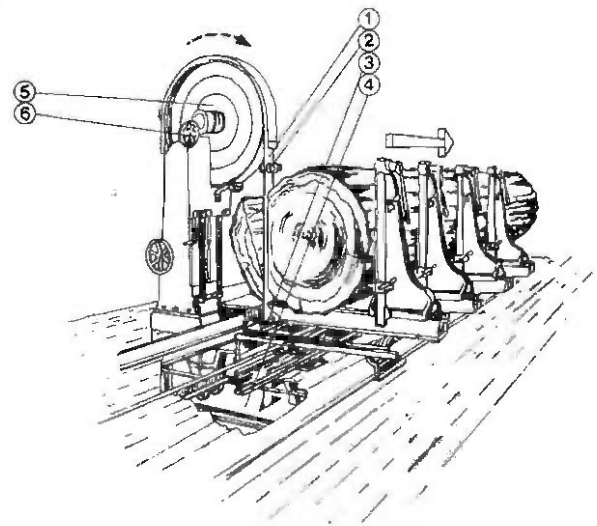
Fig. 5.4 - resawing bandsaws - singly or in groups - for sawing planks or boards from blocks or smaller-size logs. These machines often work together with chipper canters (reducers).

Disadvantages of the bandsaw

- high machine cost
- large space requirements for machine groups
- more elaborate blade maintenance

Bandsaw

- | | |
|---------------------------------|---------------------|
| 1 Bandsaw blade | 5 Tensioning pulley |
| 2 Upper blade guide, adjustable | 6 Tilt gear |
| 3 Lower blade guide | |
| 4 Driving pulley | |



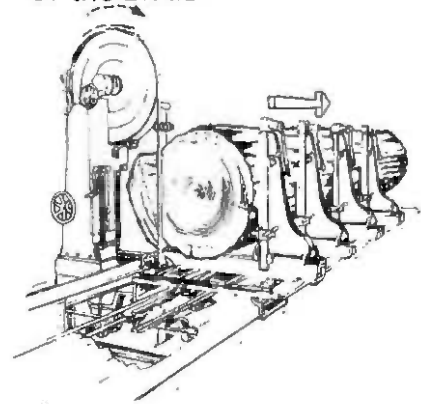
Double bandsaw

2. THE MACHINE

2.1. Working Direction

Fig. 5.5 A right-hand blade is one whose right-hand part travels downwards (clockwise) when viewed from the toothed side. The working direction of the blade must not be confused with the siting of the machine, so always be careful to state the working direction of the blade.

Right-hand bandsaw blade
Working direction of the blade

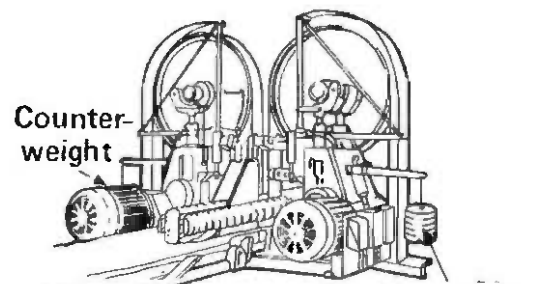


Now let's go on to have a look at the machine adjustments that decide the working conditions of the bandsaw blade.

2.2. Saw Strain or Blade Tension

Fig. 5.6 The saw strain or blade tension is adjusted by counter weights, hydraulic means, or a combination of air pressure and hydraulics. High strain gives greater sawing

Bandsaw blade tension



High tension: Counterweight
— high dimensional accuracy
— less risk of slippage
greater need for maintenance

accuracy and less likelihood of the saw slipping on the wheels, but increases the stresses on the blade and the need for more frequent maintenance. The amount of strain is dependant on the width and thickness of the saw blade being used on the particular machine and recommendations are usually furnished by the manufacturer. General guide lines for the calculation of strain required would be 100N per mm² of blade cross section (10 kg/mm²) = 1 tonne/cm². Similarly this formula ; the width of the saw in inches, times the thickness of the saw in thousandths of an inch, times 10 expressed in pounds, plus the weight of top wheel assembly is still widely used. It is most important to ensure that the straining device is always in good working order.

2.3. Blades Speed (= Cutting Speed)

Fig. 5.7 A high blade speed gives a good cut surface or permits a high feed speed but reduces the service life of the blade by reason of the higher fatigue stresses. A lower blade speed will very often give improved results when sawing high density hardwoods.

High blade speed

- good cut surface
- or
- high feed speed
- shorter life

2.4. The Pulleys

Fig. 5.8 During sawing, the timber would force the blade off the pulley unless something was done to prevent it. The upper pulley (and sometimes the lower one as well) is therefore arranged so that it can be tilted forward as needed. The tilting must be done so that the gullet line runs a maximum of 5 mm in front of the edge of the pulley while the saw is running idle.

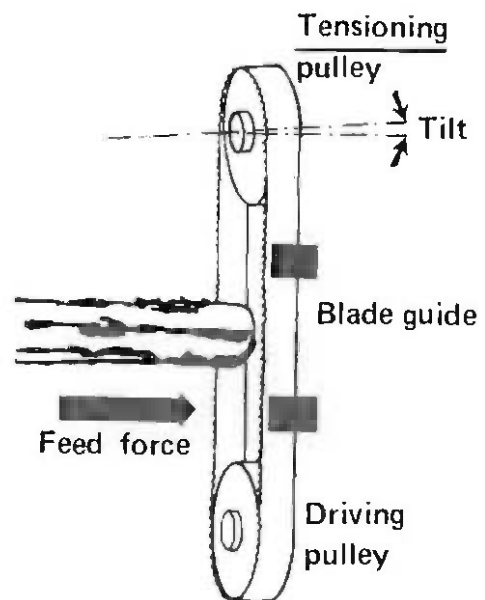
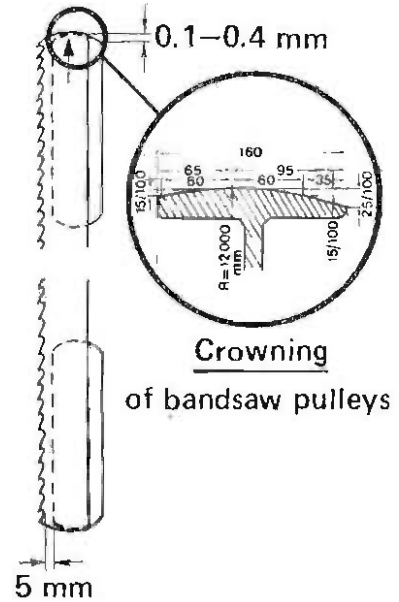


Fig. 5.9 In addition, the pulleys are usually "crowned", the rise of arc being 0.1-0.4 mm according to the width of the pulley rim. This makes the blade self-centering. The top of the crown must be on the forward third of the rim. Exceptionally large pulleys for very wide blades are often made flat with a short bevel on the edges.



Some form of convexity on the pulley rims is recommended. During operation, this prevents the blade from creeping too far ahead, developing instability at its front edge. The risk of cracking is thereby reduced.

2.5. The Blade Guides

Fig. 5.10 The blade guides serve to keep the blade running true. They employ guide blocks made of metal, thermosetting resin, lignum vitae or some similar material.

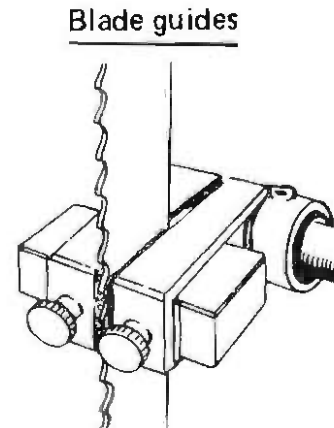
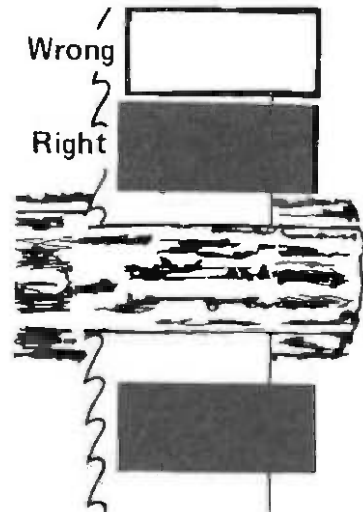


Fig. 5.11 Whatever the design of the guides, it is important from considerations of dimensional accuracy that the distance between the guides and the wood should be as short as possible and should be adjusted according to the size of the log being sawn.

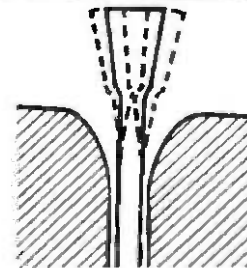
Positioning of the blade guides



The upper guide on vertical band-saws is often counter-balanced with weights or springs so that it can be rapidly readjusted.

Fig. 5.12 Guides should not be adjusted so tightly that the blade becomes heated. The guides should extend over as much of the blade width as possible and must not be allowed to become worn at the front edge.

Worn guides easily result in wavy sawing



To prevent resin deposits on the

blade and pulleys the blade or the pulley must be moistened, e.g. with diesel oil, while the machine is in operation.

In addition, the pulleys are kept clean by scrapers and to prevent sawdust, knots, small pieces of wood or other matter going between the saw and bottom wheel shear boards are fitted. Shear board carriers must be strong and firmly fixed. The shear board must be adjustable and should span the full width of the saw and extend some 50mm beyond the saw teeth in length. When the saw is under strain in its working position the shear board should be set to within 0.1 mm of the blade. Preferably the shear board will be made from brass, aluminium or similar material which will not damage the saw teeth and can be easily refaced when worn.

3. THE BLADE

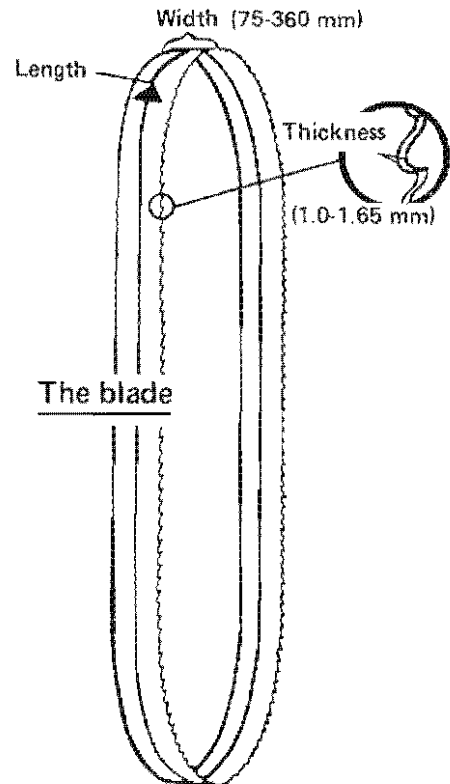
3.1. Length

Fig. 5.13 The maximum and minimum lengths are determined by the machine. New blades should be of maximum length so as to permit shortening of the blade after breakage. When blades are sent in for repair both maximum and minimum lengths must be stated.

3.2. Width

This is determined by the machine. As a rule, buy the largest width (= pulley width + tooth depth + 5 mm). This gives maximum scope for regrinding. The widths in common use by sawmills are 75-360 mm; blades of 60 mm are occasionally met with.

A blade can remain in service down to about 35% of its original width; beyond that it becomes too narrow.



3.3. Thickness

It is common practice in many sawmills for saws that have become too narrow for a particular machine to shorten them for use on another. The success of this depends on the relationship between the diameter of the band-wheel and the thickness of the saw blade. If fatigue stress cracks are to be avoided the diameter of the wheel must be at least 1000 times the thickness of the saw blade being used if under 1.5 mm thickness. For saw blades over 1.5 mm thickness the wheel diameter should not be less than 1,200 times the thickness of the saw being used.

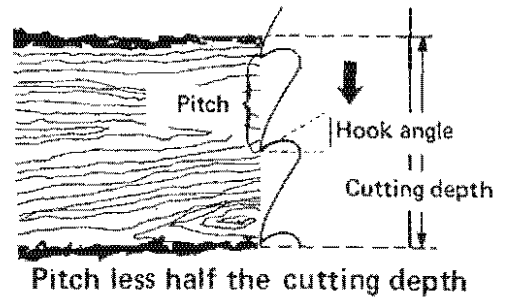
4. THE TOOTH

The tooth shape is specified in terms of

4.1. The Pitch

Fig. 5.14 A large pitch permits a high feed speed but gives a poorer surface. In order to ensure good stability during sawing the pitch should be less than half the cutting depth, so that two or more teeth are in action at all times.

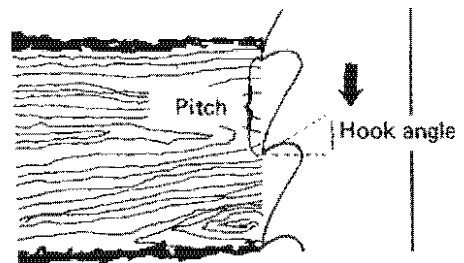
Serration of the bandsaw blade



4.2. The Hook Angle

Fig. 5.15 The hook angle is chosen so that only a small force will be needed for the timber feed. The angle is put at 25-30 degree for softwoods and somewhat less for hardwoods.

Serration of the bandsaw blade



The hook angle must give a low feed force

- 25-30° for softwoods
- 15-20° for hardwoods

One should aim at the largest possible hook angle. The angle for any particular wood will have to be decided by experience.

Making the hook angle unduly large entails the risk that the

blade will be drawn into the wood of its own accord, tearing the chips out and vibrating. The results will be poor sawn surfaces, quick dulling of the edges, and a risk of cracking.

If the hook angle is unduly small the blade will require too much feed force, tooth bite will be low and the risk of cracking greater.

4.3. Tooth Shape

The tooth should have a gently rounded gullet of generous radius so as to give a good service life. Common tooth shapes for wide bandsaw blades are shown as follows:

Fig. 5.16 - Type S, with a tooth depth about 40% of the pitch. It is intended for small-size logs, compelling the use of small pitches, but with which high feed speeds and green timber give an abundance of tangled chips.



- Type LS, with a tooth depth about 30% of the pitch. It is suitable for all timber and large dimensions on which a larger pitch can be used. The lateral stability of the teeth is high, which is necessary with high density hardwoods.



There is also a special chip-breaker tooth, Type SB, for sawing green, high density timber. The tooth depth is 30% of the pitch.



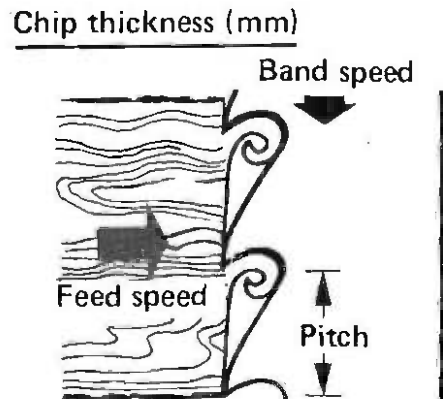
The tooth depth is usually put at about ten times the blade thickness.

5. OPERATING CONDITIONS

5.1. The Chips

Fig. 5.17 The thickness of the chips produced by a bandsaw will be

$$\frac{\text{tooth pitch(mm)} \times \text{feed speed(m/s)}}{\text{blade speed (m/s)}}$$

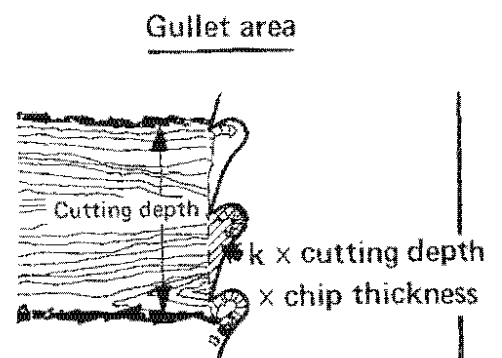


One normally aims at chip thickness of 0.3-0.7 mm for broadleaf wood in large sizes, 0.5-0.8 for dry rip-sawing and 1.0-1.2 for the rip-sawing of green wood. With a feed speed of 0.75 m/s, a pitch of 35 mm and a band speed of 35 m/s we get a chip thickness of 0.75 mm.

Fig. 5.18 Finer chips would not stay in the gullet but would run out into the space between the blade and the wood, resulting in harmful heating, a risk of wavy sawing and chip adhesion. Thicker chips are more valuable as a raw material for pulp or fibreboards but give a poorer surface quality and may lead to more vibration in the blade.

Finer chips would run out between the blade and the wood
Thicker chips give a poorer surface

Fig. 5.19 The gullet area must provide room for the chips. If the gullet is too small, the chips are packed so tight that the stability of the blade is reduced.

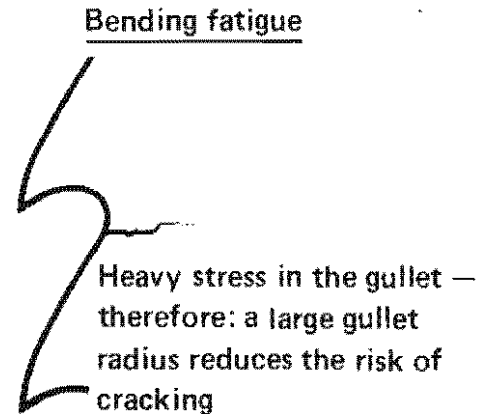


5.2. The Life of the Blade:
Bending Fatigue

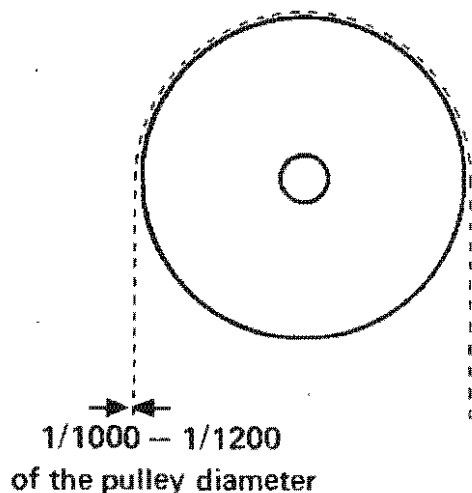
Fig. 5.20 Among other things, the life of a bandsaw blade is limited by the cracks that fatigue stress is liable to produce in the tooth gullet. It would admittedly be possible to dimension the machine and the saw blade so as to rule out cracks entirely, but it would involve some very costly and heavy construction.

With good sawdoctoring and large enough pulleys, saws have been known to last their service life without cracking.

Fig. 5.21 The decisive factor in the appearance of cracks, apart from such things as faulty tensioning, is the bending of the band round the pulleys. It gives a stress change of 210 N/sq.mm (21 Kg/sq. mm) if the blade thickness is



Bending of the blade round the pulleys



1/1000 of the pulley diameter, which is the most that should be accepted below 1.5 mm. With larger pulley diameters the thickness of the blade should be not more than 1/1200 thereof, since thicker blades have a somewhat lower strength.

The flexural stress in the tooth and the tensile-stress variation due to the cutting forces are each no more than one-tenth as large: 20 N/sq.mm (2 Kg/sq.mm).

Fig. 5.22 Increasing the saw strain above the normal figure of 100 N/sq.mm (10 kg/sq.mm) has only a negligible effect on the fatigue strength but makes it necessary to retension the blade more often.

Particularly in North America, developments in recent years have led up to "high-strain" bandsaws.

High-strain bandsaws

- + thinner blades → reduced stress in the bends → higher blade tension → better dimensional accuracy
- more difficult to tension
- more susceptible to damage from stones and nails

By the use of thinner blades, 1/1500 of the pulley diameter, the flexural stress is reduced. Instead, we can then increase the blade tension by 30-50%, which improves the dimensional accuracy of the timber. The disadvantage is that the thinner blade is more difficult to tension and more subject to damage from running into stones or nails.

5.3. Feed Speed

Fig. 5.23 If we progressively increase the feed speed we reach a point beyond which the dimensional accuracy rapidly deteriorates. The maximum usable feed depends on a number of factors.

At any given plant, improvements can generally be made by one of the following:

The feed speed is decided among other things by:

- the quality of the machine maintenance
- the quality of the blade maintenance
- pitch and tooth depth
- the distance between the guides
- the blade tension

- improving the quality of machine maintenance
- improving the quality of blade maintenance
- changing the pitch and tooth depth
- changing the blade speed
- reducing the distance between saw guides
- increasing the saw strain (by raising the tensioning force on the top wheel)

5.4. Maintenance Requirements

5.4.1. Tensioning

Fig. 5.24 The tensioning of the blade is a matter of elongating its middle zone by rolling. The greater part of the tensile stresses is thereby shifted to the "short" edges.

Tensioning by rolling

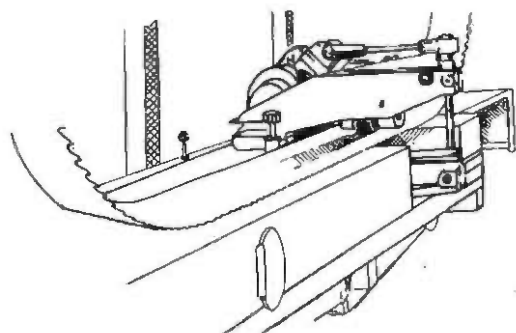
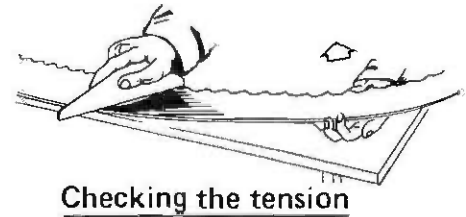


Fig. 5.25 This raises the torsional stiffness of the blade and keeps the tooth line stiff even after it has warmed up on the job. The indication of a tensioned blade is that it assumes a dished shape when bent, whereas an untensioned blade assumes a saddle shape.



The tensioning gradually disappears while the blade is in use and normally it has to be restored after 25-40 running hours. Variations may occur with different kinds of wood.

5.4.2. Swaging

Fig. 5.26 The teeth on narrow bandsaws (up to 75 mm), are most often spring-set, whereas those on wide saws are swage-set. Blades less than 0.90 mm thick are difficult to swage because of insufficient stability in the tooth. Swaging gives better dimensional accuracy in the timber, less vibration in

Swaging instead of spring-setting



- better dimensional accuracy in the timber
- less vibration in the blade
- increased hardness in the tooth points
- for evening out the teeth, grinding, pressing or rolling is required

the blade and a noticeable increase in tooth-point hardness - about 7 Rockwell C for a newly swaged blade.

Fig. 5.27 Swaging can be carried out in an automatic machine or with a hand appliance, the procedure being that an eccentric swage bar is slowly twisted in the tooth gullet. The metal of the chip face of the tooth is thereby forced backwards, outwards and upwards against an anvil which is held against the flank of the tooth.

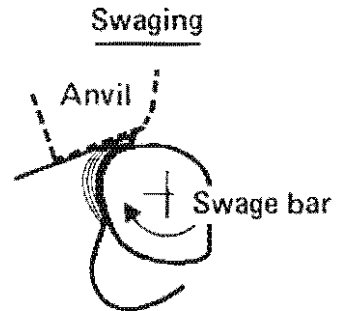
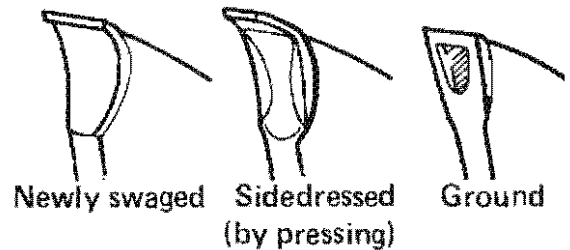


Fig. 5.28 Side-dressing or shaping - which gives the teeth the same width, the correct radial and tangential clearance - is effected by pressing, rolling or grinding. Rolling gives no tangential clearance and cannot therefore be recommended.



Normally, swaging needs to be carried out only once in every three or four regrindings, or after 15-20 running hours. Grinding is normally done after 3-4 hours of sawing, depending on sawing speed and wood density.

5.4.3. Hardening

Fig. 5.29 For sawing highly abrasive wood, tooth-point-hardened saw blades may be used. Only about 0.2 mm of the tooth point is hardened. Residual hardness must be removed during regrinding, otherwise the subsequent swaging would produce cracking.

Tooth-point hardening

0,2 mm

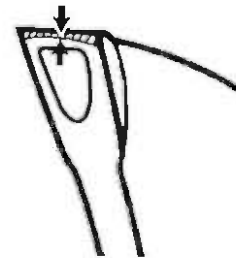
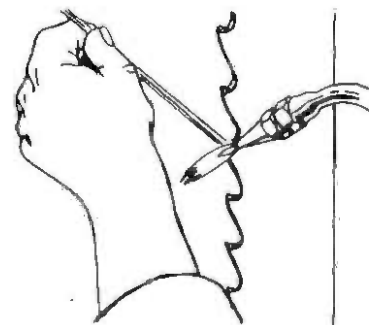


Fig. 5.30 With wide bands, a stellite face can be applied to a normal tooth using gas-welding equipment. Stellite is a cobalt-chromium-tungsten alloy possessing very high wear resistance and is suitable for tropical woods, which are often highly abrasive, examples being teak and macoré.



Stellite facing

5.5. Special Patterns

Fig. 5.31 For certain machines that deal with large-sized logs it may be necessary to serrate the back of the blade as well, using sliver teeth. The log carriage makes no lateral movement, so the kerf in the large-sized log is cleared out during the return movement of the carriage.

Sliver teeth

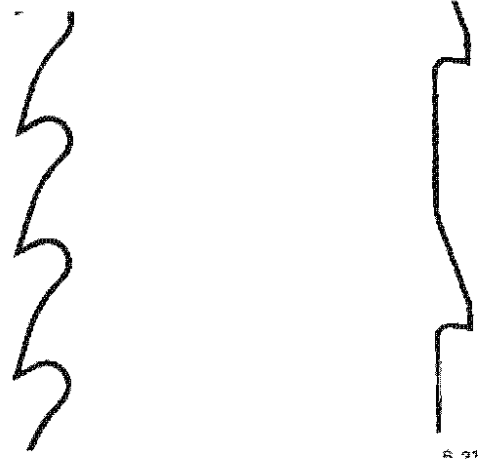
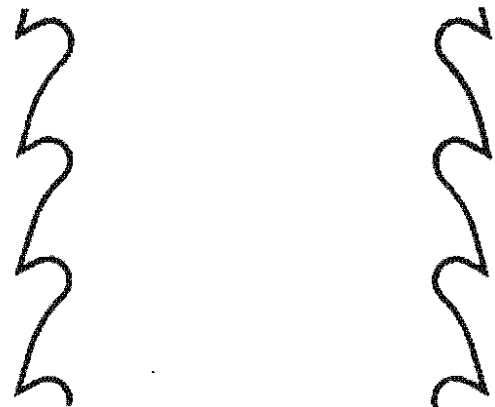


Fig. 5.32 There are also machines using blades with identical teeth along the front and back edges. Such bands cut a kerf on the return movement of the log carriage as well. This method is used when boards alone are being sawn from logs and blocks.

Serration along both edges of the band



6. SPECIMEN CALCULATIONS

The following data is intended as an example for the selection or calculation of correct tooth pitch.

Fig. 5.33 We know that the blade speed is 2050 m/min. and that the maximum feed speed is 50 m/min., which is equivalent to 2.5% of the blade speed. If you have a block of 220 mm and wish to use an LS tooth shape, you must have a 40-mm pitch without any reduction in the feed speed. The cutting depth per tooth will then be 1.0 mm, which is normal for rip-sawing green wood.

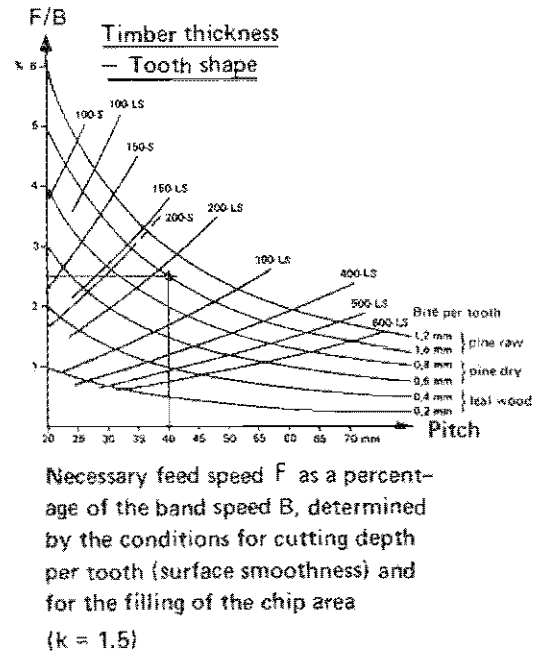
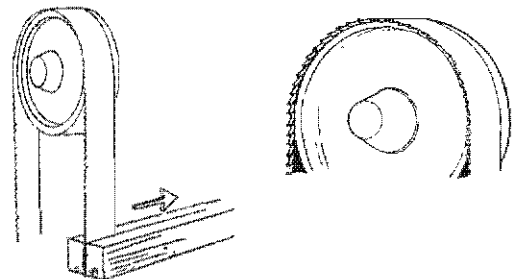


Fig. 5.34 The tooth depth with LS serration is 30% of the pitch, i.e. 12 mm. From strength considerations the thickness of the blade should be at least 1.2 mm. The bandsaw has a pulley diameter of 1500 mm and the blade thickness should therefore be under 1.5 mm. The conclusion is that suitable standard thicknesses would be 1.25-1.47mm.

Summary bandsawing



The method:

- The raw material economically used due to
- Small kerf loss
- Good flexibility by choice of cut
- High feed speed

The blade:

- Correct data choice
- Exact tensioning
- Risk for cracks in tooth gullets

CHAPTER 6 -- MAINTENANCE OF BANDSAW BLADES

1. STORAGE

2. THE BLADE

2.1. Operational Routine Procedures and Checks

2.2. Joining

2.2.1. TIG Welding

2.2.2. Butt Welding

2.2.3. Brazing with Silver Solder

2.3. Straightening

2.4. Tensioning

2.5. Levelling

3. THE TEETH

3.1. Swaging

3.2. Tooth-point Hardening

3.3. Grinding and grinding wheels

3.4. Some Common Causes of Cracks in Bandsaw Blades

4. VARIOUS KINDS OF FAULTS

MAINTENANCE OF BANDSAW BLADES

1. STORAGE

Fig. 6.1 Bandsaw blades are levelled before delivery, but they can easily become permanently deformed if they are transported or stored while too tightly coiled or bent, particularly over a protracted period. This is typical of cold-rolled steel and is due to the large mechanical stresses that are present in the material after manufacture.

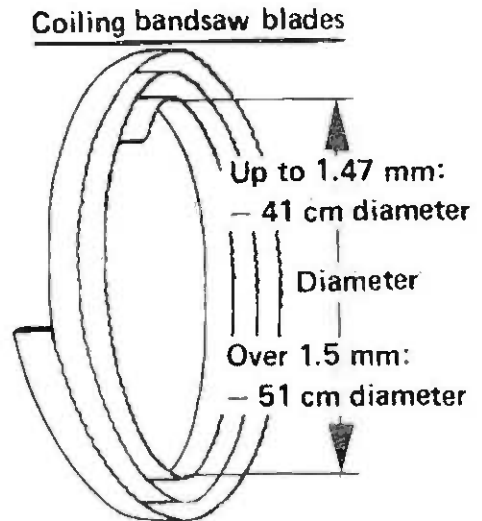
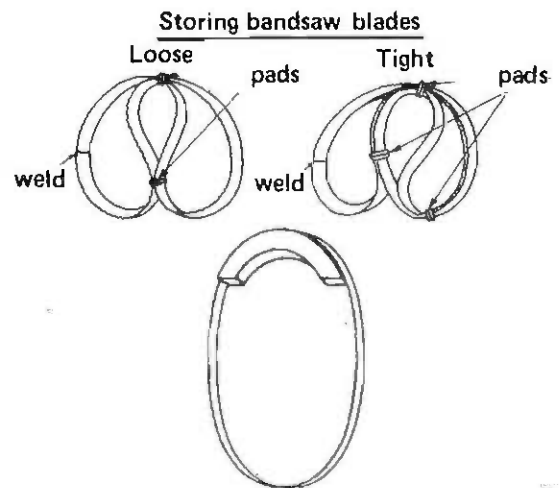


Fig. 6.2 Shorter bandsaw blades should be kept on semicircular hangers.

Longer blades are most commonly stored tied into loops. They should be kept standing on the floor in a stall. The tighter form of bundling should only be used for long bandsaws, with a length at least 6,000 times their thickness.



If the blade is bent beyond the aforesaid limits it develops a curl set along its length, although this is fairly easy to straighten, and also assumes a channelled shape, which is harder to flatten out and unsuitable in operation.

2. THE BLADE

2.1 Operational Routine Procedures and Checks

A new bandsaw blade received from a manufacturer should always be checked over on the bench before being put on the bandmill. Faults can arise during storage or in transit as previously mentioned. If the blade is found to be satisfactory and the tooth points are correctly swaged or set the saw should be given a light grind and tooth alignment checked.

On the first run if it is possible to run it for an hour without cutting and then take it off for a check up so much the better. (Perhaps this can be done during meal times). If this is not possible the saw should preferably be put to work for half an hour sawing low density timber and then taken off for re-checking. Production pressures are not always conducive to idle running of new bandsaw blades but within reason, light sawing for half an hour for the first two runs should not cause problems. After every run all blades must be thoroughly cleaned and carefully checked for any cracks, loss of tension, lumps or irregularity of the back edge. After this if all is correct the saw teeth can be checked for the condition of the swaged points and if still satisfactory the saw can be sharpened and teeth

checked for alignment in preparation for the next run. Bandsaw blades are often used in batches of four. Each saw being numbered and the number being recorded each time it goes to work and the duration of its working spell noted.

This procedure helps to highlight the need for a more stringent check on a bandsaw blade which is not giving satisfactory results.

All bandsaws should be dealt with after each run in the manner already described and techniques to deal with the various requirements likely to be identified during the check up are given accordingly under the respective headings.

2.2. Joining

Fig. 6.3 Blades that are supplied in fixed lengths or wound into coils are joined by welding or brazing. The methods employed are TIG (= Tungsten Inert Gas) welding,

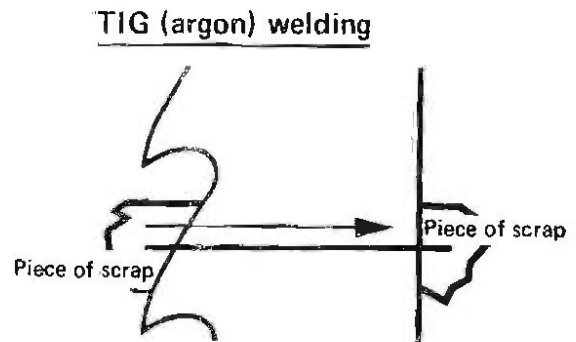
Welding methods

- TIG welding
- butt welding
- brazing
- gas welding

butt or flash welding, brazing with silver solder, and gas welding.

2.2.1. TIG Welding

Fig. 6,4 TIG welding (argon-arc welding) is becoming increasingly common. The current is supplied not through the welding rod but through a special tungsten electrode. Argon is blown onto the welding zone to prevent oxidation.



This process is faster than gas welding, which reduces the spread of heat.

This makes it possible to complete the whole weld in one run from front edge to back, and to avoid the risks of carburising or decarburising.

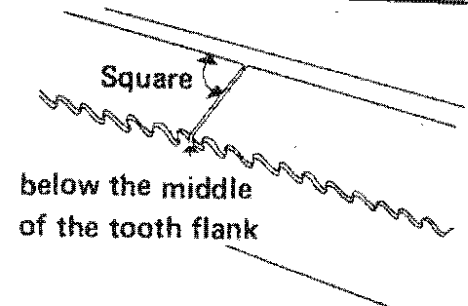
The welding procedure is as follows:

Fig. 6.5 Shear the ends of the band off square, making the cut just below the middle of the tooth flank. (The flexural stress is too high in the gullet and the abrasion is too high at the tooth point).

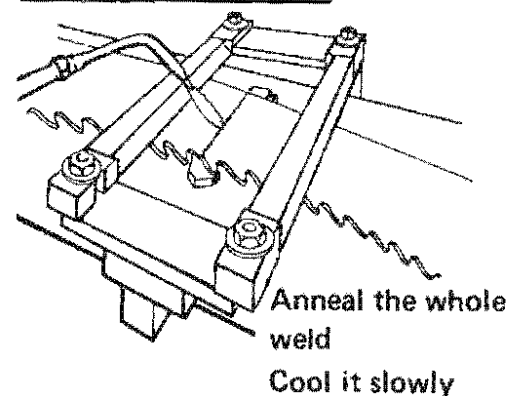
Clamp the blade in a fixture on the welding table, with a gap between the ends which is less than the band thickness. The gap disappears when the band is heated. Apply copper clamps to the ends of the band about 10 mm from the weld so as to keep them flat.

Fig. 6.6 The weld is made in a single run. Place small pieces of saw steel next to the edges of the band and run the weld out into them, since the ends of a weld exhibit cracks and fusion losses. The filler or welding rod used in the process should be of the same metallic structure as the bandsaw. Bandsaw manufacturers will usually supply welding rods but a sliver of the steel from an old bandsaw

TIG welding: the ends of the band



TIG welding: clamping



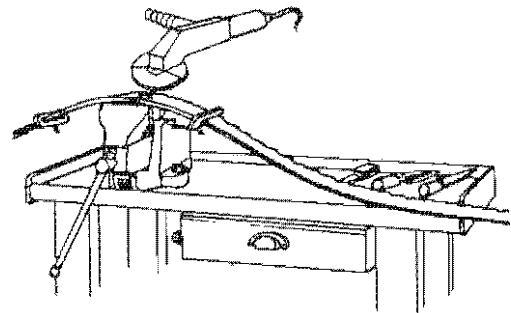
will be satisfactory if it is thoroughly cleaned. The sliver should not exceed 5 mm in width.

When the whole weld is finished it must be annealed at once with a gas flame until it is dark red. The weld should then be allowed to cool slowly.

Then cut away the pieces of scrap at the edges, and file off the flash.

Fig. 6.7 Straighten the band in a stretcher roller and by hammering. Finally, grind the edges of the band, the welded joint and the vicinity of the weld with an angled hand grinder.

TIG welding: grinding the joint



TIG welding is well suited for the repair of cracks in the blade. The working procedure is similar to that of joining.

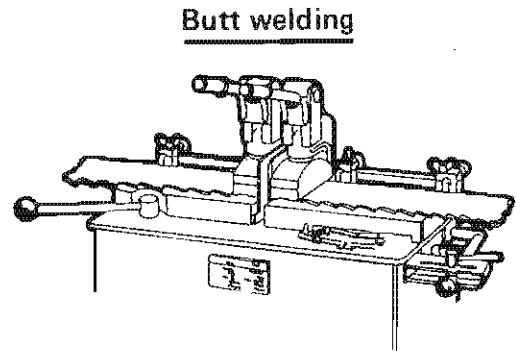
In view of the high stresses on modern bandsaws it is inadvisable to drill away the tips of cracks as a means of stopping them.

2.2.2. Butt Welding (flash welding)

Fig. 6.8 Butt welding is used in making new bandsaw blades and in repairing blades up to 150 mm wide.

The principle of the method is that an electric current of low voltage and very high amperage is passed between the ends of the band, which must be clean and in good contact with each other. When they become incandescent they are rapidly pressed against each other whereupon they weld together.

The joint is then left to cool slowly but is annealed at brief intervals according to an annealing chart. These steps in the work are carried out automatically and may vary somewhat from one machine to another.



To finish, the joint must be filed, straightened and ground just as with TIG welding.

2.2.3. Brazing with Silver Solder

Fig. 6.9 Brazing with silver solder can be used for the joining of bandsaw blades. Bevel each end of the blade over a length equal to ten times the thickness. Do not make the end quite sharp, but leave one-tenth of the thickness. Then make an overlap joint.

Brazing with silver solder

Blade ends

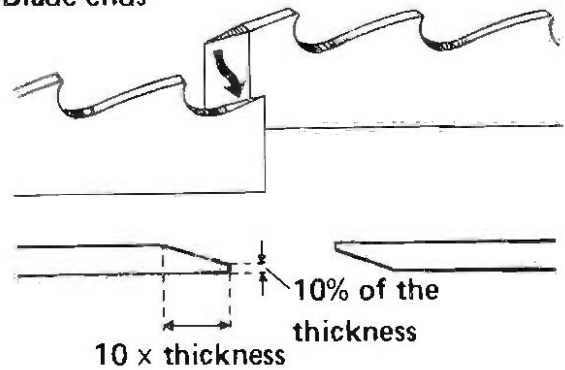
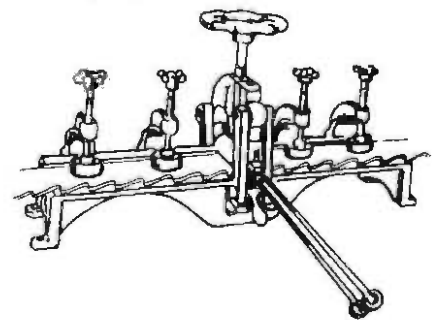


Fig. 6.10 Take some solder in the form of sheet or ribbon, clean it with emery and soak it with flux, then lay it between the bevelled and fluxed surfaces. The solder should project beyond the joint at the edges of the blade and about 1-2 mm at the overlap. Put an extra piece of solder at the ends of the joint so as to prevent the solder from being squeezed out too much.

Brazing with silver solder

Clamping the blade



If brazing irons are to be used, heat them to 750-900 degree centigrade (depending on the type of solder) and clamp them onto both sides of the joint with the clamping fixture.

Then undo the clamps holding the blade next to the joint, in order to give the blade room for thermal expansion.

Remove the irons when their colour gives way to black (at about 400 degree C). If they are left in place the joint will turn out too soft.

The brazed joint must be filed and straightened, since the ends were not made quite sharp, and excess silver solder must be removed. A kerosene-soaked rag

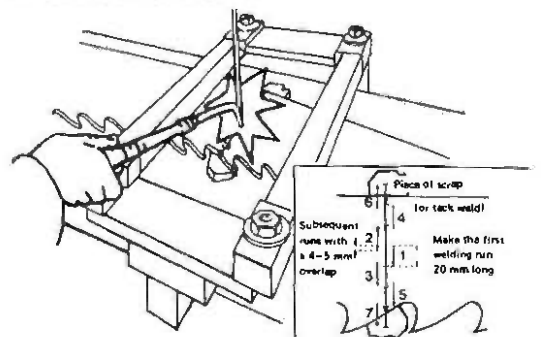
is suitable for wiping. The brazed joint is a weak point, and the teeth nearest to it should therefore be shortened. To reduce the risk of splitting it is a good idea to file the brazed zone a maximum of 0.05 mm thinner than the rest of the blade.

2.2.4. Acetylene Welding

Fig. 6.11 The preparation procedure for butt welding bandsaw using oxy-acetylene is the same as that used for TIG welding. Oxy-acetylene welding is very widely used for the purpose also for the replacement of broken teeth and the repair of cracks.

For best results a lightweight torch, a two stage regulator and a welding clamp with an adjustable anvil (preferably foot operated) are required. It is most important to ensure the bandsaw ends to be welded and the

Acetylene welding



welding rod are clean. The anvil should be preheated to help slow down cooling of the saw later and the welding flame should be adjusted by using a small excess of acetylene to show a very slight feather at the end of the inner cone. This slight feather is the indicator to ensure an excess of oxygen is not being used in the welding flame which would cause the carbon content of the steel to burn up.

The welding process starts at the centre with a run of about 20 mm and continues alternately towards the edges. After each run the anvil is raised and the weld run is forged flat. Forging must not be done when the metal is below red heat and each weld will need to be reheated as a series of light hammer blows in 2 or 3 forgings make a better weld.

After welding is complete, slack off the welding clamps and anneal as for TIG annealing process.

2.3. Straightening

Fig. 6.12 Bandsaws must be straightened so as to give them an even line of teeth and ensure that the teeth will all cut equally, and at the same time to leave the back edge true so that the blade will run smoothly over the support points during grinding.

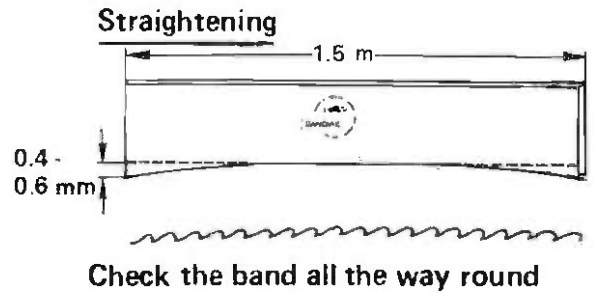
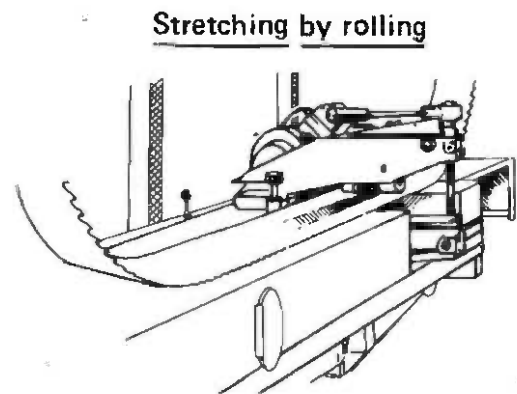


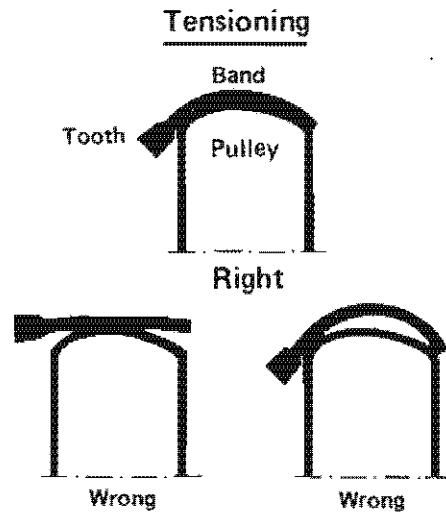
Fig. 6.13 The back edge is straightened using a stretcher roll which rolls the blade lengthwise a few centimetres from the back edge until the whole edge is somewhat convex. The blade will then run true in operation once the toothed edge has warmed up.



It is normal to give the back edge a rise of arc equal to 0.4-0.6 mm over a length of 1.5 metres. The regularity of this must be checked all round the blade.

2.4. Tensioning

Fig. 6.14 The process of tensioning a band-saw blade involves rolling it in the stretcher roll so that its central zone becomes longer than the two edges. The results of this are that the tensile force in the band is borne by the edges so that the band is better able to withstand lateral forces on the toothed line and that the band fits itself more closely to the rims of the pulleys - and their crowning, if any.



A blade with insufficient tension has a tendency to produce wavy cuts and surfaces that are not flat, since the toothed edge lacks stiffness. Besides this, the blade may wander to and fro over the pulleys as the load varies, which can also result in fatigue cracks. A blade with too much tension suffers overstrain

in the edges in flexing over the pulleys, and is more likely to develop cracks in the gullets and the back edge.

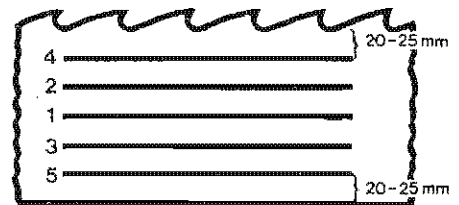
Fig. 6.15 The rolling operation is carried out in a number of parallel passes. In making a new blade the first roll passes are performed in the middle of the blade. The subsequent passes work alternately closer to the toothed and back edges.

If the rolls of the stretcher are identical - with the same curvature and both powered - the blade should lie flat on the workbench after the operation.

Fig. 6.16 Failing this, the blade should be turned over and rolled again in the spaces between the first set of passes, with the blade running beneath the table.

In the tensioning operation, no roll passes should be made less than 20-25 mm from the gullets or the back edge.

Tension rolling



Bench for tension rolling

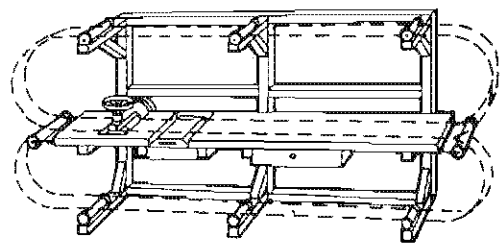
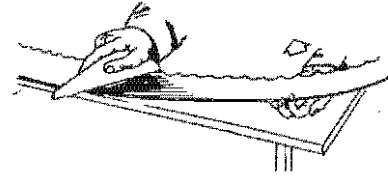


Fig. 6.17 To check the tensioning of a blade lift the blade with one hand and bend it along its length. It should flex of its own accord so as to develop a hollow across its width. The rise of arc is measured either by viewing or measuring the daylight between the blade and a straight rule or by measuring with a convex rule. The daylight must be checked on both sides and must be equal. Suitable values for various widths are:

Blade width	150	180	230 mm
Daylight	0.5	0.8	1.2 mm

Fig. 6.18 The size of the daylight (the rise of arc) must be different for different band widths and working conditions. Crowned pulleys call for a greater daylight than flat ones; hard woods call for a greater daylight than soft ones.

Check on tensioning

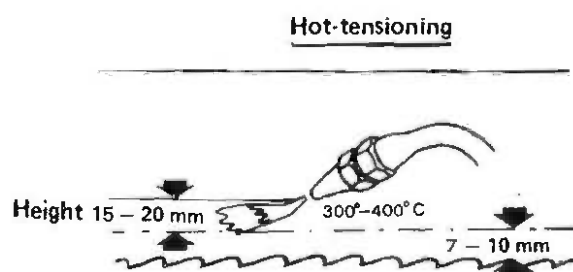


The daylight must be the same on both sides.

Greater tension if:

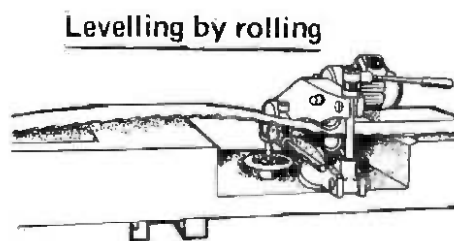
- the pulley rim is crowned instead of flat
- a hard wood is being sawn

Fig. 6.19 Hot-tensioning is an alternative to roller stretching. The edges of the band are quickly heated to 300-400 degree C using a gas welding torch. This causes a measure of shrinkage in the edges upon cooling.



2.5. Levelling

Fig. 6.20 Levelling of the blade is necessary in order to remove lumps and channelling or dishing as it is commonly called. Levelling is effected by rolling in conjunction with tensioning. Any remaining lumps are beaten down with light blows of the hammer with the band resting on a soft support, e.g. wood or leather. Heavy blows on a band resting on steel or other hard support may upset the tensioning. Lumps left uncorrected would overheat while the blade was running and lead to various kinds of trouble. A channelled or dished blade would give a wavy cut.



If a hammer is used the band must have a soft support

3. THE TEETH

3.1. Swaging

Fig. 6.21 Cold-swaging gives a new shape to the tooth point and at the same time increases its hardness (30-35% or 5-7 Rockwell C) without any loss of toughness.

Swaging
Hardness increase
in Rockwell C units

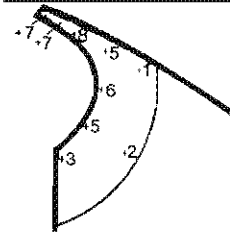
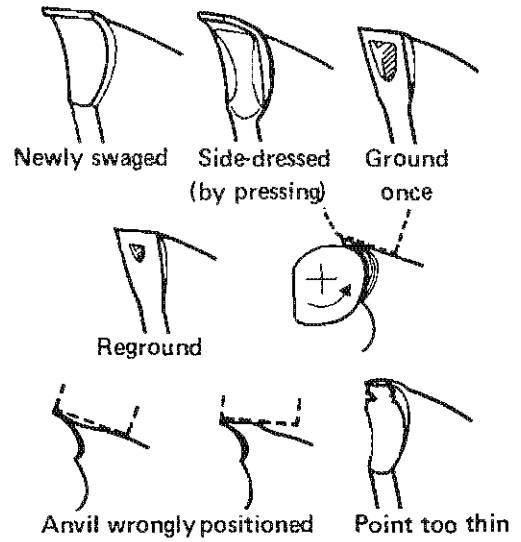


Fig. 6.22 It is very important to remove the grinding burrs before swaging. In addition, the chip face must be liberally lubricated with a stick of wax or similar, since the force applied to the small area of contact is very large and could otherwise produce cracking in the tooth point. The swage bar also suffers damage if lubrication is neglected.



The anvil in the swaging machine must project beyond the tooth point and must be adjusted so that the swaging does not reach

right up to the tip of the tooth but leaves 0.5-0.7 mm, since the steel at the tip might otherwise become so hard and brittle that it cracks or spalls. Results are best if swaging is completed in a single operation.

Swaging must be followed by side-dressing of the teeth and grinding of the edges. The amount of swage on each side should be 0.4-0.5 mm for dry wood and 0.5-0.7 mm for green wood. Added to this is an allowance of 0.3-0.4 mm per side for side-dressing.

Side-dressing or shaping, is usually effected by pressing. Subsequent grinding of the sides improves the accuracy and gives more even cut surfaces. One swaging usually lasts for three or four regrindings.

3.2. Tooth-point Hardening

Fig. 6.23 One can also harden the tooth points and achieve a longer running time. Two methods are employed, one being high frequency or inductive hardening, which is carried out after cold-swaging, and the other being hot-swaging, with the tooth-point being hardened in the same operation.

High-frequency hardening gives a thin hardened layer 0.15-0.20 mm thick, with an annealed layer beneath it, softer than the rest of the band.

Unduly deep hardening would lead to a residual increase in hardness in the tooth point after grinding, which in turn would make it difficult to cold-swage the tooth next time. If the hardening is too superficial the

Tooth-point hardening

High-frequency hardening

a thin hardened layer, 0.15-0.20 mm, with an annealed layer beneath it

Hot-swaging

hardening to a depth of about 1 mm by electric heating



blade will exhibit sudden dullness once the hard surface is worn away exposing the soft layer.

Hot-swaging gives a hardening depth of about 1 mm, the tooth being heated prior to swaging by low-voltage electricity as in making a spot weld. Otherwise, the procedure is the same as in ordinary swaging, and is unaffected by any hardness remaining from earlier hardening operations. Hot-swaging is employed to some extent in Europe.

Both these hardening methods produce a hard, untempered layer, one which is wear-resistant but not tough, involving an increased risk of spalling if the timber contains stones or nails.

3.3. Grinding

Fig. 6.24 The teeth of a bandsaw blade must be reground after a time, depending on how hard they have to work, the kind of wood being sawn, and whether the teeth have been treated in any way. It is important to grind the tooth gullets as well, since that is where micro-cracks will appear sooner or later.

Blades are ground in automatic grinding machines with aluminium-oxide wheels. It is important to make quite sure that the template fitted to the grinding machine corresponds to the tooth form you are working with. The machine must be set to grind the whole tooth true, thus maintaining the required tooth shape. This applies equally to new blades, the tooth form of which may differ from that of the grinding machine.

Grinding

- class of work, kind of wood and tooth treatment, if any, will decide how often re-grinding is needed
- the gullet must also be ground
- use the right template for the grinding machine
- the grinding wheel must be about one-third of the tooth pitch in thickness, and well rounded
- the blade must be ground from the outside

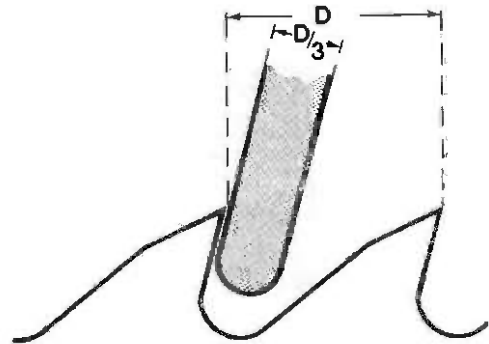
The entire profile of the tooth must be ground.

Fig. 6.25 The grinding wheel should appropriately have a thickness about one-third of the tooth pitch and should have a rounded edge. Modern grinding machines can also use thinner wheels and still give a good gullet radius. For the chipbreaker tooth there is a special wheel shape that produces the profile of the tooth.

The blade must be ground from the outside, so that the grinding burrs come on the inside where they will not be subject to tensile stress.

Certain types of steel, especially the nickel-alloy steels that are often used for the thicker kinds of bandsaws, are somewhat susceptible to "emery-hardening", which means that when the grinding wheel in use is too hard the

Grinding-wheel thickness



Avoid grinding wheels that are too hard

— they cause emery-hardening

Avoid grinding wheels that are too coarse-grained

— they cause scratches

steel surface is heated beyond the hardening temperature. This leaves it glass-hard and full of small cracks, which will serve as the starting points for fatigue cracks when the blade is in action. The same thing applies to grinding burrs, which must be removed by filing, shaving or honing.

Grinding wheels

Grinding wheels are manufactured from two main essentials; the "Abrasive" which does the actual cutting and the "Bond" by which the abrasive particles are held together.

The abrasive particles are known as the "Grit" or "Grain", and are sized according to the size of the mesh hole through which they fall during the sieving process in manufacture. The size of mesh is relevant to the number of mesh

holes per linear measurement, (e.g. 36 per linear inch). Hence lower figures denote large grit particles and the higher figures smaller particles.

The bond most commonly used for the manufacture of bandsaw sharpening grinding wheels is ceramic or vitrified, and the ideal bond is one which holds the abrasive particles together as long as they are sharp, but lets them break away when becoming dull; Thus minimising the possibility of over heating the area being ground. (Burnt saw tooth gullets cause cracks).

The "Grade" of a grinding wheel denotes the hardness of the wheel but this is not related to the hardness of the abrasive but to the strength of the bond holding the particles together. By this measure, a grinding wheel losing its abrasive particles quickly

would be called soft and one which retained them when dull would be hard.

Suitable specifications regarding grinding wheels for sharpening bandsaws will vary somewhat according to the thickness of the blade and tooth pitch. Generally thicker blades with long tooth pitch require a larger grit size than thin blades with shorter tooth pitch. Grinding wheel manufacturers will always give advice if necessary.

Grinding wheels using grit size 36-60 with a medium rate grade M N or O have proved suitable for sharpening bandsaws. For sharpening bandsaws with blades over 1.6 mm thickness and tooth pitch over 57 mm a suitable wheel would be Carborundum A36 M 4BR or an equivalent. A smaller grit size would be used for thinner gauge saws with less tooth pitch.

For the efficient operation of the automatic bandsaw sharpener and well sharpened saws the following precautions must be observed:

- Make sure the bandsaw blade and teeth are perfectly clean before starting the machine for sharpening. A dirty saw blade will gum up the grinding wheel and cause burnt gullets which will cause cracks. The blade will not feed evenly through the saw clamp and this will result in irregular grinding on the tooth faces and variation in tooth point widths.

- Avoid burnt gullets by not grinding too heavily. Dress the grinding wheel frequently and accurately which will also maintain tooth shape and avoid cracks caused by sharp corners or ridges created in the gullet area. A template fitting the correct

wheel is very useful to make sure the required shape of the wheel is maintained when the grinding wheel is dressed.

- Make sure the grinding wheel speed does not exceed the speed recommended by the manufacturer.

- Make sure the automatic sharpening machine is maintained in good mechanical working order.

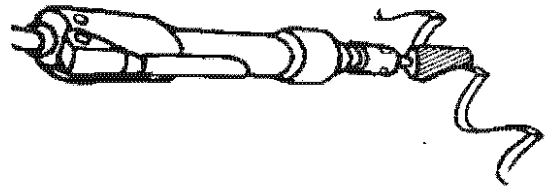
- Make sure the dust extraction unit is working efficiently.

3.4. Some Common Causes of Cracks in Bandsaw Blades

Fig. 6.26 - Improper grinding resulting in burnt gullet areas and/or sharp angles being created.

- Bandsaw blade has too much tension and/or too much crown on back edge.

Grind the gullet with a carbide bur



- Bandsaw blade not properly levelled and/or badly marked with hammer.

- Bandsaw blade has irregular back edge and uneven tension.

- Bandsaw blade running too far forward on bandmill wheels.

- Bandsaw blade being used too long when teeth are dull.

- Bandwheel scrapers allowing gum build up in patches on wheels.

- Shearboard not adjusted properly allowing sawdust and wood slivers to go between the saw and bottom wheel.

- Saw straining device not working freely.

- Saw guides set too tight causing saw blade to heat up and run off from its working position on the wheels.

- Bandsaw blade too thick for bandmill wheel diameter.

- Bandmill wheel faces badly worn and out of true causing vibration. Wheels should be refaced.

4. VARIOUS KINDS OF FAULTS

A correctly tensioned bandsaw blade is one that hugs the pulleys over the whole width with its toothed edge projecting so that the gullets are not more than 5 mm beyond the edge of the pulley rim.

Faulty tensioning or levelling can often be detected by observing the way in which the blade runs over the pulleys (in the case of crowned rims).

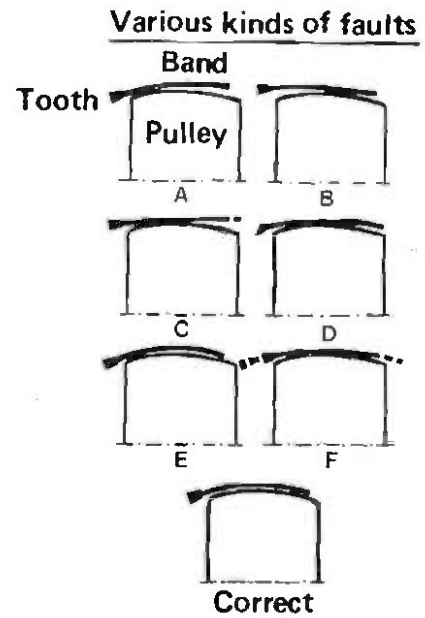
Fig. 6.27 A. The blade runs steadily but projects too far, despite reduced tilt: the back edge is too long - tension the blade near the toothed edge.

B. The blade runs steadily, but too far back, despite maximum tilt: the front edge is too long - tension the back edge.

C. The blade runs unsteadily and shifts under load: too little tension in relation to the crowning, or an incorrect hook angle.

D. The blade runs steadily but makes a wavy cut: the blade is channelled or ground out of square, or has a setting error. (May also be due to machine defect).

E. The blade runs in the right position and saws straight, but develops edge cracks: it is too



heavily tensioned in relation to the crown. May also be due to grinding errors, deposits on the pulleys or poor alignment.

F. The blade shifts rapidly back and forth on the pulleys: poor levelling (uneven back), uneven tensioning or worn pulleys.

The crowning of the pulleys must be checked to ensure that it has not been upset by adhering resin or by wear. There is otherwise a grave risk that the central zone of the band will be overloaded. The pulleys should be reground after a maximum of 5,000 running hours.

CHAPTER 7 - GANGSAWING

1. WHERE AND WHY ARE GANGSAWS USED?

2. THE MACHINE

2.1. Overhang

2.2. Saw Fitting

2.3. Feed

3. THE BLADE

3.1. Thickness

3.2. Tensioning

4. THE TOOTH

4.1. Tooth Shape

4.2. The Chips

5. SUMMARY

GANGSAWING

1. WHERE AND WHY ARE GANGSAWS USED?

Fig. 7.1 The gang saw is used mainly at the larger sawmills in Scandinavia and in Central Europe. It is a very heavy machine, weighing five or six tonnes, and stands two storeys high. Compared with other types of saw it offers the following advantages:

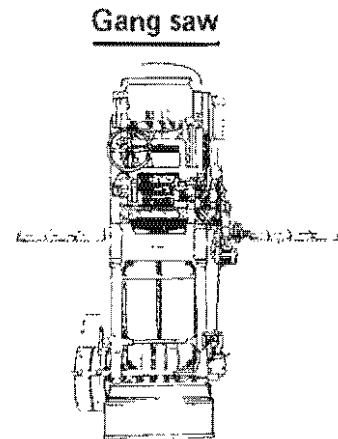


Fig. 7.2 - It makes many cuts at the same time.

- It is capable of high dimensional accuracy.

- Advantages of the gang saw
- Many simultaneous cuts
 - High dimensional accuracy
 - Usable chips

Fig. 7.3 Its disadvantages are as follows:

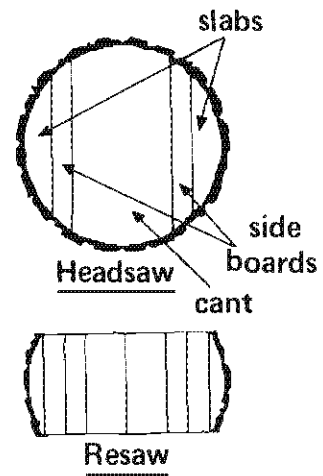
- It requires the sawlogs to be sorted.

- Its noise level is high.

- Disadvantages of the gang saw
- Sorted sawlogs required
 - High noise level
 - Low feed speed
 - Wide kerfs

- It has a low feed speed.
- It makes relatively wide kerfs, entailing a heavy chip loss.

Fig. 7.4 Gangsaws are used for two stages of production. The "headsaw" cuts the log into side boards and a cant, also called a flitch. The "resaw" cuts up the cants, and has a larger number of blades than the headsaw.

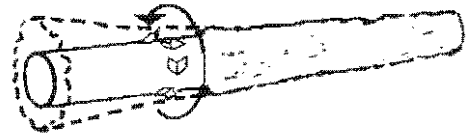


The bulk of the sawing is completed in a single pass through two machines. Thus we get a very compact and efficient line, even though each individual machine is large.

Each size calls for its own particular blade spacing in order to achieve the most economic yield. To avoid the expense of repeated reganging the saw must be supplied throughout a whole run with the same size of sawlog.

Fig. 7.5 Sawing is considerably facilitated if a "root reducer" is used to get rid of root spread.

Round reducing

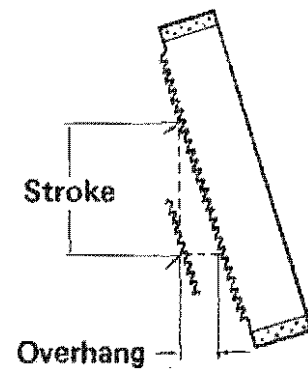


2. THE MACHINE

2.1. Overhang

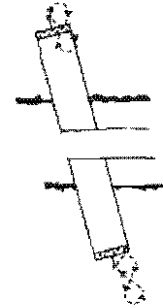
Fig. 7.6 To prevent the back of the teeth from cutting when the frame is on the upstroke, the whole gang of blades is given a forward tilt or "overhang" in relation to the wood. This permits a continuous feed to be used. A recognised standard overhang is equal to half the feed per stroke plus one to two millimetres.

Overhang



The effect of this overhang is that the teeth are not in action at the top of the stroke. Just after the bottom of the stroke, however, the teeth will "backcut" for a short distance. Backcutting puts a heavy load on the teeth and mars the sawn surface,

Fig. 7.7 and a number of designs have been proposed to avoid it. The essential feature of them is that the loose frame is given a small movement in the feed direction at the bottom of the stroke, sometimes at the top as well, so that a given point on the frame describes not a straight line but an elongated figure-of-eight.



Gang saw with non-linear movement of the loose frame

Since the designers have not succeeded in entirely eliminating back-cutting we must ensure that the clearance angle is big enough to prevent the forces acting on the blade and the feed mechanism from becoming too great. It is sound practice to have a clearance angle of at least 25 degree.

Excessive overhang leads to gullet cracks in the upper part of the blade; insufficient overhang leads to cracks in the lower part.

2.2. Ganging

Fig. 7.8 The saw blades are strained in a vertically reciprocating loose frame, which can take up to about ten blades in a single gang.

The distances between the blades are set by means of spacers, for which various materials may be used. Since one of the most important advantages of the gang saw is dimensional accuracy, which permits small tolerances, this facility should be exploited to the full by the use of light-alloy spacers. By virtue of their precision, such spacers admit smaller thickness allowances.

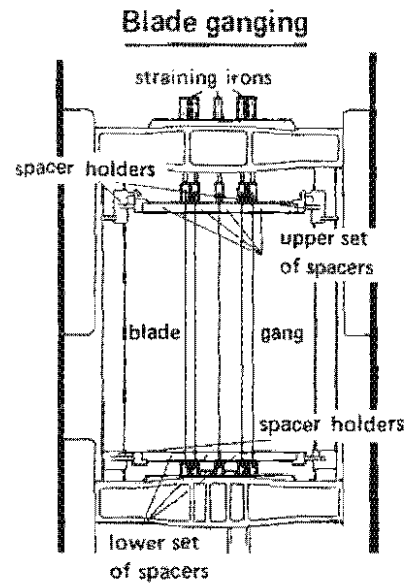
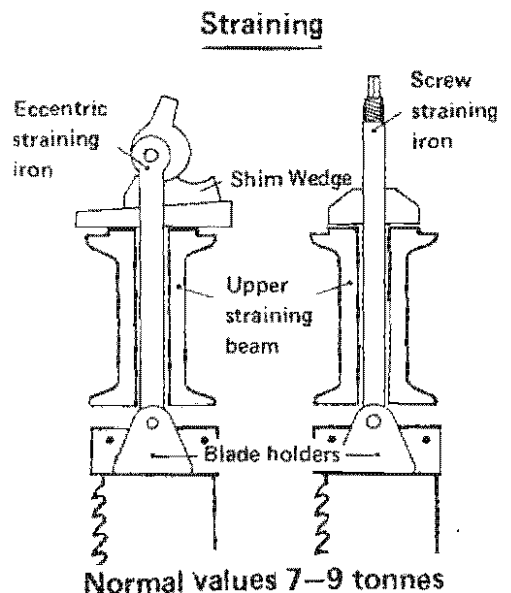


Fig. 7.9 The tension in each blade is set by means of the upper straining iron, which is adjustable by means of a screw or eccentric. To some extent the tension must be suited to the width of the blade. The broader the blade, the greater is the required tension. Normal values are 7-9 tonnes.



2.3 Feed

Fig. 7.10 The state of the feed devices is of the utmost importance for the dimensional accuracy and the life of the blades. Play, vibration, and deposits on the rails that guide the log carriage will tend to impose lateral forces on the blades. Also, the rails of the log carriage must be accurately aligned with the frame.

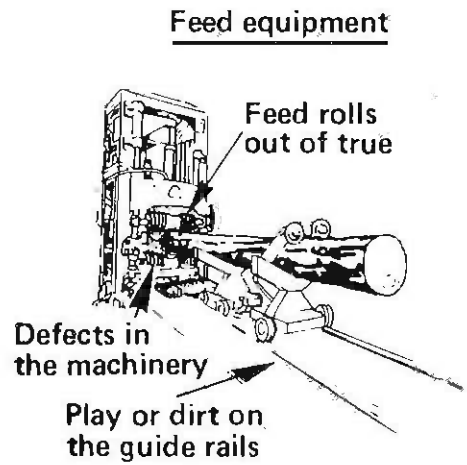


Fig. 7.11 The feed rolls must be properly aligned and set to the correct pressure so as to reduce slippage and impression damage to a minimum. Separate roll drive is the best arrangement. Feed rolls with carbide spikes retain the optimum shape longest and are superior to other types.

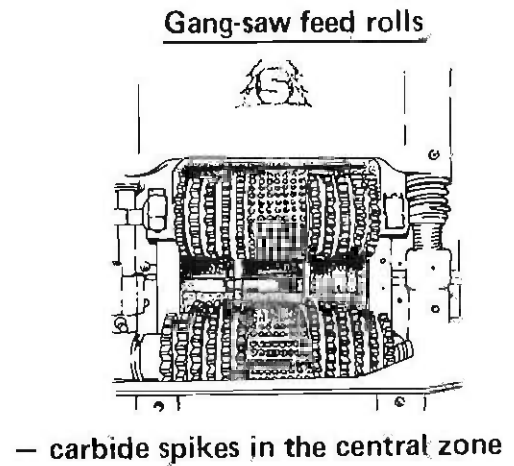
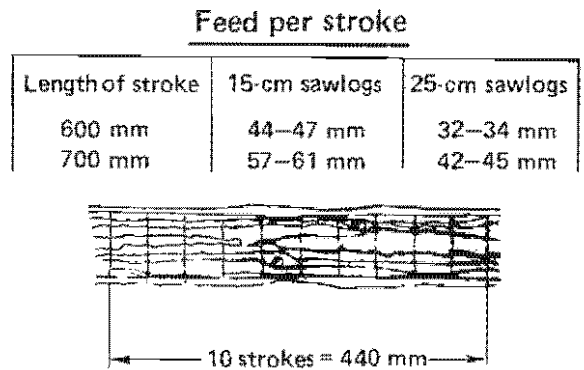


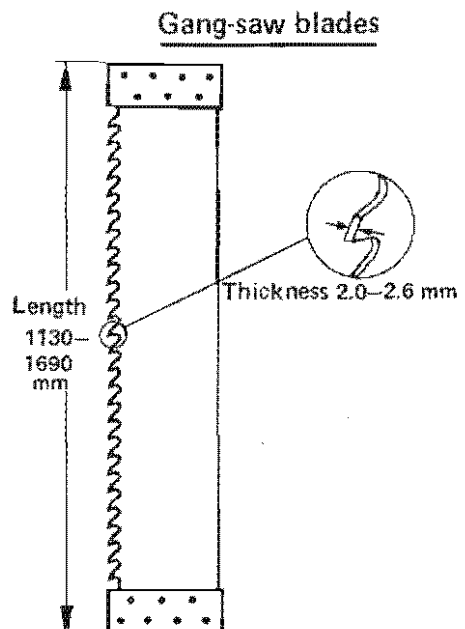
Fig. 7.12 Examples of feed speeds would be 44-47 mm per stroke for 15-cm sawlogs and 32-34 mm per stroke for 25-cm sawlogs (600-mm stroke). If the feed speed is too high this is often revealed by the failure of the blade to cut straight producing instead a "snaky" kerf. These feed speeds would be considerably reduced when sawing high density hardwoods.



3. THE BLADE

3.1. Thickness

Fig. 7.13 The thickness of gang-saw blades is generally 2.0-2.6 mm, while their length is 1130-1690 mm. Thinner blades give thinner kerfs. The disadvantage is that they are more susceptible to overloading and to damage by stones, etc., resulting in faulty sawing. They may also impose a reduction in the feed per stroke.



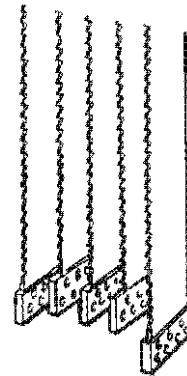
3.2. Tensioning

Fig. 7.14 If the blade is subjected to lateral forces during sawing, e.g. in wood with crooked grain and knots, there is a risk that the blade will twist. To prevent this, its torsional rigidity must be made as large as possible.

Three factors contribute to the torsional rigidity: the width of the blade, the straining force, and the tension. Wide blades are stiffer than narrow ones and should be placed outermost in the gang, where the lateral forces are greatest.

The applied straining force should be high, but it is limited by the strength of the loose frame and of the straining irons to 7-9 tonnes per blade. The third factor - tension - is brought to bear by shifting the

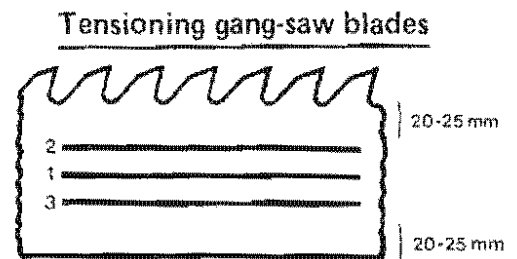
Torsional rigidity



- wide blades are placed outermost
- the tension is limited by the strength of the loose frame and the straining irons
- the tensioning keeps the toothed edge stiff even when it warms up.

tensile force as much as possible to the edges. The toothed edge will then remain stiff even as it warms up during the course of sawing.

Fig. 7.15 Tension is achieved by rolling the middle zone of the blade so as to lengthen it in relation to the edges. The edges will thus come under increased tensile stresses and will thereby be made stiffer. The rolling in the middle of the blade involves from one to five roll passes. The passes must not approach closer than 20-25 mm from the toothed or back edges.



Middle of blade is elongated
Tensile stresses set up in edges

4. THE TOOTH

4.1. Tooth Shape

Normal tooth shapes for swaged gang-saw blades have a 15 degree angle and a 25 degree clearance. Those for spring-set blades,

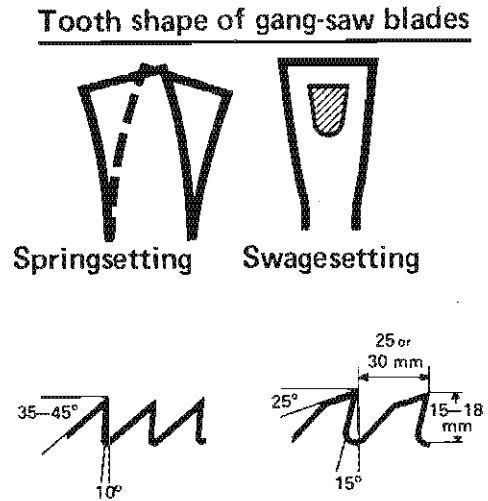
Fig. 7.16 which are used in the smaller sawmills, are given a 10 degree hook angle and a 35-45 degree clearance.

The tooth depth is from 15 to 18 mm, the lower figure being used for high density wood.

The pitch of swaged teeth is for the most part 25 or 30 mm. This means that on a 1300-mm blade, for example, there would be about 40 teeth.

Swage-set teeth give a better sawn surface than spring-set teeth; they also permit a larger pitch and a higher feed speed.

Even though the blade is not flexed it is desirable to have a large radius in the gullet. The gullet must also be properly ground, so as to reduce the risk of cracks, which would be liable to lead to blade breakage.



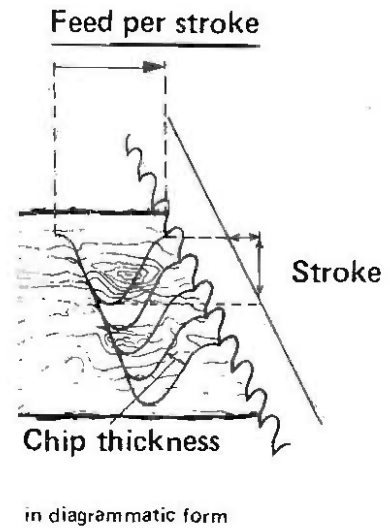
4.2. The Chips

Fig. 7.17 The thickness of the individual chips produced by a gang saw varies at different points of the stroke.

Gang saw chips are a good deal larger than those produced by bandsaws or circular saws, averaging 2-3 mm in thickness as a rule.

They are thinnest at the midpoint of the stroke and thickest at the bottom, where the blade is momentarily stationary while the feed continues.

A good mental image of the variation in chip thickness can be obtained by imagining that each tooth is provided with a pen that traces the movement of the tooth on the sawn surface.



The formula for calculating chip thickness is

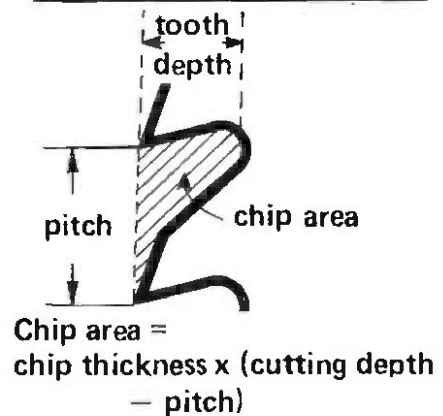
$$\frac{\text{feed per stroke}}{\text{stroke}} \times \text{tooth pitch}$$

If for example we know that the feed per stroke is 42 mm, that the stroke of the frame is 600 mm and that the pitch is 25 mm, we can then calculate that the chips will be 1.75 mm thick.

$$\left(\frac{42 \text{ mm}}{600 \text{ mm}} \times 25 \text{ mm} = 1.75 \text{ mm} \right)$$

Fig. 7.18 The chip volume that has to be packed into a gullet is, in terms of solid measure, the chip thickness x (cutting depth - pitch), since the chip will already have begun to leave the gullet by the time the preceding tooth has left the kerf. If we have the aforementioned chip thickness of 1.75 mm, and if we know that the cutting depth is

Chip area of gang-saw blades



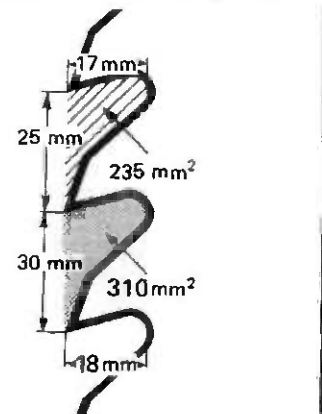
175 mm, then we shall have a chip area of 260 sq.mm (the pitch being unchanged at 25 mm). A heavy feed force is required to compress the chips. Overloading due to too high a feed force or to an incorrect overhang shows up in the form of gullet cracks in the upper part of the blade and by the fact that the chips "burst" forth when the gullet opens at the exit from the kerf.

The consequence of excessive feed, and the compression of the chips which it entails, is wavy sawing. An excess of chip space should therefore be preferred.

Fig. 7.19 Chip space for some common tooth shapes:

	<u>pitch</u>	<u>depth</u>	<u>chip area</u>
swage	25 mm	17 mm	235 sq.mm
	30 mm	18 mm	310 sq.mm

Chip space
Two common swaged teeth

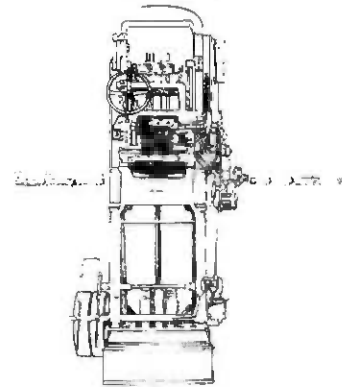


5. SUMMARY

Fig. 7.20 Gangsawing comes into its own when you are able to work on the same size of sawlog throughout a run. Its compactness, moreover, means that relatively small premises will suffice.

Although the previous information relates mainly to softwood species, gangsaws are also used very successfully on high density hardwoods in developing countries. The feed speeds are appreciably less than those quoted in Fig. 7.12 and the gangsaws are often used in conjunction with bandmills which produce cants from large logs for resawing. The quality of the sawn timber produced from these cants is invariably much higher from the gangsaws than would be achieved through other machines.

Gang saw



- same size of sawlog throughout a run
- small space requirements
- easily handled blades
- limited feed speed

The blades used in gangsawing are easier to handle than bandsaw blades, but if single cuts are wanted the feed speed is limited.

CHAPTER 8 - MAINTENANCE OF GANGSAW BLADES

1. THE MACHINE
 - 1.1. Overhang
 - 1.2. The Distance Between the Blades
 - 1.3. Alignment
 - 1.4. Outermost Blades Advanced
 - 1.5. Straining Force

2. THE BLADE
 - 2.1. Tensioning
 - 2.2. Levelling and Checking
 - 2.3. Clamping Tabs

3. THE TEETH
 - 3.1. Spring-setting
 - 3.2. Swage-setting
 - 3.3. Tooth-point Hardening
 - 3.4. Grinding
 - 3.5. Retooling

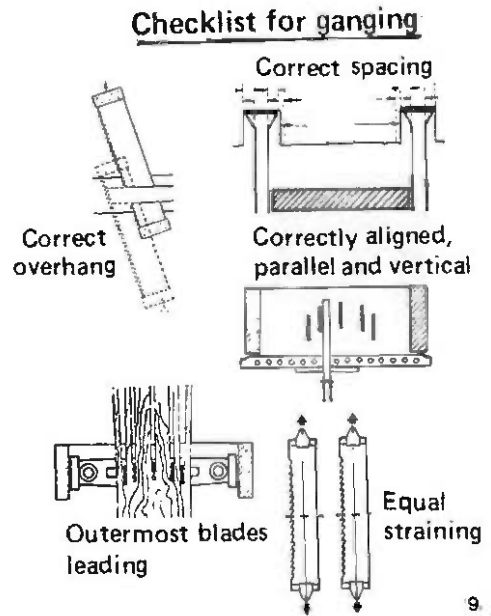
4. FAULT TRACING

MAINTENANCE OF GANGSAW BLADES

1. THE MACHINE

Fig. 8.1 In the work of ganging the blades in the loose frame it is of the utmost importance to get the following points right:

- The blades must have the right overhang (= forward tilt).
- The distance between the blades must be in accordance with the spacing diagram.
- The blades must be exactly in line with the feed and exactly vertical in the frame.
- The outermost blades must be somewhat farther forward than the rest of the gang.
- The blades must be strained equally in the frame.



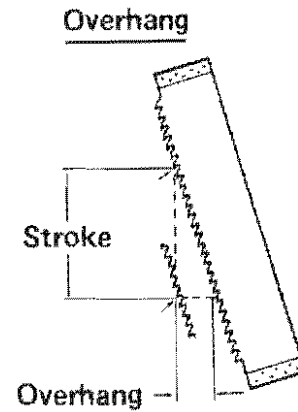
1.1. Overhang

Fig. 8.2 Most gangsaws have a continuous feed. To prevent the blade from cutting into the workpiece during the upward movement it is given a forward tilt.

With present-day machine designs however, we cannot entirely prevent the flanks of the teeth from cutting on the upstroke as well.

Back-cutting is avoided in machines with intermittent feed and a low feed per stroke, since the workpiece is stationary while the loose frame is on its upstroke.

The size of the overhang is measured in relation to the stroke of the frame, i.e. we take the difference in the position of the tooth line at the top and bottom of the stroke. A plumb-



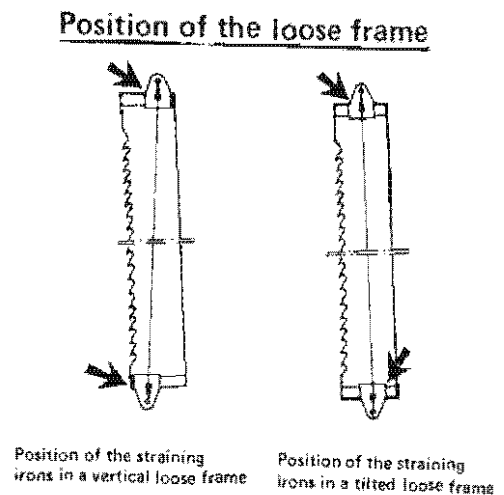
board or spirit-level is used for setting the overhang. It is necessary for the frame to be absolutely vertical. Any deviation would mean that the inclination of the blade to the work-piece would not be as intended, rendering it necessary to effect corrections.

The size of the overhang is determined by the feed per stroke. In practice, the overhang is put at a figure equal to half the feed per stroke plus 1-2 mm. This corresponds to 52-56% of the feed per stroke. For example, if we are going to saw 25-cm logs in a machine with a 600-mm stroke and feed of 32 mm per stroke, then the overhang should be about 17 mm $(1/2 \times 32 + 1)$.

The instructions given for the saw set-up will include the feed per stroke and the overhang of the blades. If the input logs are of high density the figures are often reduced by 10-15%. In our example we should therefore switch to an overhang of about 15 mm., when cutting high density logs.

Fig. 8.3 The need to give the blade an overhang might mean that its toothed edge would not be sufficiently stiff towards the top. This disadvantage can to some extent be neutralised by giving the loose frame a tilt. The tilt is produced by repositioning the blocks of the system so as to shift the adjustable guide system of the loose frame.

Giving the loose frame a tilt is a tricky operation. It is therefore made from the beginning with a tilt which corresponds to the



average need of overhang. The sawyer then gives the blades the exact desired inclination to the workpiece by setting them at a slight angle to the loose frame.

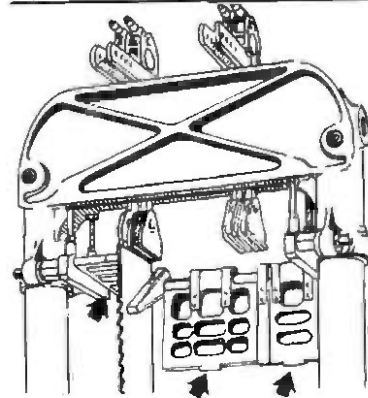
If 32 mm is the average feed per stroke, then the loose frame must be tilted $1/2 \times 32 + 1$ mm, i.e. 17 mm. If the feed is put at 34 mm per stroke for another production run then the overhang is adjusted by tilting the blades (not the frame) another 1 mm.

Since the loose frame has a tilt the upper straining beam will be farther ahead than the lower one. The upper straining irons will be nearer to the toothed line of the blades. In this way we secure the desired stiffness, which the overhang would otherwise operate against.

1.2. The Distance Between the Blades

Fig. 8.4 Spacers are used for adjusting the distances between blades and rendering them parallel. Spacers can be made of wood, plywood or light alloy. They are fitted in between the blades next to the straining irons. To ensure that the distances between blades will be exact, the spacers must be plane-parallel to within 0.1 mm and the blades must be completely flat next to the clamping tabs.

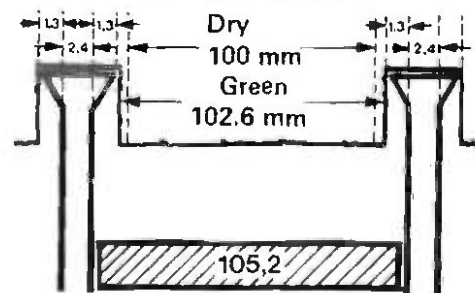
Spacers for gang-saw blades



- flatness and parallism must be accurate to 0.1 mm
- the blades must be flat next to the clamping tabs.

Fig. 8.5 The width of the spacers is determined by the desired width of the sawn timber, with additions to cover twice the setting width, the vibration of the blades and the drying allowance. For example, if we are going to saw a width of 100 mm then the size of the spacers must be 100 (desired thickness) + 2.6 (twice with setting width) + 2.6 (vibra-

Width of spacers



tion and drying allowance). The better the blade maintenance, the smaller the spacers can be made, with raw-material savings in consequence.

1.3. Alignment

Fig. 8.6 It is necessary to check that the blades are exactly in line with the feed. This is done by laying a ganging rule at an angle to the blades. If alignment is at fault the results will be wavy sawing and heavier stresses on the blades.

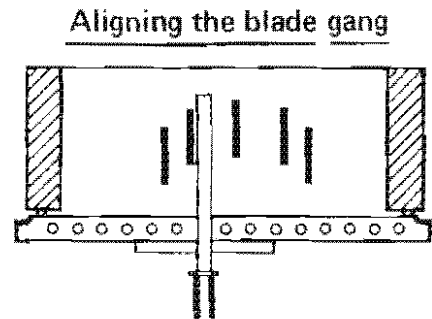
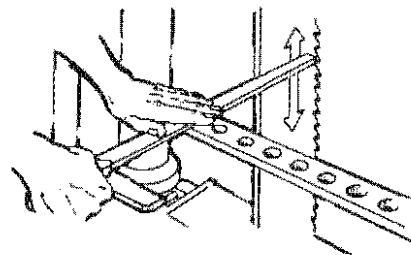


Fig. 8.7 In addition, the blades must be vertical. This is checked by running the loose frame slowly up and down with the blades touching a ganging rule. If the blades are not vertical the spacers will have to be repositioned.

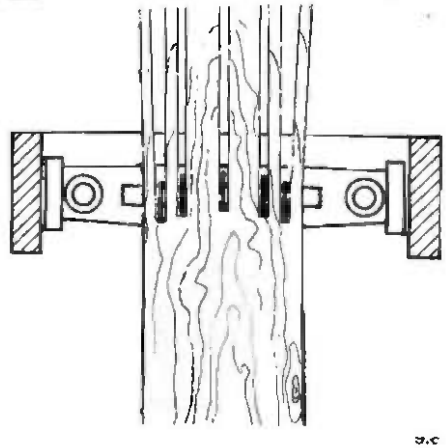
Truing the blade gang to the vertical



1.4. Outermost Blades Advanced

Fig. 8.8 As the log leaves the machine it is supposed to fall apart in such a way that the slabs drop off first, followed by the side boards, and lastly the cant. This is achieved by positioning the outermost blades somewhat in advance of the others. It may therefore be necessary to use the widest blades in the end positions and those that are most heavily ground down in the centre.

Positioning of saw blades in frame



1.5. Straining Force

Fig. 8.9 The straining force in the blades is controlled by means of the upper straining iron, which may be of screw or cam type. On the former type we use a torque wrench and on the latter a socket wrench and a slotted insert, which facilitate correct and uniform straining. Each blade should be under a straining force of between 7 and 9 tonnes.

Mounting blades with straining irons

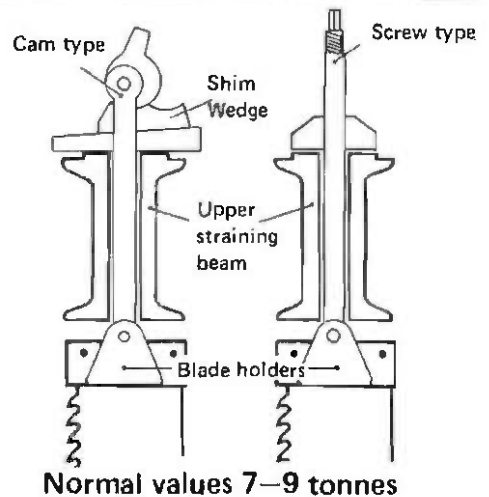


Fig. 8.10 It is neither desirable nor possible to have a completely rigid loose frame. The straining beams and sideposts of the frame will therefore flex increasingly as more and more blades are strained in. The flexure is greatest at their midpoints. In mounting the blades the middle ones should be strained last; in removal they should be taken out first.

Failure to observe this point will result in the overloading of the midmost blade and damage to the clamping tabs or rivets. If the socket wrench is lengthened, e.g. with a piece of pipe, the straining force can easily be overdone and the same kind of damage will be done. In both cases, too, there is a risk of cracking the blade.

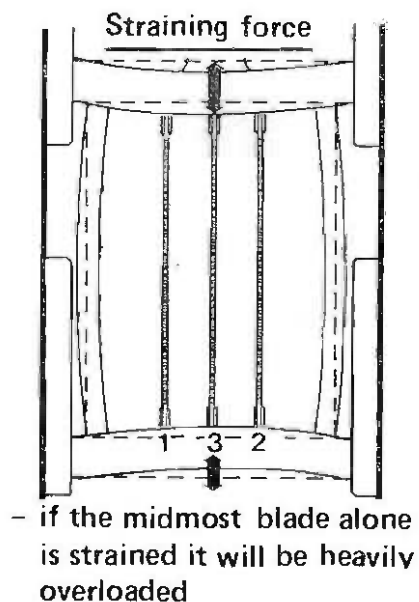
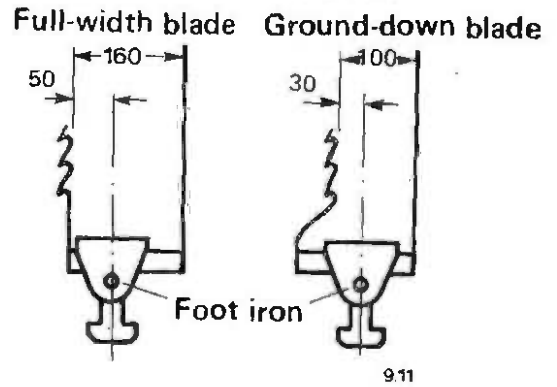


Fig. 9.11 Insofar as is possible the straining force should act parallel to the blade and on a line one-third of the remaining width of the blade from its front edge. The size of the overhang will decide the degree to which the straining force can be made parallel in the blade.

Position of the gang-saw blades in the straining irons

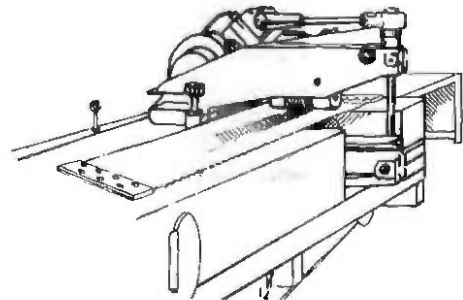


2. BLADE

2.1. Tensioning

Fig. 8.12 As gangsawing proceeds, the blade warms up along its front edge, which thus grows longer. It would then lose stiffness and be more liable to make a crooked cut were it not for the fact that it has been "tensioned", whereby the central zone of the blade is made longer than the edges. Thus the straining forces are carried mainly by the front and back edges of the blade. To maintain

Tensioning gang-saw blades

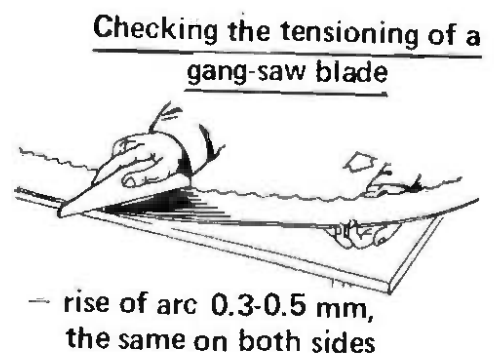


— tensioning keeps the edges of the blade stiff despite heating-up

a taut tooth edge the back edge must also be made longer and is crowned by rolling as with a bandsaw.

Tensioning is effected by rolling the zone nearest the centre of the blade. New blades are given from one to five roll passes over their full length, a few centimetres apart. Used blades are given as many roll passes as the need dictates. No passes should be made less than about 20 cm from the gullets.

Fig. 8.13 To check the tensioning of a blade it is first laid on a bench. It is then lifted at one end so that it hangs freely, supported by the hand at one end and the bench at the other. Under its own weight the blade will flex downwards and transversely. If it is correctly tensioned the blade will develop a hollow along its length.



This concavity is measured with the aid of a straightedge which is laid at right angles across the width of the blade. No pressure should be applied to the straightedge. The daylight that appears between the straightedge and the blade indicates the degree of tensioning. It can be checked by using some kind of wedge-shaped gauge which is inserted between the straightedge and the blade.

The rise of arc of the daylight gap should be around 0.3-0.5 mm, and it should be the same on both sides. Failing this, it is probable that the blade has permanent channelling, which should be beaten out with a levelling hammer.

2.2. Levelling and Checking

Fig. 8.14 Gangsaw blades require the same systematic maintenance procedure after each run as given to bandsaws which is:

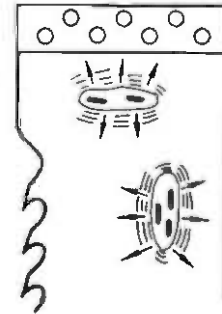
- Thoroughly clean the blade.

- Check the blade on both sides with a straight edge for lumps both lengthways and crossways. This must be done with the saw lying flat on a levelling block which has a true machined flat surface.

- Lightly hammer as necessary to make the blade perfectly level.

- Check the back edge of the blade with the appropriate back gauge for convexity or crown which is necessary to ensure the tooth edge remains taut after heat expansion when working (usually reckoned at 1 mm per 1000mm of saw length).

Straightening and levelling



- the tensioning must be restored

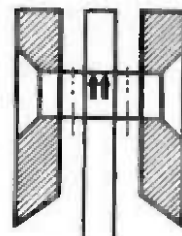
- Roll the blade as required to adjust the back edge if necessary and keep the correct tension in the blade.

- After rolling if this has been necessary recheck the blade for being level.

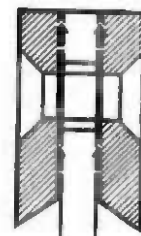
2.3. Clamping Tabs

Fig. 8.15 The clamping tabs must be firmly riveted to the blade, without any gap between them. The straining force must not be transmitted as a shear force on the rivets; the rivets must hold the clamping tabs on so tight that the friction can transmit the straining force. If the blade has been overloaded so that the rivets have necked down, the rivets must be changed. The rivets should be made of hardened and tempered steel.

Clamping tabs of gang-saw blades



Poorly riveted:
the rivets take
the load and
may be sheared
off



Tightly riveted:
the friction
takes the
load

Fig.8.16 The clamping tabs must also be checked to ensure that they are equal in width, so that the whole straining force is transmitted equally on both sides. Otherwise an excessive tension would be thrown on one clamping tab, causing it to fail before long.

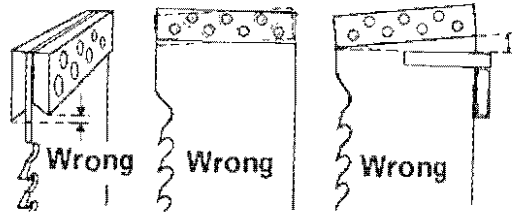
When changing saws, all hammering on the ends of the clamping tabs should be done with caution. Treating them too roughly may cause them to part from the blade, rendering it necessary to replace the tabs or re-head the rivets.

3. THE TEETH

3.1. Spring-setting

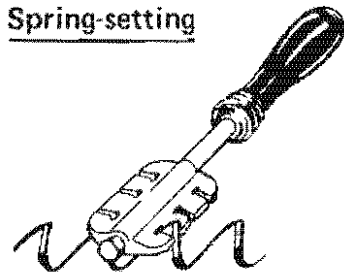
Fig. 8.17 Spring-setting used to be the commonest way of making the width of the kerf greater than the blade thickness and thereby avoiding unwanted friction between blade and wood.

Positioning of clamping tabs



2.16

Spring-setting



- normal set 0.55-0.75 mm per side
- only the tip of the tooth must be bent

Nowadays, spring-setting is met with only in the smaller sawmills, and it gives poorer dimensional accuracy. This follows from the fact that each sawn surface is worked only by alternate teeth.

The job is done using a saw set or in a setting machine. Only the very tip of the tooth should be bent; this ensures a more durable set.

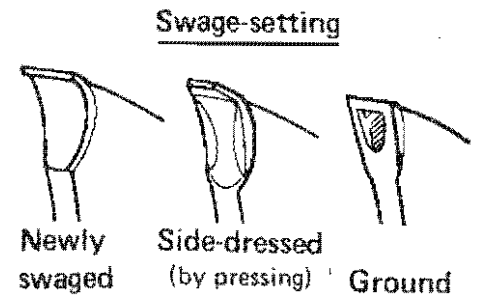
Normally, the set is about 0.55-0.75 mm per side. Variations are called for by the consistency of the wood. Low values are used on high density hardwoods; higher ones on soft and fibrous woods. The set should be restored after each regrinding.

3.2. Swage-setting

Fig. 8.18 Swaging of the teeth leaves them wholly symmetrical, and the influence of the lateral forces will be less in evidence during sawing. Since every tooth works both sawn surfaces it will "track" better in the kerf, giving better dimensional accuracy than spring-set blades.

The swaging operation is in most cases carried out in modern swaging machines. It begins with a check to see that the teeth have not been bent outwards.

Next, the chip face and flank of the tooth are smeared with grease of similar lubricant. This prevents damage to the swage bar and avoids the hazard of tearing the saw steel.



- check that the teeth are not bent out
- lubricate the chip face and flank of the tooth
- swaging width 0.9-1.0 mm on each side

As the swage bar is slowly twisted against the chip face of the tooth, the tooth point is made to spread. The following operation of side-dressing presses the swaged-out metal back. After that, the outermost tips of the tooth should be 0.9-1.0 mm beyond the sides of the blade. The resulting kerf will be wide enough to prevent friction between the blade and the wood. The swaged width normally lasts for from three to five regrindings. When it has fallen to 0.7 mm the swaging operation must be repeated.

Fig. 8.19 Swaging produces an increase in hardness in the tooth point and thus gives better wear resistance, the improvement being up to 7 Rockwell C. The hardness then declines each time the blade is ground down.

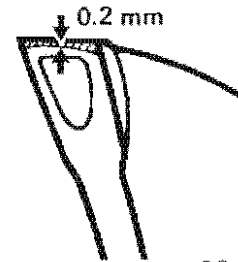
Hardness increase in Rockwell C units



3.3. Tooth-point Hardening

Fig. 8.20 A further increase in hardness may be brought about by induction hardening (high-frequency hardening) of the tooth points in automatic machines. This operation is repeated each time the blade is sharpened.

Tooth-point hardening



Only a small part of the tooth (0.2 mm) is heated to beyond the hardening temperature. Beneath the hardened layer there is an annealed layer. The difficulty in tooth-point hardening is to make the hardened layer thick enough not to be worn through before the sawing run is over, but thin enough not to interfere with the next swaging operation.

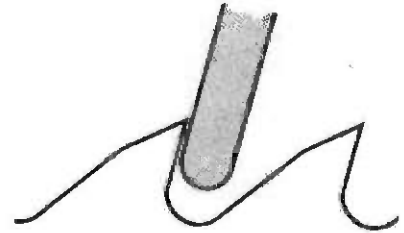
The same effect is produced by hot-swaging, though no great experience of this method has yet been accumulated.

3.4. Grinding

Fig. 8.21 When the saw blades have become dull, through wear or through running into sand or foreign objects, they must be resharpened. With normal wear this point is reached after three or four hours' sawing. The regrinding is carried out in an automatic machine, without any liquid coolant. The thickness of the grinding wheels must be about one-third of the pitch. They must be of suitable grain size and hardness. If the wheels are too hard they can easily burn the ground surface, while if they are too coarse they give unwanted grinding scratches. In both cases the effect is to increase the risk of cracking in the gullets.

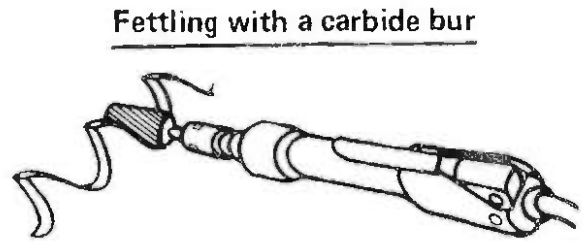
The gullets must be well rounded. A uniform tooth profile should be aimed at.

Grinding



- thickness 1/3 of the pitch
- the grinding wheel must not be too hard or too coarsegrained
- the tooth profile must be uniform

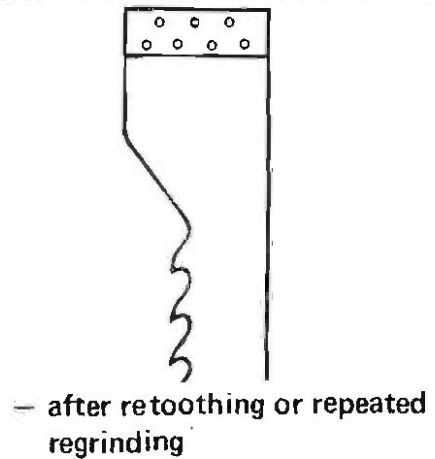
Fig. 8.22 Subsequent fettling with a carbide bur removes all coarse grinding scratches or emery-hardened metal from the gullets. Fettling reduces the risk of cracking, and it can be recommended as an after treatment.



3.5. Retooling

Fig. 8.23 Following a tooth breakage it may be worth while to retool the blade in an ordinary eccentric-shaft press - a press of simpler design will also do - if the blade is not too narrow. After retooling, the teeth of the blade must be ground to the correct shape before any further treatment. Levelling and renewal of tensioning should also be carried out.

Angle-grinding of a gang-saw blade



9.23

After retooling or repeated regrinding it is also good

practice to cut back or grind off the ends of the blade to an angle. This prevents dangerous concentrations of load in the outermost gullets while at the same time making the blade less trouble to regrind in automatic machines.

4. FAULT TRACING

Fig. 8.24 Tooth breakage

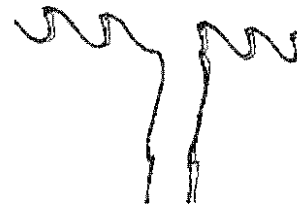
- Foreign bodies in the wood
- Incorrect overhang
- Pitch too small
- Emery-hardening
- Over feeding

Fault tracing gang-saw blades



Tooth breakage:

- Foreign bodies in the wood
- Incorrect overhang
- Pitch too small
- Emery-hardening



Blade/angle-iron breakage:

- Incorrect overhang
- Wrong working order in ganging
- Emery-hardening
- Straining too tight

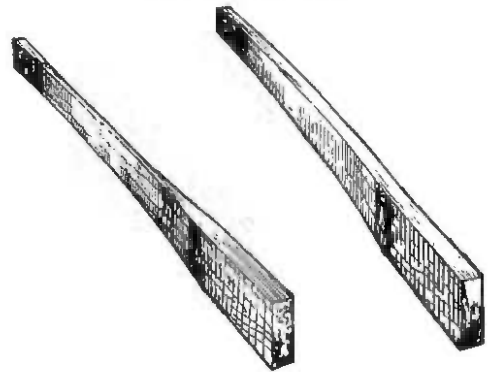
Blade breakage and angle-iron
breakage

- Incorrect overhang
- Wrong working order in ganging
- Emery-Hardening
- Hook Angle too small
- Straining too tight
- Over feeding

Fig. 8.25 Wavy sawing (uneven Thickness)

- Insufficient blade tensioning
- Poor sharpness
- Blades not vertical
- Worn spacers
- Crooked swaging and/or crooked grinding

Fault tracing gang-saw blades



Uneven thickness:

- Insufficient blade tensioning
- Poor sharpness
- Blades not vertical
- Worn spacers
- Crooked swaging and/or crooked grinding
- Straining too loose

Long crookedness:

- Faulty infeed

Poor surfaces:

- Insufficient overhang
- Pitch too large
- Poorly straightened blades
- Uneven setting

- Straining too loose

- Over feeding

Long crookedness

- Faulty infeed (log carriage)

Rapid wear

- Insufficient overhang

Poor surfaces

- Insufficient overhang

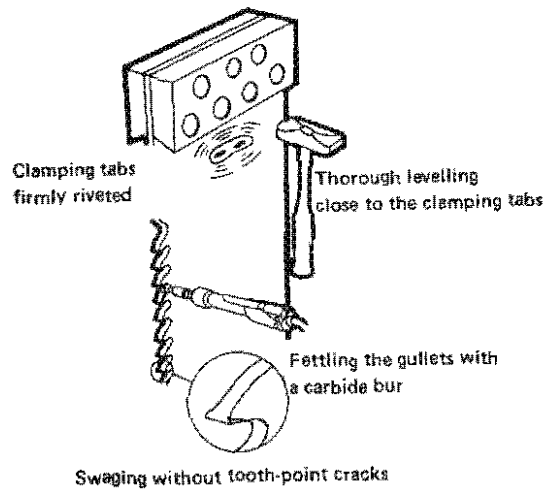
- Pitch too large

- Poorly straightened blades

- Uneven setting

- Over feeding

Summary maintenance of gang-saw blades:



High quality blade + high quality maintenance offers:
- High dimensional accuracy → raw material earnings
- Reduced number of stoppages
- Small blade consumption
- Simplified saw shop work

CHAPTER 9 - CIRCULAR SAWING

1. WHERE AND WHY ARE CIRCULAR SAWS USED?
2. RIPSAWING
 - 2.1. Sawlogs into Flitches and Planks
 - 2.2. Chipper Canters and Multi-bladed Saws
 - 2.3. Cleaver
 - 2.4. Guided Circular Saws
3. THE BLADE BODY
 - 3.1. Thickness and Taper-grinding
 - 3.2. Thicknesses
 - 3.3. Flutter
 - 3.4. Tensioning
 - 3.5. Howling Blades
4. THE TOOTH
 - 4.1. Inserted Teeth
 - 4.2. Tooth Shapes for Ripsawing
 - 4.3. The Tooth Point in Ripsawing

- 4.3. The Tooth Point in Ripsawing
 - 4.3.1. Spring-setting
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 - 4.3.3. Carbide Tipping
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- 4.4. The Tooth Shape for Cross-cutting
- 4.5. The Tooth Shape for Edging
- 4.6. Heating Up During Operation

CIRCULAR SAWING

1. WHERE AND WHY ARE CIRCULAR SAWS USED?

FIG. 9.1 Circular saws are used for most sawmilling operations and are more versatile than other types of saws.

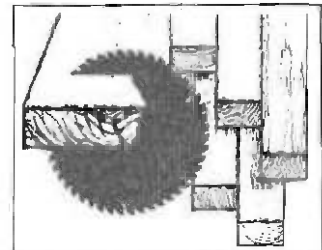
Rapid technical development is now taking place. It may be expected that in due course circular saws will gain ground in areas where gangsaws are used today.

Fig. 9.2 The foremost advantages of circular saws are as follows:

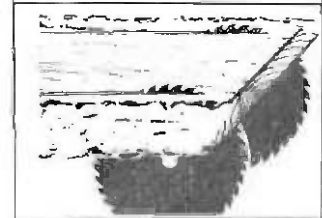
- The machine is cheap in first cost and in maintenance.
- It takes up little space.
- It can readily be incorporated into larger systems - trimmers, chipper canter, etc.

Circular sawing for

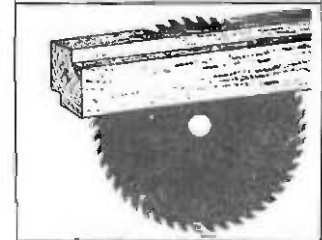
Cross-cutting



Edging



Ripsawing



Advantages of the circular saw

- cheap in first cost and maintenance
- requires little space
- fits readily into larger systems

Fig. 9.3 Some of its disadvantages are as follows:

- Thicker kerfs than other types of saw in the case of larger sizes.
- Susceptibility to heat and to overloading.
- Sub-standard dimensional accuracy in some kinds of rip-sawing.

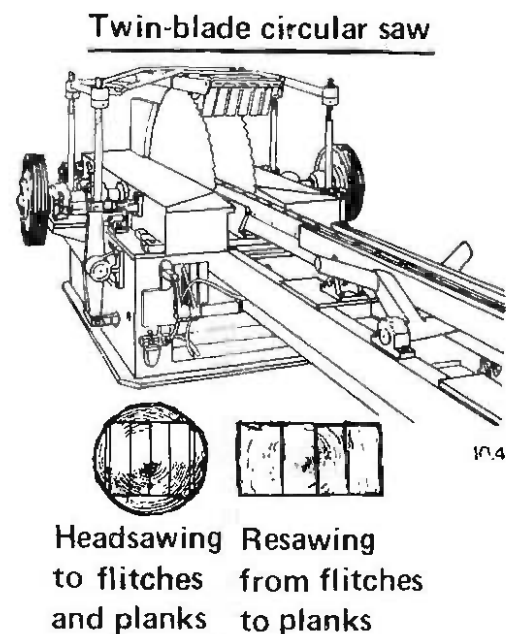
Disadvantages of the circular saw

- thicker kerfs than other types of saw in the case of large sizes
- susceptibility to heat and overloading
- sub-standard dimensional accuracy in some kinds of rip-sawing

2. RIPSAWING

2.1. Sawlogs into Flitches and Planks

Fig. 9.4 For the sawing of logs into flitches and planks, circular saws are used, particularly in the smaller sawmills and where the input consists of unsorted logs in various sizes. Such saws are made with one blade and with a reciprocating saw table, or with two blades for cant-sawing in a single operation. Resawing



to flitches and planks is carried out in similar machines, often with up to three blades. Inserted tooth saws are commonly used in these operations. See 4.1.

2.2. Chipper Canters and Multi-Bladed Saws

Fig. 9.5 Among other current uses for ripsawing circular saws we may mention the ripsawing of cants directly following chipper canters processing small-size logs.

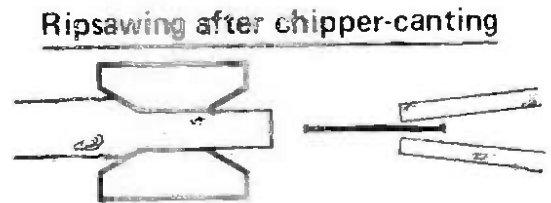


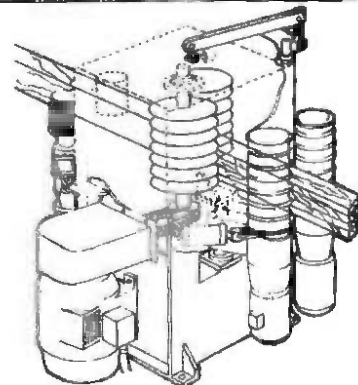
Fig. 9.6 Multi-bladed saws with a horizontal shaft are becoming more common since they can be used in continuous-flow production lines.

Multi-bladed saws with horizontal shaft



Fig. 9.7 Sawmills on the main body of the European Continent and in North America also use multi-bladed saws with vertical shafts. In such machines cants are resawn just as they emerge from the headsaw, without being turned onto their sides.

Multi-bladed saw with vertical shaft

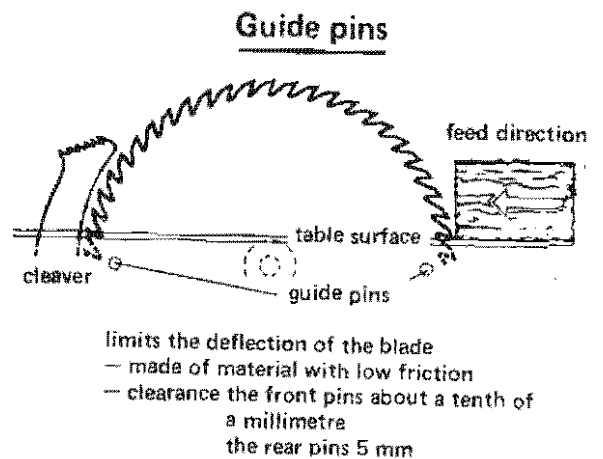
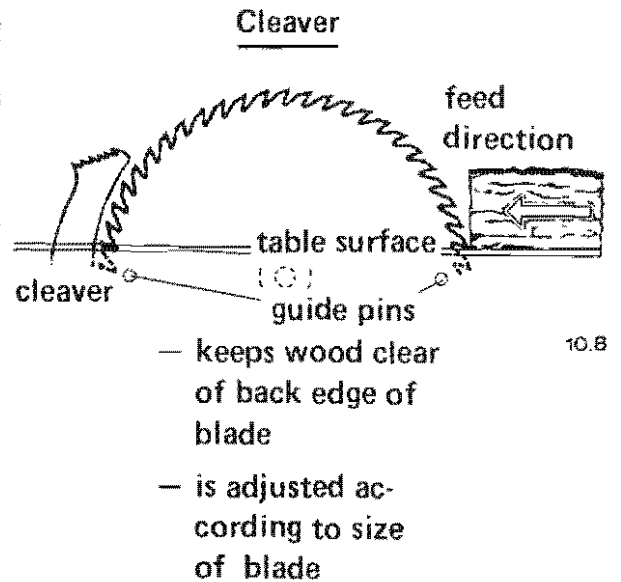


2.3. Cleaver

Fig. 9.8 All rip sawing requires the use of a cleaver, which keeps the wood out of contact with the teeth on the back edge of the blade. This is a safety requirement, to prevent the wood from being lifted or thrown back at the sawyer. It also results in better sawn surfaces.

The adjustment of the cleaver will depend on the type of saw blade in use and on the thickness of the piece of wood which it saws off. It must be adjusted according to the size of the blade.

Fig. 9.9 Rip saws must be fitted with guide pins. These pins are sited beneath the blade and as close to the tooth line as possible. They may be made of horn, lignum vitae, graphitic plastic or some other material with low friction.

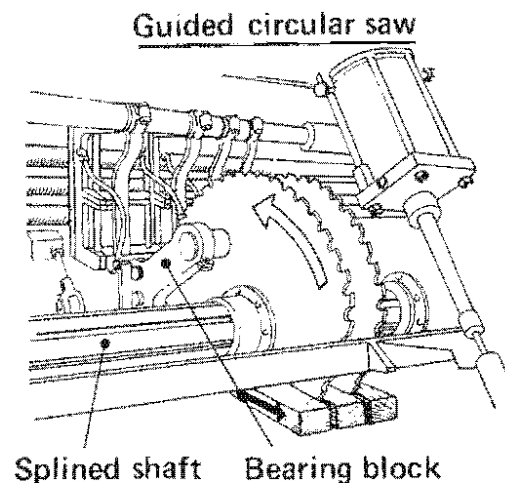


Their purpose is to limit the deflection of the blade if it should begin to vibrate or saw out of line. The front guide pins should have a clearance of about a tenth of a millimetre. The rear guide pins can have a 5-mm clearance and are there for safety reasons.

2.4. Guided Circular Saws

Fig. 9.10 A further advance along this line of development is represented by the guided circular saws. Instead of guide pins they have bearing blocks with large contact surfaces and they employ injection of air or water-mist.

The whole of the lateral force is taken up by the blocks, and the centre of the blade is made so that it can slide freely on the splined shaft. In a machine with several blades mounted on a common shaft the size of the output timber can be changed by shifting the guide blocks, without the need to stop the saw.

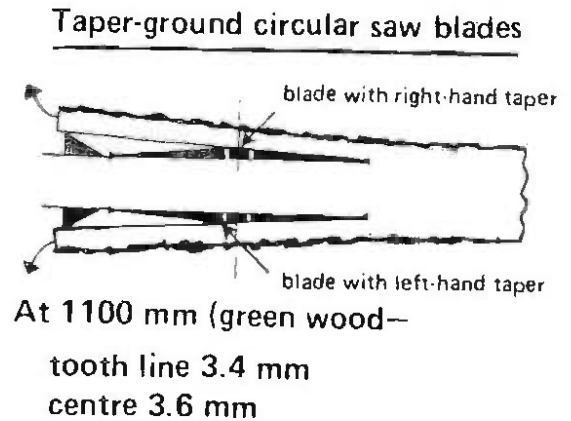


3. THE BLADE BODY

3.1. Thickness and Taper-grinding

Fig. 9.11 The thickness of circular saw blades is standardised on the basis of what experience has shown to be necessary for steady running. In sizes up to 500 mm they are thinner than gang saw blades; larger diameters are thicker.

To reduce the wood loss in the kerf, taper-ground blades are used in certain cases. This applies particularly in the rip sawing of dry timber to small sizes, where board sawn off is thin enough to permit bending aside so as not to rub against the thicker parts of the saw. Tapered blades may be single-tapered, with one flat side, or double-tapered. The latter are used for centre-line rip sawing. In rip sawing green wood a minor degree of taper may be useful in easily sawn timber.



3.2. Thicknesses

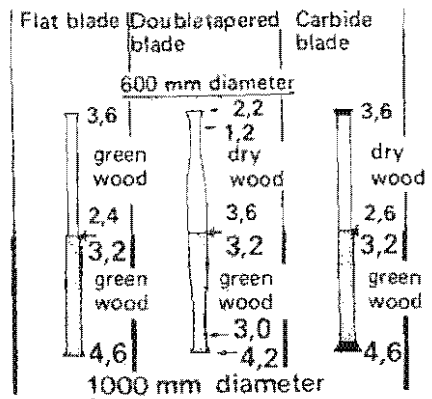
Fig. 9.12 In normal use, blades of 600 mm diameter usually have roughly the following minimum thicknesses:

- Flat blade - body 2.4, across spring - or swage-set 3.6 mm.
- Double-tapered dry-ripsawing blade - centre 3.6, body at teeth 1.0, across spring-set 1.8 mm.
- Carbide blade - body 3.5, tooth 4.5 mm.

1000 mm diameter:

- Flat blade - body 3.2, across spring - or swage-set 4.6 mm.
- Double-tapered ripsawing blade - centre 4.5, body at teeth 1.2, across spring-set 2.2 mm.
- Carbide blade - body 4.0, tooth 5.5 mm.

Ripsawing



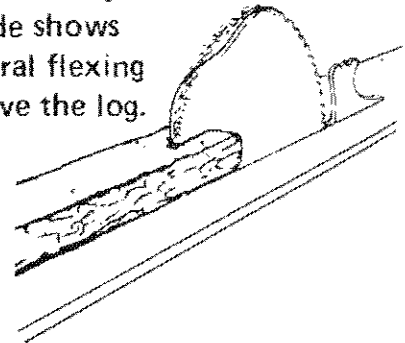
3.3. Flutter

Fig. 9.13 Circular saw blades have a limiting speed of revolution at which they completely lose their stiffness. The closer we approach this critical speed, the lower the stiffness becomes and the greater the tendency to wavy sawing.

This corresponds in the case of bandsaw blades to the limiting speed at which the feed force causes the band to buckle.

A normal production r.p.m. gives a peripheral speed around 50 m/sec. for ordinary blades. Carbide blades give 70-75 m/sec. The blades are dimensioned (tensioned) so that the flutter limit lies 40-50% above these levels.

A fluttering blade shows lateral flexing above the log.



A way of explaining this phenomenon is that the impulse from a lateral force on the blade in the kerf spreads over the blade in two wave motions. They follow the circumference, one in the same direction as the rotation, the other in the opposite direction.

These waves have the same velocity and the same impulse. Now if the saw is rotating almost as fast as the waves are traveling, the wave moving opposite to the rotation cannot get clear. Instead, it remains standing next to the kerf, and merely gets bigger and bigger as it receives further impulses from the lateral forces. Flutter, it will be seen, is not due to centrifugal force.

Thus in order to improve the stiffness and reduce the risk of flutter we must increase the speed at which the flexural waves travel.

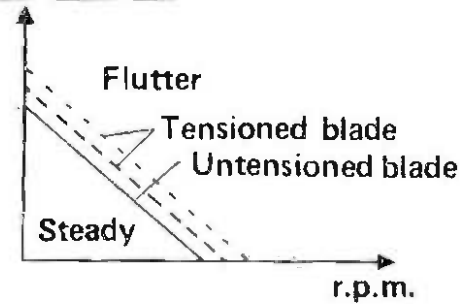
Fig. 9.14 This can be done by tensioning the blade so as to set up tensile stresses at the circumference where the flexural waves travel.

The tensile stresses greatly increase the velocity of the flexural wave. This calls to mind the way in which we alter the rate of vibration of the strings on a guitar by varying their tension. The tensile stresses in the blade must not be made too great, since this would cause it to become hollow, dished or saucershaped.

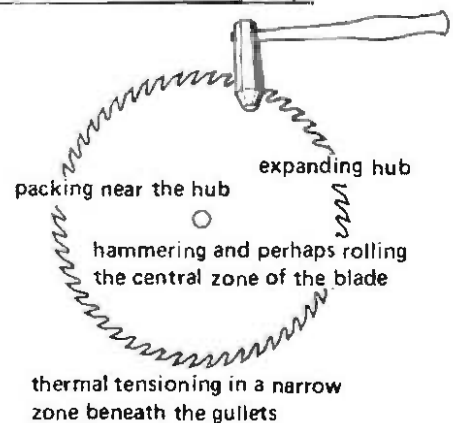
3.4. Tensioning

Fig. 9.15 The usual method of creating tensile stresses at the circumference of a blade is to place it on an anvil and hammer the central zone so that it stretches the metal and increases the diameter. However the design and

Overtemperature at the circumference



Tensile stresses at the circumference are created by:



manufacture of stretcher rolls for circular saws of all sizes has made it possible to carry out the operation much faster and more efficiently by machine.

Other, less common methods are:

Thermal tensioning, effected by rapidly heating a narrow zone immediately beneath the gullets and allowing it to cool slowly.

An expanding hub, which presses outwards on the edges of the hole; this method works only with large holes.

Packing the saw, a method that is now rarely used; cotton waste is pressed against the body of the saw so that it heats up during operation.

3.5. Howling Blades

Fig. 9.16 Besides flutter, we may also meet another oscillation problem: resonance. When certain rotational speeds are reached the saw begins to howl. The vibrations rotate with the blade and produce a widening of the kerf, in addition to the sound effects.

Resonance occurs at certain sharply defined speeds. It is markedly affected by tensioning. It can thus be avoided by altering the speed of the machine, if this is possible, or by altering the tensioning so that it becomes harder, softer, or differently distributed over the surface.

4. THE TOOTH

4.1. Inserted Teeth

Inserted tooth circular saws are widely used in many countries. They are available in sizes from

Blade howl

- Occurs at sharply defined speeds
- Dealt with by
 - changing the speed
 - changing the tensioning

around 150 mm Diameter up to 1500 mm with various styles and numbers of teeth to suit the type and size of logs or lumber to be sawn. Saw manufacturers will gladly provide detailed information and advice regarding the most suitable type of saw for any purpose.

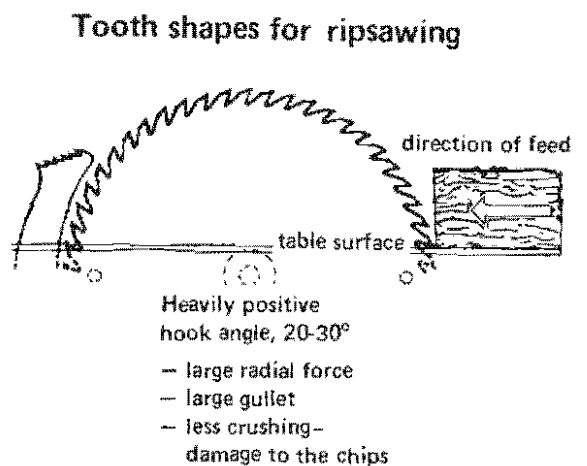
The initial cost of inserted tooth circular saws is higher than the cost of solid circular saws of comparable diameter with punched teeth. From a maintenance point of view the same techniques apply for both types of saw but, the inserted tooth saw will never need jointing or gumming as the teeth are only sharpened on the face and replaced when worn out, thus maintaining the same diameter.

The standard tooth bits can be hand filed but high speed steel bits and bits with Stellite

overlay which are readily available can only be sharpened by grinding. These tooth bits are ideal for high density hardwoods or abrasive species, and, although more expensive, the cost is negligible when the increased production is taken into account. Inserted tooth saws using these bits are sharpened on precision hand sharpening machines. These cost much less than automatic saw sharpeners with high frequency hardening units.

4.2. Tooth Shapes for Ripsawing

Fig. 9.17 The tooth shape used for ripsawing must have a heavily positive hook angle - 20-30 degree. There are many reasons for this, among them being the following:



- While the blade is running, a large part of it is within the wood. A large radial force is needed to ensure that the wood will be held down against the saw table when the shaft is beneath the table.

On the other hand, when the shaft is above the table, hook angles of 0-5 degree can be used in the case of upcut sawing.

- A positive angle gives a larger gullet and a chip form that effectively fills the gullet.

- The chips have more suitable properties as raw material for pulping or manufacturing chip-board, since they suffer less crushing damage.

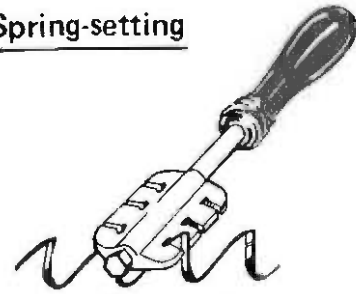
4.3. The Tooth Point in Ripsawing

The tooth point in a ripsaw may be (1) spring-set, (2) swage-set, or (3) carbide-tipped.

4.3.1. Spring-setting

Fig. 9.18 Spring-set blades are still the most common kind. The set should be 0.3-0.6 mm to each side for dry or high density wood, and 0.6-0.8 for green wood.

Spring-setting

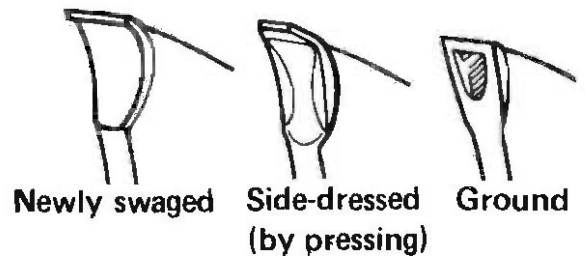


- dry frozen wood 0.3-0.6 mm to each side
- green wood 0.6-0.8 mm

4.3.2. Swage-setting

Fig. 9.19 Swage-set teeth are not so common, though they are gaining ground. The swaging width should be 0.4-0.7 mm on each side. Swaged teeth are made wholly symmetrical. This means that with the same surface smoothness as from a spring-set blade we can increase the pitch and the feed speed. Swaging gives the tooth increased hardness and wear resistance. It can also be combined with tooth-point hardening by inductive heating or by hot-swaging. For specially abrasive tropical woods, stellite is applied to the swaged surface by overlay welding.

Swage-setting



Newly swaged **Side-dressed (by pressing)** **Ground**

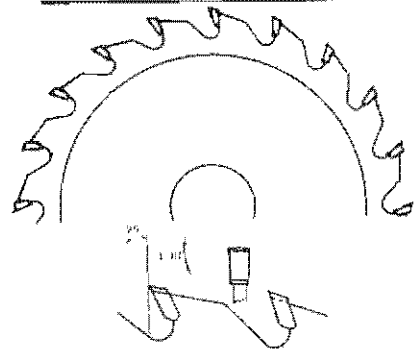
- swaging width 0.4-0.7 mm on each side
- gives increased hardness and wear resistance
- also hardening or stellite

4.3.3. Carbide Tipping

Fig. 9.20 Carbide-tipped circular saws are becoming increasingly common, especially for small-size timber and ripsawing of dry wood. Carbide blades give wider kerfs than spring-set or swaged blades, and are used for the most part in diameters up to a maximum of 600 mm.

Carbide blades for ripsawing have a 20-25 degree hook angle and their teeth are ground to an alternating 3-10 degree angle on the top. The only circumstances in which carbide blades are not suitable is when the timber contains grit or metal bodies, since any damage suffered by the carbide will be a good deal more costly to repair.

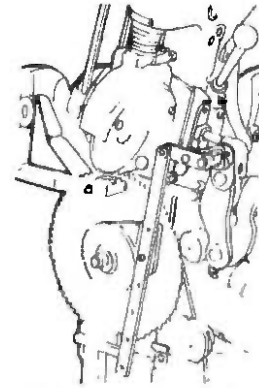
Carbide blades in ripsawing



4.3.4. Sharpening Ripsaw Blades

Fig. 9.21 The durability of the sharpness varies with the shape of the tooth point. A spring-set blade has the least durable sharpness - 3-4 hours, while a swaged blade needs to be reground after 6-8 hours. A carbide-tipped circular saw can go for 50-100 hours without regrinding.

Sharpening blades

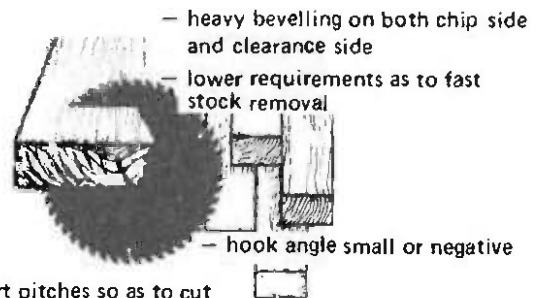


- spring-set blade - every 3-4 hours
- swaged blade - every 6-8 hours
- carbide-tipped blade - every 50-100 hours

4.4. The Tooth Shape for Cross-cutting

Fig. 9.22 The blades used for cross-cutting, e.g. in deck saws and trimming saws, are quite different from those used in rip-sawing. The hook angle can be zero or negative, in combination with a heavy bevel of 15 degree on both chip side and clearance side. On blades with carbide teeth the hook angle is 0-10 degree positive, often combined with alternating bevel-grinding of the tops of the teeth.

Cross-cutting



short pitches so as to cut without splintering.

- heavy bevelling on both chip side and clearance side
- lower requirements as to fast stock removal

- hook angle small or negative

In cross-cutting, the demand for fast cutting is generally not so important as in ripsawing. The desirability of a cut without splintering and with a good surface leads to the use of small pitches, 15-20 mm, and small chip thicknesses.

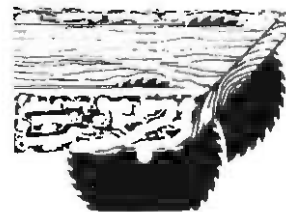
Fig. 9.23 The pointed tooth, Type F, produces an uneven cut surface when the feed is high, owing to the flexing of the teeth and to uneven wear. The use of carbide blades is therefore preferable.

Tooth shapes for cross-cutting



4.5. The Tooth Shape for Edging

Fig. 9.24 Edger blades cannot be made so thin as ripsaw blades, since the lateral forces are particularly high in edgers.



Edging

Thicker blades should be used

The need is for a robust blade that does not become deformed and start sawing off line upon uneven heating, and does not loose teeth.

Carbide blades are used only where there is little risk of hitting stones in the wood.

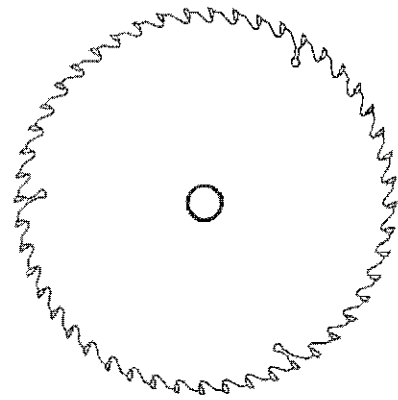
4.6. Heating Up During Operation

Fig. 9.25 When the saw blade is at work, the teeth and the peripheral zone warm up. This reduces the tensile stresses in a tensioned blade, while an untensioned blade may develop compressive stresses. In both cases the speed of wave travel is reduced and the risk of flutter increases.

Blades that get especially hot along the tooth line, e.g. carbide blades, are provided with three to five slots. Their depth should be equivalent to 10-15% of the radius in order to avoid compressive stresses.

Fig. 9.26 To keep the heating within bounds it is necessary to maintain the teeth sharp and also - particularly with green coniferous woods - to use a large spring-set or swage width.

Slots to counteract heating



Overheating is controlled by

- making slots in carbide blades equivalent to 10-15% of the radius
- keeping the teeth sharp
- using a large spring-set or swage-set width on green coniferous wood

The use of thin blades is limited to the lower critical r.p.m. and the greater susceptibility to heat. This necessitates the need to cut down feed speed and increase setting width which cancels out the gain anticipated from the use of a thin blade.

CHAPTER 10 - MAINTENANCE OF CIRCULAR SAW BLADES

1. THE BLADE BODY
 - 1.1. As-delivered Condition
 - 1.2. Flatness
 - 1.3. Tensioning
 - 1.3.1. Enlarging the Central Zone
 - 1.3.2. Central Zone Too Slack
 - 1.3.3. Dished Blade
 - 1.3.4. Checking the Tensioning

2. THE TOOTH
 - 2.1. Spring-setting
 - 2.2. Swage-setting
 - 2.3. Sharpening
 - 2.4. Edger Blades

3. CARBIDE BLADES

4. FAULT TRACING

MAINTENANCE OF CIRCULAR SAW BLADES

1. THE BLADE BODY

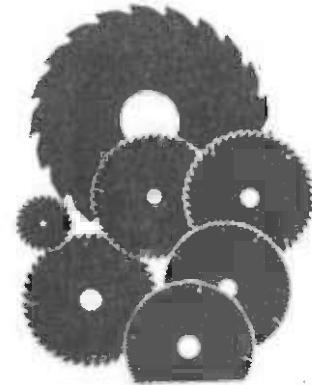
1.1. As-delivered Condition

Fig. 10.1 The smaller sizes of circular saw blades (up to 600 mm) are delivered ready for use. Larger blades sometimes come with the teeth only presharpener, while setting and sharpening remain to be done. One reason for this is that the tooth templates in the grinding machines of the sawmills may differ from the usual pattern.

1.2. Flatness

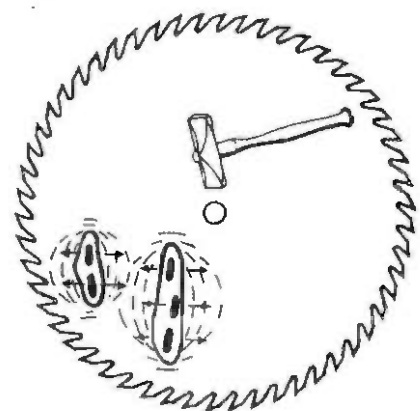
Fig. 10.2 When a used blade is to be resharpened it must first be checked for flatness. Lumps do not disappear of their own accord; they get worse as time goes on until the blade is warped and useless - unless you beat them down.

Circular saw blades



- smaller blades are supplied ready for use
- sometimes only have pre-sharpened teeth

Beating down elongated lumps

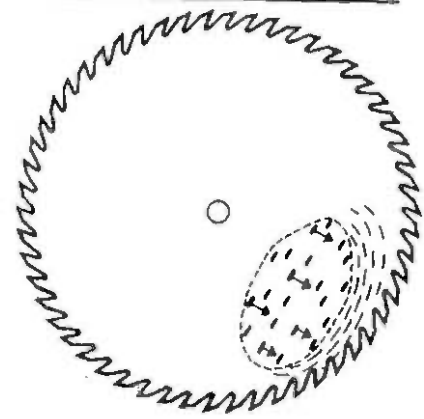


For beating down elongated lumps you use a panelbeater's hammer (twistface), which has the effect of straining and shifting the metal at right angles to the long, narrow face of the hammer, but not parallel to it. The blows are delivered with the hammer face parallel to the long axis of the lump.

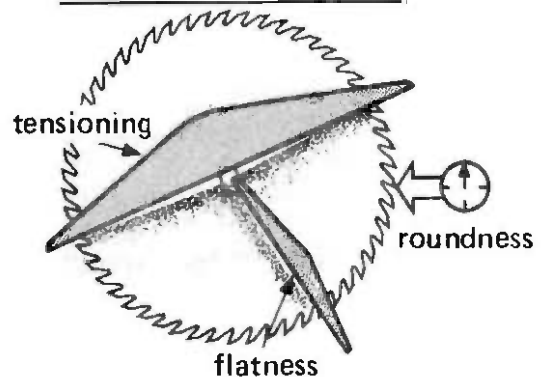
Fig. 10.3 If the lump is round, the hammer blows are delivered tangentially, since it is easiest to shift metal out towards the periphery of the blade.

Fig. 10.4 Small lumps are beaten down with the panelbeater's hammer (twist-face). During the flattening operation you should check with the straightedge to see whether you have got the saw flat and whether the tensioning has been changed. Finally, a check is made to ensure that the roundness has not been affected.

Hammering round bumps



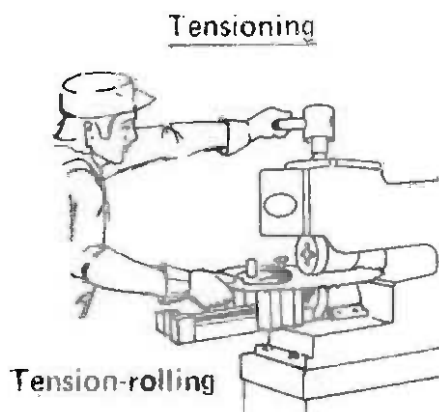
Checks after flattening



1.3. Tensioning

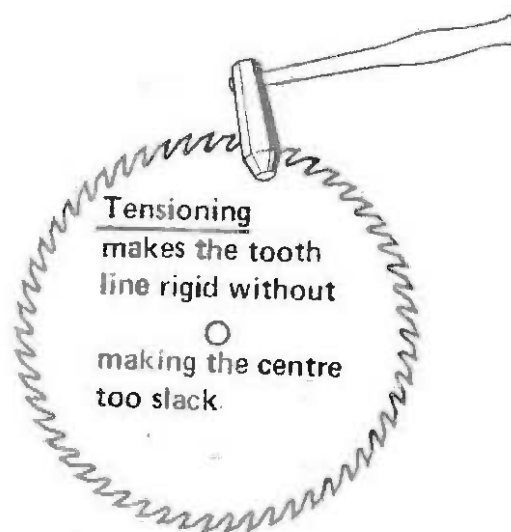
1.3.1. Enlarging the Central Zone

Fig. 10.5 The serviceability of the blade depends on whether you still have tensile stresses at the tooth line even after the saw has warmed up.



This is achieved by hammering with a round hammer known as a doghead. You can also enlarge the central zone of the blade by rolling one or more rings around the blade, using a stretcher roll, which is more effective, accurate and less damaging to the steel of the sawblade.

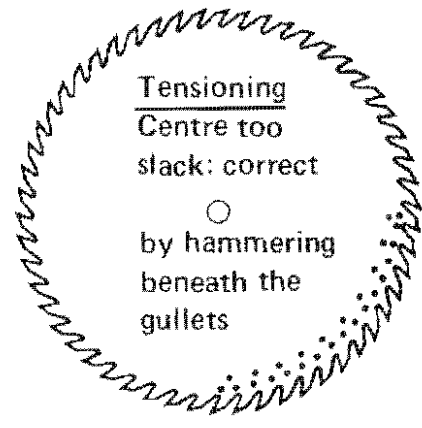
Fig. 10.6 When you hammer or roll an area you reduce its stiffness and cause it to feel slacker. The aim in tensioning must be to make the tooth line as stiff as possible without making the centre unduly slack. The most



effective area to hammer or roll is half way between the centre-hole and the teeth and a bit farther out.

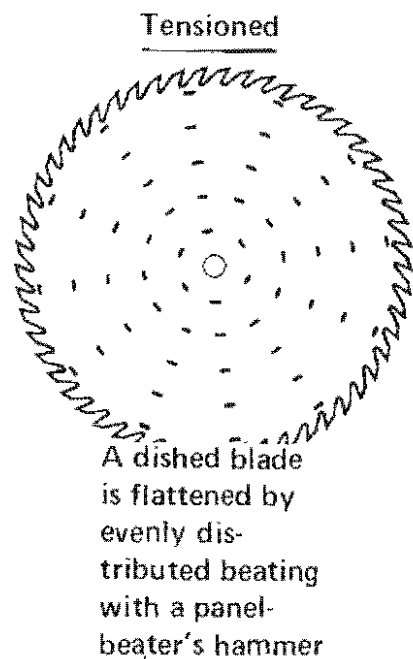
1.3.2. Central Zone Too Slack

Fig. 10.7 If the blade has been too heavily tensioned the centre will be so slack that it buckles out to one side or the other and can with ease be pressed to and fro. The tooth line is now too stiff, and is eased a little by hammering just beneath the gullets with the round hammer.



1.3.3. Dished Blade

Fig. 10.8 The blade may also become "dished" or hollow without being too slack in the centre. In this case it is flattened by hammering with a panelbeater's hammer all over the convex side. Likewise it can be levelled much quicker by using a stretcher roll.



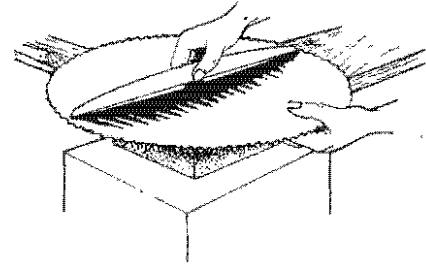
1.3.4. Checking the Tensioning

Fig. 10.9 The blade can be checked in various ways to see that it has the right degree of tension. To check it during the straightening operation, lift the blade by the edge so that it rests on the teeth at the opposite side. This causes a tensioned blade to "dish". This is confirmed by viewing the daylight beneath a straightedge held transversely along a diameter. Approximate daylights measured at the centre, for various diameters, are as follows:

- Ø 400 mm - 0.3-0.5 mm
- Ø 600 mm - 0.6-0.8 mm
- Ø 1000 mm - 1.6-1.8 mm
- Ø 1400 mm - 2.4-2.6 mm

The upper end of the range applies to thin blades. Blades for extra-high speeds require a larger daylight.

Checking the tensioning

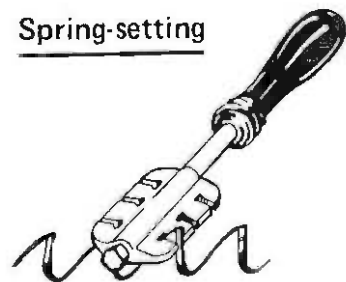


- Daylight at the centre:
- Ø 400 mm - 0.3-0.5 mm
 - Ø 600 mm - 0.6-0.8 mm
 - Ø 1000 mm - 1.6-1.8 mm
 - Ø 1400 mm - 2.4-2.6 mm

2. THE TOOTH

2.1. Spring-setting

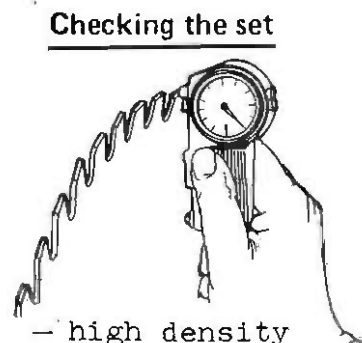
Fig. 10.10 Spring-setting is carried out with simple tools - a saw set or, in the case of thin blades, a pair of setting pliers. Automatic machines are also commonly used. On ripsaws, the tooth should be bent to such an angle that only the extreme tip touches the sawn surfaces, not any appreciable length of the flank, the set involving a certain measure of twisting as well. If the bend is made farther down on the tooth, much of the set will disappear when the blade is put to work.



Spring-setting

— on ripsaws, only the extreme tip should touch the sawn surfaces

Fig. 10.11 The set should be 0.3-0.6 mm to each side for high density wood and 0.6-0.8 mm for low density wood. The size of the set is checked with a setting gauge, which has three or four feet that bear against the blade body.



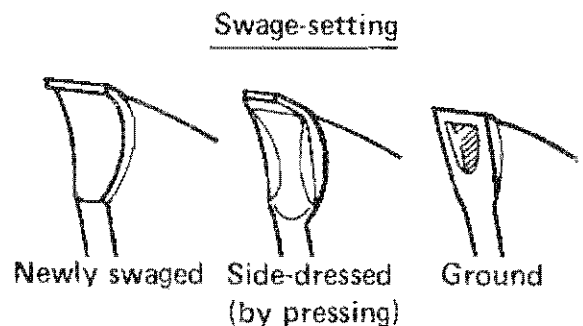
Checking the set

— high density wood: 0.3-0.6 mm to each side
— low density wood: 0.6-0.8 mm to each side

The set must be the same size on both sides. A tooth here and there that is overset will give a very poor sawn surface.

2.2. Swage-setting

Fig. 10.12 Swaging is carried out by hand or in automatic machines and must leave the teeth symmetrical. The swaging operation first shapes the chip face of the tooth by pressing with a twisting eccentric swage bar. The hook angle must be at least 20 degree so as to afford a grip for the swage bar.



The swaging must not extend right to the tip of the tooth but must stop about 0.5 mm short of it, since cracking and nicking would otherwise occur. On the other hand, the tooth must be widened right out to the point. The chip side to the tooth must be

lubricated so as to avoid tearing the metal and to spare the swaging tools.

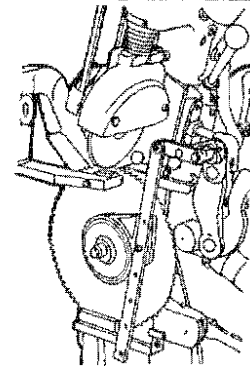
The sides of the tooth are then dressed to a suitable clearance and in form width by using a shaper.

Swaging need not be repeated more often than once every three or four regrindings.

2.3. Sharpening

Fig. 10.13 Once the blade is flat and tensioned, the teeth must be ground. If heavy grinding is needed it should be done before the final tensioning so as not to risk upsetting the tension. Spring-set and swage-set blades are reground at the sawmills, since the job needs repeating in every shift. Carbide blades, which are reground at much larger intervals, are usually sent to special service shops.

Grinding in an automatic machine



- the grinding wheel must not be too hard, leaded, or poorly dressed
- the centre of the grinding wheel must be directly above the tooth

Grinding is carried out in automatic machines without any liquid coolant. It is important to have a sufficiently high rate of stock removal and a grinding wheel that is just soft enough. A grinding wheel that is too hard, too heavily loaded or too badly dressed produces so much heat that it results in emery-hardening on the surface of the tooth and annealing beneath it.

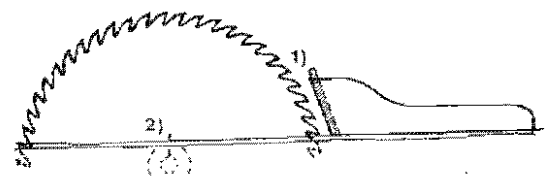
The grinding machine must be adjusted according to the thickness of the saw so that the centre of the grinding wheel comes directly above the tooth. The teeth would otherwise be asymmetrically ground.

Ripsaw blades are ground at right angles, except for the top of the teeth, which are given an alternating bevel. In cross-cutting blades, the entire teeth are bevel-ground alternately. Swage-set teeth, however, are usually NOT BEVELLED.

Fig. 10.14 The most important factor regarding the sharpening of all circular saws is to ensure the blade is made a true circle with all the points being equidistant from the centre. Modern automatic circular saw sharpeners maintain this condition as the saw is located on a conical centre piece which rotates on a fixed shaft during the sharpening operation.

Circular saws which are hand filed can easily become out of round with some teeth higher than others. These saws need rounding or jointing as it is commonly called. The procedure can be carried out by hand filing and the use of a circular saw filing vice with a jointing fixture. The saw is located on the conical arbor and the jointing fixture adjusted to the height of the lowest tooth to which level all

Resharpener by grinding



- 1) Turn the blade true
- 2) If the blade is to be taken out of the bench its position should first be marked

the other teeth can now be filed. Similarly the gullet depth can be increased if necessary which is a procedure widely known as gumming. After these operations are completed all the teeth can be sharpened taking every care to ensure the filing is just sufficient to bring up a sharp edge. Filing after this will make the tooth point lower than the others.

Hand filing is a slow process and files are expensive which is why many sawshops have precision hand sharpening machines. Some of these machines can be used on saws from 150 mm diameter to 1500 mm diameter and are ideal for fast accurate jointing, gumming or sharpening operations. The saw is located on a conical arbor and the grinding head which pivots can be set to stop at the lowest tooth point. All the other teeth are then brought under the grinding wheel head and

reduced to a uniform tooth height. Similarly the grinding wheel head is set to stop at the depth of gullet required and each gullet is then brought under the grinding wheel head which is fitted with the appropriate size of wheel suitably dressed. The grinding wheel is then carefully pulled down to the stop and a uniform depth of gullet obtained, care being taken to avoid burning the tooth points or gullets through heavy grinding. Final sharpening can likewise be carried out making sure that tooth points are not sharpened below the tooth level created from the jointing operation.

Jointing can also be carried out by leaving the saw in the machine and using a special holder carrying an abrasive stone called a hone which is moved against the front of the teeth when the saw is running and reducing them all

to the same height. If the saw has no driving pin it is advisable to mark the saw blade and saw flange or collar to ensure the saw goes back on the arbor in the same position after removal for sharpening. This practice of jointing and resharpening is confined to small woodworking operations where the machines are not in continuous operation and capital outlay on saw sharpening equipment is not warranted.

2.4. Edger Blades

Fig. 10.15 A problem specific to edger blades is that the wood on one side of it, the edging, is flexible, so that most of the frictional heating occurs on the other side. To prevent its becoming convex on the inside, the blade used for edging is thicker than for ordinary rip-sawing.



Edging

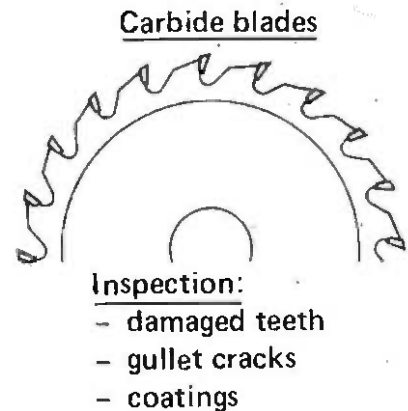
Thicker blades should be used

It is also particularly important to use guide pins in edging machines.

3. CARBIDE BLADES

Fig. 10.16 Even if most sawmills do not regrind their carbide blades, the blades still require strict routine inspection and cleaning.

Inspection and cleaning should be carried out at least once a day. A particular watch should be kept for damaged teeth and gullet cracks. If the blade is found to be coated with gum or similar deposits it must be carefully cleaned in a suitable liquid.



4. FAULT TRACING

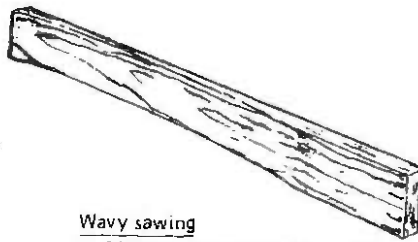
FAULT	CAUSE	
	BLADE	MACHINE ETC.
Rough, scratchy sawn surface	some of the teeth are over-set	bearing play
Wavy sawing	Difference between r.h. and l.h. sides in set or sharpening	poor alignment (shaft play, warped flanges). Feed rolls out of parallel
Crooked sawing	Poor tensioning	Poor alignment. Play in the feed mechanism.
Pattern of burnt spots	Poor tensioning	Cleaver too thin. Cleaver wrongly positioned
Occasional burnt spots	Poor flatness	Bent shaft
Sluggish sawing, motor loses speed	Poor sharpness, insufficient hook angle, insufficient set	Power source undersized
Tooth failure	Excessive hook angle, excessive clearance angle, insufficient gullet radius, over- set, heavy emery- hardening in gullet	Running into nails or stones

Fig. 10.17

Fault tracing circular saws:



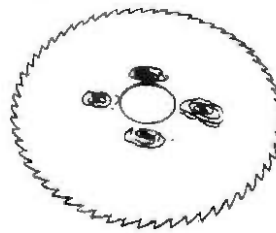
Rough, scratchy sawn surface
 - Some of the teeth are over set
 - Bearing play



Wavy sawing
 - Difference between r.h. and l.h. sides in set or sharpening
 - Poor alignment
 - Feed rolls out of parallel

Fault tracing circular saws

Crooked sawing
 - Poor tensioning
 - Poor alignment
 - Play in the feed mechanism



Pattern of burnt spots
 - Poor tensioning
 - Cleaver too thin or wrongly positioned

Occasional burnt spot
 - Bent shaft
 - Poor flatness

Fault tracing circular saws:

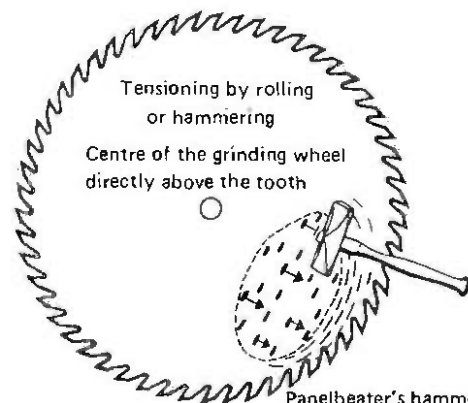


Tooth failure:
 - Running into nails or stones
 - Insufficient gullet radius
 - Lack of smoothness in gullet
 - Heavy emery hardening



Sluggish sawing, motor loses speed:
 - Power source undersized
 - Poor sharpness
 - Insufficient set

Summary maintenance of circular saws



Tensioning by rolling or hammering
 Centre of the grinding wheel directly above the tooth

Panelbeater's hammer for small bumps

High quality blade + high quality maintenance offers:

- Narrow cut → raw material earnings
- Reduced number of stoppages
- Reduction of noise
- Small blade consumption

CHAPTER 11 - SAWMILL TOOL DEVELOPMENT

1. RAW MATERIAL YIELD
 - 1.1. Kerf-loss
 - 1.1.1. High-strain bandsawing
 - 1.1.2. Gang-sawing with non-linear movement
 - 1.2. Chip quality
 - 1.2.1. Reducer technique

2. PRODUCTIVITY
 - 2.1. Feed
 - 2.1.1. Guided circular saws
 - 2.2. Running time
 - 2.2.1. Fettling of tooth gullets
 - 2.2.2. Tooth-point hardening
 - 2.2.3. Stellite facing
 - 2.2.4. Swage-set circular saws

3. ENVIRONMENT
 - 3.1. Noise
 - 3.1.1. Silent carbide tipped circular saws

4. TOOL MAINTENANCE
 - 4.1. Band saw blade tensioning
 - 4.2. TIG/MIG-welding

SAWMILL TOOL DEVELOPMENT

1. RAW MATERIAL YIELD

1.1. Kerf-loss

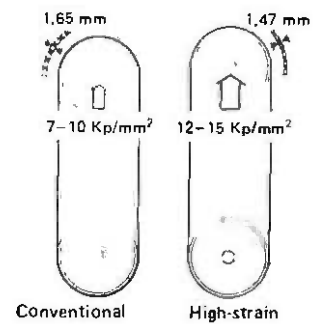
1.1.1. High-strain Bandsawing

Fig. 11.1 "High-strain" versus "normal strain" is often discussed. "Normal strain" indicates a blade flexural stress of 7 kp/sq.mm and "high-strain" some 12 kp/sq.mm.

This indicates that "high-strain" can use a thinner blade and still keep the same dimensional accuracy as with a thicker blade.

In reality, "high-strain" is nothing new. To solve sawing problems, sawyers have tended to increase saw strain considerably. However, this can create new problems such as broken shafts and tooth gullet cracks.

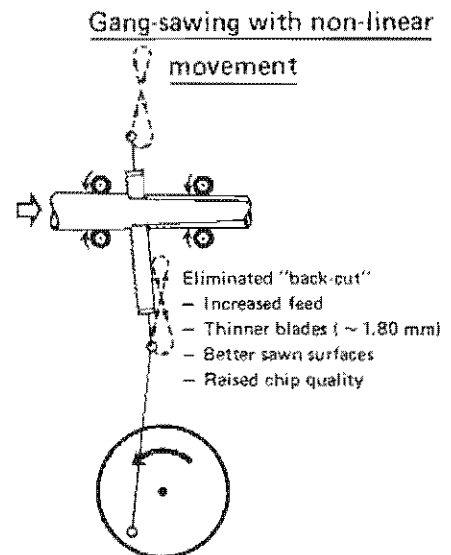
High-strain bandsaw



Thinner cut
Dimensional accuracy kept
More difficult to tension

1.1.2. Gang-sawing with Non-linear Movement

Fig. 11.2 Gang-sawing with continuous feed puts a heavy load on the blade at the upturn off the blade after the bottom of the stroke ("back-cut"). Gang-sawing with an elongated figure-of-eight has been developed in order to avoid this problem. The principle is shown in the picture.



Sawing with a figure-of-eight avoids the "back-cut" completely. The following advantages are to be found in comparison with conventional gang-saws:

- Increased feed
- Thinner saw-blades
- Better sawn surface
- Increased quality of the chips

1.2. Chip Quality

1.2.1. Reducer Technique

Fig. 11.3 Sawmill reducer technique is relatively new and still developing.

There are three types of reducers:

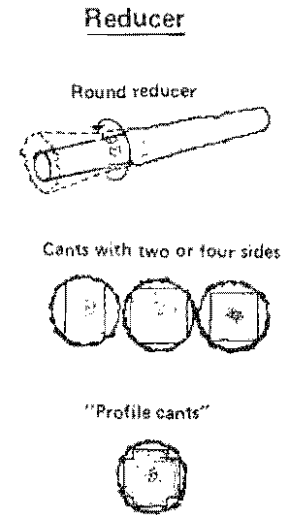
A. Round reducer

B. Chipper canters which produce cants with two or four sides

C. Chipper canters which produce cants with "profile"

A. Round reducer produces a log with a more uniform diameter for subsequent sawing. The main task is to remove swellings at the root end.

B. Chipper canter can give the log two or four flat sides for



further processing. The method is also used for production of sleepers.

C. "Profile" chipper canter produces a cant with such a profile that sawing and chipping can be done in a continuous process without edgers involved.

Fig. 11.4 Reducer technique offers the following advantages:

- Handling and transport is facilitated by the removal of swellings and other irregular form. Edgings and slabs which would normally arise are directly processed as chips.

- Sawing is facilitated as logs without root end swellings can be processed using smaller sawing equipment. Advantageous combinations can be made with band-, gang- and circular saw equipment.

Reducer technique advantages

- The logs are given a known maximal dimension
- Smaller sawing equipment can be used
- Easily combined with band-, gang- and circular sawing

Disadvantage

- Less valuable chips, increased amount of fines

2. PRODUCTIVITY

2.1. Feed

2.1.1. Guided Circular Saw

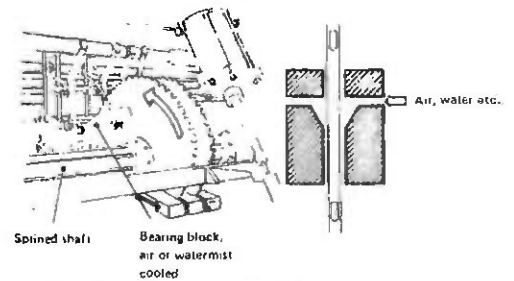
Fig. 11.5 The products from circular sawing can be negatively influenced by four factors:

- Vibrations in the saw blade
- Heating of the saw blade
- Incorrect tensioning
- Incorrect saw shop work (faulty setting/swaging, grinding)

Circular saws with bearing blocks instead of guide pins have been in use for a considerable time. These bearing blocks have large contact surfaces. Jets of air or water-mist are used in order to decrease the friction between block and blade.

Vibration is diminished by the block which, as well as the air or water-mist, moderates the heating.

Guided circular saw



- Vibration and heating decrease
- Less susceptible to incorrect tensioning
- Allows for the use of thinner blades
- Quick change to different timber output dimensions

The bearing blocks have also made it possible to reduce the blade thickness in some cases by 50%.

Main advantages with guided circular saws are:

- Diminished vibrations and heating

- Reduced blade thickness

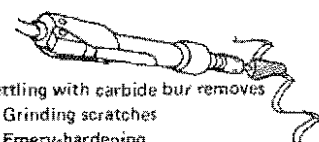
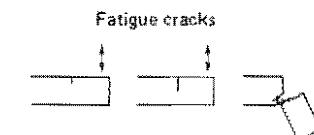
- The centre of the blade can slide freely on a splined shaft. The size of the output timber can be changed by shifting the guide blocks, without the need to stop the saw.

2.2. Running Time

2.2.1. Fettling (polishing) the tooth Gullets

Fig. 11.6 Breakage of blade or tooth is usually due to the presence of stones, nails or other matter in the wood.

Fettling of tooth gullets



Fettling with carbide bur removes
- Grinding scratches
- Emery-hardening

Limit for fatigue cracks increases =
fewer cracks and failures

Cracks are usually caused by poor blade maintenance or metal fatigue due to prolonged operation when saw teeth are dull. Tests have shown that the limit for fatigue cracks increases substantially by fettling (polishing) with a rotating carbide bur.

The fettling will remove both coarse grinding scratches and emery-hardened metal from the gullets. This leads to:

- Fewer cracks and thus fewer break downs with subsequent down time.

- Extra saw shop work is created but this is compensated for by less work due to reduction of cracks.

2.2.2. Tooth-point Hardening

Fig. 11.7 Several methods for increasing the hardness of saw blades are now in common use. Tooth-point hardening by induction (high-frequency) is quite common.

Tooth-point hardening



- Doubled wear resistance: increased feed and/or longer regrinding intervals
- Exact depth of hardened layer necessary
- Hardening repeated after each regrinding

The process, in principle, is as follows:

Each tooth passes after swaging and grinding a coil, which has high-frequency alternating current. The temperature in the tooth-point causes a change of structure. The fast cooling coming from the cold part of the tooth is sufficient to cause hardening of the tooth-point.

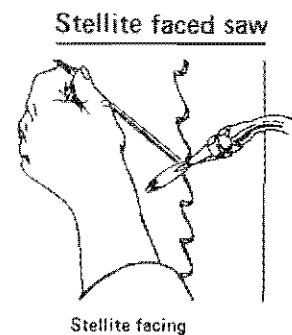
It is very important that only a layer of some 0.2 mm is hardened. A layer, even softer than the rest of the material, will appear if the hardened layer is not

thick enough to stand a certain wear. A hardened layer that is too thick will remain by the next grinding and swaging. The tooth-point will thus get cracks etc. Factors affecting the thickness of the layer are the power of the treatment and the distance between the coil and the tooth-point.

Increased hardness in the tooth-point can result in increased feed and/or longer intervals between regrindings.

2.2.3. Stellite Facing

Fig. 11.8 Some tropical woods are very difficult to saw as they contain silicon. Normal blades will stay sharp only a few minutes. Suggested solutions have been tooth-point hardening, carbide tipping etc. A good result has been obtained by the use of stellite facing on the tips.



Increased wear resistance (2-3 times) but limits because of blade fatigue

This material is not very hard but has good wear resistance. It can be ground with conventional grinding wheels and can be applied on steel by gas-welding.

It is advantageous to sharpen stellite tipped saws at least once per day, even if they are still in a fairly sharp condition. This will minimise the possibility of cracks arising from blade fatigue created by dull teeth and loss of tension due to a prolonged working period.

Stellite has been used successfully on gang-saw blades for cutting high density tropical hardwoods and abrasive species.

Stellite-facing implies:

- Increased wear resistance.
- More work in the saw shop with the welding, but lesser grinding time due to fewer saw changes.

2.2.4. Swaged Circular Saws

Fig. 11.9 Swaged saw blades have been used since the 'Second World War'. The lack of a suitable swaging machine delayed the development and use of circular saws to some extent. Machines which will take blades of all dimensions are now available.

A special material has been produced, suitable for swaged blades which is unlikely to crack or chip. A comparison with spring-set circular saw blades offers the following advantages for the swaged blade:

- Increased feed speeds.
- Better sawn surfaces.
- Longer intervals between regrindings.

Swage-set circular saw



- Special steel quality demanded
- Offers possibilities for increased feed, better sawn surfaces, longer intervals between regrindings and more valuable fines

3, ENVIRONMENT

3.1. Noise

3.1.1. "Silent" Carbide Tipped Circular Saws

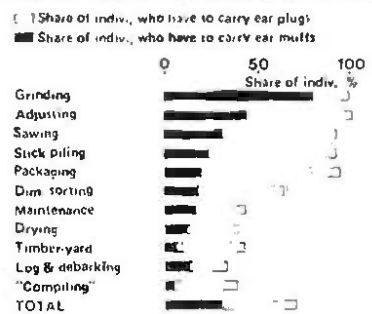
Fig. 11.10 Noise is a big problem within the sawmill industry. The heavy products as well as the speedy cutting tools affect the environment. Investigations have shown that noise not only gives hearing defects, but also makes the individual isolated as conversation is made difficult.

Regulations in many countries stipulate that cutting tools shall have their noise reduced.

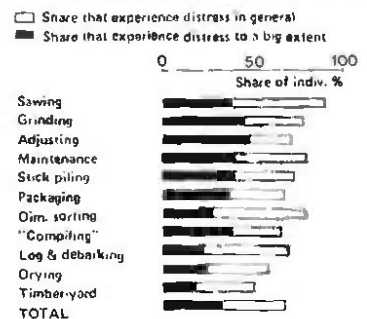
Sawing creates two kinds of noise:

- Sounds generated apart from the sawing process.
- Sounds generated in the sawing process.

Hearing damage risk ranking in sawmill production



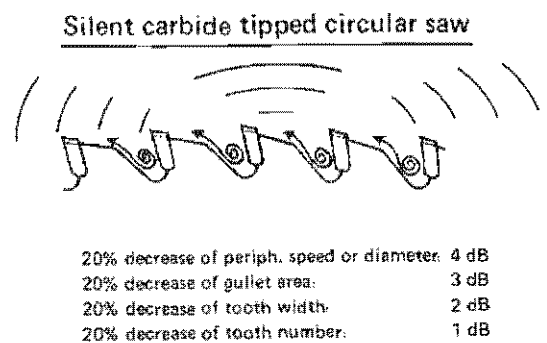
Experienced distress ranking in sawmill production



The first type of sound comes from air eddies at cutting edges and tooth gullets and from vibration of the tool.

The sawing process generates vibrations both in the saw blade and in the work. The biggest part comes from the periphery speed.

Fig. 11.11 Reduction of noise from air eddies can be achieved by diminishing the diameter of blade, number of revolutions, width of the tooth and tooth gullet area. The cutting process must, however, not be disturbed.



The following approximations are given:

20% decrease of periph. speed or diameter	4 dB
20% decrease of gullet area	3 dB
20% decrease of tooth width	2 dB
20% decrease of tooth number	1 dB

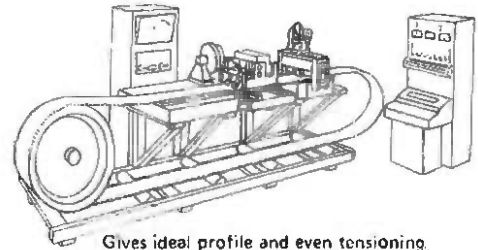
4. TOOL MAINTENANCE

4.1. Band Saw Blade Tensioning

Fig. 11.12 Tensioning of wood band saw blades is today done manually in a stretcher roller. The "profile" of the blade must suit the crown of the pulleys and the thickness of the blade. It is, however, rather difficult to reach the correct result manually. An automated band saw blade tensioning equipment has thus been constructed.

The required tension "profile" is fed into a computer. The blade will then be tensioned automatically until this profile is reached. Main disadvantages are that the blade must be thoroughly levelled in advance and that the operation is rather slow.

Automated band saw blade tensioning



Gives ideal profile and even tensioning.
Disadvantages: levelling required
slow operation

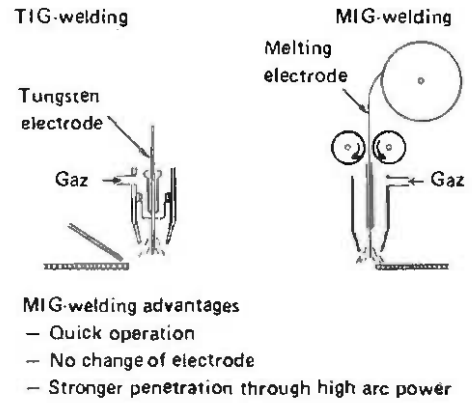
4.2. TIG/MIG-welding

Fig. 11.13 These gas-arc welding methods TIG, MIG have been substantially developed. They offer improved welding work. Main features are:

- High welding rate.
- Good uniform welding.
- Well suited to automation.

These methods have inert gas blown onto the welding zone to prevent oxidation. In the MIG-method the heat comes from an electric arc formed between an electrode, which at the same time acts as filler metal, and the workpiece. In the TIG-method the arc is formed between an tungsten electrode and the workpiece. A separate rod or wire of filler metal is used.

TIG/MIG-welding



MIG has the following advantages in comparison with other gas-arc welding methods:

- Faster welding.

- The bare electrode is continually fed to the weld spot from a spool. Electrode is not changed.

- Deeper penetration because of high arc power.

GLOSSARY OF TECHNICAL TERMS WIDELY USED
RELEVANT TO SAW MAINTENANCE

<u>ABRASIVE CLOTH</u>	A cloth or string flexible sheet of paper coated with abrasive particles.
<u>ANNEAL</u>	To soften metal and make it ductile by heat treatment.
<u>ANVIL (SAW)</u>	A block of steel usually with a convexed surface and chilled face used for levelling and tensioning saw blades.
<u>ANVIL (SWAGE)</u>	The fixed steel component in a saw swage which rests on the top of the saw tooth that is being pressed by the action of the die.
<u>ARBOR</u>	The shaft or mandrel on which a circular saw is mounted.
<u>BACK GAUGE</u>	A long steel gauge usually with one edge straight and the other slightly concave used for checking the shape and uniformity of bandsaw blade back edges.
<u>BRAZE</u>	To join bandsaw ends or attach carbide inserts to saw teeth by using a hard type of solder usually called silver solder.
<u>BRAZING IRONS</u>	A pair of steel bars heated to around 950°C used in a brazing clamp for joining the two ends of a bandsaw with silver solder.
<u>BURR</u>	The rough edge remaining on the inside face of saw teeth after the grinding operation.
<u>CARBIDE</u>	A common term used to describe the very hard material which is used for saw tooth inserts and other wear resisting components relevant to saw operation and maintenance.
<u>CAM</u>	A rotating steel disc, specially shaped to create movement of machine parts controlling other movements such as the rise and fall of a grinding wheel head, or, the forward and backward movement of the pawl finger in automatic saw sharpening machines.
<u>CARBURIZING FLAME</u>	An Oxy/Acetylene flame using excess acetylene.

<u>CARRIAGE</u>	The unit specially designed for carrying logs during the sawing operation. The carriage consists of a heavy frame carrying headblocks, setworks and other devices which hold the log steady during sawing and move it forward after each cut as required. The complete carriage assembly is mounted on wheels which run on tracks parallel to the saw and is usually motivated by power driven cable.
<u>CENTRIFIGUAL FORCE</u>	The force created by rotation which impels material to move outward from the centre of rotation.
<u>CIRCULAR HEADSAW</u>	A circular saw used on sawing machinery for converting logs to lumber.
<u>CLEAVER</u>	Also called riving knife, spreader of splitter. A disc or knife blade fixed behind a circular headsaw to prevent boards binding or pinching the saw and boards or pieces falling on to it.
<u>COLLAR</u>	A steel flange for supporting circular saws or grinding wheels. One on each side.
<u>CONCAVE</u>	A shape which is hollow. Curved inwards.
<u>CONVEX</u>	A shape which is rounded. Curved outwards.
<u>CROSS FACE</u>	A special hammer for levelling bandsaws.
<u>CROWNED PULLEY</u>	A pulley with the face ground convex.
<u>CROSS CUT</u>	Cut across the grain. A cross cut saw.
<u>DEPTH OF CUT</u>	Distance through which saw cuts from top to bottom of "workpiece".
<u>DIE (SWAGE)</u>	Specially shaped very hard steel spindle designed to be rotated against the front top section of a saw tooth face and spread it wider under pressure against the anvil.
<u>DISHED</u>	A term used to describe the condition of a saw blade that has become hollow on one side. Also used to describe a grinding wheel specially made with one side concave and the other convex.
<u>DOG HEAD HAMMER</u>	A hammer with crowned face round head used for tensioning saw blades.

<u>DRIVE PULLEY</u>	The wheel by which motivation is passed on.
<u>EDGER</u>	A machine used for sawing length ways through boards to remove wane and produce square edged lumber of desired width.
<u>EXPANSION SLOT</u>	A slot in the rim of a circular saw designed to minimise the effect of stresses developed when the saw expands.
<u>FAST SAW</u>	A circular saw with the rim area too long for the inner area of the blade when running at operating speed.
<u>FEED SPEED</u>	Speed at which the timber of workpiece is fed into the machine for sawing.
<u>FEED WORKS</u>	The mechanism by which the log carriage is fed past the saw.
<u>FENCE</u>	A straight rail or linebar fixed parallel to the saw blade against which the lumber, cant or flitch slides as it is sawn.
<u>FIXED COLLAR</u>	A collar fixed to the saw arbor as distinguished from a loose collar which is pressed against the other side of the saw by a nut.
<u>FILING SADDLE</u>	A curved block of wood on which brazed joints or butt welds are filed.
<u>FLAT TOP GRIND</u>	A term used to describe saw teeth which are sharpened square on top as opposed to teeth with alternate top bevels such as those on circular cross cut saws.
<u>FLITCH</u>	A section of a log sawn on two or more sides indented for remanufacturing into lumber. Also called "cant" or "deal".
<u>FLUX</u>	Substance used when brazing or welding to prevent oxidisation and remove films of oxide forming during the operation.
<u>FORGE</u>	To hammer metal when it is red hot in order to shape it and improve the strength of the section being forged.
<u>GAUGE</u>	A term used to describe the thickness of a saw blade usually termed "Birmingham Gauge".

<u>GANG CIRCULAR</u>	A machine having a number of circular saws all running in the same machine on the same shaft or two shafts.
<u>GANG SAW (SASH)</u>	A frame saw in which a number of straight blades are fixed in a reciprocating frame and the log or cant is fed into them.
<u>GANGING</u>	A term used for fitting the saw blades into the frame of a gang saw.
<u>GLAZED GRINDING WHEEL</u>	A grinding wheel which no longer cuts freely due to the abrasive particles having worn and/or the bond pores being filled with metal.
<u>GUIDES</u>	The device fitted above and/or below the cut with hardwood or similar inserts to keep the saw cutting on a straight line.
<u>GUIDE RAIL</u>	Usually a vee rail controlling the log carriage movement to a fixed line.
<u>GULLEY</u>	The area between saw teeth in which the sawdust particles or chips are carried.
<u>GUMMING</u>	The procedure covering the deepening or cutting out the gullets of a saw.
<u>HAMMERING</u>	The process of using a hammer to straighten, level or tension a saw blade.
<u>HAND (RIGHT OR LEFT)</u>	The hand side from which the log passes the sawyer in his operational position.
<u>HEADRIG</u>	The unit assembly of equipment used for the primary breakdown of logs.
<u>HOOK</u>	The angle between a line down the tooth face and a line from tip of the tooth edge square across the blade.
<u>HUSK</u>	Term usually used to describe the main frame carrying the saw arbor and other components on a circular saw headrig.
<u>JOINTING</u>	The procedure whereby all the tooth points on a circular saw are made equidistant from the saw centre.

<u>KERF</u>	The width of the gap created by the saw when cutting is called kerf and due to tooth misalignment, saw blade irregularities, etc. is usually larger than the actual width of the saw teeth.
<u>LAP</u>	The length by which the ends of a bandsaw blade overlap to make a brazed joint.
<u>LUMP</u>	A raised section in a saw blade located by the use of a straight edge.
<u>OPEN SAW</u>	A circular saw stretched too much in the inner area of the blade which will not stand straight.
<u>OXIDES</u>	Oxygen compounded with other elements which can form rust on saw steel.
<u>OXIDISING FLAME</u>	A welding flame using more oxygen than acetylene.
<u>PAWL FINGER</u>	The part of an automatic saw sharpening machine which pushes the teeth forward ready for sharpening.
<u>PIN HOLES</u>	The holes in the body of circular saws through which the driving pins from the fixed collar on the arbor go into the loose collar. On deep cuts these pins prevent the saw slipping round on the arbor.
<u>PITCH (TOOTH)</u>	Distance between tooth points.
<u>RIM SPEED</u>	The speed of the saw blade at tooth point periphery when rotated.
<u>RIP SAW</u>	The term given to a saw used for cutting wood lengthwise parallel to the fibres.
<u>RIP TOOTH</u>	The type of saw tooth developed for cutting wood parallel to the fibres.
<u>SHANK</u>	The component which holds and locks the inserted tooth point in a circular saw.
<u>SIDE CLEARANCE</u>	The distance between the body of the saw and the extremity of the saw tooth point which must project beyond the line of the saw blade body to create clearance when sawing.

SIDE DRESSING

The process carried out by use of a shaper which is a small mechanical manually operated implement for compressing newly swaged saw teeth. The saw tooth points are pressed between the shaper jaws or dies to an accurate uniform shape.

SIDE GAUGE

A measuring device for checking the projection of saw teeth beyond the body of the saw blade.

SPREADER

A steel disc or curved blade mounted close behind circular headsaws to prevent boards binding or pieces falling on the saw. They should be fixed 10 mm to 15 mm from the back of the saw.

SPRING SET

The term used to describe saw teeth which have been bent sideways alternately to create the necessary blade clearance in the cut.

STELLITE

The trade name for a hard metal alloy widely used for tipping cutting tools in order to achieve longer working periods between sharpening requirements.

STRAIN

The state imposed on a bandsaw by various means (usually balance weights) to keep the blade pulled tight between the bandmill pulleys.

SWAGE

A mechanical device incorporating clamping screws, anvil and eccentric die by which the top front section of saw teeth can be uniformly widened under pressure.

TENSION

A term used to describe the condition created in a saw blade after the centre section of the blade has been expanded by hammering or rolling.

TENSION GAUGE

A piece of flat steel with one edge straight and the other ground convex. The straight edge is used for checking the blade for level (flatness) and the convex edge for checking the degree of tension and its uniformity around the blade. The gauges are manufactured with various convex curvatures to suit the various widths of bandsaws.

TOP CLEARANCE

The degree of clearance existing backwards from the top of the saw tooth. Also called back clearance angle.

<u>TOOTH BITE</u>	The depth by which each saw tooth enters the wood when sawing.
<u>TUNGSTEN CARBIDE</u>	An extremely hard and abrasive resistant material used for cutting tools and other fast wearing components.
<u>TWIST FACE</u>	A special hammer used for levelling circular saws.
<u>WANDERING</u>	Term used to describe a bandsaw which deviates from a straight line in the cut.
<u>WAVY SAWING</u>	Term used to describe inaccurate dimensional sawing caused by wandering saws.
<u>WOBBLE</u>	Term used to describe the motion of a circular saw which is incorrectly tensioned for the speed at which it operates.

DIAMETER OF SAWS SUGGESTED FOR VARIOUS LOG DIAMETERS

SAW DIAMETER REQUIRED INCHES	AVERAGE DIAMETER OF LARGEST LOGS INCHES	SAW DIAMETER REQUIRED MILLIMETERS	AVERAGE DIAMETER OF LARGEST LOGS MILLIMETERS
40	18	1016	457
44	20	1118	508
48	22	1219	559
52	26	1321	660
56	30	1422	762
60	34	1524	864

RECOMMENDED SIZES OF BAND MILL WHEELS TO BANDSAW BLADES

WHEEL DIAMETER		BLADE WIDTH		BLADE THICKNESS		RATIO WHEEL DIAMETER BLADE THICKNESS
FEET	METRES	INCHES	CENTI- METRES	INCHES	MILLI- METRES	
5	1.52	5- 9	12.70-22.86	0.058	1.473	1034
5.5	1.68	7-11	17.78-27.94	0.065	1.651	1015
6	1.83	8-12	20.32-30.48	0.072	1.829	1000
7	2.13	10-14	25.40-35.56	0.083	2.108	1000
8	2.44	12-16	30.48-40.64	0.095	2.413	1000
9	2.74	14-16	35.56-40.64	0.109	2.769	1000

The above table is intended as a guide in order to prevent fatigue cracks in bandsaws being caused by running blades too thick on the wheels concerned. The relationship should always be a minimum of 1000 times the blade thickness to the diameter of the wheel.

SAW GAUGE THICKNESS CONVERTED TO INCHES AND MILLIMETERS

BIRMINGHAM GAUGES		FRACTION OF INCH	THOUSANDTHS OF INCH	MILLIMETRES
		1 = 1.000	1000	25.40
		7/8 = 0.875	875	22.225
		3/4 = 0.750	750	19.05
		5/8 = 0.625	625	15.875
		1/2 = 0.500	500	12.70
		15/32 = 0.46875	468	11.905
0000		29/64 = 0.454	454	11.53
000	FULL	27/64 = 0.425	425	10.70
00	FULL	3/8 = 0.380	380	9.65
0	SCANT	11/32 = 0.340	340	8.64
1	SCANT	5/16 = 0.300	300	7.62
2		9/32 = 0.284	284	7.21
3	FULL	1/4 = 0.259	259	6.57
4		15/64 = 0.238	238	6.04
5		7/32 = 0.220	220	5.59
6		13/64 = 0.203	203	5.18
7	SCANT	3/16 = 0.180	180	4.57
8	FULL	5/32 = 0.165	165	4.19
9	SCANT	5/32 = 0.148	148	3.76
10	FULL	1/8 = 0.134	134	3.40
11	SCANT	1/8 = 0.120	120	3.05
12		7/64 = 0.109	109	2.77
13		3/32 = 0.095	95	2.41
14	FULL	5/64 = 0.083	83	2.10
15	SCANT	5/64 = 0.072	72	1.82
16	FULL	1/16 = 0.065	65	1.65
17	SCANT	1/16 = 0.058	58	1.47
18		3/64 = 0.049	49	1.24
19		= 0.042	42	1.06
20		= 0.035	35	0.89
21		1/32 = 0.032	32	0.81
22		= 0.028	28	0.71
23		= 0.025	25	0.64
24		= 0.022	22	0.56
25		= 0.020	20	0.51
26		= 0.018	18	0.46
27		1/64 = 0.016	16	0.41
28		= 0.014	14	0.36
29		= 0.013	13	0.33
30		= 0.012	12	0.30