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Sawing – Course: Manual woodworking techniques. Instruction examples for practical vocational training

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Sawing – Course: Manual woodworking techniques. Instruction examples for practical vocational training

**Institut für berufliche Entwicklung e.V.
Berlin**

Original title:
Lehrbeispiele für die berufspraktische Ausbildung
“Sägen”

Author: Fritz Dienemann

First edition © IBE

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Order No.: 93–33–3302/2

Preliminary Remarks

The present booklet includes five selected instruction examples to practise the sawing techniques like sawing across the grain, sawing with the grain, sawing of curves, sawing of panels and manufacturing of connecting elements. The applied material is sawn wood and plies.

The necessary precision reaches from cutting to length with working allowances for further working steps to sawing to final size with high precision.

To help with the preparation and realization of the work, the necessary materials, tools and auxiliary accessories are indicated for each instruction example. Necessary basic knowledge of scribing is also mentioned and should be repeated before starting with sawing.

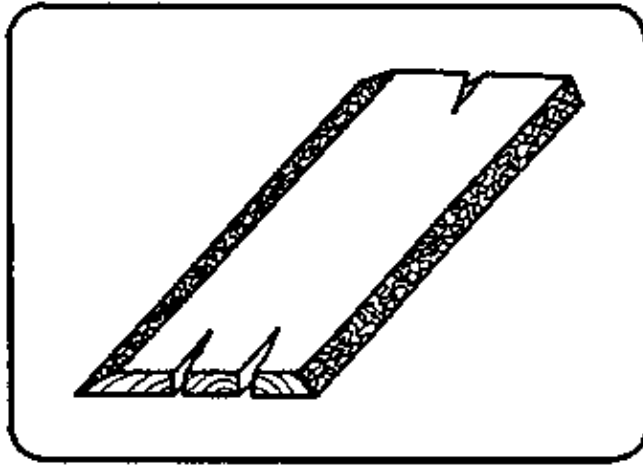
The sequence of operations specified for each instruction example includes the steps necessary to manufacture the relevant workpiece. This sequence is to be followed if a good quality is to be achieved.

To each instruction example a working drawing is added showing the required shapes and dimensions of the workpieces.

The results of the instruction examples are single parts which, after further working steps like planing, can be used to manufacture fillings for different purposes.

Instruction Example 2.1. Cutting to Length of a Board

A raw board shall be cut to length by separating cuts across the grain.



Material

A raw board of hard wood or soft wood

Thickness: 30 mm

Width: at least 150 mm

Length: at least 1250 mm

Tools, measuring and testing means

Folding rule, pencil, try square, frame saw (cross-cut saw), cutting angle = 120°

Auxiliary accessories

Saw horses, bench (carpenter's bench)

Necessary previous knowledge

Measuring, scribing, reading of drawings

Explanations to the working drawing

1 – required length

Sequence of operations	Comments
1. Prepare the working place.	Check for completeness.
2. Place the material on the saw horses or clamp the material in the carpenter's bench.	The number of the saw horses depends on the length of the board.
3. Scribe the board according to the drawing, mark the cutting line nearly square to the grain with a pencil.	Ask for the sizes of the required length; consider the length allowance; check the scribed line with the try square.
4. Select and check the fram saw.	Cuts across the grain require push-and-pull cutting, check the sharpness of the saw.

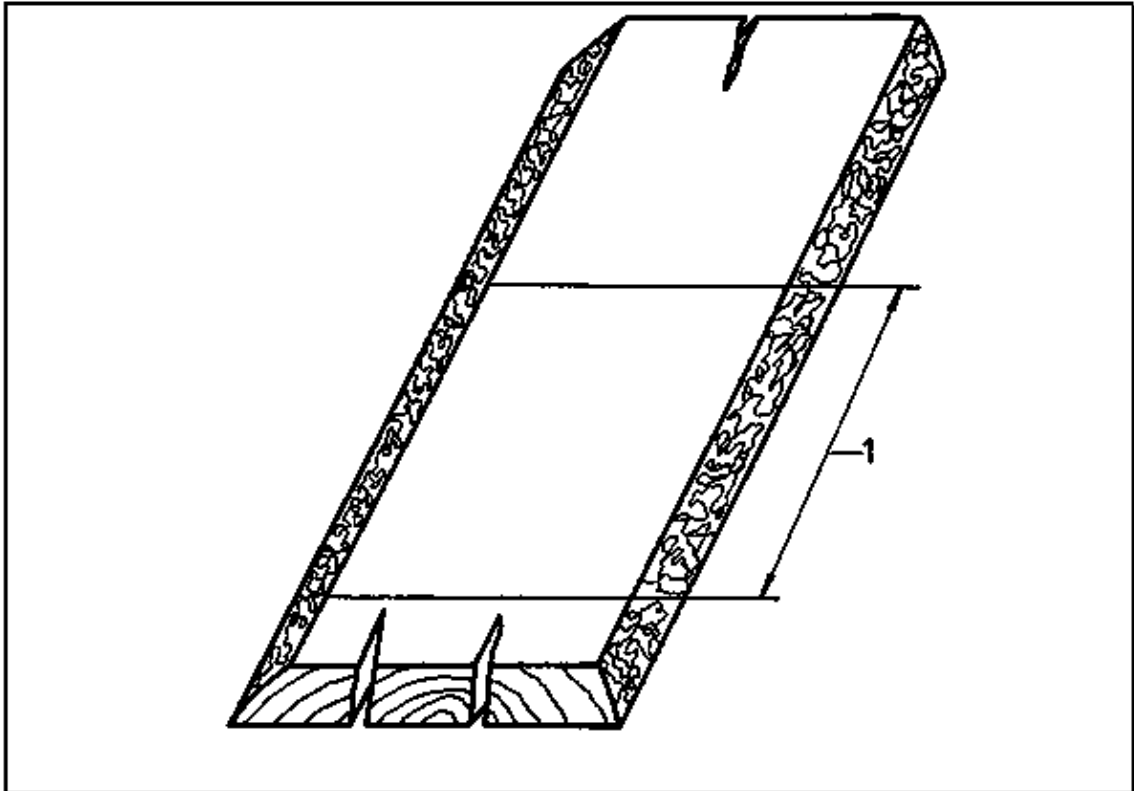
5. Cut off the board's end. Guide the sawing tool in an acute angle to the surface of the workpiece.

6. Cut the board to length.

Prevent tilting over of the board standing out.

7. Check the result.

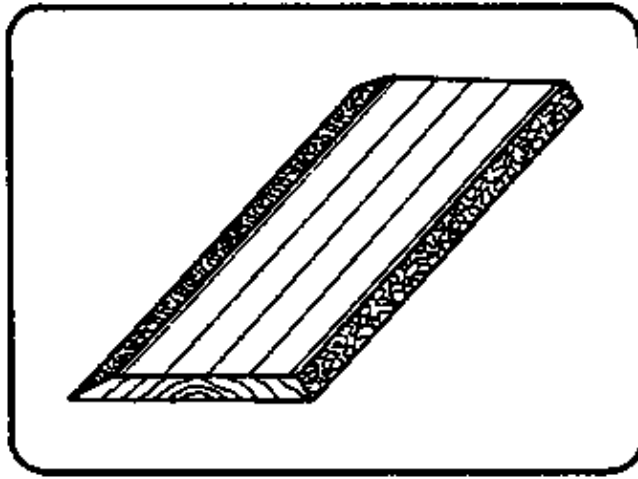
The boards cut to length are used for the second instruction example.



				2.1.
IBE	Cutting to Length of a Board			3302

Instruction Example 2.2. Cutting to Length of Strips (Frame Strips)

Strips shall be manufactured from the board cut to length acc. to instruction example 2.1.



Material

A board cut to length as per instruction example 2.1.

Tools, measuring and testing means

Folding rule, pencil, try square, straightedge, frame saw (ripping saw), pad saw, cutting angle = 90°

Auxiliary accessories

Saw horses, carpenter's bench

Necessary previous knowledge

Measuring, scribing, reading of drawings

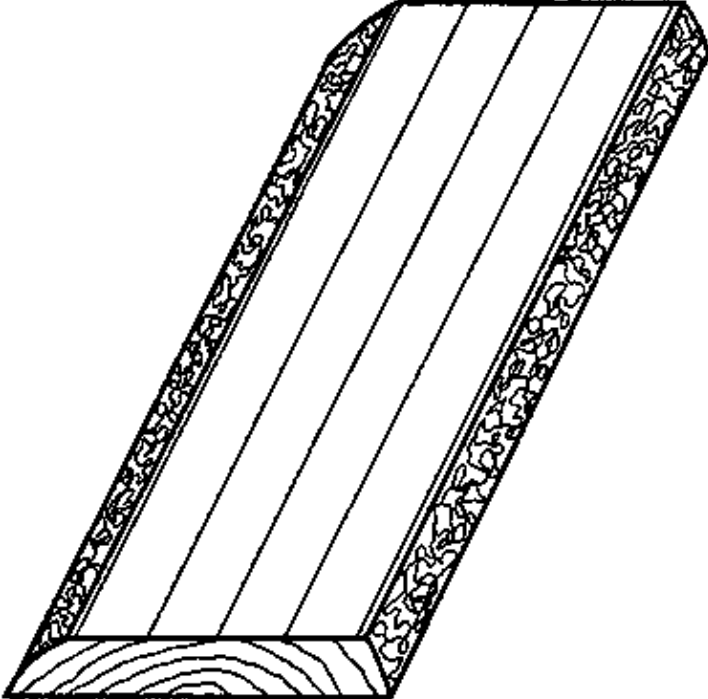
Sequence of operations	Comments
1. Prepare the working place.	Check for completeness.
2. Place the material on the bench.	
3. Scribe the side line on the natural bevel and the width lines of the strips.	Consider the width allowance and the cuts.
4. Clamp the workpiece in such a way that the cutting line runs parallel to the bench's edge.	When cutting to length with the grain <i>push-type cutting teeth</i> are required; check the sharpness of the saw.
5. Select and check the saw.	
6. Cut off the natural bevel (edging).	
7. Clamp the workpiece again.	

8. Cut off the strips.

Repeat until the required number of strips is produced.

9. Check the result.

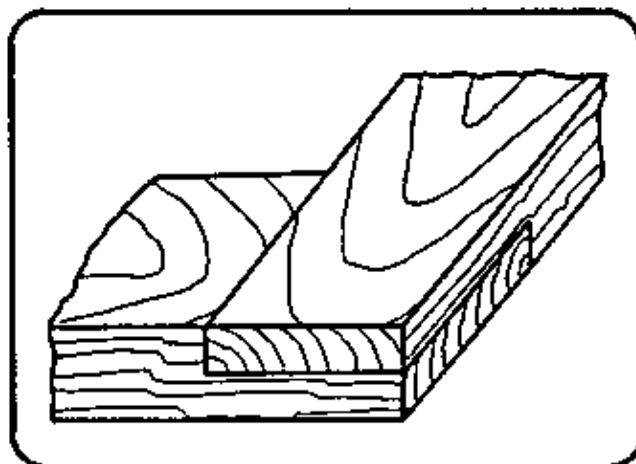
The produced strips are used for the instruction example 2.3.



				2.2.
IBE	Cutting to Length of Strips (Frame Strips)			3302

Instruction Example 2.3. Overlapping Joint

The strips produced in the previous instruction example are now worked after an intermediate operation (planing). Now fine cuts with the grain and across the grain shall follow to manufacture wood connections.



Material

Cut to length and planed out strips from the instruction example 2.2.

Tools, measuring and testing means

Folding rule, pencil, try square, marking gauge, slitting saw, fine tooth wood saw

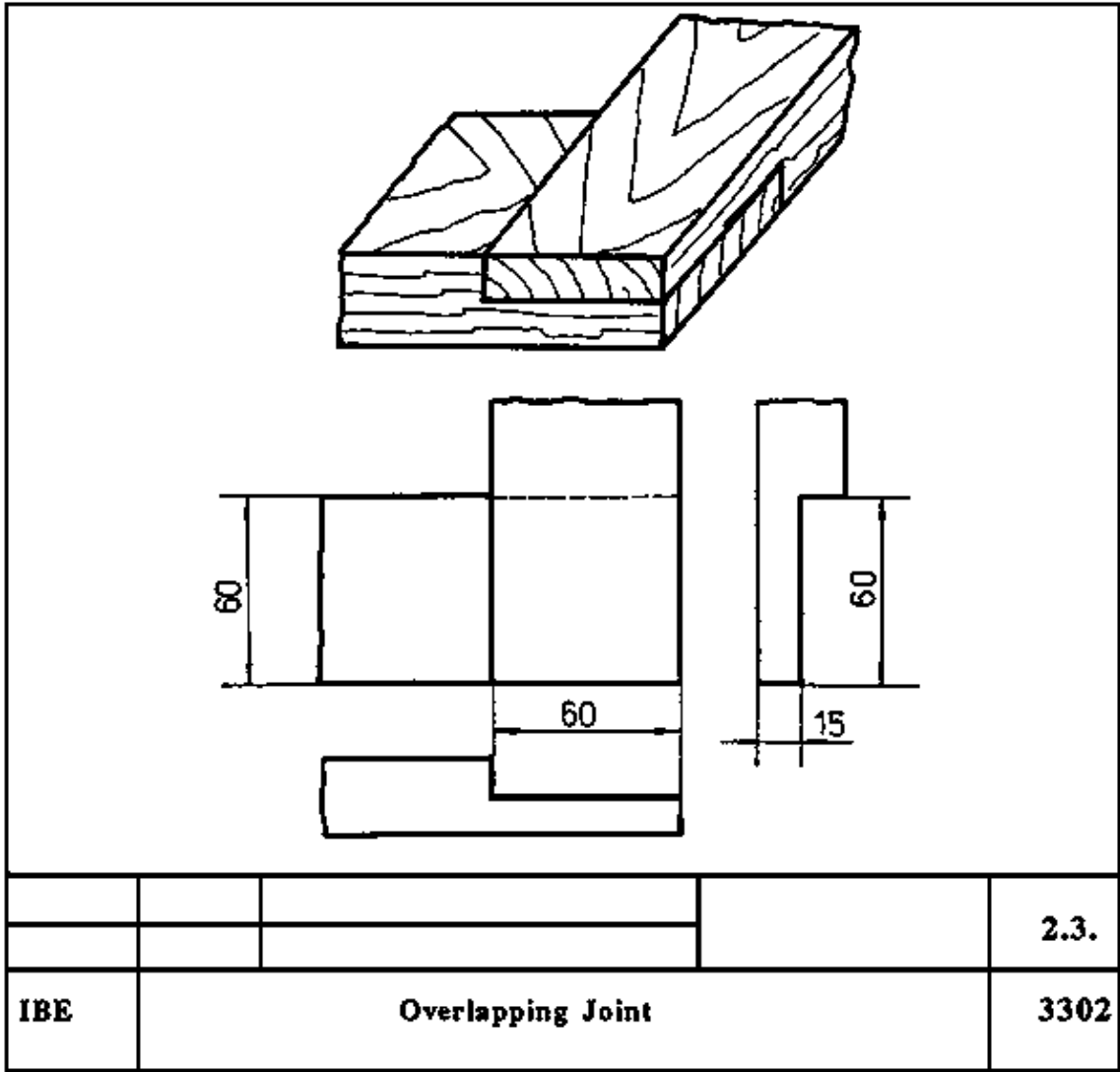
Auxiliary accessories

Carpenter's bench

Necessary previous knowledge

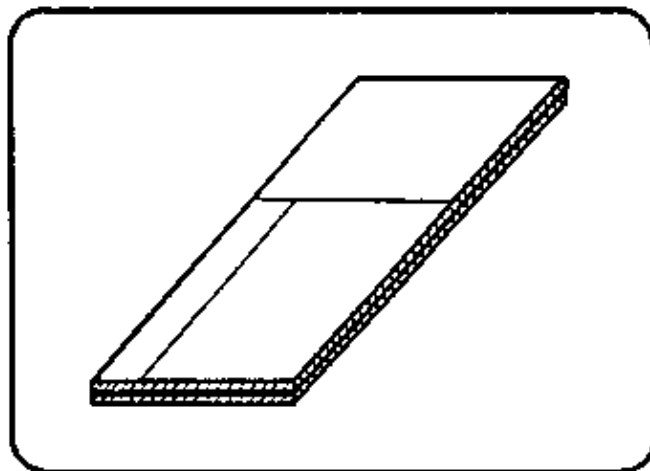
Measuring, scribing, reading of drawings

	Sequence of operations	Comments
1.	Prepare the working place.	Check for completeness.
2.	Draw the frame strips together.	The best side of the frame strips shows in-wards; mark as datum edge.
3.	Scribe all length sizes (length of the frame wood and of the overlapping wood).	Clamp and scribe parallel strips together.
4.	Scribe the working sizes along the thickness of the workpiece.	With a workpiece thickness of "a" the thickness of the half joint should be "a/2".
5.	Clamp the frame strips vertically.	
6.	Check the slitting saw.	
7.	Saw with the grain.	Guide the saw horizontally and steadily; leave half of the scribed line.
8.	Clamp the frame strips horizontally.	
9.	Check the fine tooth wood saw.	
10.	Cut the steps of the half joint.	A precise cut is necessary for the tightness of the joints.
11.	Check the result.	



Instruction Example 2.4. Cutting of Plies

The cutting of panels shall be practised on chipboards, fibreboards and plies.



Material

A ply

Thickness: 4 mm

Tools, measuring and testing means

Folding rule, pencil, try square, straightedge, frame saw and pad saw (push-and-pull type cutting teeth)

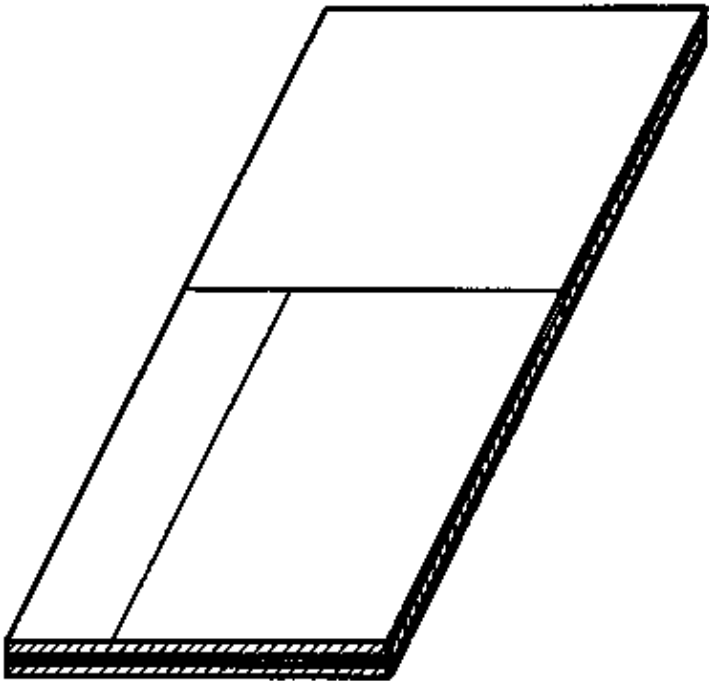
Auxiliary accessories

Saw horses, carpenter's bench

Necessary previous knowledge

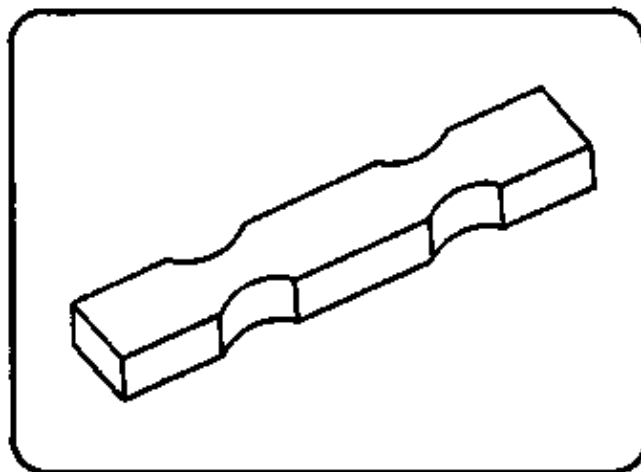
Structure of a ply, measuring, scribing, reading of drawings

Sequence of operation	Comments
1. Prepare the working place.	Check for completeness.
2. Place the ply on the bench.	
3. Select and mark the datum edge.	It should be straight and undamaged.
4. Scribe the width of the workpiece.	Take into account the working allowance and mark the cutting line with the straightedge.
5. Select and check the saw.	Select a frame saw or a pad saw depending on the accessibility of the cutting line.
6. Cut off.	
7. Scribe the cross cuts by means of the try square.	Take into account the working allowance.
8. Perform crosscutting.	Attention with the end of the cut – prevent splintering!
9. Check the result.	The panel can be used to fill the frame from the instruction example 2.3.

			
			2.4.
IBE	Cutting of Plies		3302

Instruction Example 2.5. Curves

Practising of curve-shaped cuts on solid wood and on panel material made of wood



Material

Planed boards

Length: 1000 mm

Width: 100 mm

Thickness: 20 mm

Tools, measuring and testing means

Folding rule, pencil, try square, stencil, fret saw

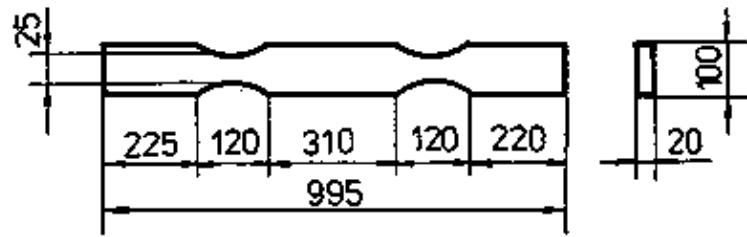
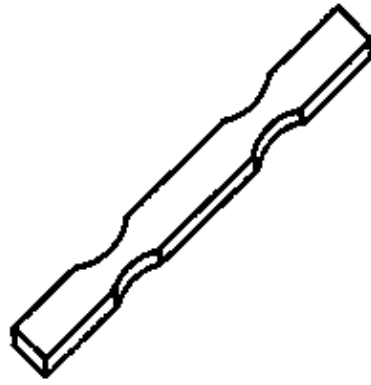
Auxiliary accessories

Carpenter's bench

Necessary previous knowledge

Measuring, scribing, handling of stencils, sawing with the grain and sawing across the grain

Sequence of operations	Comments
1. Prepare the working place.	Check for completeness.
2. Place the material on the bench.	
3. Scribe the curves.	Measure the position of the curves and mark the cutting line with the help of the stencil, take into account the working allowance.
4. Clamp the workpiece vertically.	
5. Check the fret saw.	Set the saw blade angle.
6. Cut out the curves.	Hold the board at the free end with the left hand.
7. Clamp the workpiece again.	
8. Cut out the rest of the curves.	
9. Check the result.	



			2.5.
IBE	Curves		3302

**Sawing – Course: Manual woodworking techniques. Trainees'
handbook of lessons**

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Sawing – Course: Manual woodworking techniques. Trainees' handbook of lessons

Institut für berufliche Entwicklung e.V.
Berlin

Original title:
Arbeitsmaterial für den Lernenden
“Sägen”

Author: Fritz Dienemann

First edition © IBE

Institut für berufliche Entwicklung e.V.
Parkstraße 23
13187 Berlin

Order No.: 93–35–3302/2

1. The Purpose of Sawing

Sawing means to separate wood and wood-based materials by cutting in a thin saw kerf.

We distinguish between

- sawing across the grain (cross cutting)
- sawing with the grain (ripping)
- curving and
- sawing for making wood joints.

2. The Basic Construction of Sawing Tools

During sawing particles are removed by the sawing teeth in a saw kerf.

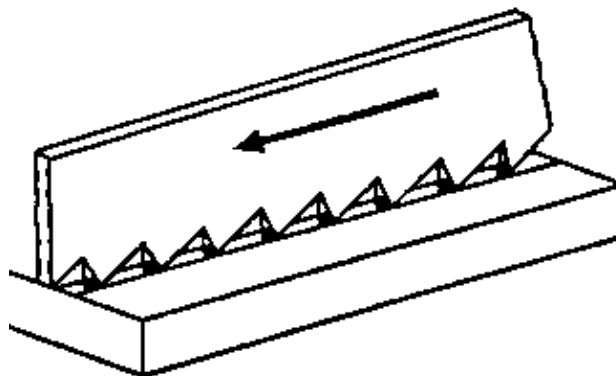


Figure 1 Cutting by saw teeth

Many triangular sawing teeth placed one after the other cut the wooden material.

Which parts does the sawing blade consist of?

1. _____
2. _____
3. _____

4. _____
5. _____
6. _____

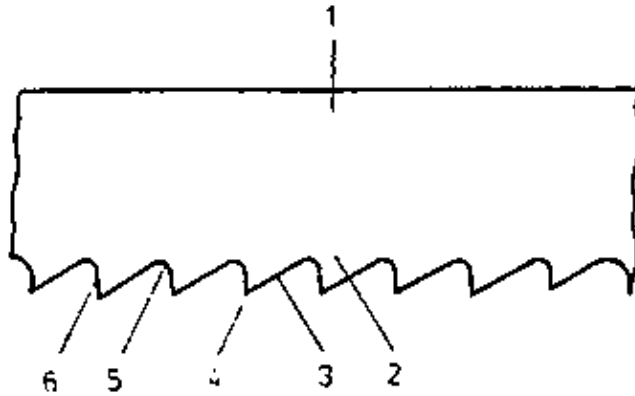


Figure 2 Parts of the saw blade

1 saw blade, 2 saw tooth, 3 tooth space, 4 tooth point, 5 tooth gullet, 6 tooth face

The angle between

- the tooth face and
- the top line of teeth (breast) is responsible for the cutting efficiency of the different types of saws. This angle is called
- cutting angle.

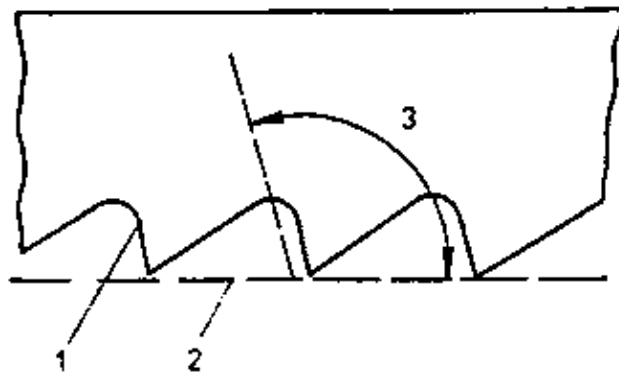


Figure 3 Cutting angle

1 tooth face, 2 tooth top line, 3 cutting angle

For manual sawing the following types of teeth are used:

- The teeth are arranged for push-type cutting
 - the cutting angle is 90°
 - cutting is effected in pushing direction only
 - high effort is necessary
 - well suitable for sawing of wood *with* the grain
 - not suitable for sawing of wood *across* the grain and of chipboards.

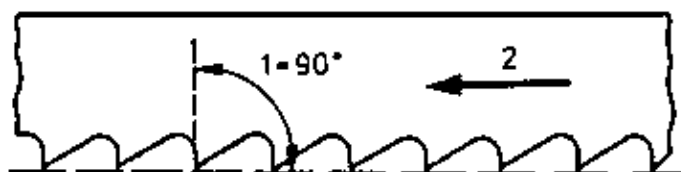


Figure 4 Push-type cutting teeth

1 cutting angle at 90° , 2 cutting is effected in pushing direction

- The teeth are arranged for push-and-pull type cutting
 - the cutting angle is larger than 90°
 - cutting is effected in pushing direction and scraping in the opposite direction
 - low effort is necessary
 - well suitable for sawing of wood *across* the grain
 - when sawing wood *with* the grain there is a low cutting efficiency

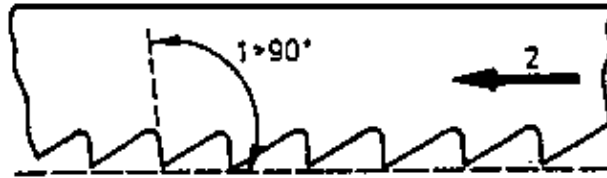


Figure 5 Push-and-pull type cutting teeth

1 cutting angle larger than 90° , 2 cutting is effected in pushing direction

How do hand saws work?

The teeth of the saw blade are bent alternately to the left and to the right of the saw teeth top line to avoid jamming of the saw in the wood during sawing.

- This bending of the teeth is called setting.
- Set saws make it possible for the saw blade to move freely in the kerf.



Figure 6 Set teeth

- The kerf is wider than the saw blade's thickness.

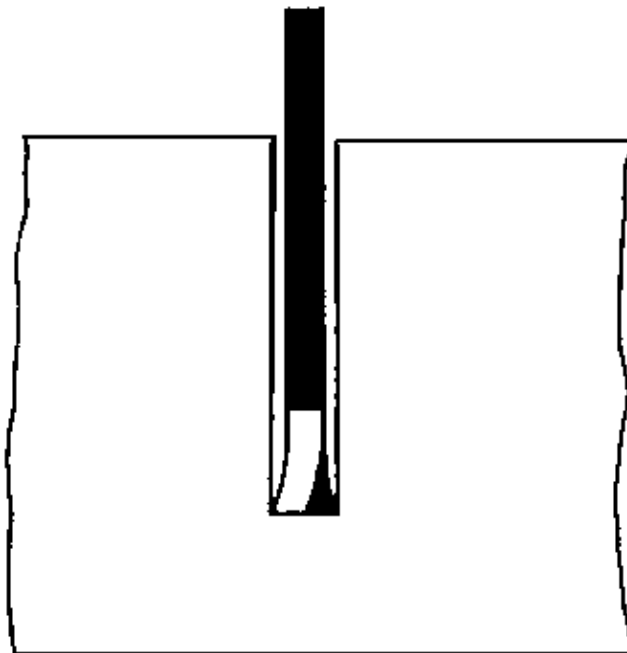


Figure 7 Saw blade with kerf

What are the reasons for jamming of saws in the wood?

3. Types of Saws

Different sawing tools are applied for the different requirements in manual woodworking and are divided into the groups of frame saws and frameless saws.

Frame saws

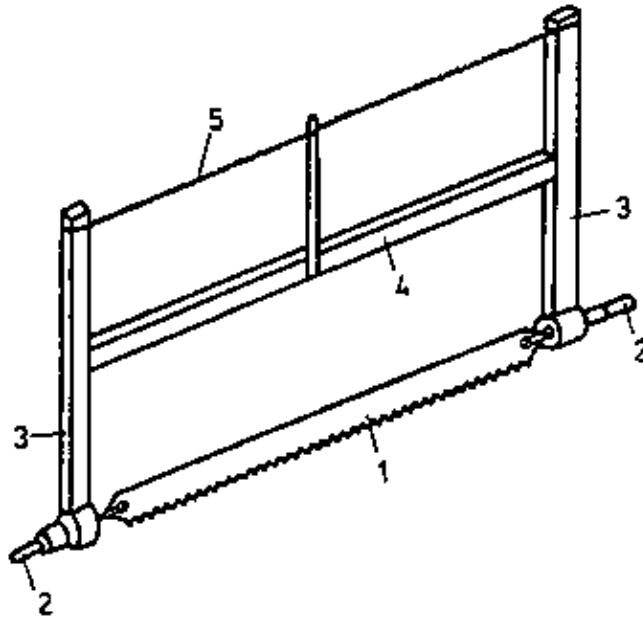


Figure 8 Frame saw

1 saw blade, 2 saw knobs, 3 saw arms, 4 stretcher, 5 tensioning device

The parts of a frame saw are called:

1. _____
2. _____
3. _____
4. _____
5. _____

- Frame saws are applicable for nearly all processes in manual woodworking.
- The necessary tension of the saw blade in the frame is reached with the help of the saw arms, the saw knobs, the stretcher and the tensioning device.
- The saw blade can be fixed in any position to the arms.

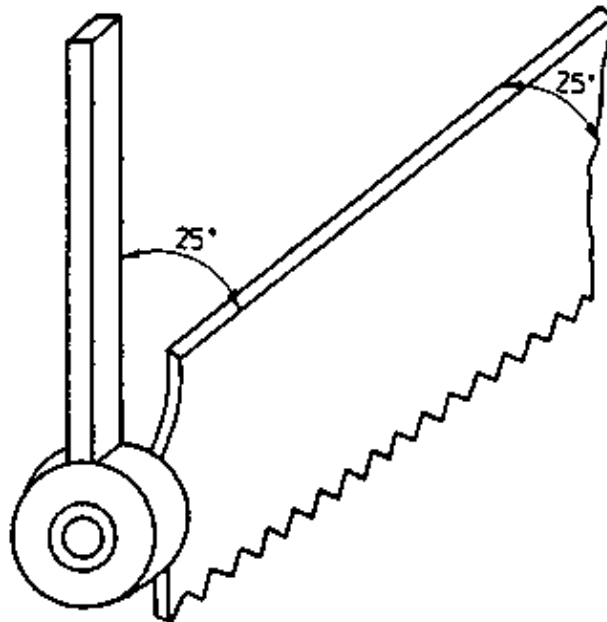


Figure 9 Adjustable saw blade

– In frame saws there can be clamped saw blades with *push-type* or *push-and-pull type* cutting teeth.

List 1 shows frame saws with their features and application.

Table 1: Frame saws with their features and application

Designation	Features	Application
Ripping saw	– cutting angle – 90°	– cuts with the grain
	– tooth depth = 5 mm	– edging and dividing of boards
	– coarse cuts	
	– works fast	
Cross-cut saw	– cutting angle = 120°	– cuts across the grain
	– tooth depth = 5 mm	– cutting to length
	– coarse cuts	
	– works fast	
Slitting saw	– cutting angle = 100°	– short and precise cuts with the grain
	– tooth depth = 3 mm	
	– precise cuts with the grain	– slitting
Fine tooth wood saw	– cutting angle = 110°	– fine cross cuts
	– tooth depth – 2 mm	– cutting of steps
	– precise cuts	
Fret saw (turning saw)	– cutting angle = 110°	– cuts in all directions
	– tooth depth = 2 mm	– cutting of bends
	– blade width = 10 mm	– cutting of curves

– the saw blade can be unhinged

What kind of cuts in wood are saws with *push-and-pull* type teeth especially suitable for?

Frameless saws

Frameless saws consist of a saw blade and a handy grip. The saw blade has a sufficient stability or it is provided with a back support. Form and size of the saw blade as well as the tooth form are determined by its application. Table 2 shows frameless saws with their features and application.

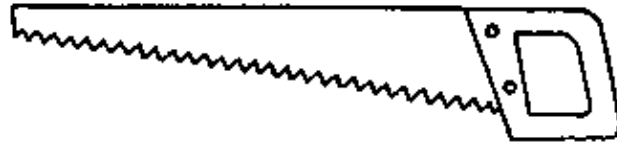


Figure 10 Cross-cut saw

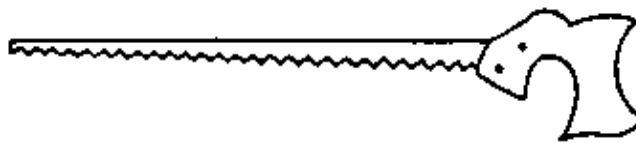


Figure 11 Compass saw

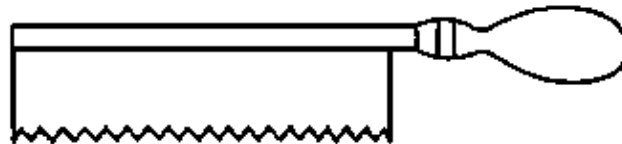


Figure 12 Fine saw

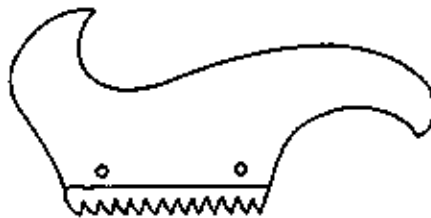


Figure 13 Arris saw



Figure 14 Veneer saw

Table 2 Frameless saws with their features and application

Designation	Features	Application
Cross-cut saw	– trapezoidal saw blade	– for smaller sawing cuts
	– tooth depth = 3...5 mm	– for cutting of panels
Compass saw	– narrow, pointed saw blade	– cutting out openings
Fine saw	– right-angled saw blade	– cutting of strips (fillets)
	– tooth depth = 1.5 mm	– bevel cuts (mitre cuts)

Arris saw (Grooving hand saw)	– the blade's back is tightly screwed in the wooden grip	– cutting in grooves
	– pull-type cutting	
Veneer saw	– saw blade with double tooth shape	– sawing of veneer

4. Sharpening of Sawing Tools

Only with perfect and sharp saws you can cut quickly, easily and precisely. Blunt saws make the job more difficult and cause a bad cutting quality.

The sharpening of saws is to be divided into the following steps:

- fasten the saw blade in the clamping device (hand vice)
- check the tooth top line and, if necessary, adjust it
- thereafter file out ground teeth
- set the teeth, i.e. the teeth are bent alternately
- sharpen the saw (file the teeth)

First set the teeth and then file!

Sequence of operations

- Check the tooth top line; examine the tooth top line for straightness or standing out tooth points.

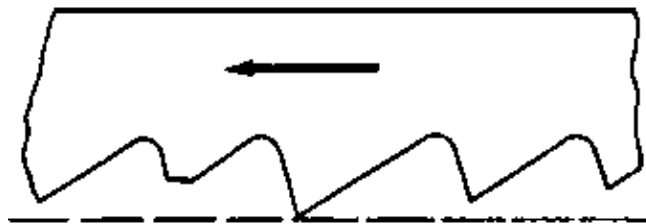


Figure 15 Unequal tooth points

- If there are standing out tooth points adjust them with a flat file.

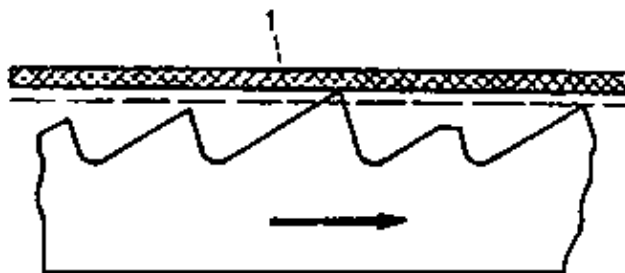


Figure 16 Adjusting the tooth points

1 flat file

- When adjusting smaller teeth file out with a three-square file.

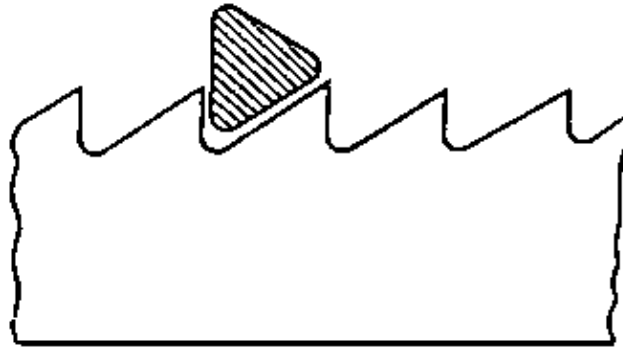


Figure 17 Filing out the tooth spaces

– Setting of the teeth

With an alternately lateral bending of the saw teeth out of the tooth top line a free cutting action of the saw is achieved.

Saws can be set with

- a saw set or
- a saw set plier.

With a saw set you set by bending off the upper part of the tooth.

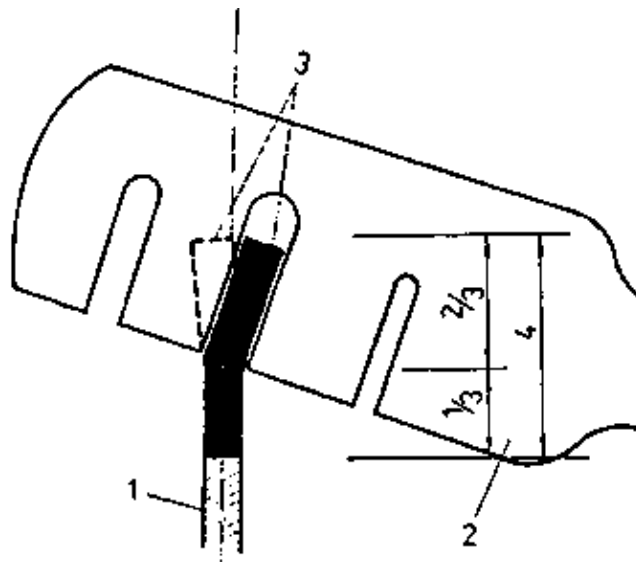


Figure 18 Saw set

1 saw blade, 2 saw set, 3 bent saw teeth, 4 saw tooth length

With a saw set plier saws are set more uniformly. The width of set can be adjusted with an adjusting screw on the plier.

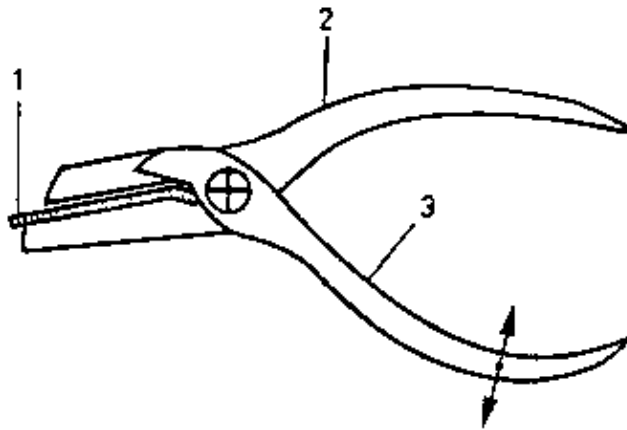


Figure 19 Saw set plier

1 saw blade, 2 stationary lever of the plier, 3 movable lever which bends the saw tooth to the desired set width

What tools are saws set with before being filed?

– Sharpening of the saw (filing of the teeth)

- Select a three–square file with a cross–section that is equal to the form of the tooth space.
- Guide the file at right angles to the saw blade and file the tooth face and the tooth back at the same time.
- Sharpen all teeth with the same number of file strokes.. Badly filed teeth are sharpened again with a few file strokes.

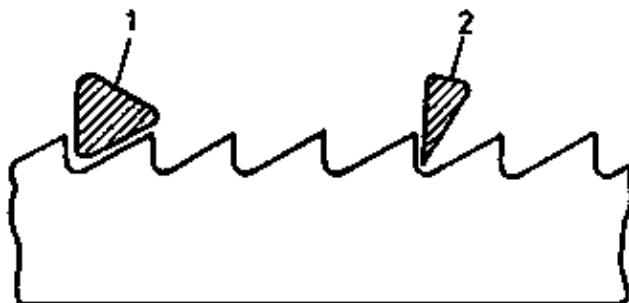


Figure 20 Cross–section of a file

1 correct cross–section, 2 wrong cross–section

Why must the file always fill out the whole tooth space?

Files must have a tight–fitting handle in order to avoid injuries. Sticking dirt has to be removed with a solvent from the file.

What mistakes have been made with this useless and badly filed saw?

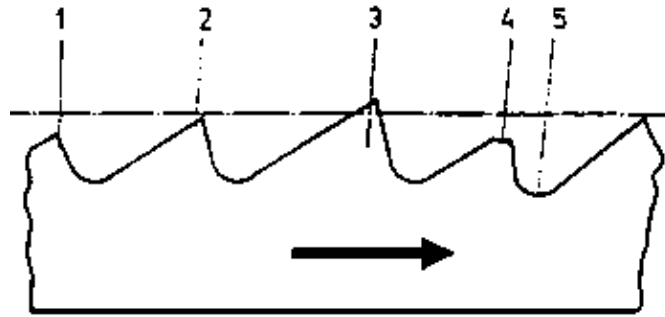


Figure 21 Badly filed saw teeth

1 correct tooth form, 2 tooth point too low, 3 tooth point too high, 4 broken-off tooth, 5 tooth space distance too much

1. Correct tooth form _____
2. _____
3. _____
4. _____
5. _____

5. Working Rules for Sawing of Wooden Materials

- Selection of the appropriate saw.
- Checking the saw for serviceability.
- The thumb of the left hand supports the correct placing of the saw close to the scribed line.
- With the first cut draw back the sawing tool at an acute angle.

Be careful with the first cut, avoid stumbling of the saw – risk of injury!

- Firm stand, body at rest, only arm work out of the shoulder joint.
- Move the sawing tool smoothly, slightly pushing it forward and drawing it back without pressure. Relax the arm and use the total blade length.
- Guide the saw blade vertically along the scribed line when sawing curves and sawing with the grain with the ripping saw, otherwise guide it along the scribed line at an acute angle to the surface of the workpiece.
- Use the full length of the saw blade.
- When the cutting through is nearly finished the left hand grips over the cut so that the falling piece will not break off. Lift both the parts a bit.
- Pay attention to the working data.
- Check the workpieces for wood defects and woodworking errors.

Badly placed cuts can be hardly corrected during sawing. Frame saws are stored unclamped and in hanging position after end of work.

Why must the full saw blade length be used when sawing?

Why must the saws always be placed on the opposite side of the marking?

**Operations on Band and Circular Sawing Machines – Course:
Mechanical woodworking techniques. Instruction examples for
practical vocational training**

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Operations on Band and Circular Sawing Machines – Course: Mechanical woodworking techniques. Instruction examples for practical vocational training

Institut für berufliche Entwicklung e.V. Berlin

Original title:

Lehrbeispiele für die berufspraktische Ausbildung
"Arbeiten an Band- und Kreissägemaschinen"

Author: Johannes Schollbach

First edition © IBE

Institut für berufliche Entwicklung e.V.
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13187 Berlin

Order No.: 93–33–3401/2

Preliminary Remarks

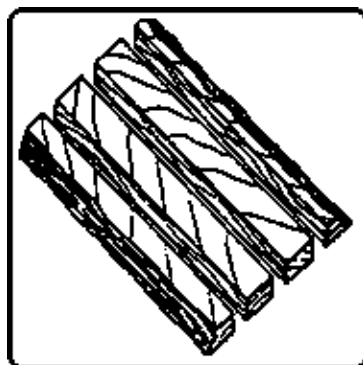
This material contains five instruction examples for practising the sawing of straight–line oblong, cross and angle cuts on the circular sawing machine, equally sawing curved oblong and cross–cuts on the band sawing machine.

In order to facilitate preparations and operations the necessary materials, machines and tools, measuring and testing means besides aids have been indicated, similarly also required preliminary knowledge for the exercises. The added work sequence sets out the sequence of steps for undertaking the exercises. Each instruction example has a workshop drawing indicating the size and shape of the workpieces. The execution of cuts true to both size and shape constitutes the preliminary stage to further processing workpieces determining the ultimate quality of the final product. Commensurately, practising pieces complying with practical work tasks were selected as instruction examples. These are all single items which, following further processing, become usable objects: frames for various purposes, individual parts of a wall shelf. The linear measures are recommended lengths which may be aligned to local conditions by the trainees.

Instruction Example 1.1.: Frame Sections

Undertaking oblong cuts using the circular saw bench for seaming and cutting frame sections to width.

Material



Unseamed boards

Length: 1200 mm
 Width: 200 mm
 Thickness: 45 mm

Machines and tools

Circular saw bench, circular saw blade with acute-angled teeth or gullet teeth

Measuring and testing means

Folding rule

Aids

Straight edge, feed strip, pencil

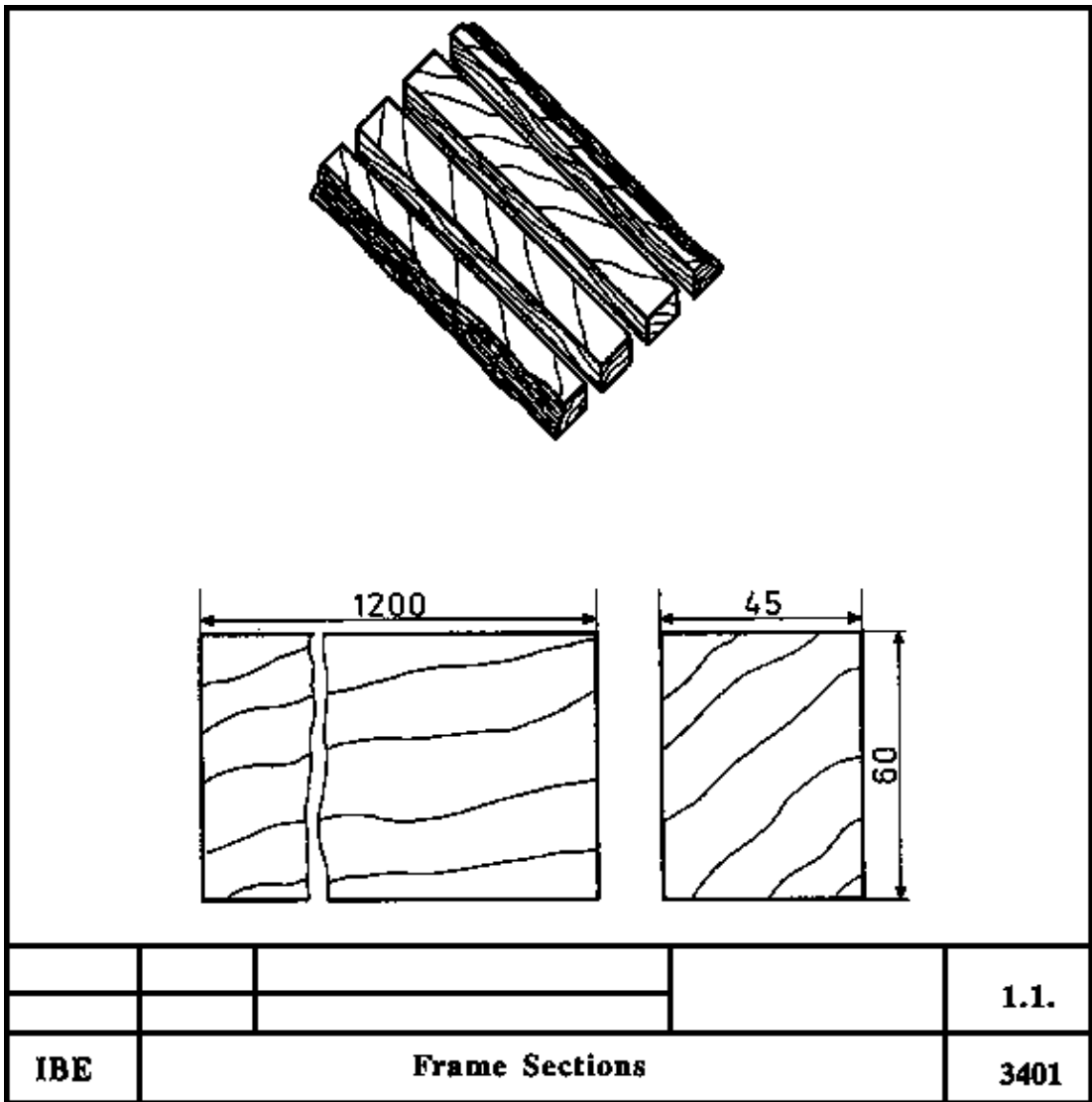
Necessary previous knowledge

Measuring and marking

Sequence of operations	Comments
1. Position material, mark with pencil and straight edge onto the board.	Mark so that the external edges are rectangular after cutting. Saw blade teeth tips should only protrude slightly beyond the workpiece thickness, set splitting wedge max. 10 mm behind the saw blade, guard hood must be 20 mm above the saw blade circle.
2. Set saw blade to workpiece thickness, set splitting wedge and guard hood.	
3. Switch on the machine and seam the board as marked through oblong cut.	Oblong cut at scribed line requires special attention.
4. Switch off the machine.	
5. Check the seamed narrow face.	Check the seamed narrow face for evenness visually or with straight edge.
6. Following machine standstill set stop rule at the width.	
7. Switch on the machine and cut the board to width.	Push the board through with feed strip.
8. Switch on the machine.	
9. Check the board for dimensional accuracy, if required reset the stop rule.	Undertake dimensional inspection using folding rule.
10. Oblong-cut the remaining boards, switch off the machine.	Ensure a tidy workplace, remove chippings to prevent accidents.

Possible addition

Seam further boards and cut to various frame sections of differing widths.

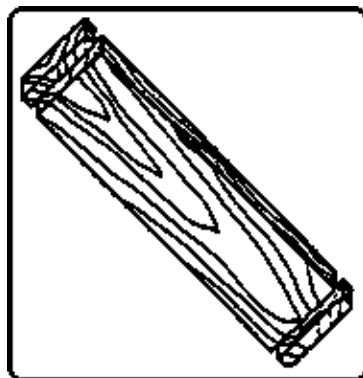


Frame Sections

Instruction Example 1.2.: Frame Sections

Undertake cross-cuts at an angle of 90° using the table circular saw bench for sawing off frame sections cut to width.

Material



Sawn timber from instruction example 1 seamed on both sides

Length: 1200 mm
Width: 60 mm
Thickness: 45 mm

Machines and tools

Circular saw bench, circular saw blade with acute-angled tooth

Measuring and testing means

Folding rule, try square

Aids

Pencil

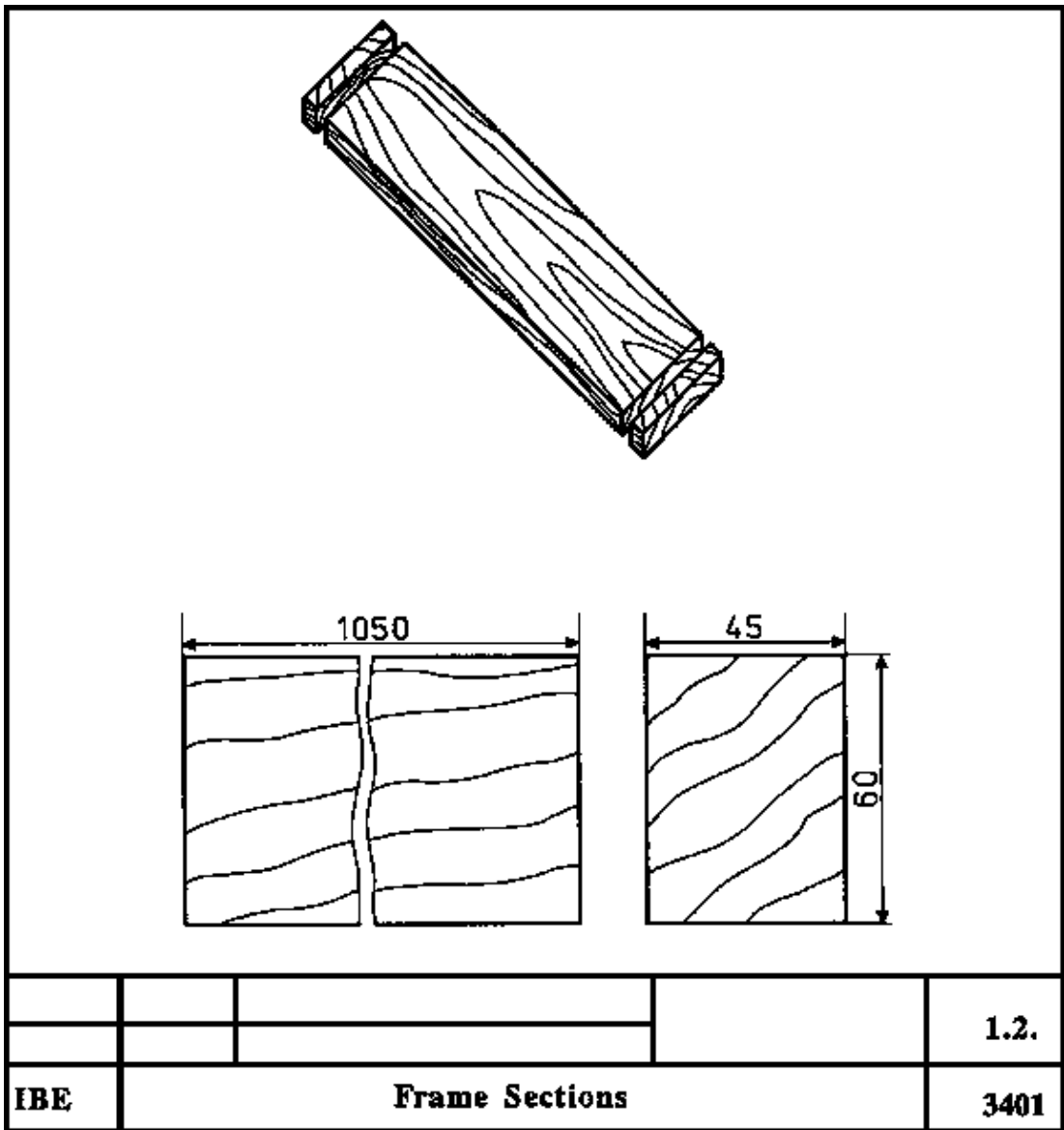
Necessary previous knowledge

Measuring and marking

Sequence of operations	Comments
1. Position material, switch on machine.	
2. Undertake first cross-cut using sliding table.	Sliding table should be easily movable, check angle accuracy of 90°.
3. Mark linear measure at other end of board or at the length setting position of the sliding table.	Mark linear measure using try square and pencil.
4. Undertake second cross-cut at other end of board.	Ensure dimensional accuracy, minimal feed to avoid fraying.
5. Control dimensional accuracy of length.	Undertake dimensional inspection using folding rule.
6. Switch off the machine.	Ensure a tidy workplace, remove chippings to prevent accidents.

Completion

Mill the broad and narrow faces, insert slotted frame connections, glue connections and grind frames for yielding complete, usable frames.

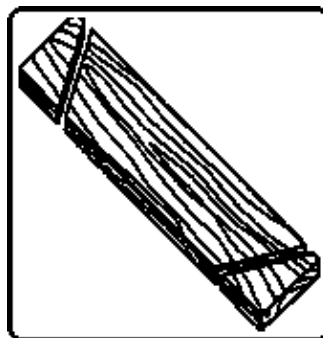


Frame Sections

Instruction Example 1.3.: Frame Sections

Executing angle cuts at an angle of 45° using the circular saw bench to cut off frame sections.

Material



Sawn timber taken from instruction examples 1 and 2

Length: 1050 mm
Width: 60 mm

Thickness: 45 mm

Machines and tools

Circular saw bench, circular saw blade with acute-angle tooth

Measuring and testing means

Folding rule, mitre angle 45° or 135°

Aids

Pencil

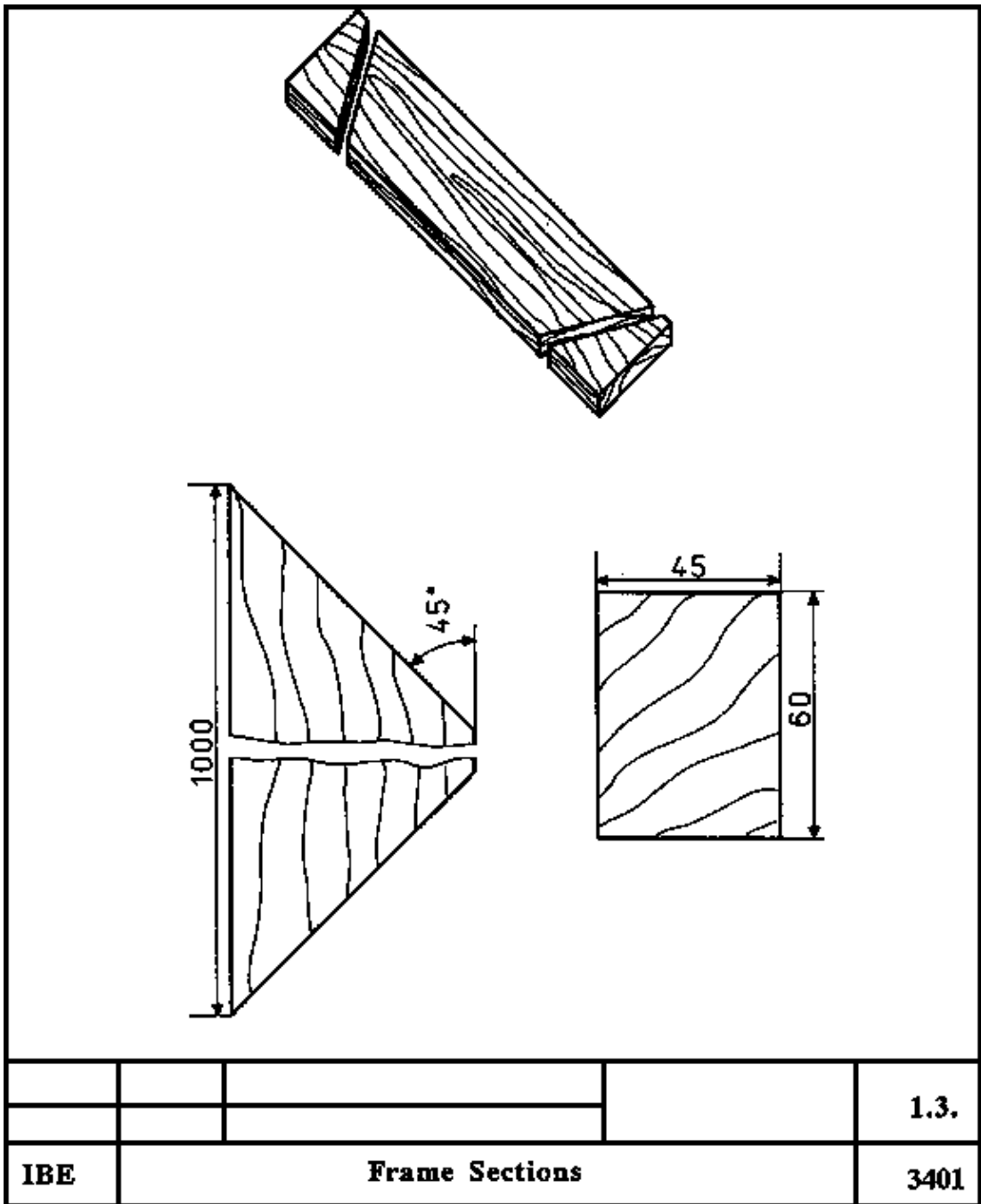
Necessary previous knowledge

Measuring and marking

Sequence of operations	Comments
1. Position material, set sliding table stop to a cutting angle of 45°.	
2. Switch on the machine and undertake two test cuts. Check angle accuracy.	Fold up test piece. Both pieces must when put together form an angle of 90°.
3. Undertake the angle cuts of 45° on all workpiece adhering to the required linear measure.	Low feed rate yields a clean cutting edge and avoids fibre fraying.
4. Check for proper fitting and control dimensional accuracy.	Fit together the frame woods, visually check the mitre joints, dimensional inspection using folding rule.

Completion

Mill the folds, glue the mitre joints, finish and grind the frames and break the edges with abrasive paper for yielding complete, usable frames.



Frame Sections

Instruction Example 1.4.: Curved Frame Sections

Execute curved cuts using the band sawing machine.

Material



Sawn timber with milled wide and narrow faces

Length: 1100 mm
Width: 280 mm
Thickness: 45 mm

Machines and tools

Band sawing machine, wide band saw blade, trammel points

Measuring and testing means

Folding rule

Aids

Pencil

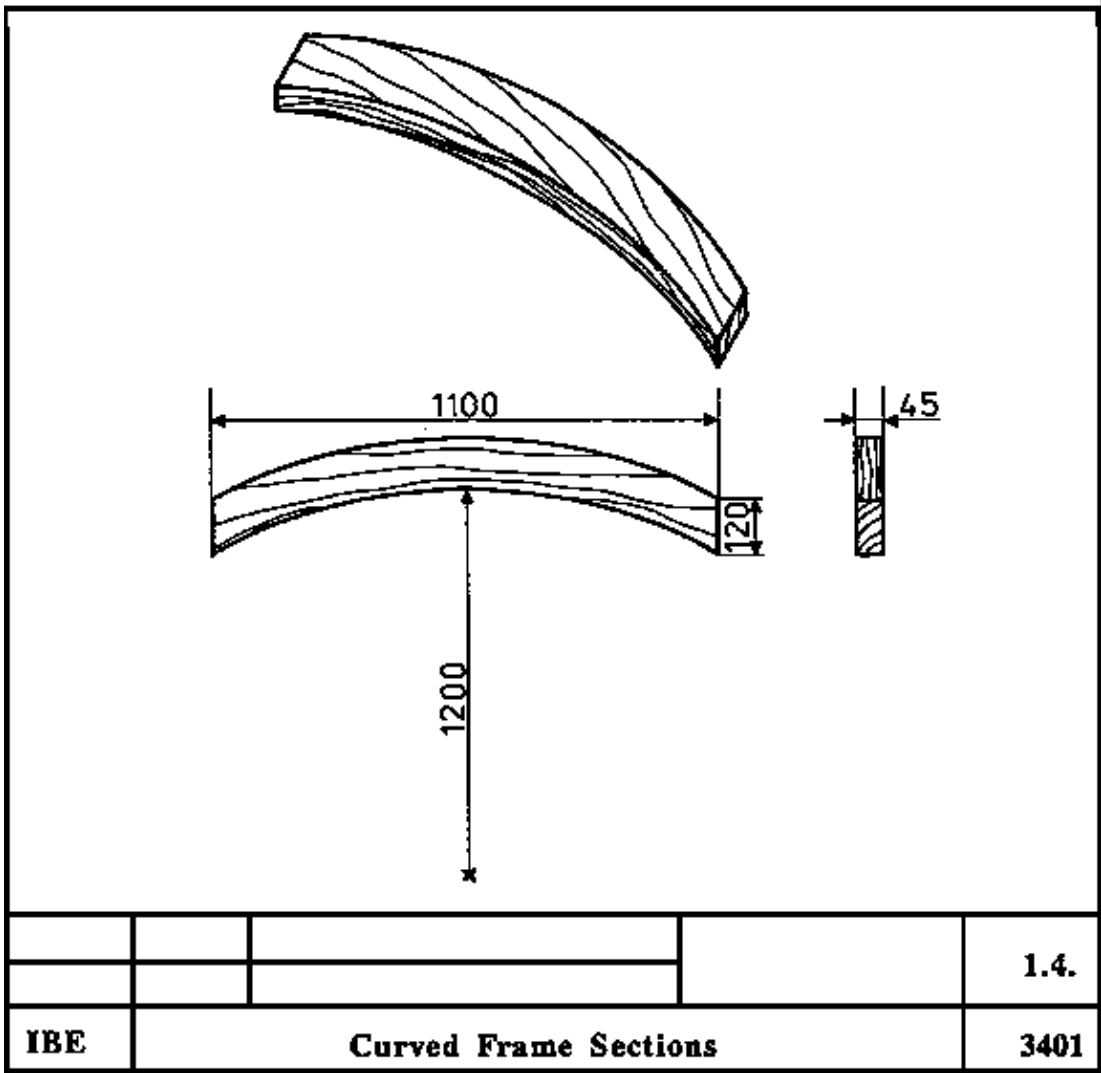
Necessary previous knowledge

Measuring and marking

Sequence of operations		Comments
1. Mark curve on the workpiece.		Use trammel points.
2. Set up band sawing machine:		
	– check saw blade tension	
	– set saw blade roll guide and saw blade covering to workpiece thickness.	
3. Set up the machine and undertake curved cut, freehand, cutting at the scribed line.		Position workpiece securely to sawing table, do not push too quickly. Otherwise saw blade can move away from scribed line.
		Whilst sawing keep hands away from the sawing area.
4. Switch off the machine and cover up the saw blade to the table surface.		Given longer machine standstill, unchuck the saw blade.
5. Control cutting accuracy.		Visually check the concurrence of scribed line and saw cut.

Possible addition

Cut curves of varying dimensions on the band sawing machine.

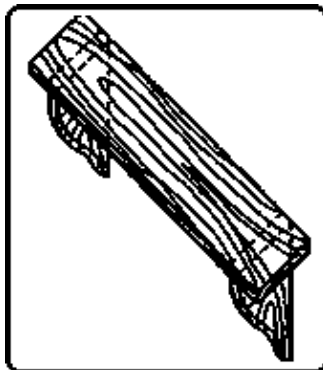


Curved Frame Sections

Instruction Example 1.5.: Wall Shelf

Undertaking oblong, cross and curved cuts on the band sawing machine.

Material



Sawn timber with milled wide and narrow faces (1)

Length: 500 mm
 Width: 150 mm
 Thickness: 20 mm

Sawn timber – milled (2)

Length: 400 mm
Width: 130 mm
Thickness: 20 mm

Machines and tools

Band sawing machine, narrow band saw blade

Measuring and testing means

Folding rule, try square

Aids

Templet for the curve, pencil

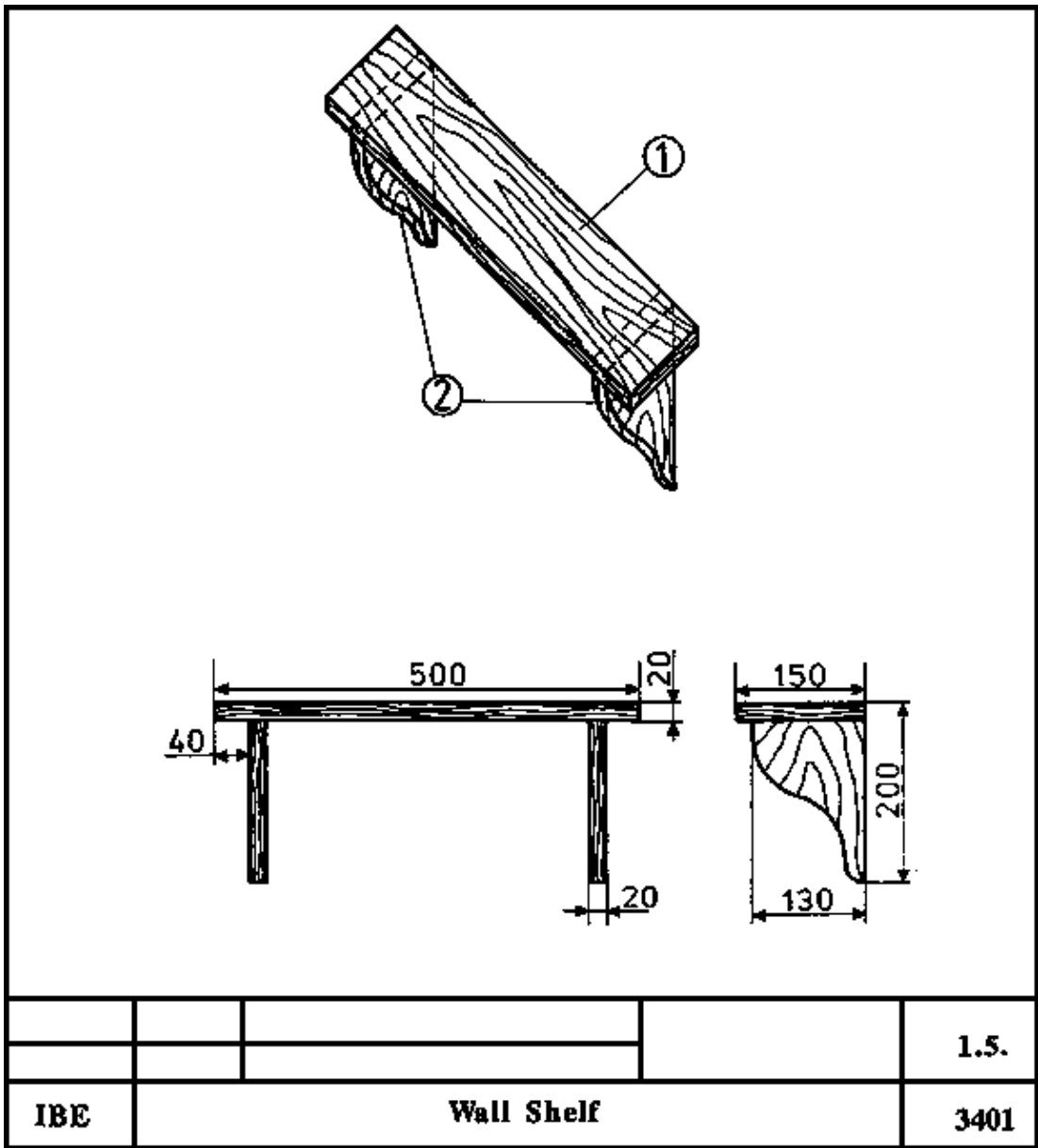
Necessary previous knowledge

Measuring and marking

Sequence of operations	Comments
1. Complete templet.	Make templet manually of plywood or hard cardboard.
2. Check and set up band sawing machine.	Position narrow band saw blade.
3. Set workpiece width on stop rule.	Process parts (1) and (2).
4. Switch on the machine and cut workpiece to width.	Push slowly, otherwise saw blade can disappear.
5. Mark linear measure on the workpieces and cut from length using the angle guide.	Check adjustable angle guide for correct angle setting.
6. Mark curves on the parts (2) according to the templet.	The templet ensures that all curves are like-formed.
7. Cut out the curves freehand at the scribed line.	Ensure that the hands are not in the sawing area during operations.
8. Switch off machine.	
9. Control cutting accuracy.	Visual check.

Completion

Connect parts (1) and (2) by means of burr-joints. Grind the wide and narrow faces, glue burr-joint, break edges.



Wall Shelf

**Operations on Band and Circular Sawing Machines – Course:
Mechanical woodworking techniques. Trainees' handbook of lessons**

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Operations on Band and Circular Sawing Machines – Course: Mechanical woodworking techniques. Trainees' handbook of lessons

Institut für berufliche Entwicklung e.V.
Berlin

Original title:

Arbeitsmaterial für den Lernenden
"Arbeiten an Band- und Kreissägemaschinen"

Author: Johannes Schollbach

First edition © IBE

Institut für berufliche Entwicklung e.V.
Parkstraße 23
13187 Berlin

Order No.: 93–35–3401/2

1. Purpose of Circular Sawing Operations

Circular sawing machines are used for sawing straight-line oblong, cross and angular cuts in solid wood and sheet material.

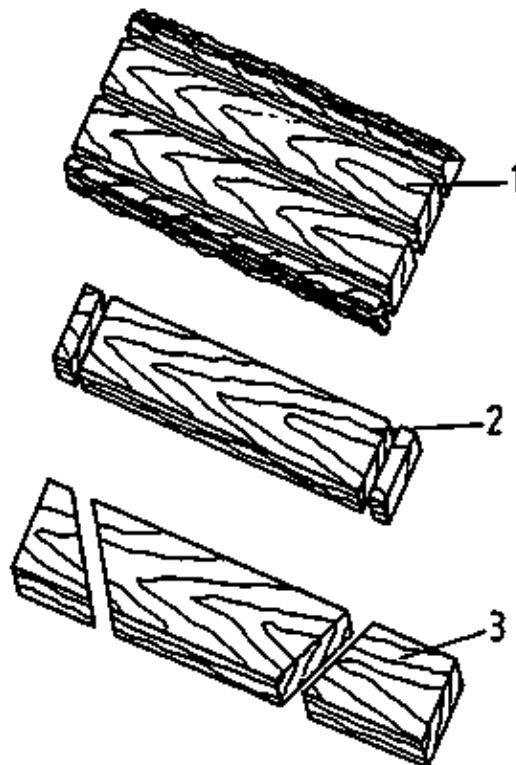


Figure 1 Circular saw machine operations 1 oblong cut, 2 cross-cut, 3 angle cut

Solid woods are seamed and sheet material cut down to width through oblong cuts. Solid woods and sheet material are cut to length through cross and angular cuts.

Which cut varieties are possible on circular sawing machines?

Different types of circular sawing machines are used in wood workshops, for example:

– table circular sawing machine:

is used for straight–line oblong, cross and angular cuts as the most common circular sawing machine

– double–format circular sawing machine:

is used for straight–line and parallel form cuts, particularly of sheet material, is in furniture construction

– hand circular saw:

used for oblong and cross cuts of solid wood and sheet material on building sites and during assembly work.

2. Assembly of a Table Circular Sawing Machine

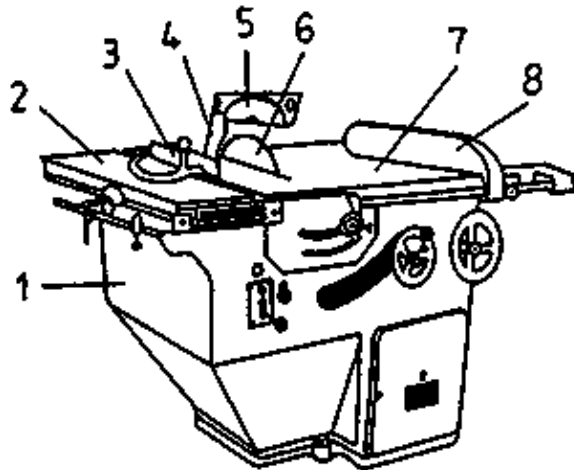


Figure 2 Assembly of a table circular sawing machine 1 stand, 2 receding table, 3 stop for cross and angle cuts, 4 splitting wedge, 5 guard hood, 6 saw blade, 7 machine table, 8 stop rule

Stand

The stand bears the machine table and movable receding table and also houses the height–adjustable motor.

Machine table

The machine table is directly attached to the stand and serves to direct the workpieces to the saw blade.

A stop rule which is adjustable and parallel to the saw blade is on the machine table – to the right of the saw blade. This stop rule serves to set the width of oblong cut workpieces.

Receding table

This is positioned in a movable manner vis-a-vis the stand and serves to undertake cross and angular cuts whose angle setting can ensue by means of a stop.

Motor, motor shaft and saw blade

Motor and motor shaft can be adjusted up to an angle of 45° by means of hand wheels. The saw blade is attached to the saw shaft by means of two flanges and a chucking nut.

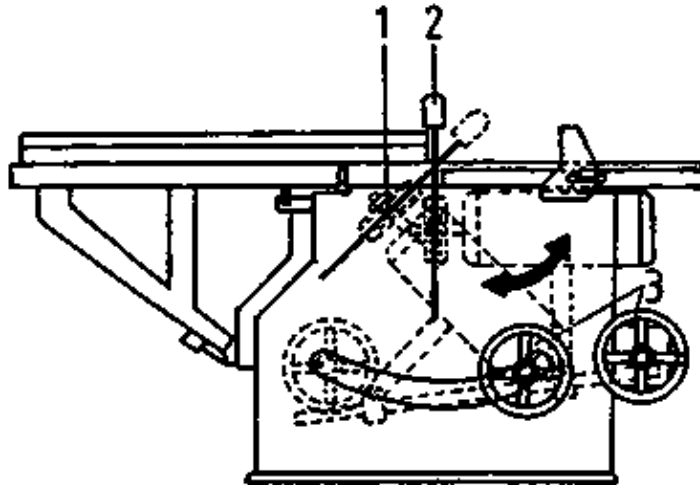


Figure 3 Adjusting the saw blade 1 saw blade at maximum angle setting at 45° – motor swiveling, 2 saw blade in vertical position with motor in horizontal position, 3 hand wheels to adjust the motor

The table edges close to the saw blade and the machinable material are interchangeable.

The distance between saw blade and table edges must not be greater than 3 mm in order to prevent the drawing in of narrow wood pans!

Protective facilities

Splitting wedge and guard hood are protective devices of the circular sawing machine. The machine shall not be used without these protective facilities, otherwise considerable accident risk!

The splitting wedge is adjustable and aligned to the curve of the saw blade whereby the distance from saw blade shall not exceed 10 mm!

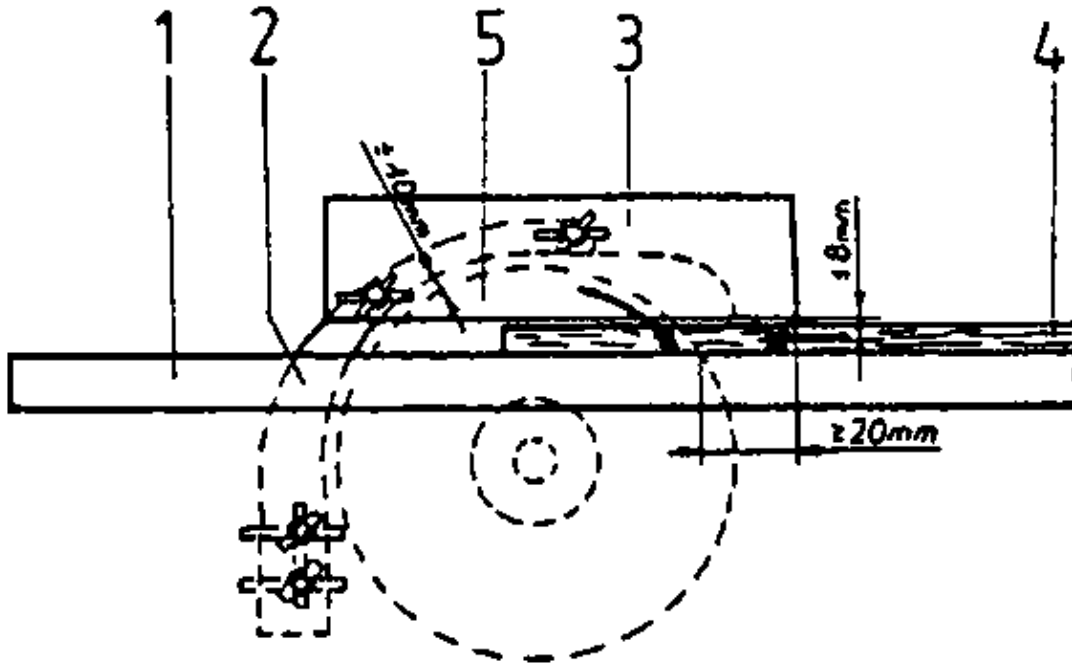


Figure 4 Required protective distances 1 machine table, 2 splitting wedge, 3 guard hood, 4 workpiece, 5 saw blade

The splitting wedge is safeguarded from slipping, adjusting or moving upwards and shall keep apart the separated workpieces thereby ruling out upward and backward sliding of the workpiece. The guard hood is attached to the splitting wedge and consists of machinable material. The saw blade is thus covered up from above. Chips arising are deflected through an escape slot.

The guard hood must protrude 20 mm above the cutting circle of the saw blade feed in the machine table!

Distance of guard hood to workpiece surface shall not exceed 8 mm in rest position!

During the cutting operation the guard hood shall only expose the saw blade section required for cutting. After the cutting operation is over the saw blade must be completely concealed.

If these hints are not observed serious accidents may result!

What is the purpose of the splitting wedge?

What is the purpose of the receding table?

What is the stop rule employed?

3. Tools

The circular saw blades are the tools of the circular sawing machine. These saw blades are circular-shaped steel disks with spikes which may be differently shaped.

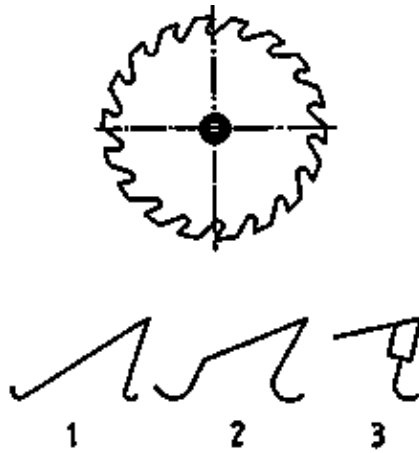


Figure 5 Teeth shapes of circular saw blades 1 acute–angled tooth (normal tooth), 2 gullet tooth, 3 tooth with hard metal tips

These saw blades are suitable for the following applications given normal strain in hand feed operation:

- saw blade with sharp–angled tooth (normal tooth): oblong and cross cuts of hard wood, soft wood and sheet material
- saw blade with gullet tooth: oblong cuts of hard wood, moist and dry soft wood
- saw blade with hard metal tool tips: oblong and cross cuts of hard and compact wood varieties, chip– and fibreboards, plastic materials

Circular saw blades with sharp and gullet teeth are usually saw set whereby the teeth may be bent to the right or left (setting width of 0.3 to 1.0 mm).

In the case of circular saw blades with hard metal tool tips the cutting tip of the cutting edge is wider than the backing material of the saw blade.

In order to prevent the saw blades from jamming in the kerf and to avoid frictional saw blade heating, the saw blades must cut "freely".

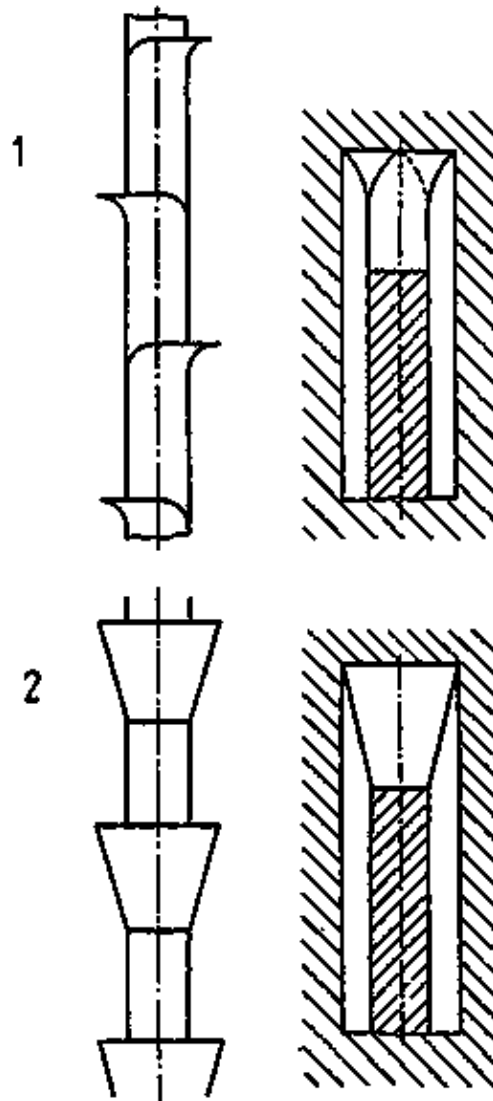


Figure 6 Free cut of saw blades 1 setting of normal teeth, 2 relief grinding for hard metal cutting tips

The following hints are to be taken into consideration:

Check condition of circular saw blade before using!

Do not use cracked, deformed, wobbling and unbalanced saw blades!

Do not exceed the top speed indicated on the saw blades!

Blunt and resined saw blades must be replaced.

In the case of reground hard metal tipped circular saw blades the cutting tip thickness must be at least 2 mm.

Hard metal tipped saw blades with successively impaired cutters or cutters more than 10 per cent worn shall no longer be used.

Which saw blades are used for cutting hard wood, soft wood and sheet material?

How can unimpeded cutting of various circular saw blades be guaranteed?

4. Mode of Operation of a Circular Sawing Machine

The saw blade brought into play by an electric motor separates solid wood and sheet material longitudinally and crosswise to grain direction.

Stop rule and receding table facilities permit the cutting of size-accurate workpieces. This results in a rough cutting edge which must be further processed.

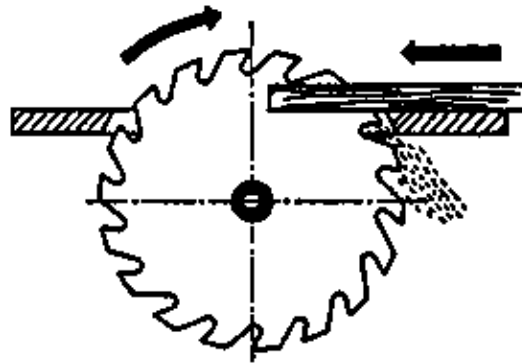


Figure 7 Mode of operation of circular sawing

5. Circular Sawing Technology

5.1. Oblong cuts

Marking the workpiece:

Marking ensues with pencil and straight edge in line with the sizes cited in the technical drawing or the widths of the unseamed plank edges. The seam cut is so marked that the uneven, rind-covered narrow face falls down after cutting and the board has rectangular outer edges.

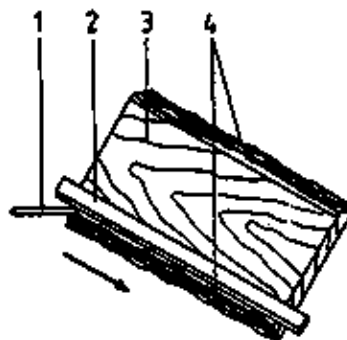


Figure 8 Marking the hem cut 1 pencil, 2 straight edge, 3 plank face, 4 seam edges

Setting up the circular saw:

The saw blade with the desired tooth form is chucked in line with the material being processed whereas the projection depends on the workpiece thickness. Subsequently splitting wedge and guard hood are set.

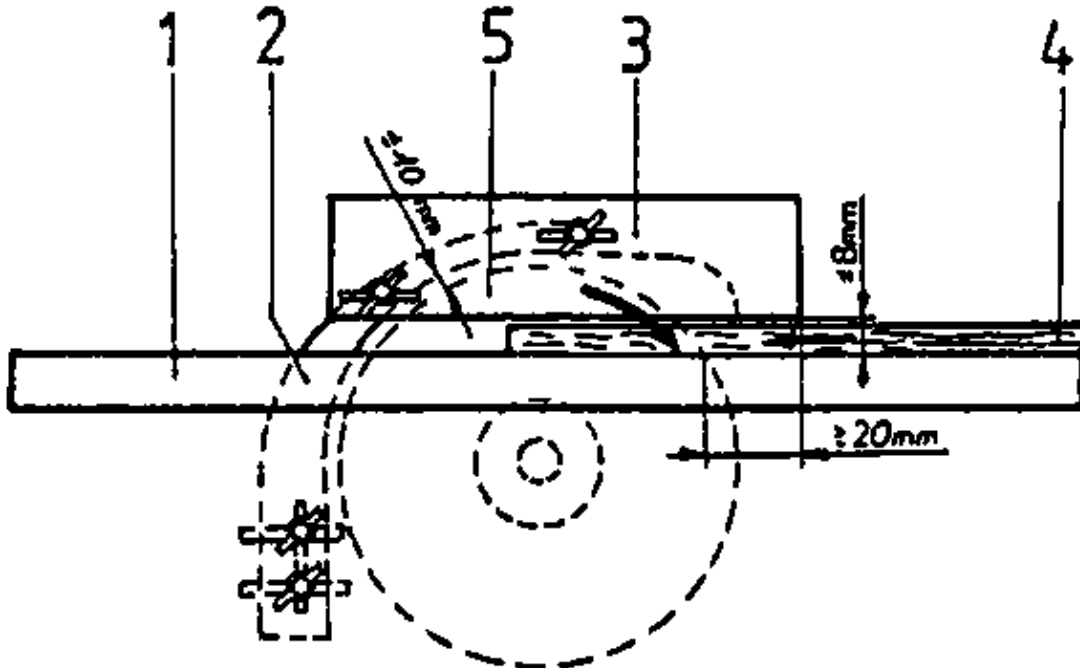


Figure 9 Setting up the circular saw 1 machine table, 2 splitting wedge, 3 guard hood, 4 workpiece, 5 saw blade

Saw cut execution:

The machine is switched on. Check saw blade for smooth running.

Unseamed planks are sawn freehand according to marking. Grip and guide the plank to the side of the marking.

Following the seam cut, the stop rule is set to the desired board width. By means of the feed strip the board at the stop rule is pushed through the saw blade.

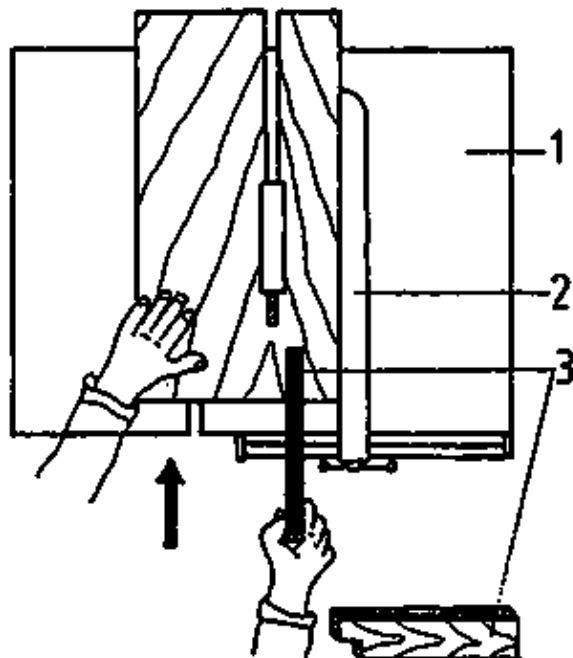


Figure 10 Sawing oblong cuts 1 machine table, 2 stop rule, 3 feed strip

Employ noise reduction means!

Check the saw cuts:

Size control ensues by means of the folding rule. The evenness of the cut edges is checked using the straight edge or visually.

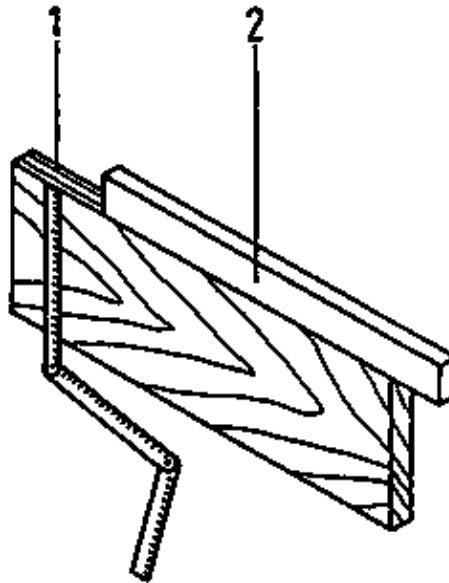


Figure 11 Controlling saw cuts *1 size control with folding rule, 2 evenness control with straight edge*

Reset the stop rule if board width inaccuracies arise. After sawing, switch off the machine and remove saw chippings to prevent stumbling.

How is the seam cut marked?

What must be heeded when setting up the circular saw?

Why must a feed strip be used?

5.2. Cross and Angular Cuts

Producing a reference edge:

The board is cut laterally or at the required angle on one end face. Commensurately, set the stop on the receding table to which the board is positioned during sawing. The cross-cut is so marked that minimal cut-back results.

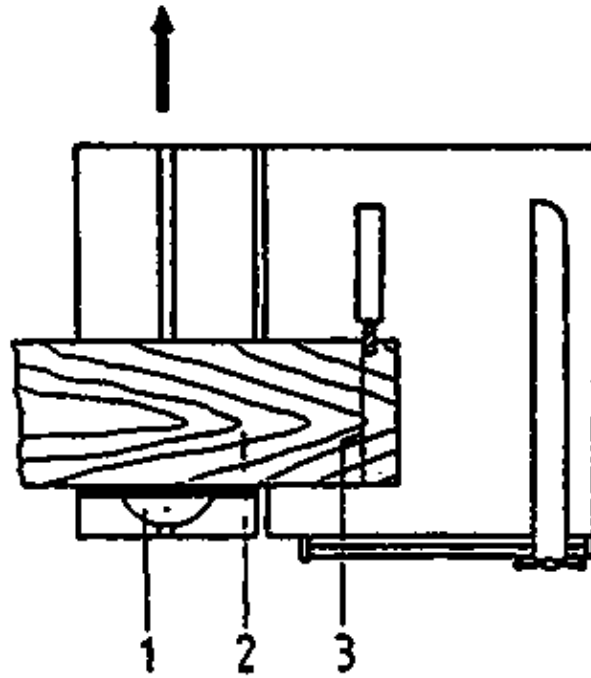


Figure 12 Producing a reference edge 1 stop on machine table, 2 workpiece, 3 mark

Marking the length:

The required length is marked at the other board end or at the stop of the receding table in line with the lateral or angle cut.

Sawn kerf execution:

The plank with the receding table is fed slowly through the saw blade.

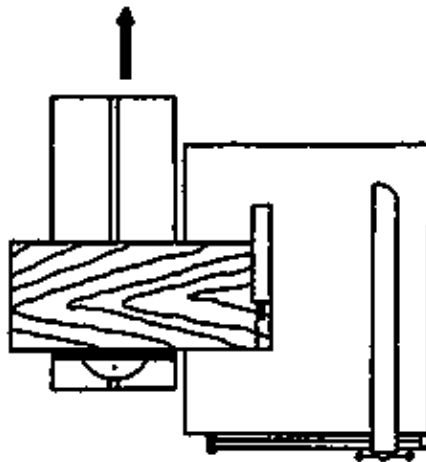


Figure 13 Saw cut with the receding table

Checking size consistency:

The size consistency of lengths is checked by means of the folding rule. Rectangular cross-cuts are checked using the try square. Mitre cuts of 45° are checked by means of a mitre angle of 45° or 135° whilst an angle measuring device is used for other angles.

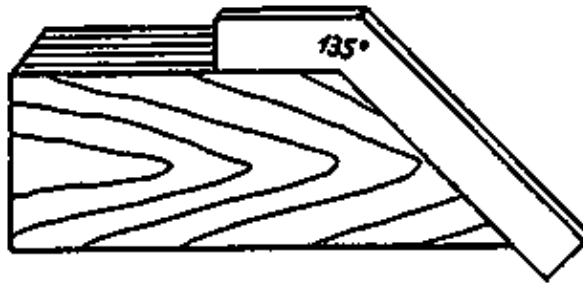


Figure 14 Checking mitre angle

How can angle cuts be accurately attained?

Which operation precedes marking the precise length of a workpiece?

6. Purpose of Band Sawing Operations

Band sawing machines are used for sawing straight-line oblong, cross and angle cuts, equally for curved cuts (curves) of solid wood and sheet material.

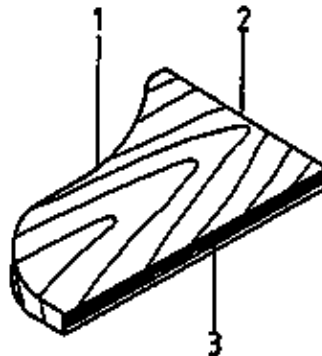


Figure 15 Band sawing machine operations 1 curved cut, 2 cross-cut, 3 oblong cut

Which main difference is there between using a band sawing machine and a circular sawing machine?

7. Assembly of a Band Sawing Machine

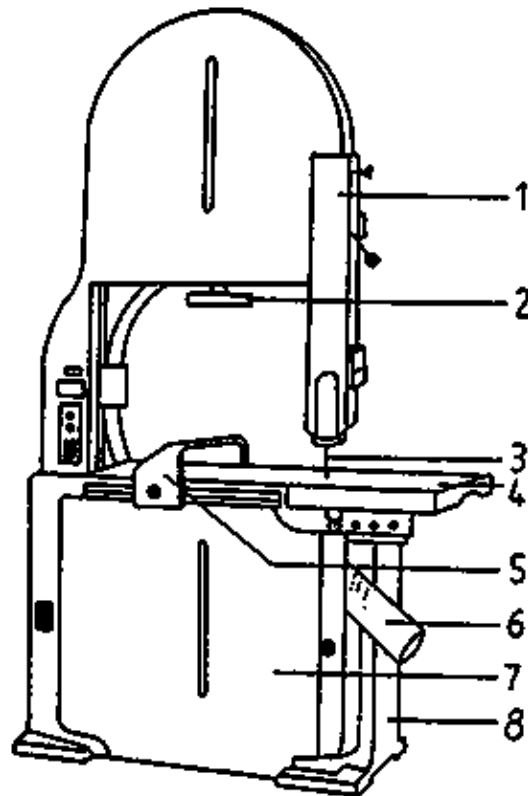


Figure 16 Assembly of a band sawing machine 1 adjustable saw blade sheathing, 2 hand wheel to chuck the saw blade, 3 saw blade, 4 machine table, 5 stop rule, 6 contact/or exhaust facility, 7 casing with lower saw band roll and motor, 8 stand

Stand:

The cast iron stand bears the upper and lower band roll, the machine table and the drive motor of the lower band roll.

Machine table:

The machine table is adjustably supported for undertaking angle cuts. The machine table features an adjustable and pivoted stop rule for parallel cuts.

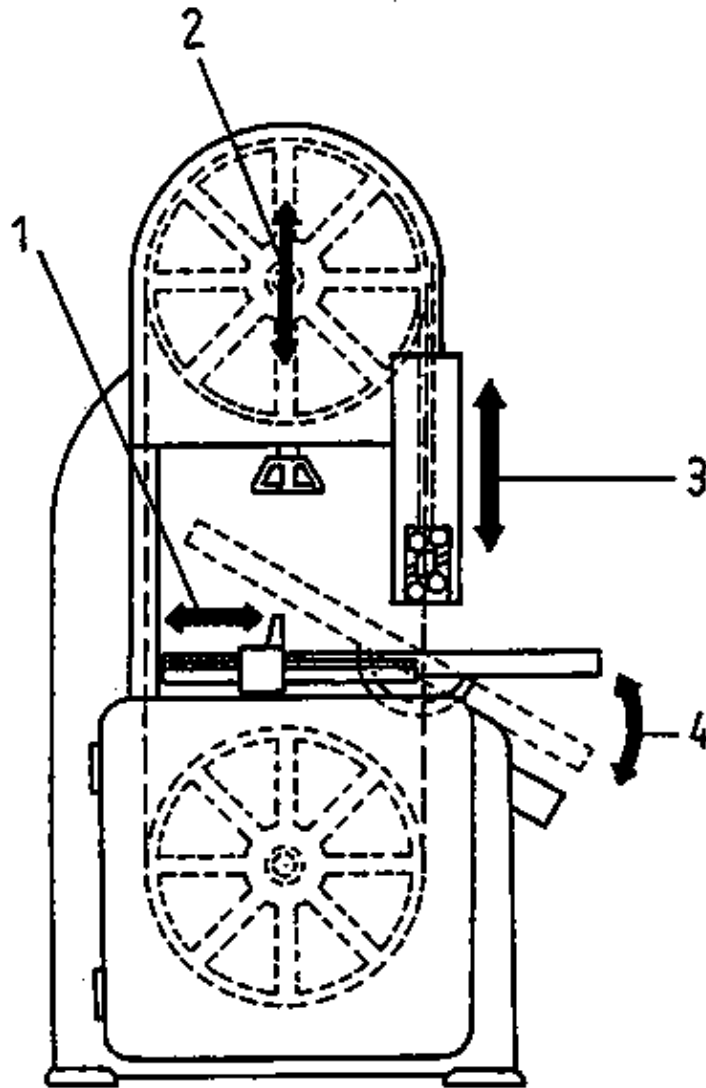


Figure 17 Adjustability of facilities *1 shifting the stop rule, 2 chucking the saw blade, 3 shifting the saw blade sheathing, 4 tilting the machine table*

Band rolls:

The lower band roll is firmly pivoted and driven by a motor.

The top band roll is positioned vertically above the lower band roll. It can be adjusted by means of a hand wheel for chucking the saw blade heightwise.

The shaft of the top band roll is inclined towards the running setting of the band saw blade.

The band rolls have rubber bandages for improved adhesive power of the saw blade.

Check that rubber bandages are clean and not damaged or worn!

Saw blade sheathing:

Both band rolls and the band saw blade section not required for cutting are sheathed. The adjustable saw blade sheathing can be set to the thickness of the material to be cut.

Saw blade guidance:

The top saw blade guidance above the table can be set heightwise to material thickness. The guidance positioned below the machine table is rigid. The saw blade guidance consists of lateral and back guide rolls which absorb the feed pressure of the workpiece.

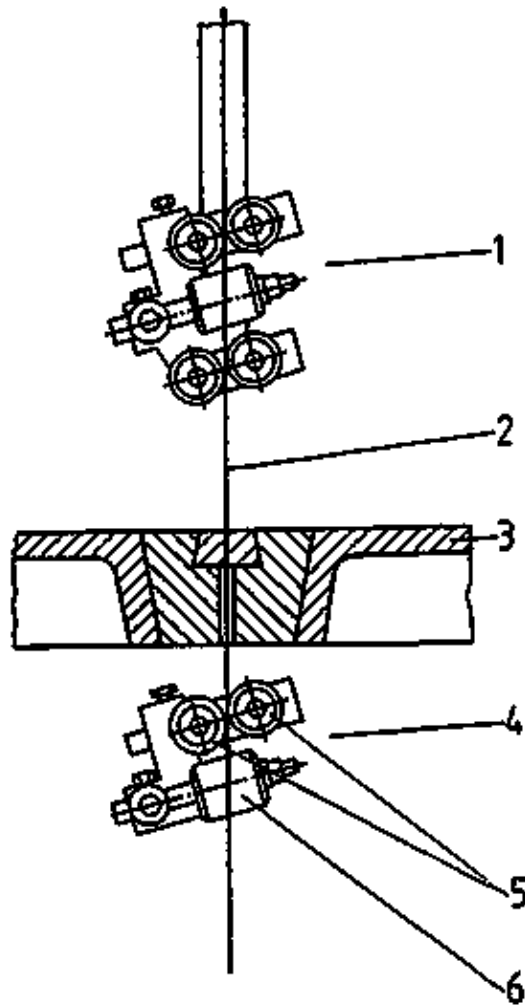


Figure 18 Assembly of saw blade guidance 1 top saw blade guidance, 2 band saw blade, 3 machine table, 4 lower saw blade guidance, 5 lateral guide roll, 6 rear guide rolls

The saw blade teeth must protrude beyond the guide rolls so that the saw blade slides easily through the guide rolls.

The band saw blade is properly set when the unstressed saw blade extends 2 mm plus tooth height above the lateral guide rolls and is then 1 mm away from the back guide roll.

Regulating the top saw blade guide should be possible without any danger whilst the machine is running!

Saw blade guides must guarantee smooth saw blade running. The saw blade sections not used for sawing should be sheathed until they are shortly beyond the workpiece surface.

The saw blade run of the machine table must not exceed 3 mm in width!

The correct setting of the guide rolls must be constantly checked!

Relieve the saw blade during longer machine standstill periods.

Why is the machine table adjustable?

Why is the top band roll movably pivoted?

Why do the band rolls have rubber bandages?

How shall the saw blade guidance be set?

What must be done during longer machine standstill periods?

8. Tools

The tools of band sawing machines are the band saw blades. They are, in point, saw blades combined into an endless band by means of hard soldering or welding, which may be differently arranged in widths, tooth division and height.

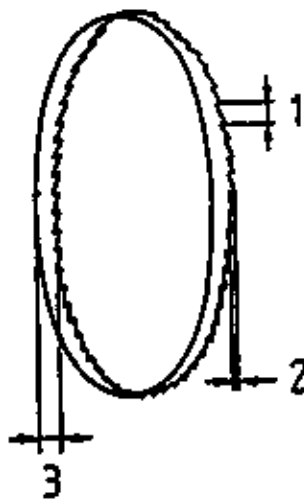


Figure 19 Band saw blade 1 teeth division, 2 teeth height, 3 band width

Generally speaking acute-angled teeth are used. Saw blades with a rough teeth division (8–10 mm) are used for sawing soft wood whilst for hard wood and sheet material saw blades with a smaller teeth division (6–8 mm) are employed. The free cutting of the saw blades is ensured through teeth displacement, less frequently also through linear contraction.

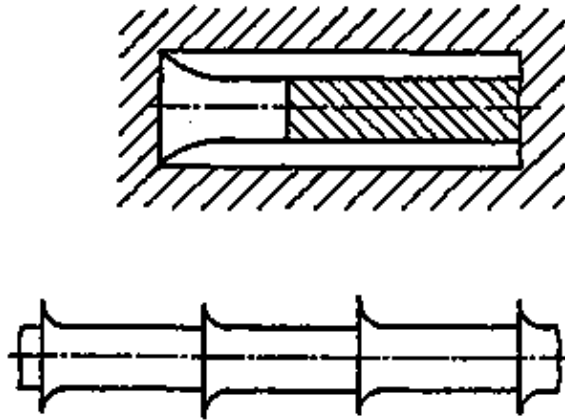


Figure 20 Free cut through saw blade linear contraction

Repairs:

Tom saw bands must be resoldered or rewelded prior to sharpening. The free ends are cut rectangularly, cleaned and inclined to lengths between 10 and 15 mm.

- When the ends are soldered together they must be so positioned to one another that the blade backs at the point of connection are not bent and the original teal division is adhered to. The solder point should re-anneal and only cool off gradually; it is hammered, cleanly filed on both sides and ground to normal blade cross-cut.

- The ends are positioned bluntly to one another, welded and subsequently the welding crust is removed during saw blade welding.

New, freshly soldered or welded saw blades operate idle running for five minutes prior to first actual operations!

Saw blades are stored hung up with the teeth to the wall!

9. Mode of operation of a band sawing machine

The endless saw blade running above the two band rolls separates through chip removal solid wood and sheet material. The small blade width makes possible curved cuts with various fret radii. Parallel, straight-line oblong or cross-cuts can be undertaken at the stop rule. This results in a rough cutting edge which requires further processing.

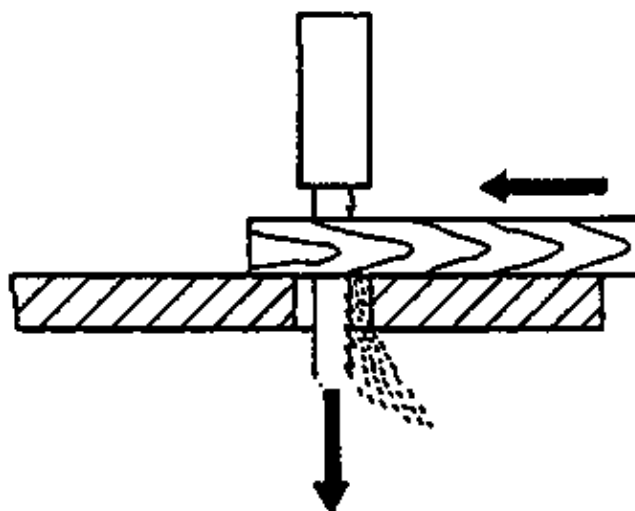


Figure 21 Mode of operation of band sawing

10. Band Sawing Technology

10.1. Oblong and Cross-cuts

Setting up the machine:

A band saw blade is positioned in the desired width according to the material being processed. The guard devices and roll sheathing are opened and the saw blade is chucked. The band sequence is so regulated by setting the batter of the top band roll so that the saw blade teeth are positioned in front of the bandage.

Thereby the band rolls are manipulated manually. The guide rolls above and below the table should be so set that the teeth are positioned in front of the rolls and the blade glides easily between the rolls. There remains an air fissure of one mm between the rear and band rolls. The guard devices and roll sheathing must be ground prior to undertaking a trial run.

Marking the workpiece:

The workpiece is pencil-marked according to the size data of the technical drawing. Given simple, straight cuts the width can be set directly on the stop rule on the machine table.

Saw cutting:

Switch on the machine and ensure smooth saw blade running. Position the workpiece securely in front of the saw band. Use both hands to guide the workpiece and push it slowly through the saw band. An untrue cut may arise through the following shortcomings:

- a too narrow saw blade
- irregular teeth setting
- insufficient saw blade chucking
- a too blunt saw blade
- idle running in the soft annual rings through too great rate of speed

Controlling size consistency:

The sizes are determined by commensurate measuring means.

Which band saw blade is chucked for straight oblong and cross-cuts?

Why must the workpiece not be pushed through at a high rate of speed?

10.2. Curved Cuts

Setting up the machine:

Select the saw band according to the type of material and curve radii:

- narrow saw band for small radii
- wide saw band for wide radii

Commensurately, as already described, set up the machine accordingly.

Marking the workpiece:

Mark the kerf outline on the workpiece surface employing suitable marking means or aids.

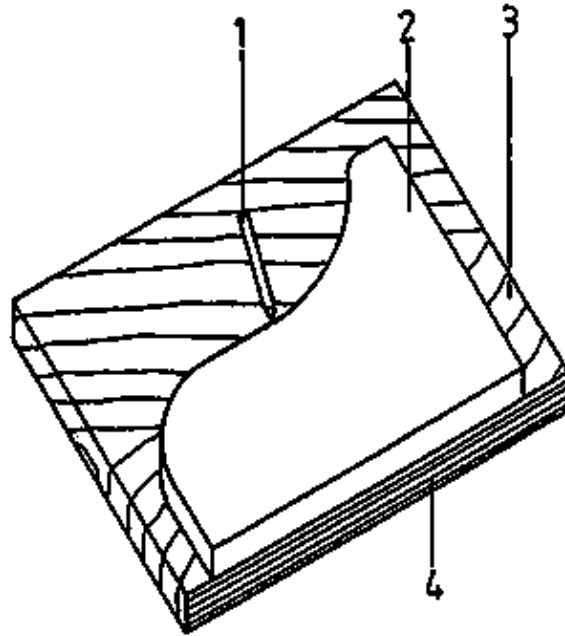


Figure 22 Marking curved cuts with templet 1 pencil, 2 templet, 3 plant, 4 reference edge

Saw cutting:

Hold and guide the workpiece with both hands. It is cut freely at the marked points.

- Always keep hands away from the sawing area!
- Select a slow speed rate!

Checking size consistency:

Check the sizes and curved forms by means of a templet or suitable measuring means.

Which band saw blade is chucked for small radii?

How is a curved kerf attained?

**Operations with Shaping Machines – Course: Mechanical
woodworking techniques. Instruction examples for practical vocational
training**

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Operations with Shaping Machines – Course: Mechanical woodworking techniques. Instruction examples for practical vocational training

Institut für berufliche Entwicklung e.V.
Berlin

Original title:
Lehrbeispiele für die berufspraktische Ausbildung
“Arbeiten an Unterfräsmaschinen”

Author: Günther Hanisch

First edition © IBE

Institut für berufliche Entwicklung e.V.
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Order No.: 93–33–3404/2

Preliminary Remarks

This material contains five selected instruction examples employing shaping machines.

Varying possibilities of tool utilisation feature equally differing degrees of difficulty. The required materials, machines, tools, aids and devices are given for each instruction example.

Preliminary expertise necessary to prepare and implement the instruction examples is cited.

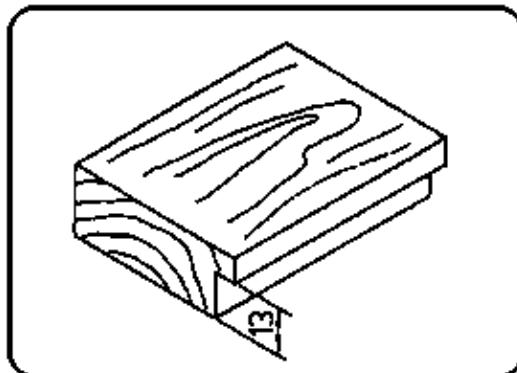
The instruction examples also dwell on wood connections and how these are obtained.

The cited work sequence must be adhered to stepwise in order to ensure optimal work safety of the work–piece being processed. Labour safety provisions must be observed throughout when undertaking instruction example operations.

Each instruction example has attached a workshop drawing showing the dimensions and shape of the work–pieces. Test pieces are selected as instruction examples. Following completion these test pieces yield usable workpieces.

Instruction Example 4.1.: Workpiece with Fold

Sawing a throughgoing fold in two work sequences employing a circular saw blade.



Material

Solid wood piece, levelled and milled to 20 mm thickness, small surfaces rectangularly abutted

Dimensions:

minimum length 350 mm
minimum width 100 mm

Machines and Tools

Shaping machine, one circular saw blade – diameter about 100 mm, bore 25 mm, two chucking disk – diameter about 40 mm, bore 25 mm

Measuring and testing means

Folding rule

Aids and labour safety facilities

Steel strip deflector, pressure comb

Necessary preliminary knowledge

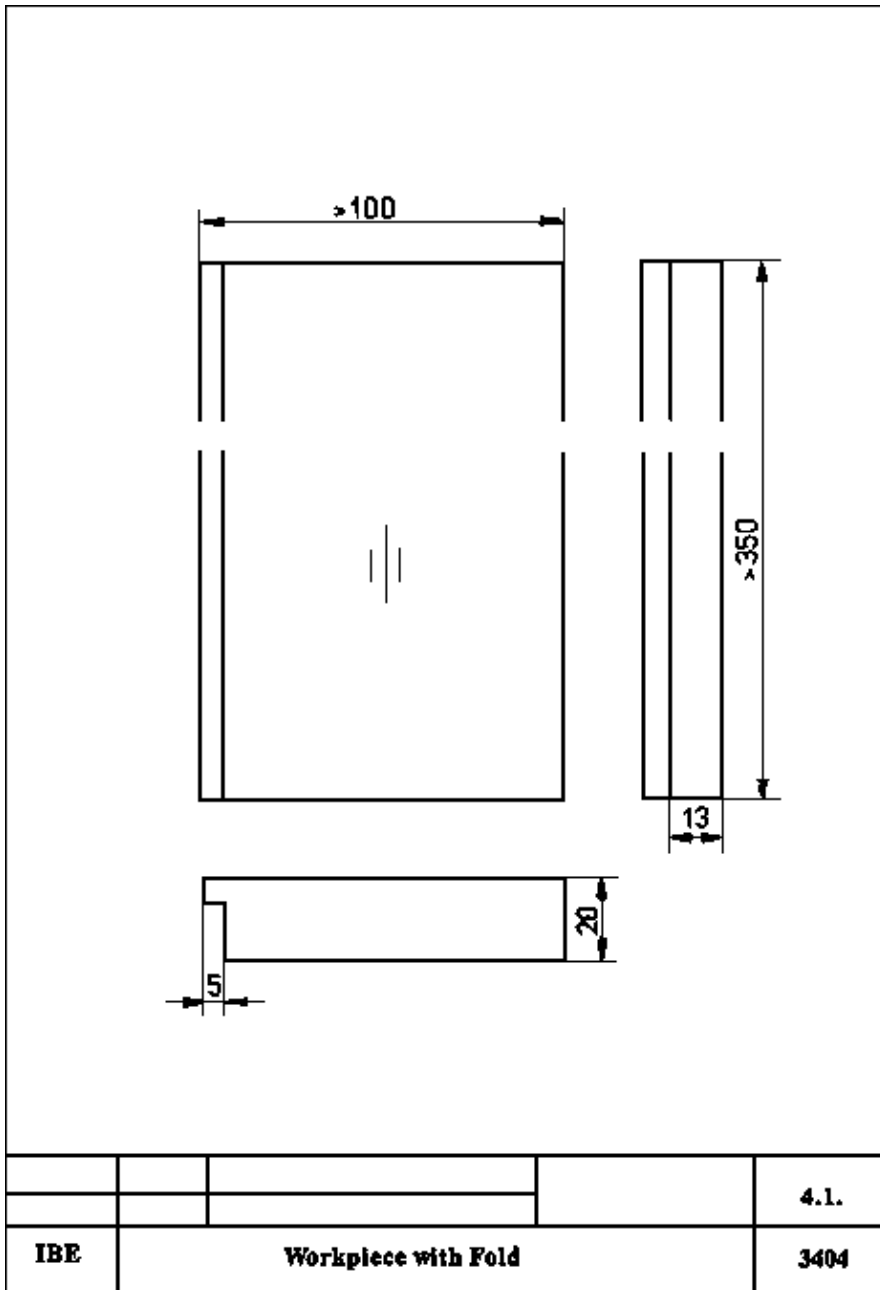
Assembly and function of a shaping machine, labour safety provisions when using a shaping machine, chucking processes whilst engaging in circular sawing operations, reading drawings, measuring and testing

Sequence of operations	Comments
1. Preparing work materials, position reference faces to workpiece.	Check the completeness and sound condition of the workpieces, aids and machine.
2. Arrest the cutter arbor and fix the circular saw blade between two chucking disks to the milling arbor, subsequently remove the catch.	Use a milling arbor (without top bearing tenon) of 25 mm.
3. Fold width = 13 mm to be set, following setting again lock the milling support.	Tool running direction must ensue counter to direction of feed (counter rotation); use sharp tools only!
4. Set the stops of the guide rule in line with the machine tool diameter.	Loosen milling support and set the spindle height at 13 mm between machine table and saw blade top edge.
5. Fold depth = 5 mm to be set, arrest the guide rule after setting.	Set the workpiece in parallel position to the guide rule by the saw blade. Ensure a fold depth of 5 mm.
6. Steel strip deflector is attached to the guide rule.	Position the steel strip deflector about 8 mm above the workpiece. The steel strip deflector should prevent hand contact with the turning workpiece.
7. Check the machine in respect of labour safety requirements.	Ensure that the work table is in a clean condition. Check once again that the tool, stop and steel strip deflector are properly secured. Check the unimpeded running of the spindle.
8. Switch on the exhaust device, switch on the main switch of the machine. Preselect a spindle speed of 3000 min ⁻¹ and then switch on the machine.	Ensure the correct rotational direction of the spindle. A wrong rotational direction can cause serious accidents!
9. Saw the first indentation for the fold.	Place the workpiece with the wide reference face onto the machine table and position the tool in line with the stop rule. Ensure that the hands are kept clear of the tool working area.

10. Switch off the machine and the exhaust facility.	
11. Set up the machine for cutting out the fold depth.	Remove the steel strip deflector. Setting ensues are for the work steps 3., 4. and 5., whereby at the milling support the fold depth is set at 5 mm between the top edge of the saw blade and the machine table. The fold width of 13 mm is set at the guide rule.
12. Fix the pressure comb to the machine table.	The workpiece shall be lightly and evenly pressed to the stop face of the guide rule.
13. Check the machine in respect of adherence to labour safety requirements.	Ensure that the work table is in a clean condition. Check once again that the tool, stop and pressure comb are properly secured. Check the unimpeded running of the spindle.
14. Switch on the machine.	
15. Saw the second indentation for the gold.	Place the workpiece with the narrow reference face onto the machine table and position the tool in line with the stop rule. Ensure that the hands are kept clear of the tool working area. Watch out! Do not remove residue material manually. Danger of accidents.
16. Switch off the machine, main switch and exhaust device.	
17. Check the fold dimensions and control quality parameters.	

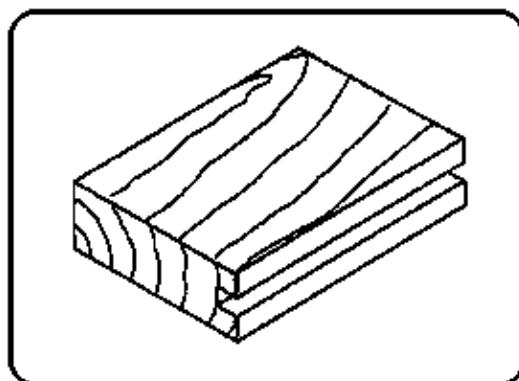
Possible additions

All work steps can be repeated on the opposite narrow faces of the workpiece.



Instruction Example 4.2.: Workpiece with Groove

Practise the accurate and sound setting up of a shaping machine and become acquainted with the work technique "slot milling" on solid wood pieces.



Material

Solid wood, levelled and milled to a thickness of 20 mm, small faces rectangularly abutted

Dimensions:

Minimum length 350 mm
Minimum width 80 mm

Machines and tools

Shaping machine, slot mill with 6 mm working width

Measuring and testing means

Folding rule

Aids and labour safety knowledge

Steel strip deflector

Necessary preliminary knowledge

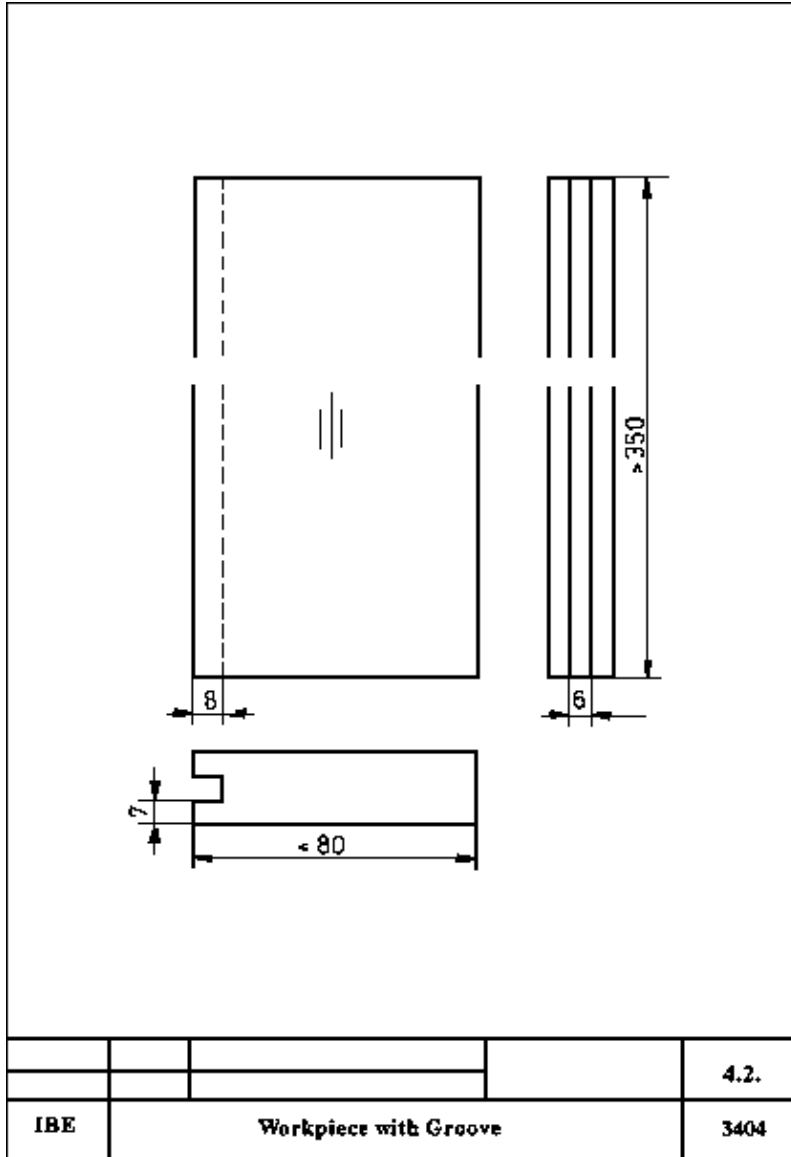
Assembly and function of the shaping machine, basic labour safety provisions when using the shaping machine, knowledge and expertise when setting up a shaping machine, knowledge of chucking processes when handling solid wood, reading drawings, measuring and testing.

Sequence of operations	Comments
1. Position work material and tools. Place the reference faces firmly along the work-piece.	Check for completeness and proper condition.
2. Chuck the tool firmly to the lower part of the cutter arbor, subsequently remove the locating pin from the spindle.	Rotational direction of the tool must be directed against feed motion of the workpiece (counter rotation), otherwise high risk of accidents!
3. Set the measure (7 mm) of the slot cheek between machine table and lower tool edge.	Untighten the milling support, set the measure, then again arrest the milling support.
4. Set the slot depth.	Workpiece is positioned parallel to the stop faces by a fully turned out cutting edge of the tool and the required measure is set on the guide rule. Next arrest the guide rule and align the stop faces to the tool diameter.
5. Tighten the steel strip.	The steel strip deflector is so positioned that there is no manual contact with the tool, however the work process – milling – is not impeded.
6. Check the machine in respect of labour safety stipulations.	Ensure work-table cleanliness. Once again check tool, stop and steel strip deflector for sound positioning and spindle as regards true running.
7. Switch on the exhaust and the main machine switch, preselect the spindle speed (4500 min ⁻¹) and switch on the machine.	Ensure correct rotational direction of the spindle, incorrect rotational movement can cause serious accidents!
8. Milling a groove.	Position the workpiece with the broad reference face on the machine table and the narrow reference face to the guide rule and slowly and evenly bring the tool into place.

9. Switch on machine, main switch and exhaust facility.	
10. Dimensional control and checking of the groove quality.	Watch out for chipped edges. These may be caused by blunt tools or a too rapid rate of feed!

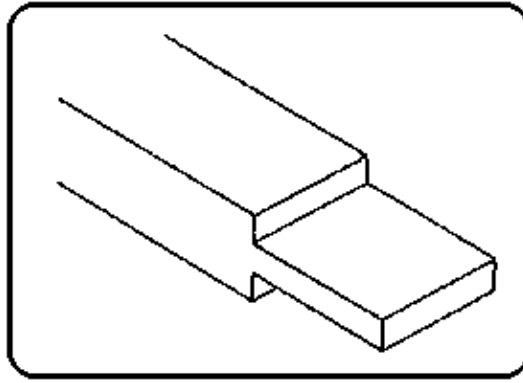
Possible addition

A slot can also be milled into the opposite narrow face.



Instruction Example 4.3.: Workpiece with Tenon

Yielding a tenon by means of a circular saw blade, employing a shaping machine in two work steps.



Material

Solid wood piece, levelled to 30 mm thickness and a width of 50 mm.

Workpiece cut rectangularly at the grain ends

Minimum length: 350 mm

Machines and tools

Shaping machine, circular saw blade of some 160 mm diameter and a bore fitting the cutting arbor, two chucking disks of some 50 mm diameter.

Measuring and testing means

Folding rule, try square (scratch), pencil

Aids and labour safety facilities

One stop board with longitudinal holes and holding screws, one stop strip about 10 mm thick to attach to the guide rule, one guiding facility for processing upright positioned workpieces, one guard spacer or guard cap with a diameter greater than the saw blade.

Necessary preliminary knowledge

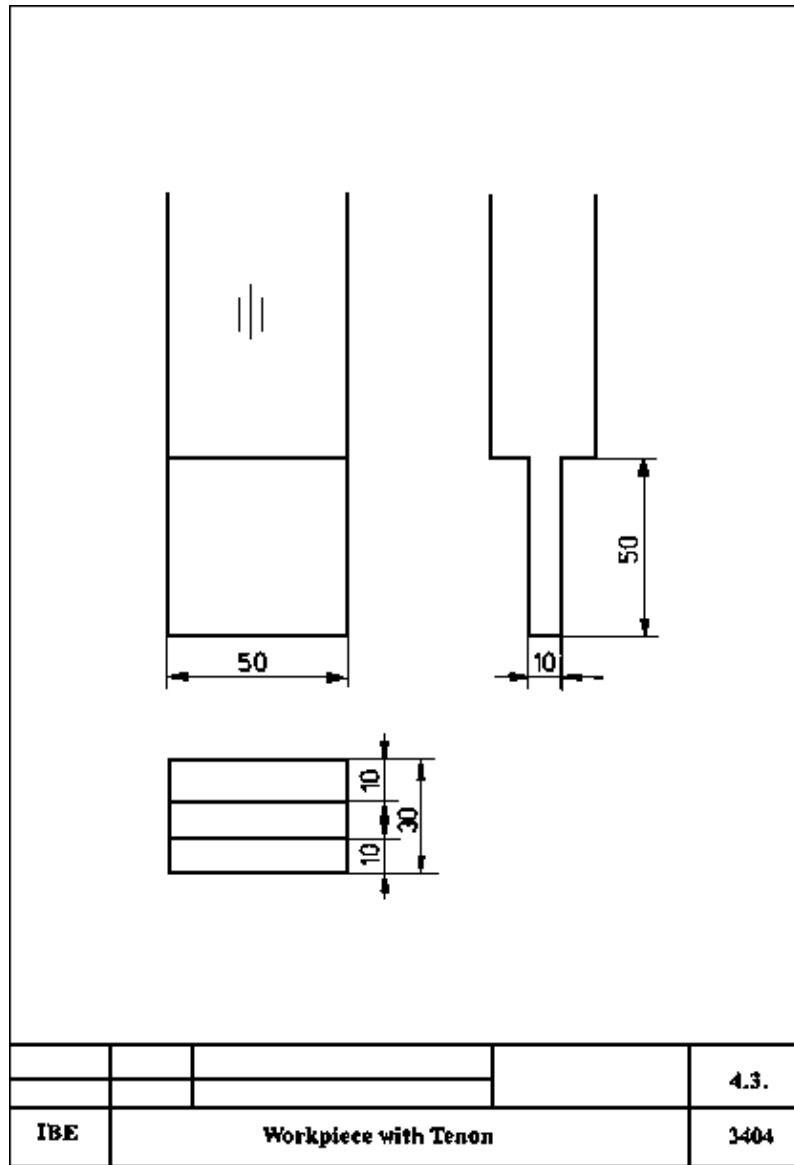
Assembly and function of a shaping machine, labour safety provisions enumerated for various shaping machines, chipping processes whilst circular sawing, reading a drawing, marking a journal, measuring and checking.

Sequence of operation	Comments
1. Position the work materials.	Check for completeness and proper condition.
2. Mark the tenon length = 50 mm with a folding rule and pencil.	
3. Transfert the fissure by means of the try square to all four longitudinal faces of the workpiece.	Use a sharp pencil and ensure accurate marking.
4. Mark the tenon thickness as a scratch or using a pencil.	As opposed to tenon cutting with a hand saw, the tenon need not be completely marked.
5. Position the saw blade onto the cutting arbor, arrange the guard spacer 25 mm above the saw blade and chuck tightly together with the saw blade.	Kerf direction of the saw blade must run counter to the feed direction! Guard spacer must be bigger than the saw blade. A guard cap may be used instead of a guard spacer.
6. Set the saw blade height on the machine.	Set the spindle with saw blade according to scratch or pencil fissure on the workpiece.

7. Attach the stop board by means of two screws in the through holes of the machine table.	The stop board must be so fixed that the envisaged middle line of the workpiece is directed to the spindle middle.
8. Check the milling spindle for free running, control the stop and the labour safety facility for proper positioning and secure holding.	
9. Switch on the exhaust facility and the main switch of the machine, preselect spindle rotational speed (3000 min ⁻¹) and switch on the machine.	
10. Notch the workpiece 2–3 mm both sides in the tenon area and control the measure.	Given measuring inaccuracy the spindle setting can be corrected.
11. Cut a slot.	The tenon length should only be notched to the fissure on the workpiece narrow face.
12. Turn the workpiece and notch the second tenon side.	
13. Switch off the machine, remove the stop board and dismantle guard spacer and saw blade from the cutter arbor.	
14. Set up the saw blade some 50 mm above the machine table.	Guard spacer is not required in the following work sequences.
15. Set the spindle height at 50 mm between machine table and saw blade top edge.	
16. Bring the guide rule into position, align the stop face to the tool diameter and fix the stop strip to the stop faces.	Following alignment of the stop faces to the saw blade, the guide rule is again moved far enough away from the spindle that the saw blade no longer rises above the stop face.
17. Control the unimpeded running of the spindle, check the tool for firm positioning.	
18. Switch on the machine and move the guide rule carefully towards the spindle whereby the saw blade must penetrate the stop strip and extend some 12 mm beyond it.	Select a rotational speed = 3000 min ⁻¹ , ensure correct rotational direction. Move the guide rule slowly and evenly.
19. Switch off the machine.	
20. Set the guide rule.	The rule is set according to the dimensions of the workpiece. The sawn kerf must completely displace the tenon which must not be notched.
21. Switch on the machine (3000 min ⁻¹).	
22. Displace the tenon by means of a guide facility, turn the workpiece and also displace the tenon on the rear side.	Kerf direction is lateral to the grain, therefore select a low speed rate. If no guide facility is on hand the tenon must be displaced using the hand saw.
23. Switch off the machine.	
24. Control size consistency and quality parameters attained.	

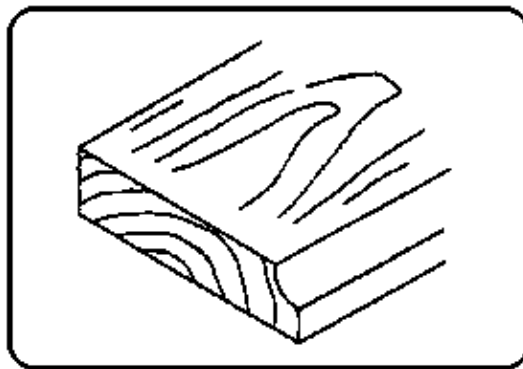
Possible additions

The workpiece can have a further tenon fitted at the other end. A tenon can be produced as part of a frame comer joint in conjunction with a slot or a cutting hole.



Instruction Example 4.4.: Workpiece with Quarter Chamfer

Milling a profile within the area accounted for by the workpiece narrow face, employing a chamfer milling machine.



Material

Solid wood piece, levelled and milled to a thickness of 20 mm with narrow faces abutted.

Dimensions:

Minimum length: 350 mm
 Minimum width: 100 mm

Machines and tools

Shaping machine, chamfer milling machine

Diameter about 80 mm
 Radius about 8 mm

(according to tool set at the machine)

Measuring and testing means

Folding rule

Aids and labour safety facilities

Spring-loaded comb

Necessary preliminary knowledge

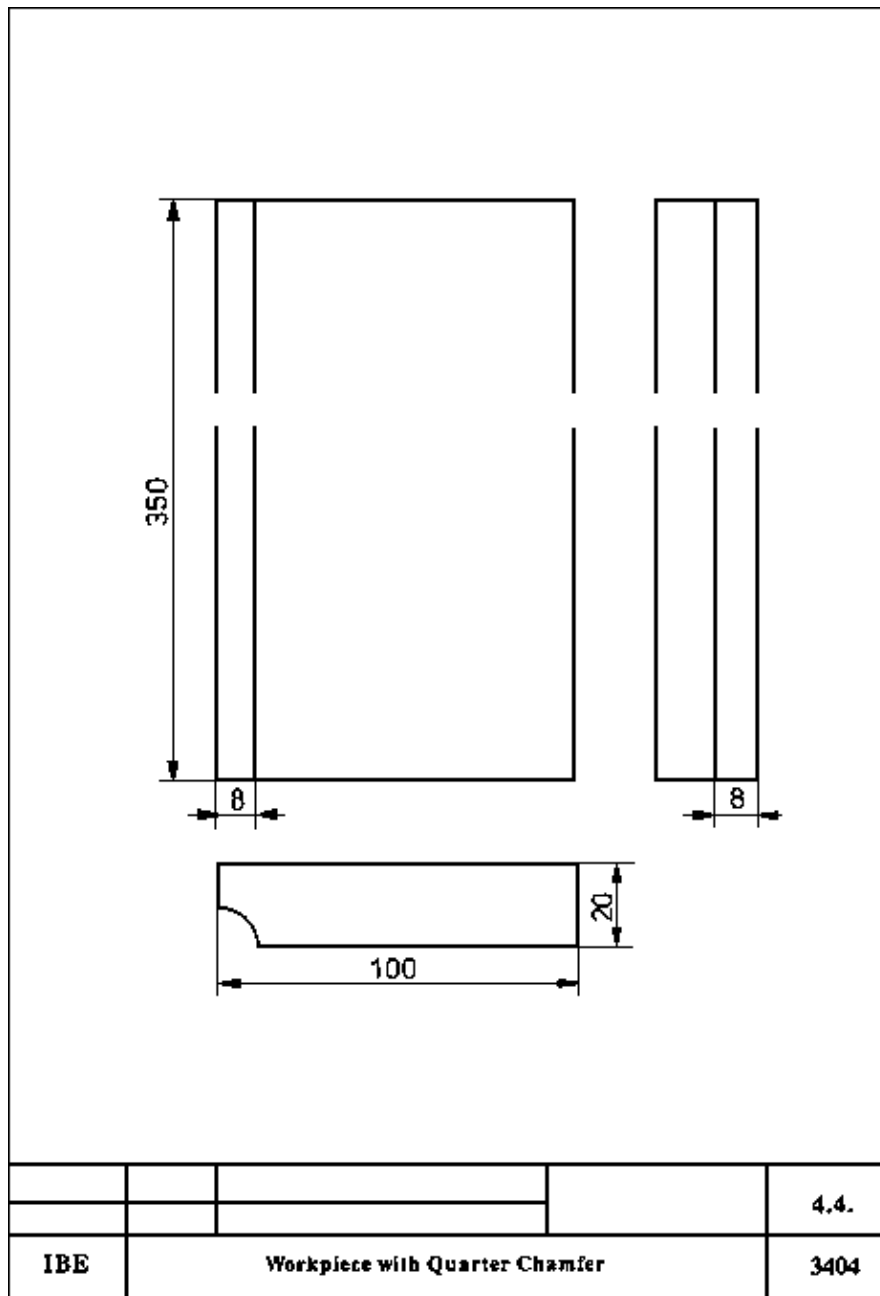
Extensive knowledge of the assembly and function of a shaping machine besides all the essential labour safety measures whilst milling. Read drawings, measuring and testing.

Sequence of operations	Comments
1. Position the work materials and check tools and machines in respect of sound technological condition.	Workpiece length and width are determined by labour safety requirements and must not fall below these dimensions!
2. Mark the rest and bearing surfaces on the work-piece by means of a square sign.	The face of the workpiece to be worked should not feature any knots or knot ends.
3. Attach the tool to the cutter arbor and employ table spacers in line with the tool diameter.	The tool is attached in counter direction to the lower part of the cutter arbor. The spindle arrest is removed following firm chucking.
4. Set the spindle height at 8 mm between tool top side and machine table.	Position a short, straight strip onto the cylindrical cutter and control the measure of the spindle setting by means of a folding rule.
5. Set the guide rule at 8 mm to the knife cutting circle and arrest.	A tool cutting edge is turned to the maximum engagement size vis-a-vis the stop face. Position the workpiece parallel to the guide rule on the tool cutting edge and control the measure.
6. Align the stop faces to the knife circle.	
7. Attach the pressure comb to the stop faces of the guide rule.	The pressure comb should completely enclose the tool vis-a-vis the stop faces.
8. Check the proper functioning of the machine.	Ensure that the machine table is clean. Ascertain that the tool, stop and spring-loaded comb are firmly positioned and check the spindle for unimpeded running.
9. Switch on the exhaust, switch on the main machine switch, preselect the spindle (3000 min ⁻¹) and switch on the machine.	Ensure the correct rotational direction (counter running) of the spindle as an incorrect rotational direction can lead to serious accidents!

10. Mill a chamfer. Move the workpiece slowly and evenly towards the tool.	Position the workpiece with the broad reference face onto the machine table and with the envisaged narrow face to the right rule face.
11. Remove the processed workpiece and switch off the machine, main switch and exhaust facility.	
12. Control the measure and attained quality.	Watch out for chipped edges. The chamfer should not evidence any unevenness as hollow chamfers can only be reworked by means of extensive manual operations.

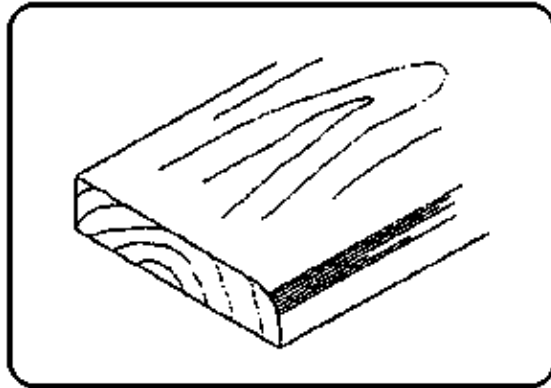
Possible addition

Further chamfers can be milled along the remaining longitudinal edges of the workpiece. Thereby, heed possible slight changes in the workpiece grain sequence and reduce the rate of speed accordingly.



Instruction Example 4.5.: Workpiece with Quarter Round Chamfer

Milling a quarter round profile.



Material

Solid wood, levelled and milled to a thickness of 20 mm. Narrow faces rectangularly abutted.

Dimensions:

Minimum length 350 mm
Minimum width 100 mm

Machines and tools

Shaping machine, quarter round cutter – diameter about 80 mm, working width approx. 20 mm (according to tool set at the machine)

Measuring and testing means

None

Aids and labour safety devices

Spring-loaded comb

Necessary preliminary knowledge

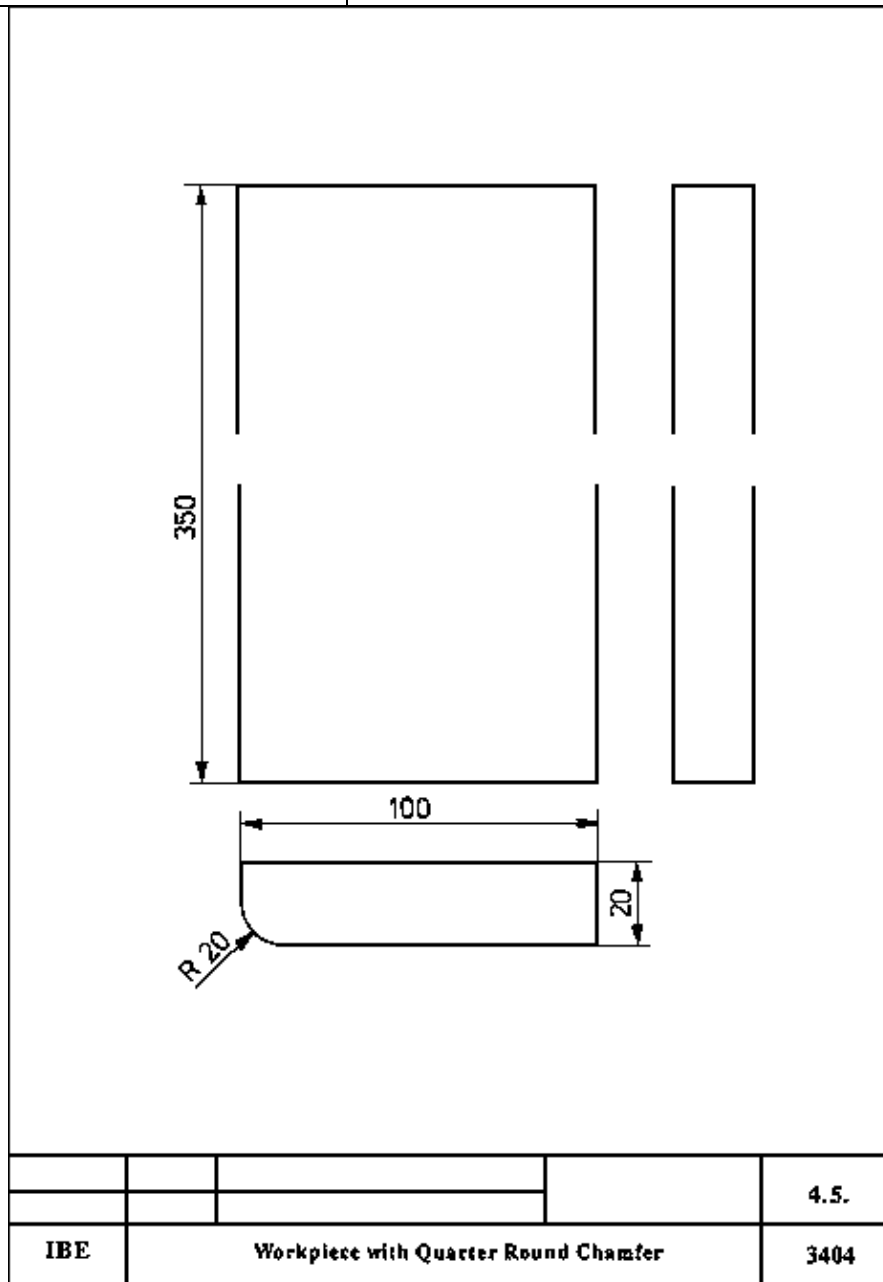
Extensive knowledge concerning the assembly and functioning of a shaping machine, similarly in regard to the necessary labour safety measures when milling by means of cylindrical cutters. Knowledge of chipping processes whilst milling, reading drawings.

Explanation regarding workshop drawing

The sign “ “ is a square sign and is used to designate reference faces.

Sequence of operations	Comments
1. Position work material and check the proper working order of both tool and machine.	Length and width of the workpiece are determined by labour safety considerations and must not fall below the cited values!
2. Mark the support and bearing surfaces of the workpiece by means of a square sign.	
3. Attach the workpiece to the cutter arbor, employ table rings in line with the tool diameter, the cutting profile points upwards.	Tool is attached in counter running direction to the lower part of the cutter arbor. The spindle is removed following firm chucking.

<p>4. Set the spindle height and arrest the spindle.</p>	<p>Position the workpiece with the support surface on the machine table and the wood grain end to be processed facing the cutting profile.</p> <p>Set the spindle height so that the profile is evenly imprinted into the working face.</p>
<p>5. Set and arrest the guide rule.</p>	<p>Position the workpiece for processing to the right stopstrip. The wood grain end is facing the cutting profile. Set the guide rule so that the curve is evenly imprinted into the bearing surface.</p>
<p>6. Attach the pressure comb to the stop faces of the guide rule.</p>	<p>Pressure comb should completely enclose the tool vis-à-vis the stop faces.</p>
<p>7. Functionality control of the machine.</p>	<p>Ensure that the machine table is clean and that tool, stop and spring-loaded comb are firmly positioned. Check the spindle for unimpeded running.</p>



**Operations with Shaping Machines – Course: Mechanical
woodworking techniques. Trainees' handbook of lessons**

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Operations with Shaping Machines – Course: Mechanical woodworking techniques. Trainees' handbook of lessons

Institut für berufliche Entwicklung e.V.
Berlin

Original title:
Arbeitsmaterial für den Lernenden
"Arbeiten an Unterfräsmaschinen"

Author: Günter Hanisch

First edition © IBE

Institut für berufliche Entwicklung e.V.
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Order No.: 93-35-3404/2

1. Purpose of Shaping Machine Operations

Shaping machines are wood-working devices used mainly for chip-forming cutting of workpieces (narrow faces). Milling results in workpiece profiles.

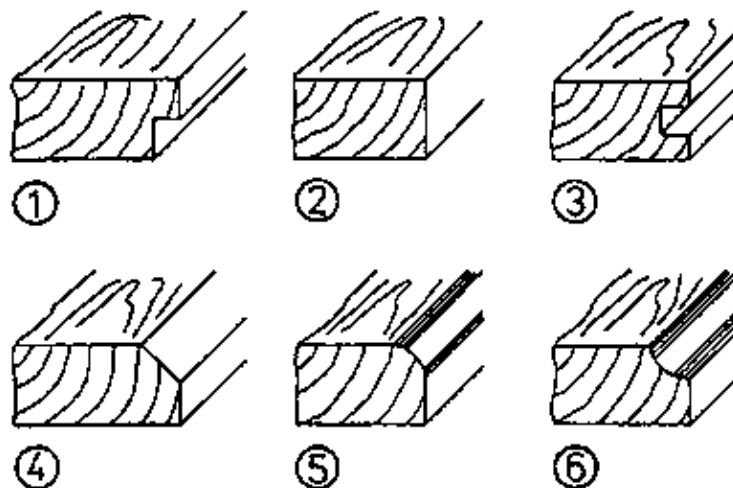


Figure 1 – Simple workpiece profile forms

(1) fold, (2) plane, (3) slot, (4) grain, (5) quarter round, (6) quarter chamfer

A combination of various basic profiles can also be realised.

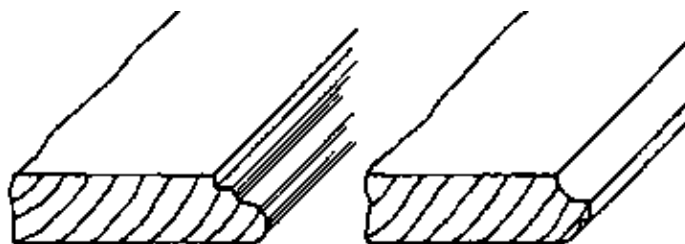


Figure 2 – Profile combinations

The combination of profiled faces ensues in various wood connections in furniture construction (tables, cupboards) and when making doors and windows.

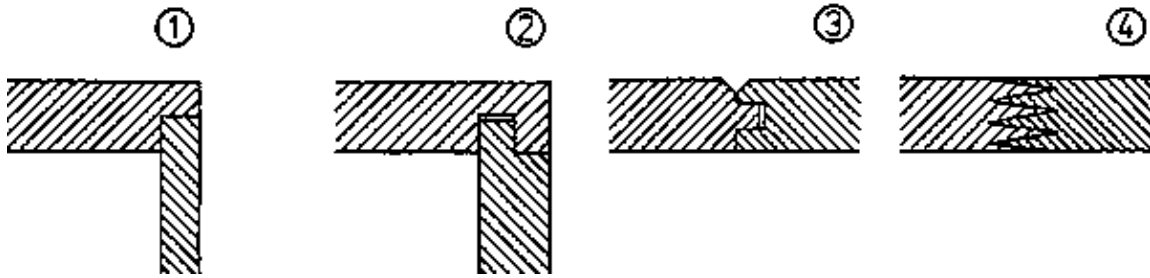


Figure 3 – Examples of wood connections (joints)

(1), (2) face corner joints, (3), (4) lateral joints

What is the purpose of milling?

2. Construction of a Shaping Machine

A shaping machine consists in the main of a machine frame with a stationary resp. movable machine table, the milling support, cutter arbor, guide rule with exhaust cap, drive facilities with operating elements and labour safety provisions.

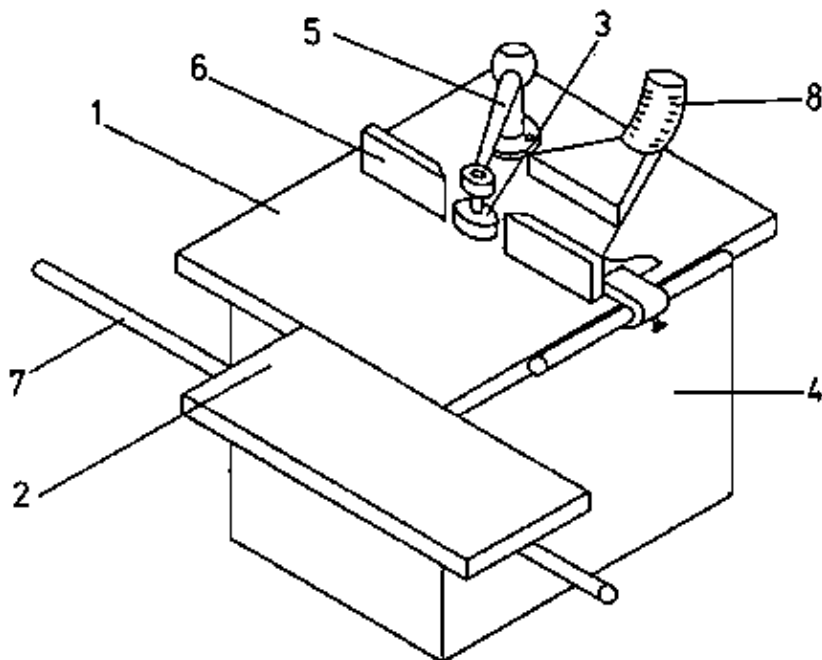


Figure 4 – Shaping machine

1 machine table, 2 movable table, 3 cutter arbor with tool, 4 machine frame, 5 top bearing support with top bearing, 6 guide rule with stop faces, 7 guide tube, 8 exhaust facility

The machine table is plane and smooth and features a circular shaped opening to absorb the cutter arbor. The opening has a diameter of 260 mm and is aligned to the processing job in hand by means of table spacers. The machine table also features throughgoing tap holes for attaching additional aids.

The movable section of the table makes it possible to chuck on bigger workpieces to the table.

This improve work safety, particularly when larger tools are used, for instance when undertaking tenon milling. A boom for the top bearing can be mounted onto the stationary section of the table. This is, moreover, essential when using heavy tools on a cutter arbor with top bearing tenon. The top bearing protects the cutter arbor and spindle from damage through overloading.

Milling support

This consists in the main of a milling spindle, a guide facility for adjusting the height of the milling spindle and operating elements for the height adjustment. The milling spindle has precision running in bearings. Felt spacers prevent the penetration of dust into the bearings. The top section of the spindle, the spindle neck, features a coned bore.

No dirt must enter this bore whilst the cutter arbor is changed. Otherwise the fitting is destroyed and the cutter arbor does not run centrally.

The spindle neck has an external thread and features a sleeve nut for attaching the cutter arbor. Two belt pulleys are attached to the lower end of the milling spindle for the selective setting of two speed variants.

Cutter arbor

Cutter arbors with a shaft diameter of between 25 and 30 mm are used for normal shaping machine operations. Cutter arbors with or without top bearing tenons are used depending on the size of tools employed and rotational speed load.

Cutter arbors with top bearing tenons may only be used with top bearings!

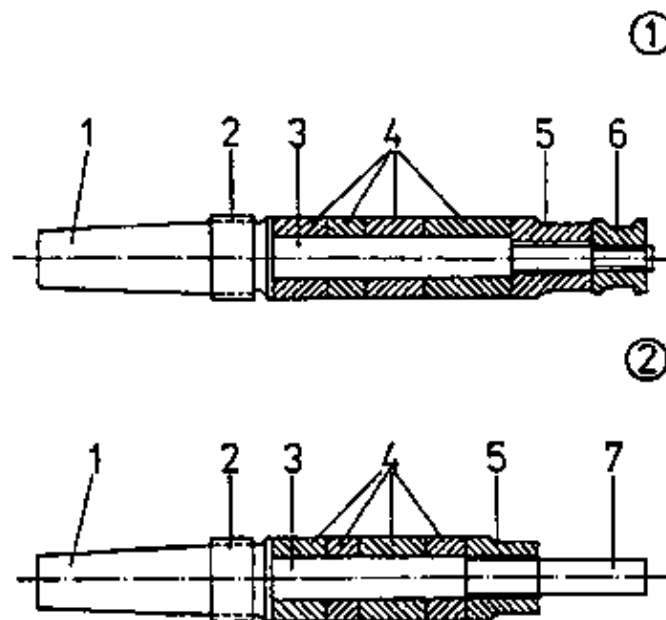


Figure 5 – Cutter arbors

- (1) cutter arbor without top bearing tenons,
- (2) cutter arbor with top bearing tenons

1 morse taper, 2 differential thread, 3 cutter arbor shaft, 4 cutter arbor spacers, 5 cutter arbor nuts, 6 safety nut, 7 top bearing tenon

The cutter arbor is securely connected to the spindle by means of the Morse taper and differential nut thread. The spindle thread features a lesser increment than the cutter arbor thread (difference = one mm). Ensure when tightening the differential nut that already slight wrench tightening gives rise to considerable chucking stress in the Morse taper fitting. For that reason a wrench extension should not be used when tightening the cutter arbor nut. The inserted cutter arbor must clearly feature two thread leads above the differential nut.

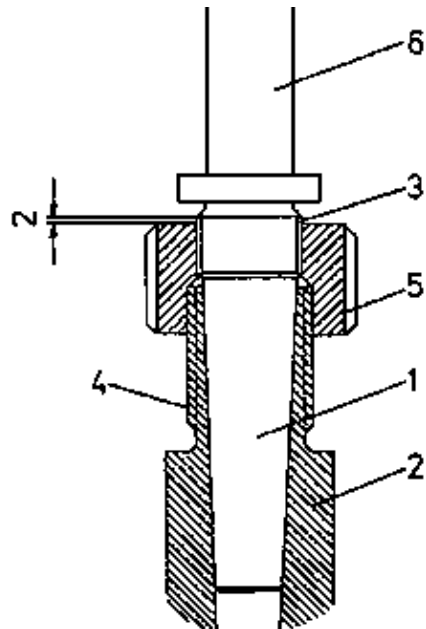


Figure 6 – Spindle neck with assembled cutter arbor

1 morse taper, 2 spindle neck, 3 differential thread (cutter arbor), 4 differential thread (spindle neck), 5 differential nut, 6 cutter arbor shaft

The cutter arbor spacers of differing thicknesses permit the mounting of milling tools of varying strengths. Try to ensure that the tool attached to the cutter arbors without top bearing tenons is positioned in the lower shaft area.

Minimal unbalance of the tool and uneven processing forces are consequently more easily compensated for by the milling spindle.

The cutter arbor nut with the complete thread engaged is required for tightly chucking the tool. This requirement can be met through a proper selection of the differing cutter arbor spacers.

Where cutter arbors have a shaft diameter of 25 mm the cutter arbor spacers have a height respectively of 5, 8, 10, 16 and 25 mm. The cutter arbor nut has a thread of M24 x 2 or M30 x 2. If (in exceptional cases) the spindle is operated in clockwise rotation with a cutter arbor without top bearing tenons, a safety nut must be counteracted against the cutter arbor nut.

The safety nut has a M16 x 1.5 left thread!

Ensure that the cutter arbor nut is only slightly tightened. On no account extend the wrench, otherwise the cutter arbor will be stressed unduly.

Given anti-clockwise running of the spindle, the moments of inertia of the tool and the cutting forces exert a tightening effect on the cutter arbor nut.

After the cutter arbor nuts have been tightened the locating pin must be removed from the lower section of the milling spindle.

The drive motor can be seriously damaged if the machine is switched on whilst the spindle is arrested!

Why are cutter arbor spacers of differing thicknesses used to attach the tool?

Why must a safety nut with left thread be used additionally on cutter arbors without top bearing tenons given clockwise rotation of the machine?

Drive

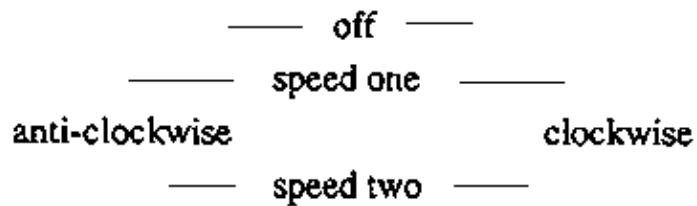
The drive motor is a pole-changeable three-phase synchronous motor. Its performance level is geared to the machine size. The motor can be switched to two varying speeds.

Motor speed 1 = 1450 min⁻¹

Motor speed 2 = 2880 min⁻¹

Thus, four spindle speeds can be set if the driving belt is selectively aligned to one of the two belt pulley pairs.

Switch position:



Rotational speed settings:

Pulley setting	Switch setting	Spindle rotational speed (min ⁻¹)
I	1	3000
I	2	6000
II	1	4500
II	2	9000

Provided the spindle rotational speed is properly selected, a favourable cutting speed conforming to the material being processed can be attained for each tool diameter.

Survey 1

Cutting speed in m • s⁻¹

- 1 tool of quick cutting steel,
- 2 tool with hard metal cutters,
- 3 soft wood,
- 4 hard wood,
- 5 chipboard,
- 6 hard board,
- 7 plywood,
- 8 thermoplast,
- 9 phenoplast

$$n = \frac{30 \text{ m} \cdot 60}{\text{min} \cdot 0.125 \cdot 3.14}$$

$$n = \frac{1800}{\text{min} \cdot 0.3925}$$

$$n = 4585.99 \text{ min}^{-1}$$

Select a spindle rotational speed of 4500 min⁻¹.

Guide rule

The guide rule ensures a sound support and accurate workpiece guidance in the tool working area. The guide rule distance to the cutter arbor can be adjusted on the table surface.

The two stop rules can be adjusted to one another and, thereby, make possible an alignment to the knife cutting circle of the utilised tool.

The distance between the knife cutting circle and the edges of the stop rule must not exceed 3 mm (see also Figure 14)

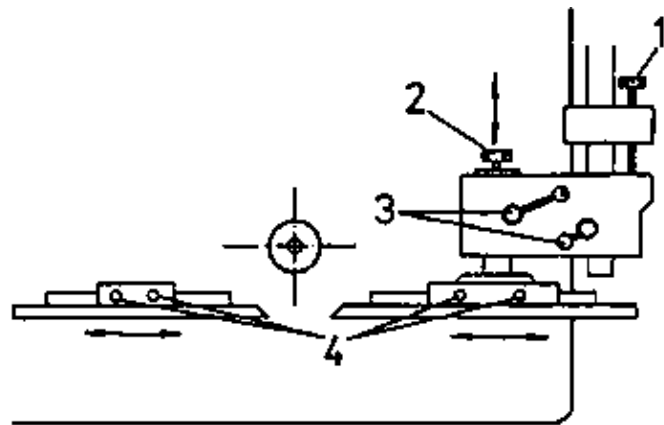


Figure 7 – Guide rule with adjusting device

1 rough setting, 2 fine setting, 3 arrest for rough and fine setting, 4 setting device for the stop rules

The guide rule features an attachment means for a chip exhaust device.

Additional stops, guidance facilities and labour safety devices can be attached to the stop faces.

For example: stop strips, stop block, spring-loaded comb and steel strip deflector. It is not permissible to utilise clamps with quick chucking mechanism or impact clamps to attach such items. Such clamps can loosen through vibrations thereby causing serious accidents.

Warming up spacers can be employed instead of the guide rule when processing workpiece faces which are not straight. Such warming up spacers are mainly used for positioning to a model. By means of milling tools the workpiece can then be aligned to the model shape. Powerwise the warming up spacer has been decoupled from the cutter arbor.

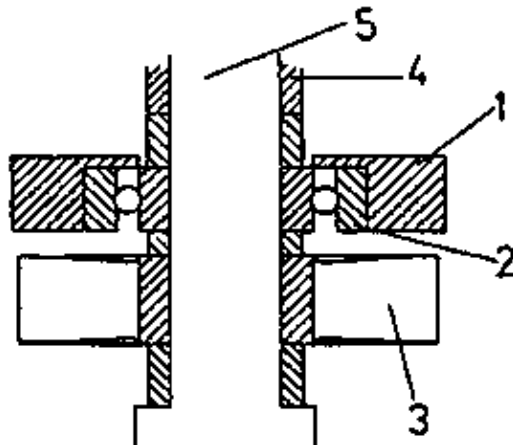


Figure 8 – Cutter arbor with tool and warming up spacer

1 warming up spacer, 2 ball bearing, 3 tool, 4 cutter arbor spacer, 5 cutter arbor

The guide rule can be replaced by a stop board for undertaking deep cutting operations (slits).

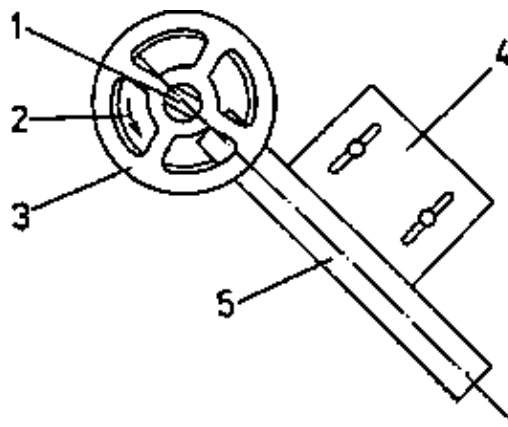


Figure 9 – Stop board mounting

1 cutter arbor, 2 tool, 3 guard spacer, 4 stop board, 5 workpiece

When processing workpieces with unfavourable dimensions job safety can be increased by means of additional devices, for instance a guidance facility for offsetting when turning out a tenon.

Why should no clamps be used to attach additional stops to the guide rule?

3. Tools of a Shaping Machine

The shaping machine tools are subdivided into three tool categories depending on their concrete tasks and commensurate differing constructions, namely

- cylindrical cutter
- cutter heads
- milling combinations

Cylindrical cutter

They are milling tools whose basic shape resembles a disk.

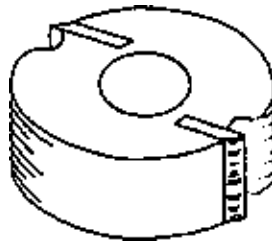


Figure 10 – Milling tool (cylindrical cutter)

The milling tools feature a central bore for attachment to the tool bearer. The tool cutters have been arranged so as to form the knife cutting circle at the tool periphery. Cylindrical cutters of tool steel are used for processing wood. These miller cutters have been hardened.

Mainly millin tools with hard metal cutters are used for processing hard materials such as chip- and fibre-boards. Such tools have a long life but can only be sharpened by means of special grinding disks.

Übersicht 2

Frequently used cylindrical cutters

flat miller (cutter)		
rebating cutter		
grain cutter		
groove cutter		
quarter round cutter		
quarter chamfer cutter		

Cutter heads and milling disks

These are tools whose essential body has been constructed so as to incorporate interchangeable tool cutters.

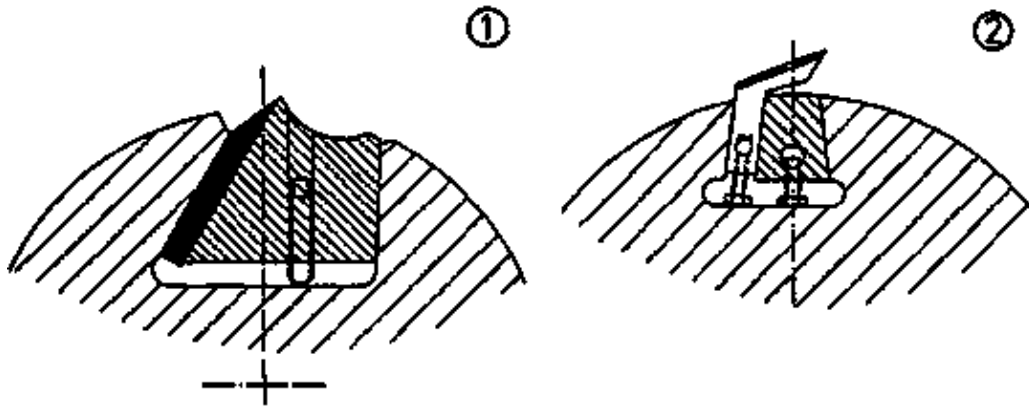


Figure 11 – Cutter heads and milling disks

- (1) gib strip tension of a cutter head,
- (2) compression taper tension of a milling disk

Multi-part milling gear is only envisaged for limited speeds. Cutter heads can only be used up to 6000 min^{-1} whilst the permissible greatest rotational speed has been imprinted onto milling disks. Exceeding these top rotational speeds can result in both tool and machine destruction through centrifugal forces.

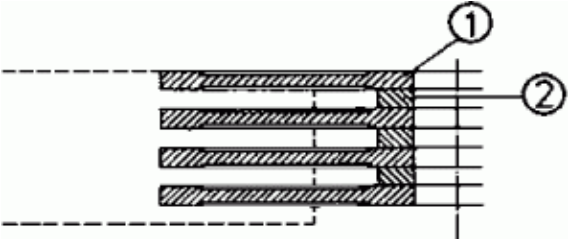
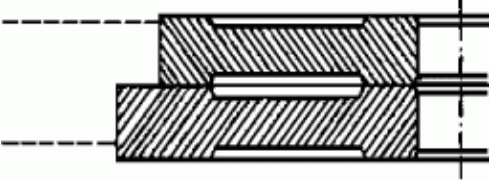
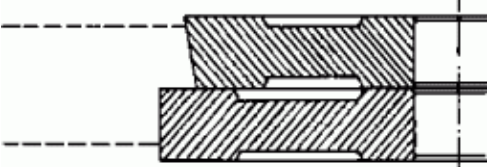
There is furthermore a considerable risk of accidents.

Milling combinations

These are made up of various single millers. However, they can also be utilised as a set of several identical and similarly sized single millers with distance resp. chucking elements. By means of milling combinations several operations can be undertaken at the same time by the machine.

Übersicht 3

Tool combinations

milling set for finger prongs (1) groove cutter, (2) spacer ring	
door fold milling combination	
milling combination for window wooden parts	

4. Mode of Operation of a Shaping Machine

Arc-like chipping ensues through milling with a shaping machine, moreover in a similar manner to level milling, thickness milling and circular sawing. Thereby one differentiates between climb-feed and counter-rotational

cutting in line with the chipping direction vis-a-vis the direction of feed.

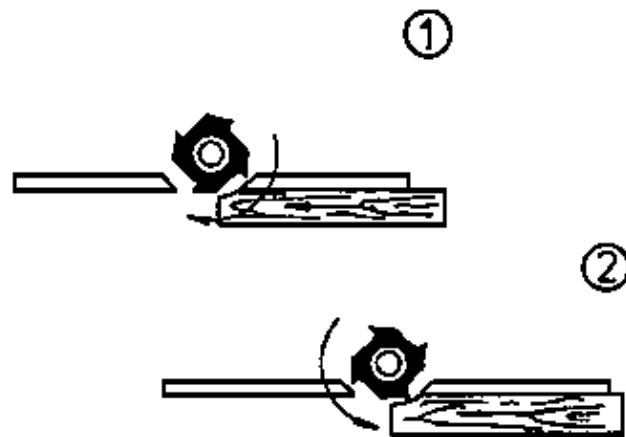


Figure 12 – Types of tension

- (1) climbfeed cutting,
- (2) counter-rotational cutting

Given climbfeed cutting the cutting elements along with the feed force motivate in the same direction. The processed faces are extremely clean, however given manual feed the workpiece can be pulled away from the hands.

Given manual feed, climbfeed cutting is forbidden because of the considerable accident risk!

In the case of counter-rotations cutting the cutting forces operate against the feed force. Consequently safe manual feed becomes possible. Chipped edges along the processed surfaces of slotted and milled cuts may result during counter-rotational milling. This occurs because of the unfavourable cut direction of the tool cutters vis-à-vis the grain direction of the work-piece.

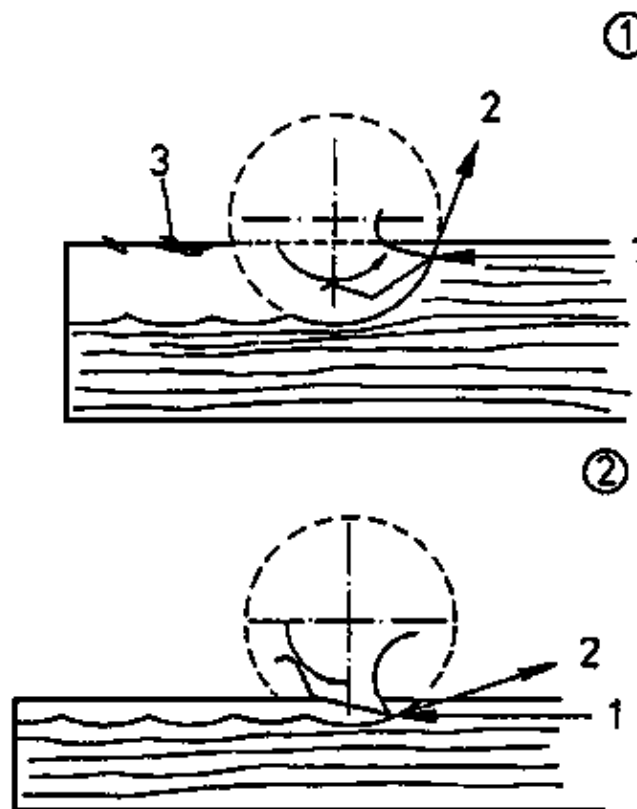


Figure 13 – Cutting force

- (1) cutting force at great cutting depth
- (2) cutting force at small cutting depth

1 feed force, 2 cutting force, 3 chipped edges

Why is climbfeed cutting so prone to accidents?

The tool cutters been arranged in a knife cutting circle. As cutting ensues, given an even workpiece feed, a wavy processed surface results. These waves are known as cutter blows. The nature of the waves, resp. the cutter blow depth, depends on:

- the number of tool cutters
- the tool diameter
- the rotational speed of the tool spindle
- the rate of feed of the workpiece

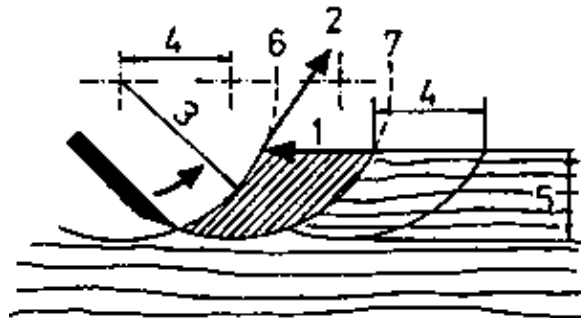


Figure 14 – Chip formation through milling

1 direction of feed, 2 cutting direction, 3 tool radius, 4 cutter feed, 5 engagement size, 6 knife cutting circle of cutting edge one, 7 knife cutting circle of cutting edge two

In order to ensure sound cutting it is necessary that all the cutters of a tool rotate through the same knife cutting circle, that is to say equidistant from the tool axis. This requirement should be especially heeded during tool maintenance. An extremely wavy or carelessly milled workpiece face can prove a hindrance during subsequent top surface processing and precondition extensive reworking.

What is the effect of using blunt tools for million operations?

5. Servicing and Looking After the Machine

Regular and proper servicing and maintenance of the machine is to a marked extent a guarantee for proper functioning and, as a result, equally for considerable job safety. Dirt should be removed daily from the table and support surfaces. The throughgoing bores and locator grooves of the machine table become soiled extremely quickly. All adjustment facilities of the guide rule and the spindle must be cleaned after machine and lightly greased at regular intervals.

The roller guide of the movable table must always be kept free from dust. Soilage can hamper the forward movement of the movable table and, thus, lead to accidents.

Every machine has an operating manual and a lubrication plan. These documents indicate:

- where and how lubrication of the machine should be undertaken, similarly also the lubrication points,
- which lubricants should be used,
- the necessary lubrication quantities,

- the lubrication intervals for the various positions.

These stipulations, which vary according to machine types, must be adhered to strictly.

The passage of air to the motor must not be impeded by fallen chips. Motor damage through overheating can result from defective air cooling of the drive machine. There is, moreover, also a great risk of fire!

The drive belt, as power-transmitting machine element, must always have the prescribed pulley tension.

The belt may loosen through wear and tear, in which case full power transmission is no longer possible. This state of affair can be discerned by a reduced spindle rotational speed as the machine is taxed. Consequently, a belt tightening facility has been positioned near to the motor attachment. Thus, the belt can be tightened, respectively relieved as it is switched to the other belt pulley pair. (This is necessary when switching to another rotational speed category).

The drive belt should not, however, be too tight. A belt which is too tight can result in:

- losses in power transmission through greater power requirements in the belt gears,
- excessive strain of the motor and spindle bearings and
- a more rapid wear of the drive belt

6. Labour Safety Measures

Shaping machine operate at high rotational speeds. This denotes, apart from a greater strain on tools and the rotating machine parts, also a greater risk of accidents.

If the machine is not properly handled and the accident-prevention stipulations remain unheeded, two serious of accidents can ensue:

- injuries through loosening tool parts, tools or parts of the tool chucking facilities,
- cuts of the hands by touching rotating tools.

The machine must not be operated without sufficient knowledge of commensurate labour safety measures!

In order to avoid industrial accidents the following labour safety hints must be strictly observed.

- cutter arbors with top bearing tenons can only be utilised along with top bearings,
- the tool should be positioned as close as possible to the spacer nut on cutter arbors without top bearing tenons,
- the maximum rotational speed cited on multi-part and heavy tools must not be exceeded, otherwise the centrifugal forces within the tool could lead to its destruction,
- the tools must be exactly set and all cutters shall only operate within their commensurate knife cutting circles,
- tools with broken off cutters or with removed tool parts are no longer dynamically balanced. Vibrations can ensue given high rotational speeds. These in turn result in irregular blows on the workpiece and damage to the machine. Considerable accident risk.
- the tool bore must conform to the shaft diameter. Turned gauge rings may be used on small cylindrical cutters to compensate for a bigger tool bore on the cutter arbor shaft.,
- the machine has a braking device to attain spindle standstill within 10 s of switching off the motor,
- the guide rule must not feature any defects

- no screw or impact clamps should be used to attach additional devices to the machine table or guide rule as the cited clamps can easily loosen through vibrations and cause accidents,
- given hand feed, only counter–rotational cutting is possible!
- do not use any blunt tools for they exert a considerable cutting force and, then, the workpiece can only be held and guided manually with great difficulty,
- stop blocks must be placed alongside the stop faces of the guide rule if surface milling takes place. This prevents back movement of the workpiece.

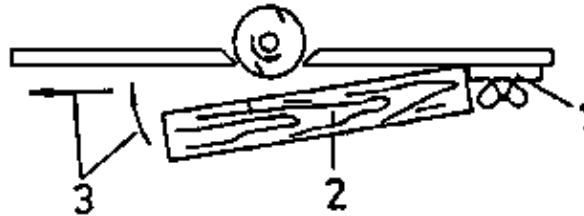


Figure 15 – Guide rule stop for surface million operations

1 stop block, 2 workpiece, 3 sequence of movement

Additional guides and blocks can, if required, be attached to the machine table. This is ensured by the throughgoing bores with internal thread in the table surface. Steel strip deflectors, protective caps and guard spacers are frequently employed to ensure that the hands do not come into contact with tools. The guard spacer should always be greater than the tool diameter. It is envisaged for milling operations on starting–up spacers, that is to say where no guide rule can be employed. The guard spacer is of light alloy and has rounded edges. Hand contact with the guard spacer can ensue and may even be painful, however cut injuries through the tool are prevented. Where possible the guard spacer should be set up a little distance away from the tool. If the distance between machine table and tool top edge is more than 30 mm the guard spacer no longer serves its envisaged purpose. In such a case a different protective device should be employed.

The guard cap is attached to the radial arm. As applies to the guard spacer, the guard cap too is envisaged for cutting operations without a guide rule. The guard cap cannot be used in conjunction with a cutter arbor with top bearing. Generally speaking, because of the partial view hindrance, the utilisation of a guard cap makes necessary additional stops or guide facilities. A guard cap is also handy in preventing cut injuries. The guard cap should also be greater than the tool diameter.

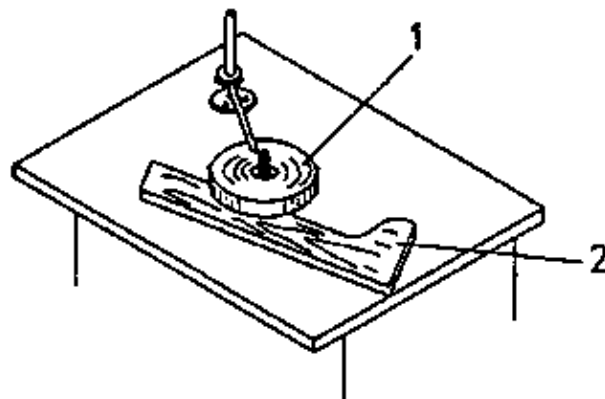


Figure 16 – Utilising the guard cap

1 guard cap, 2 workpiece

The steel strip deflector is an elastic steel belt with two holders which are used to place the steel strip deflector into two bores of the top narrow faces of the guide rule. The height is set so that its lower edge is not more than 8 mm away from the workpiece top edge. The elastic steel belt, given a favourable selection of bores in the stop rule, permits an arc–like shielding of the tool working area.

Pressure combs can be attached to the machine table and guide rule for improving tool handling capacity and preventing a backwards movement of the workpiece. A pressure comb ensures a partial covering of the tool.

Pressure combs are not standard machine equipment and must be made in the workshop.

What is the function of the “pressure comb” as an aid and labour safety facility?

Why is only counter-rotational milling permissible for manual feed milling operations?

Cleanliness and proper order are essential preconditions for accident-free operations!

**Smoothing and Sanding – Course: Manual woodworking techniques.
Instruction examples for practical vocational training**

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Smoothing and Sanding – Course: Manual woodworking techniques. Instruction examples for practical vocational training

Institut für berufliche Entwicklung e.V.
Berlin

Original title:
Lehrbeispiele für die berufspraktische Ausbildung
“Putzen und Schleifen”

Author: Rolf Jakoby

First edition © IBE

Institut für berufliche Entwicklung e.V.
Parkstraße 23
13187 Berlin

Order No.: 93–33–3307/2

Preliminary Remarks

The present booklet contains two instruction examples to practise manual finishing of wood by planing, filing and sanding.

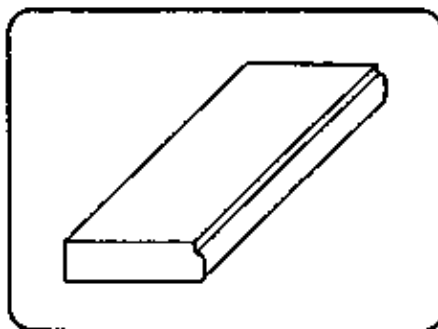
To facilitate the preparation and execution of the work, the necessary materials, tools and auxiliary accessories are specified for each example. Moreover, the previous knowledge of the trainees and the working techniques required for working of the workpieces are also mentioned. They should be recapitulated before starting with the work.

The sequence of operations given for each example contains the order of the working steps necessary to complete the relevant workpiece. Peculiarities of craftsmanship to achieve good quality are pointed out.

The size and shape of the workpieces have been selected so that the workpiece of the first example can be used as bottom board and two workpieces of the second example as cheeks for a wall shelf. A working drawing is attached to each example showing the suitable size and shape of the workpiece for manual preworking or premachining and for manual finishing. Possible deviation therefrom can be decided at the instructor's discretion.

Instruction Example 7.1.: Wall Shelf – Bottom Board

Smoothing and sanding of flat and profiled solid wood faces to be practised.



Material

Premachined or manually preworked boards (planed, sawn to size and profiled)

Width: 120 mm

Length: 550 mm

Thickness: 20 mm

Tools

Double plane, scraper, various sanding pads, flexible sanding tool, metal hammer

Auxiliary accessories

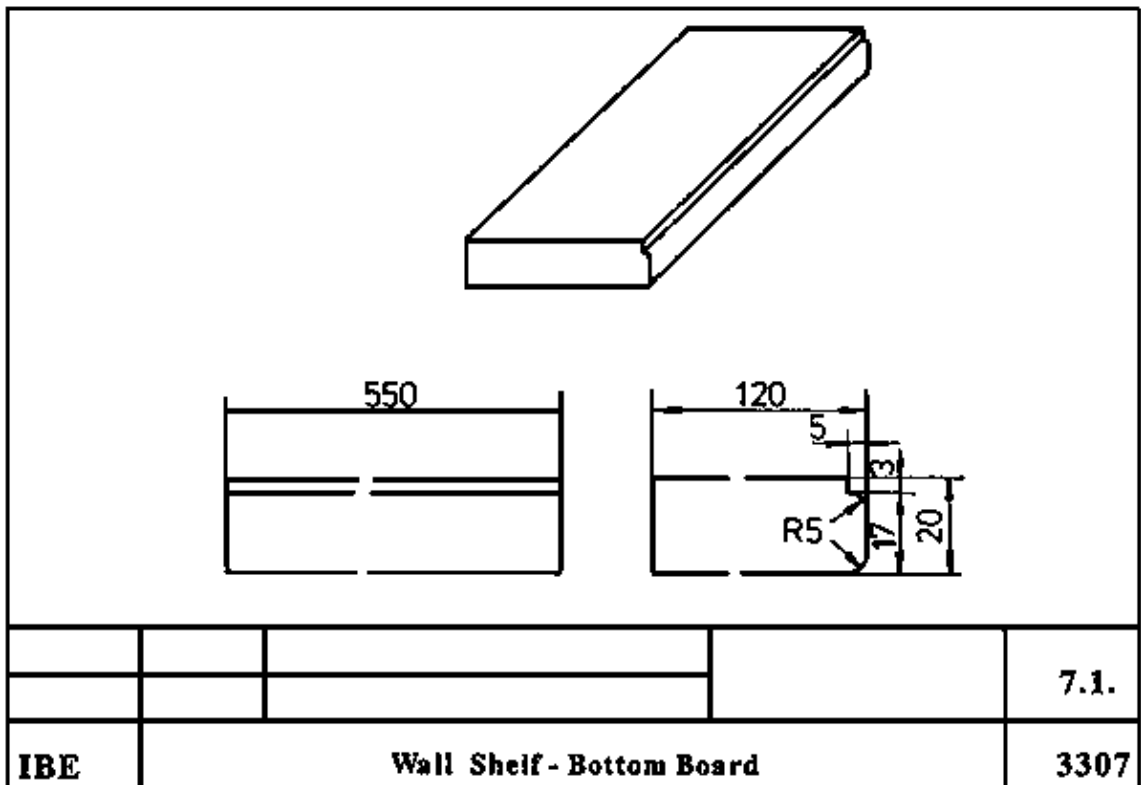
Carpenter's bench, clean supporting and packing faces, straightedge

Necessary previous knowledge

Planing, testing

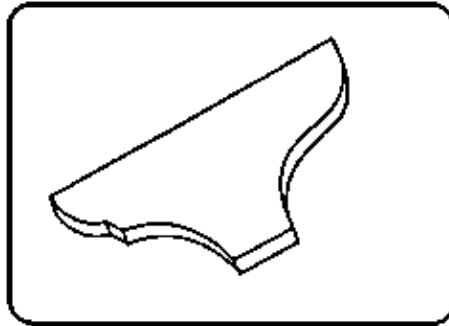
	Sequence of operations	Comments
1.	Prepare the workplace. Make the tools available.	Check for completeness.
2.	Set double plane for removal of fine chips.	Test on a test piece.
3.	Firmly clamp the workpiece between the timber dogs of the carpenter's bench with one wide face on top.	Working direction and grain direction of workpiece to be considered. Use clean packing faces to avoid pressing marks. Hold timber dogs and lateral packing pieces under the face to be worked.
4.	"Smooth" (fine-plane) the wood face with the double plane with long strokes throughout.	In the case of opposite wood grain direction, clamp the workpiece the other way round.
5.	Remove heavy irregularities (on harder woods) with the scraper.	Guide the scraper in the direction of the wood grain.
6.	Sand the face with sanding tools longitudinally with the wood grain.	
7.	Check the face for flatness and smoothness.	Check the face in longitudinal and cross directions with straightedge and visually and touch it with the hand.
8.	Re-clamp the workpiece so that the opposite wide face is on top.	

9. Work the second wide face according to steps 4. to 7. above.
10. Re-clamp the workpiece so that the profiled narrow face is on top. Use the front chop of the carpenter's bench and packing faces.
11. Smooth the flat narrow face with the double plane according to steps 4. and 5. above.
12. Re-sand the face longitudinally with the wood grain.
13. Sand the quartered rod profile with the wood grain. Start sanding on the wide or narrow face and complete on the adjacent narrow or wide face.
14. Sand the quartered rod profile with plate (rabbet) with the wood grain. Use sharp-edged sanding pad of hard wood. Start sanding in the profile corner and complete on the wide face.
15. Sand the longitudinal edges of the work-piece with the wood grain (chamfering of edges). Sand with slight pressure on the edge only.
16. Check the narrow face and profiles for flatness, straightness and smoothness.



Instruction Example 7.2.: Wall Shelf – Check

Filing and sanding of curved narrow faces to be practised.



Material

Premachined or manually preworked boards (planed, sawn to size)

Width: 130 mm

Length: 300 mm

Thickness: 20 mm

Tools

Double plane, scraper, flat file, half round file, various sanding pads, flexible sanding tool, metal hammer

Auxiliary accessories

Carpenter's bench, clean supporting and packing faces, testing templates for curves

Necessary previous knowledge

Planing, testing

Sequence of operations

Comments

1. Prepare the workplace. Make the tools available. Check the double plane for completeness and fine setting.
2. Firmly clamp the workpiece in the carpenter's bench, smooth and sand the opposite wide faces.

"Smooth" (fine-plane) the wood face with the double plane with long strokes throughout.

Remove heavy irregularities (on harder woods) with the scraper.

Sand the faces with sanding tools longitudinally in grain direction.

Check the face for flatness and smoothness.

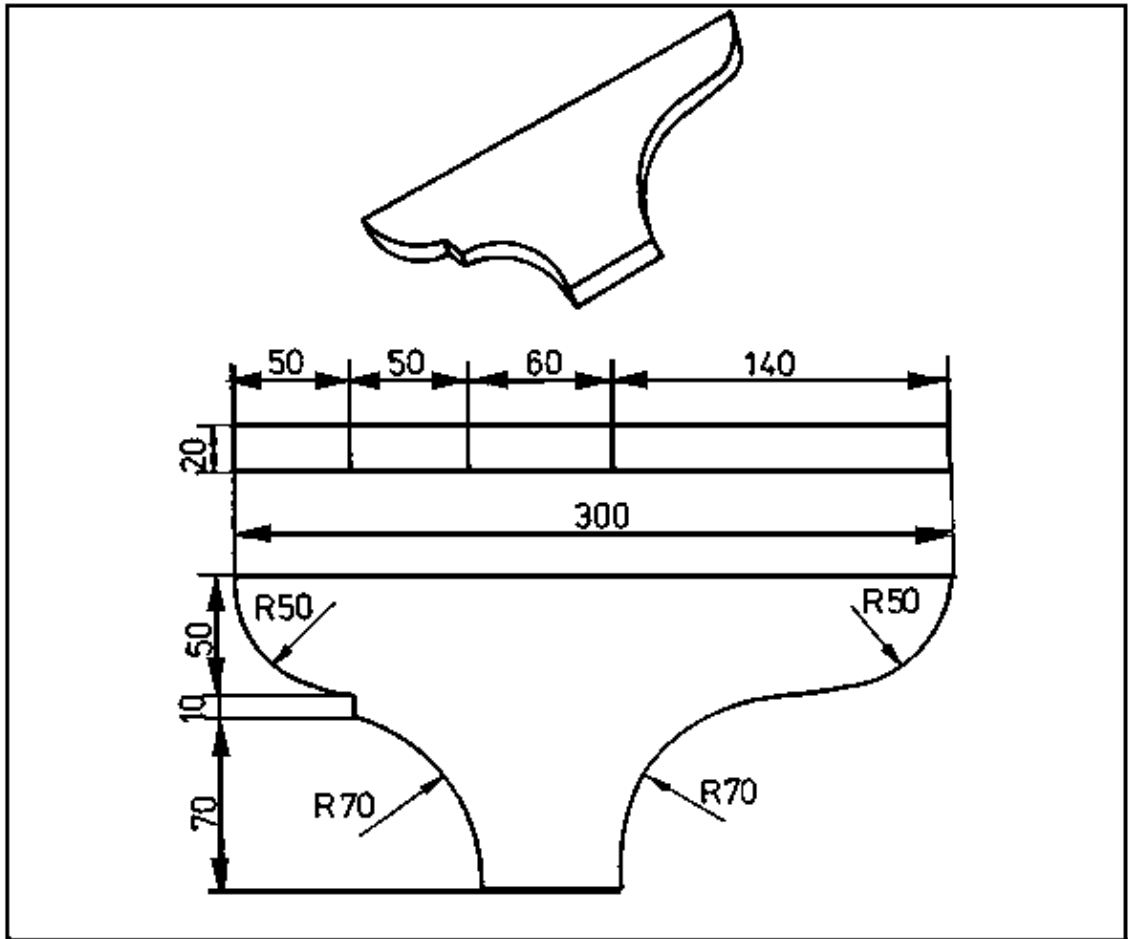
- | | |
|--|--|
| 3. Re-clamp the workpiece so that the short, flat longitudinal narrow face is on top. | Working direction and grain direction of the workpiece to be considered. Use clean packing faces to avoid pressing marks.

Hold timber dogs and lateral packing pieces under the face to be worked. |
| 4. Smooth the narrow face with the scraper. | In the case of opposite grain direction, clamp the workpiece the other way round. |
| 5. Re-sand the narrow face with sanding pad and flexible sanding tool. | Guide the scraper in the direction of the wood grain. |
| 6. Re-clamp the workpiece so that short cross-grained narrow face and separate curved narrow faces are on top. | |
| 7. File outwards curved (cambered) narrow face and cross-grained narrow face accurately to shape with a flat file. | If possible, file should not be guided across the wood grain (workpiece thickness) to avoid breaking out of wood fibres.

Where cross-filing is necessary (cross-grained face and corner) work with slight pressure on the file.

Check the face in longitudinal and cross directions with straightedge and visually and by touching it with the hand. |
| 8. File inwards curved (hollow) narrow face accurately to shape with a half round file. | See comments as per 7. above. |
| 9. Re-sand the filed narrow faces. | Use sanding pads with suitable shape.

See comments as per 7. above. |
| 10. Re-clamp the workpiece so that continuously curved narrow faces are on top. | |
| 11. Work the cambered and hollow narrow faces according to steps 7. to 9. above. | |
| 12. "Chamfer" workpiece edges with flexible sanding tools. | |
| 13. Check the narrow faces for accuracy to shape | Place templates on curves and compare. |



			7.2.
IBE	Wall Shelf-Chek		3307

**Smoothing and Sanding – Course: Manual woodworking techniques.
Trainees' handbook of lessons**

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Smoothing and Sanding – Course: Manual woodworking techniques. Trainees' handbook of lessons.

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First edition © IBE

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Order No.: 93–35–3307/2

1. Purpose and Meaning of Smoothing and Sanding

Smoothing and sanding are chip-producing woodworking techniques for finishing of wood surfaces aiming at:

- final shaping of the workpiece,
- improvement of the surface finish.

Smoothing is the manual technique of shaping and finishing the surfaces by:

- planing,
- filing,
- working with the scraper (sheet steel).

Sanding is the technique of final fine-finishing of the surfaces by sanding tools.

What is the purpose of smoothing and sanding?

2. Types and Mode of Action of Smoothing and Sanding Tools

Smoothing of flat wood surfaces by planing is performed by means of the double plane. Smooth surfaces are achieved by planing by

- a narrow opening in the plane face,
- a sharp plane cutter edge,
- setting a maximum distance of 0.5 mm between the breaker edge of the plane-cutter flap and the cutting edge,
- a small projection of the cutting edge at the plane face.

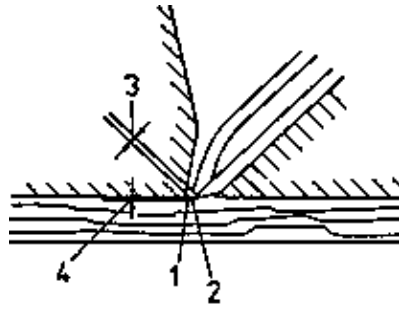


Figure 1 Fine setting of the double plane

1 narrow opening in the plane face, 2 plane cutter edge, 3 distance of the flap breaker edge to the cutting edge, 4 distance of the cutting edge to the face

Profiled and curved surfaces are planed by means of special planes, such as

- double rabbet plane,
- plane with profiled plane face and adequately profiled plane cutters with flap,
- plane with curved plane face.

The hand tools for size-finishing and smoothing of curved surfaces are rasps and files of different shapes. The chips are removed by successive cutting edges which are called "cuts". The cuts are cut or milled into the basic body, the blade. At the top end the blade is designed as tang to which the handle is fixed.

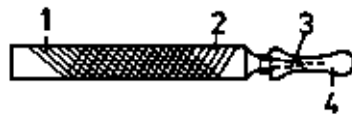


Figure 2 Parts of rasps and files

1 cuts, 2 blade, 3 tang, 4 handle

Rasps are used for rough-smoothing of the workpiece. Files are used for the subsequent finishing by removing very thin chips. The files differ according to the different jobs and quality requirements. They differ with respect to

- the arrangement and distances of the cut rows,
- the shape of the file blade.

There are single-cut and double-cut files. Single-cut files have an angle of 110 to 115 degrees between the cut rows and the axis of the file.

Double-cut files have, in addition to the undercut, a second cut (overcut) at an angle of 52 to 56 degrees to the axis of the file.



Figure 3 Types of files according to the cut rows, angles of cut rows (1) Single-cut file

1 single-cut file blade, 2 axis of the file, 3 angle of the undercut rows to the axis



Figure 3 Types of files according to the cut rows, angles of cut rows (2) Double-cut file

1 double-cut file blade, 2 axis of the file, 3 angle of the undercut rows to the axis. 4 angle of the overcut rows to the axis

The following rules apply to the selection and use of the files:

- Single-cut files and big distances between the cut rows remove bigger chips.
- Double-cut files and small distances between the cut rows remove fine chips and produce smooth surfaces.

The shape of the file blade depends on the purpose of use. The main shapes are:

- flat file,
- flat round file,
- half round file,
- round file.



Figure 4 Profiles of different files

1 flat file, 2 flat round file, 3 half round file, 4 round file

When filing resinous and glued woods, the cuts of the file are filled with chips, resin and glue. The files are to be cleaned as follows:

- Softening and swelling of the dirt in water.
- Subsequent brushing out of the dirt using a root brush or fine brass brush.

Burning out or scratching out of the dirt by means of pointed objects or a sharp wire brush would damage the cuts and reduce the service life of the file.

Small irregularities of the surface left after planing or filing are removed with a scraper. The sheet-steel scraper has a length of about 150 mm, a width of 50 mm and a thickness of 1 mm. The fine chips are removed by a uniform, sharp ridge at the longitudinal edges of the tool.

Sharpening of the scraper involves the following operations:

- Clamping in a clamping fixture.
- Levelling of the longitudinal narrow faces by means of a flat metal file.
- Whetting of the longitudinal narrow faces with coarse and fine whetstones and whetting fluid.
- Whetting of the wide faces by means of whetstones and whetting fluid.
- Burnishing of the wide faces by means of a scraper burnisher humidified with oil until there is no ridge anymore.
 - Scraper burnisher to be firmly pressed on the wide face during burnishing.
- Burnishing of the ridge by moving the scraper burnisher along the longitudinal narrow faces and pressing it towards the wide face.

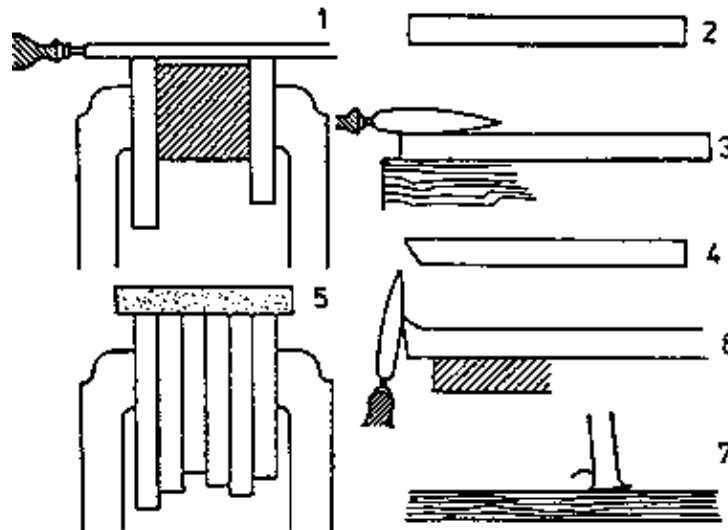


Figure 5 Sharpening of the scraper For better file support, a wooden block is to be clamped between two scrapers

1 filing, 2 filed and whetted, 3 burnishing, 4 burnished, 5 whetting, 6 burnishing of the ridge, 7 scraper in use

Finally the surfaces are fine-finished by sanding using flexible sanding tools.

They consist of

- the flexible abrasive carrier
- and the adhesive-bonded abrasives.

Abrasive carriers mainly used are:

- water-proof and non water-proof paper,
- rigid fabric

and for special applications:

- metal or plastics or a combination of these materials.

Abrasives are sharp-edged and very hard mineral or synthetic materials. Synthetic abrasives are harder than mineral abrasives.

The table shows the types and hardnesses of the abrasives.

Table 1 – 1. Types of Abrasives

Type of abrasive	Hardness (to Mohs)
Mineral abrasives:	
1.1. Cullet	4 to 6
1.2. Flint	5 to 7
1.3. Garnet	7
1.4. Emery	7 to 8
1.5. Natural corundum	8 to 9
Synthetic abrasives:	
1.6. High-grade corundum	8 to 9

The quality of the sanded surface depends on the size of the abrasive grains and on their distance from each other (distribution density). The following rules apply to the selection and use of the abrasive grains:

- Grains of big size and big distance produce a rough surface.
- Grains of small size and smaller or no distance produce a smooth, clean surface.
- When the abrasives are dull, further use is possible by shining the sanding tool and then the abrasives are to be replaced.

The tools for manual sanding are sanding pads around which the flexible sanding tools are clamped. Wide faces are sanded by means of sanding pads consisting of

- cork,
- soft wood with glued-on felt support.

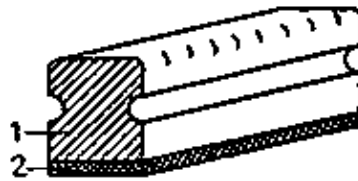


Figure 6 Sanding pad

1 softwood, 2 felt support

Hard-wood sanding pads are used for sanding of narrow faces. Profiled and curved faces are sanded by means of sanding pads with counterprofile.

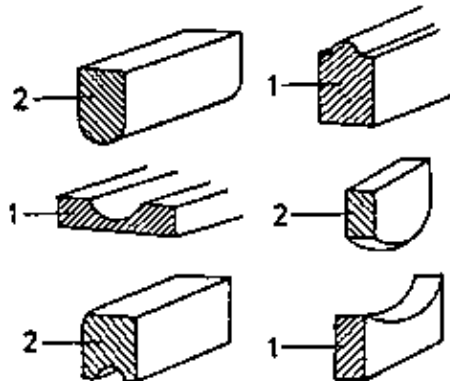


Figure 7 Sanding pads with adequate shape for sanding of profiled and curved faces

1 workpiece, 2 sanding pads with counterprofilis

3. Finishing of Flat Wide and Narrow Faces

Finishing of flat wide and narrow faces involves the following operations:

Clamping of the workpiece in a carpenter's bench or work bench with the face to be finished on top

- To avoid pressing marks on the workpiece, clean packing faces of wood or other solid materials are to be used.
- Long workpieces are to be supported at the free end by a vertically adjustable rest.
- The working direction and grain direction of the workpiece are to be taken into account.

Planing with the double plane and fine-chip setting

The planing strokes should be long and overlap a little.

Working with the scraper

The scraper is mainly used for finishing of hard wood. With soft wood, the wood grains would press into the face during working and no chip would be removed.

The scraper is to be guided lightly over the face with both hands

- with drawing cut,
- with the ridge edge slightly oblique to the working direction,
- parallel, oblique or square to the wood grain direction, depending on the requirements.

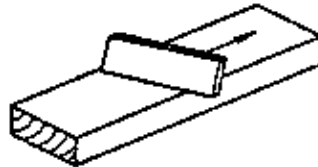


Figure 8 Guiding direction of scraper

Sanding with sanding tools

Sanding includes the steps:

- Selection of the flexible sanding tool.
- Selection of the sanding pad.
- Wrapping the flexible sanding tool around the sanding pad and holding it with the hand.
- Sanding movements to be performed with slight, uniform pressure on the face in the following working directions:
 - across the wood grain in the case of surfaces to be provided with covering coat of paint,
 - parallel to the wood grain in the case of surfaces with straight-line grain direction,
 - circular or with the wood grain in the case of surfaces with irregular grain direction.
- Uncovered edges of the workpiece are to be sanded throughout (smoothing off of edges) with slight, uniform pressure.

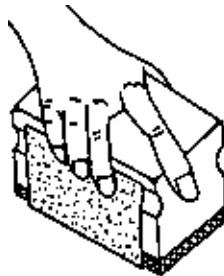


Figure 9 Holding of the flexible sanding tool at the sanding pad

Checking the surface for flatness and smoothness.

The surface quality is to be checked by:

- comparison of the face with a straightedge according to the light-gap testing method.
- sighting over the face.

The face is flat if the sighted workpiece edges are congruent.
The face is smooth if no shadow effect caused by irregularities is visible.

- touching the face with the hand.

The face is smooth if no irregularities are sensible.

Why must uncovered workpiece edges be sanded?

4. Finishing of Profiled Faces

The use of the tools and the working steps for finishing of profiled faces depend on:

- the surface finish of the profiles produced manually or on machines,
- the shape of the profiles,
- the possibilities for using the tools.

Profiles with heavy and medium irregularities can be finished with any suitable and available smoothing and sanding tools. Profiles with slight irregularities are finished by sanding.

The selection and use of the tools depend on the shape of the profiles. Profiles are finished by tools with counterprofile or in sections by several different tools. The sanding pads with counterprofile required for sanding of profiles are specially made from hard wood.

Smoothing of profiled faces involves the following operations:

- Clamping of the workpiece with the profiled faces on top, if possible.
- Planing.
- Working with the scraper.
- Sanding.
- Checking for smoothness by
 - sighting over the profiled faces and/or
 - touching the profiled faces.

For profiled faces having just slight irregularities, the operations planing and scraper working can be skipped.

5. Working to Size and Finishing of Curved Surfaces

Shaping and finishing of faces curved by sawing tools involve the following operations:

- Clamping of the workpiece with the faces to be worked on top, if possible.
- Shaping and finishing.

The selection and use of the tools depend on the shape and size of the curves.

- Slightly curved radii are worked with:
 - plane with adjustable face,
 - fine-set double plane,
 - scraper,
 - sanding tools.
- Slightly curved hollow faces are worked with:

- plane with adjustable face,
- plane with fixed, curved face,
- scraper,
- sanding tools and sanding pads with adequate shape.

– Highly curved radii are worked with:

- flat rasps,
- flat files,
- scraper,
- sanding tools.

– Highly curved hollow faces are worked with:

- half round rasps,
- half round files,
- flat round files,
- scraper,
- sanding tools and sanding pads with adequate shape.

Curved faces are worked with rasps and files with

- one hand gripping the handle of the tool,
- the other hand guiding the tool at the blade,
- the tool guided with the wood grain, if possible, or obliquely to the wood grain,
- the tool guided parallel to the curving.

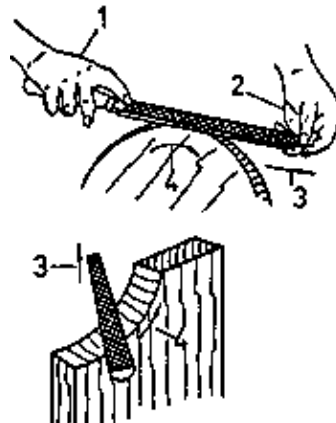


Figure 10 Guiding of rasps and files

1 gripping of the tool at the handle, 2 guiding of the tool at the blade, 3 guiding with and obliquely to the wood grain, 4 guiding parallelly to the curving

Checking of the curved faces for:

– working accurate to shape

- with templates placed on the face and compared with the face to the light–gap method.

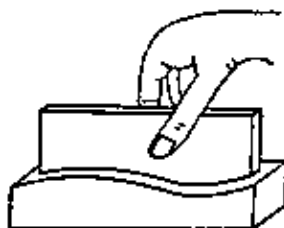


Figure 11 Checking a curved face with a template

1 workpiece, 2 template

– smoothness by

- sighting
- touching.

Why must the rasps, files and sanding tools be guided preferably with the wood grain or obliquely to the wood grain?

**Splitting and Carving – Course: Manual woodworking techniques.
Instruction examples for practical vocational training**

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Splitting and Carving – Course: Manual woodworking techniques. Instruction examples for practical vocational training

**Institut für berufliche Entwicklung e.V.
Berlin**

Original title:
Lehrbeispiele für die berufspraktische Ausbildung
"Spalten und Schnitzen"

Author: Fritz Dienemann

First edition © IBE

Institut für berufliche Entwicklung e.V.
Parkstraße 23
13187 Berlin

Order No.: 93–33–3303/2

Preliminary Remarks

The present booklet contains three instruction examples to practise the techniques of splitting and carving with various splitting and carving tools for different jobs, such as

- splitting–up of round timbers and logs,
- rough shaping of timbers with the axe,
- carving of accessories for furniture and structural elements.

Free working with splitting and carving tools can be applied in the entire field of manual woodworking.

The necessary materials, tools and auxiliary accessories are specified for each example to facilitate the preparation and execution of the work.

Previous knowledge of sketching, drawing and stencil making is required and should be recapitulated at the beginning.

The sequence of operations given for each example contains the order of working steps required for the relevant working technique. This sequence should be followed if a good quality of work is to be achieved.

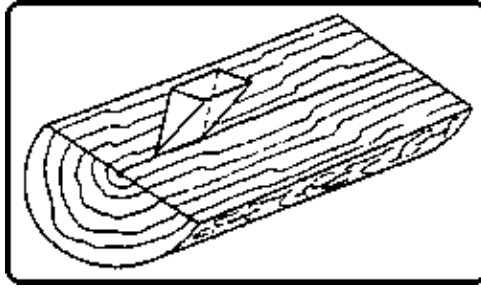
The operations included in the instruction examples serve for preworking of workpieces which, after further working steps, can be finished to produce things ready for use.

Instruction Example 3.1.: Splitting–up of Round Timber

Splitting–up of logs (halving and quartering) to permit crack–free drying of the wood required for carving.

Material

Round timbers of different lengths (1500 mm maximum) and diameters



Tools, measuring and testing means

Axe, steel wedges, wooden wedges, sledge hammer

Auxiliary accessories

Supporting block, different pieces of wood to secure the logs to be split up.

Necessary previous knowledge

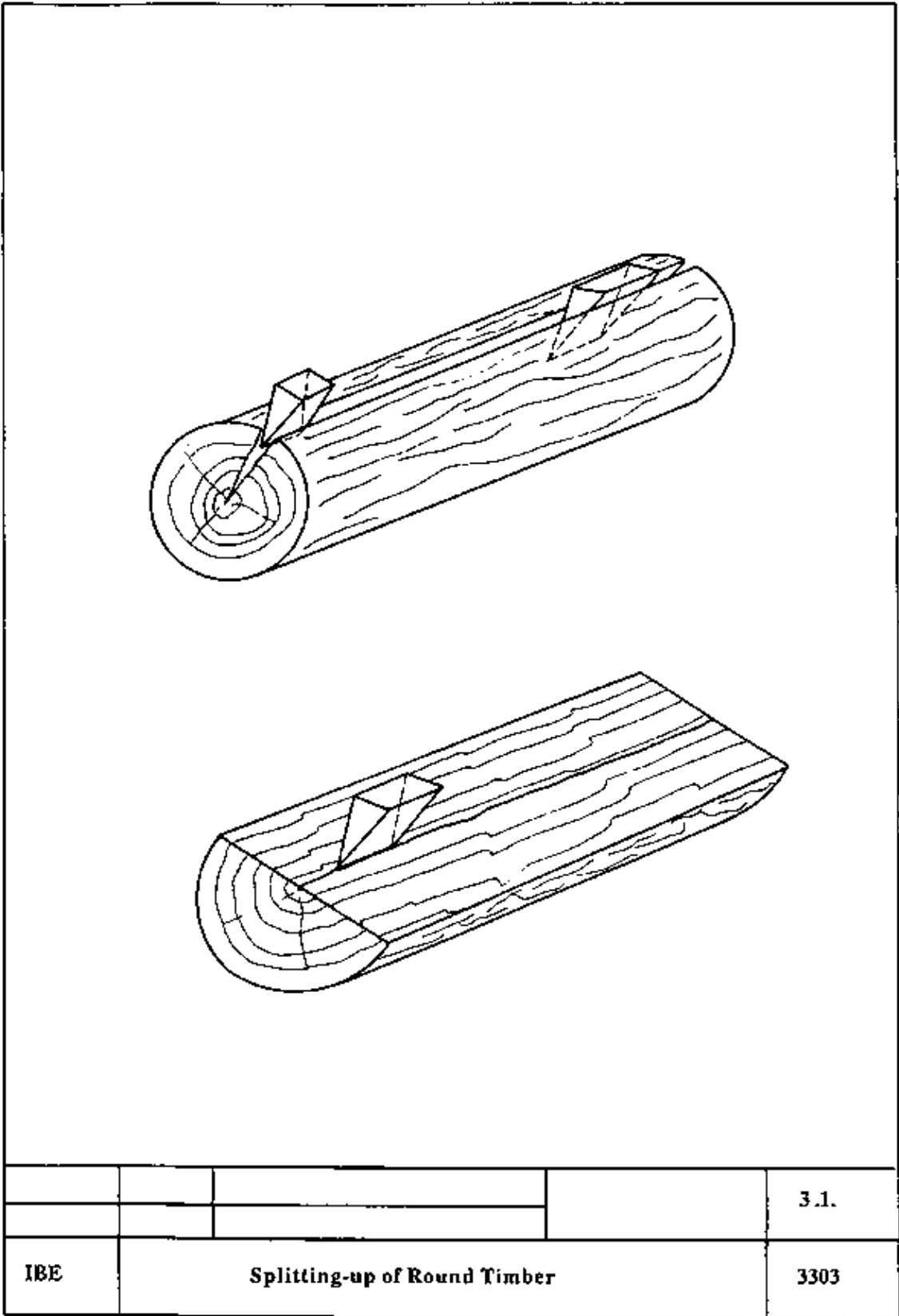
Structure of wood, splitability of wood, tangential and radial cutting directions, fundamentals of wood drying

Sequence of operations

1. Prepare the working place.
2. Inspect the log and select suitable spot for splitting.
3. Turn the log so that the side to be split will show up wards.
4. Secure the log at both sides.
5. Pre-split the log at the selected spot by the axe.
6. Remove the axe and place a steel wedge at the same spot and drive it slightly in with the hammer.
7. Drive the wedge into the wood with powerful hammer blows.
8. Place and drive-in further steel wedges if required by the log size.
9. Drive-in thicker wooden wedges into the splits produced and continue until the log is split up into halves.
10. Turn the log halves so that the heart of the log is showing upwards.
11. Place and drive-in the steel wedges in the heart (medullary).
12. Repeat the above steps 7 to 9 until log is quartered.
13. The split wood is to be taken to the drying place and prepared for drying.

Comments

- Check the tools, make available the auxiliary accessories.
- Find out direction of cracks, if any, in the cross-grained wood and take it into account for splitting.
- The log must be prevented from rolling off during the work to avoid accidents.
- Do not use the axe for driving-in the wedge!
- Be careful when the log halves are falling apart – danger of injuries!
- Secure the halves from slipping off or jumping off.
- On completion of work pick up, clean and store the tools.



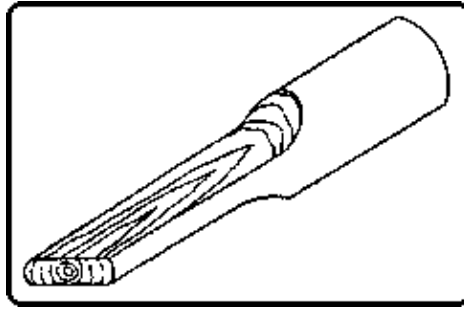
Splitting-up of Round Timber

Instruction Example 3.2.: Shaping of Round Timber

Rough shaping of timbers with the axe to produce simple commodities where accuracy and surface finish are of minor importance.

Material

Round timbers of dimensions depending on the purpose of use.



Tools, measuring and testing means

Folding rule, axe

Auxiliary accessories

Wooden block, pencil

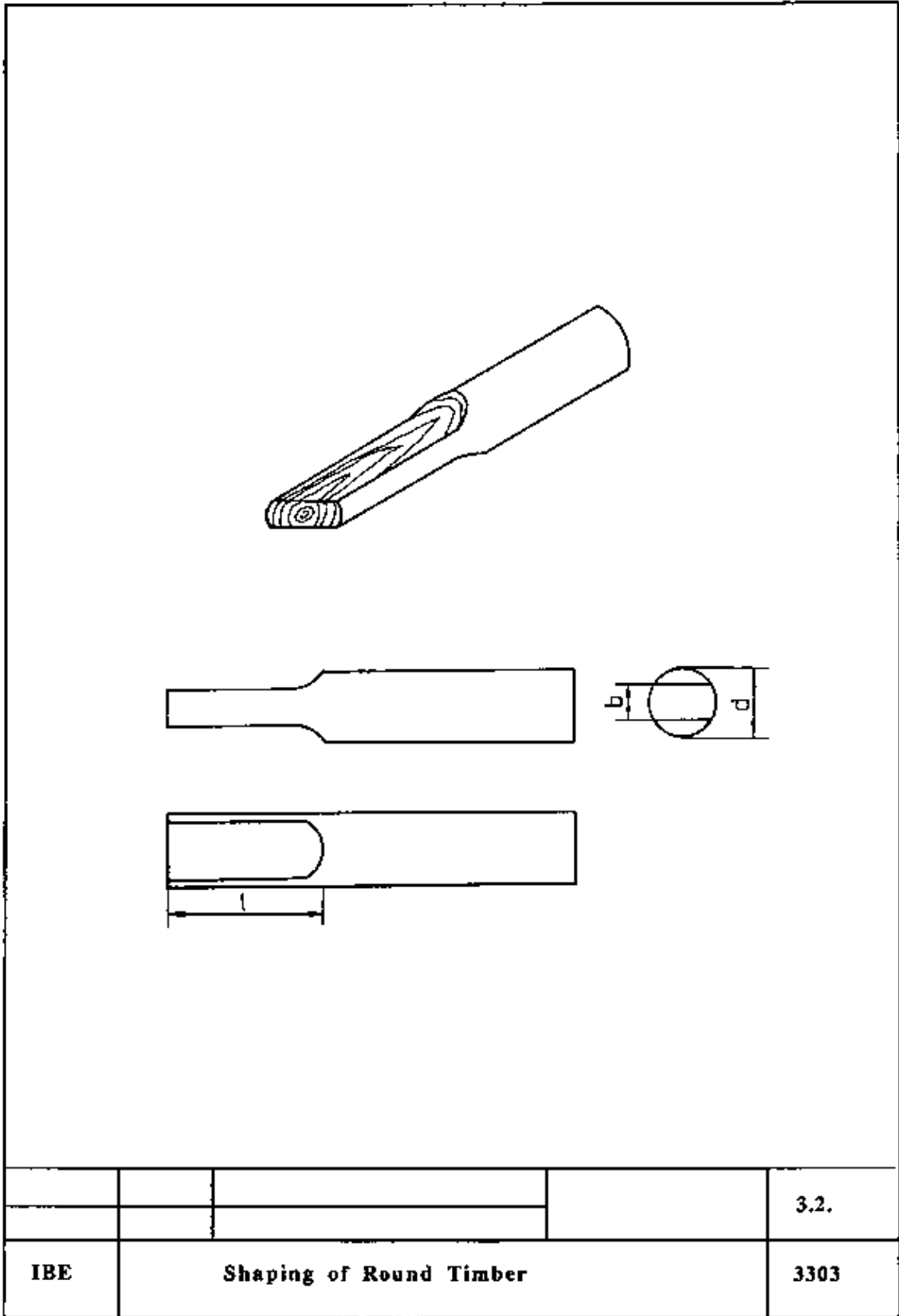
Necessary previous knowledge

Structure of wood, properties of wood, measuring and scribing

Sequence of operations

Comments

- | | |
|--|---|
| 1. Prepare the working place. | Check and, if necessary, sharpen the axe. |
| 2. Make available the material and inspect the properties and growth of the round timbers. | It is difficult to work knotty spots with the axe. |
| 3. Decide on the working direction. | Axe strokes should be in grain direction, if possible. |
| 4. Scribe the dimensions to be worked. | Scribe with folding rule and pencil the length on the circumference and the depth to be worked on the crossgrained end of the round timber. |
| 5. Roughly work the faces by axe strokes. | Correct working position is important to avoid accidents if the axe slips off. |
| 6. Check the dimensions worked. | |
| 7. Smooth the faces by cutting-off small chips with the axe. | Use a small, very sharp axe for smoothing. |
| 8. Check the working results. | The faces worked should be of equal size. |



Shaping of Round Timber

Instruction Example 3.3.: Relief

This instruction example explains how to produce a relief with simple raised letters. The term "Manual Woodworking" maybe replaced by any other term or name.

Material

Board of a well-grown deciduous tree without branch knots

Length = 400 mm

Width = 250 mm

Thickness = 30 mm

The board is to be planed out and sawn to final size.

Tools, measuring and testing means

Carving chisels of different shapes, mortise chisel, folding rule

Auxiliary accessories

Carpenter's bench or work bench, letter stencil, clamping pieces of wood, pencil, abrasive paper

Necessary previous knowledge

Sketching and drawing, handling the firmer chisel, ripping and mortising

Sequence of operations

Comments

- | | |
|--|--|
| 1. Prepare the working place. | Check the tools. |
| 2. Clamp the workpiece flat on the bench. | Use clamping pieces of wood to prevent damage to the workpiece edges. |
| 3. Mark out the sizes chosen for distribution of the area with pencil strokes on the right board side. | |
| 4. Transfer the letters with stencils or off-hand onto the scribed lines. | Choose the type of letters as simple as possible. |
| 5. The blank space around the letters is to be worked out to a depth of approx. 2 mm. | The recesses may be flat or undulatory. |
| 6. Scratch-in the contours of the letters and the framing with a firmer chisel. | |
| 7. Roughly carve-out the blank space around the letters with a gouge and mortise chisel. | Don't work too near to the edges when rough-carving. |
| 8. Finish-carve with different carving chisels. | Finish-carving is to be done preferably without mortise chisel. (One hand guides the carving chisels, the other one moves them.) |
| 9. Carve-out the interior spaces in the letters with narrow carving chisels. | The work is to be done with great care since the narrow letters may easily spall. |
| 10. If the recesses shall be flat, smooth them with abrasive paper. | Be careful – don't break off the edges of the letters! |
| 11. Remove any pencil strokes left carefully with a scraper or with abrasive paper. | |
| 12. Check the working result. | |

**Splitting and Carving – Course: Manual woodworking techniques.
Trainees' handbook of lessons**

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Splitting and Carving – Course: Manual woodworking techniques. Trainees' handbook of lessons

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Original title:
Arbeitsmaterial für den Lernenden
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Author: Fritz Dienemann

First edition © IBE

Institut für berufliche Entwicklung e.V.
Parkstraße 23
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Order No.: 93–35–3303/2

1. Purpose and Meaning of Splitting and Carving

Splitting and carving are cutting and chip-producing techniques to produce simple commodities as well as to design and produce objects of arts and crafts from the natural material of wood. Splitting of wood is looked upon here as prestage of carving to prepare the raw material for the drying process.

2. Splitting and Carving Tools

2.1. Mode of Action and Types of Splitting Tools

Wood which is relatively easy to work is used for carving. This calls for a wood moisture contents of 8 % to 10 %. Drying of wood in the trunk (log) results in many drying cracks which heavily limit the use of the wood or even make it useless. The logs must be prepared first before the drying process can start. For this purpose the logs are cut on machines in sawmills as many times as necessary or they are manually split up. The basic shape of all splitting tools is the shape of a double-sided wedge which effects the chip less cutting of the wood.

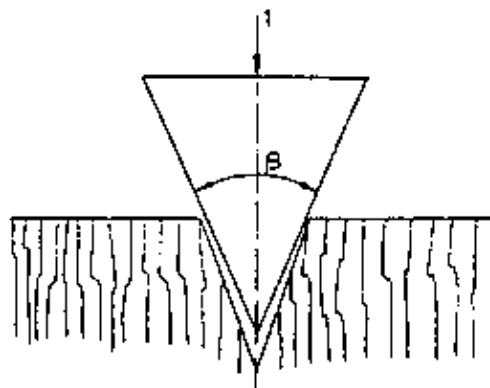


Figure 1 Double-sided wedge

1 beating force or pressure (F), β angle of wedge

The axe is used for splitting of thin round timbers and for rough chiselling-off of wooden objects.

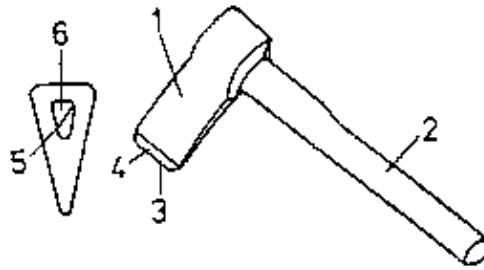


Figure 2 Axe

1 blade, 2 handle, 3 cutting edge, 4 bevel, 5 blade head, 6 wooden key or steel key

The handle should have a length of approx. 600 mm and be firmly secured (keyed) in the blade head. The cutting edge has the shape of a double-sided wedge with an angle of wedge of 25 degrees and must always be kept sharp.

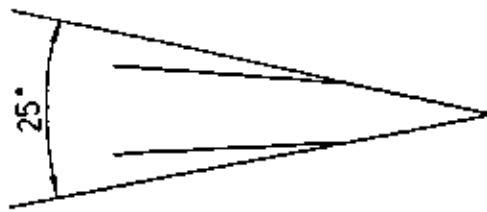


Figure 3 Angle of wedge of the axe cutting edge

For splitting of shorter and longer logs, steel or hardwood wedges are used which are driven into the wood by a sledge hammer.

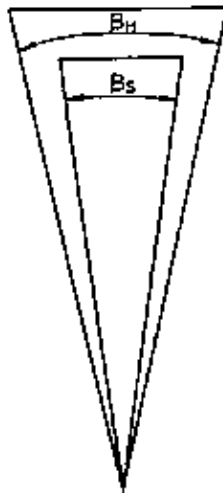


Figure 4 Hardwood and steel wedges

- ?_H hardwood wedge angle = 25 degrees
- ?_S steel wedge angle = 15 degrees

The slenderness ratio (angle of wedge) is important for the shape of the wedges.

What components does an axe consist of?

2.2. Mode of Action and Types of Carving Tools

Different types of carving knives and carving chisels are used as carving tools. The carving knives are provided with a ground double-sided taper and consequently with the shape of a double-sided wedge with a

very small angle of wedge.

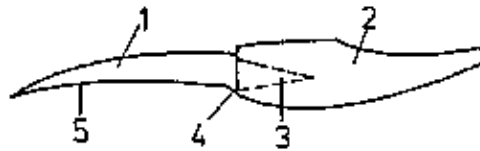


Figure 5 Carving knife

1 blade, 2 handle, 3 spike, 4 bit, 5 cutting edge

The carving knife is held and guided by one hand and predominantly used to produce smaller objects which can be carved in the hand with no need for clamping devices. The carving chisels are provided with a ground single-sided taper and consequently with the shape of a single-sided wedge. Therefore, their mode of action is similar to that of firmer chisels and mortise chisels.

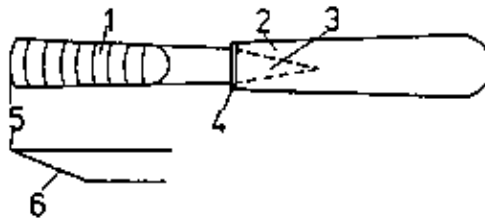


Figure 6 Carving chisel (sculptor's chisel)

1 cutter, 2 handle, 3 spike, 4 bit, 5 cutting edge, 6 bevel

The carving chisels, also called sculptor's chisel, are guided by hand or beaten by a wooden cudgel (mortise cudgel).

Carving chisels are produced in a great variety of shapes and sizes and thus can be used for any types of carving operations.

Table 1:

Carving chisels (sculptor's chisels)

Designation	Features	Application
Straight chisels for different cuts	Square, angular or round main cutting edge	Carving of recesses of different types
Bent chisels	Chisels are bent or offset in their longitudinal axis	Carving of hidden recesses

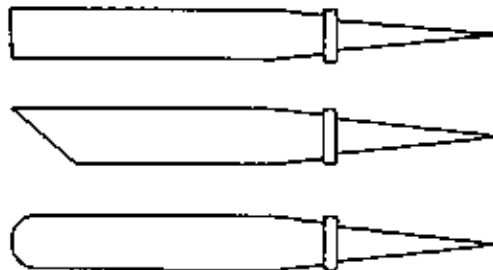


Figure 7-1 Carving chisels: straight chisels for different cuts

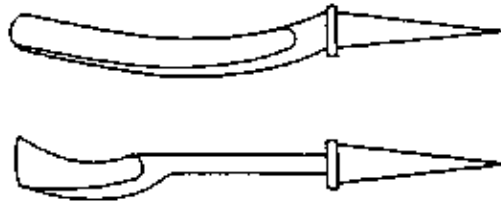


Figure 7–2 Carving chisels: bent chisels

Why must a carving chisel, which is beaten by a wooden cudgel, have a metal ring at the upper handle?

2.3. Maintenance of Tools

Maintenance of carving tools comprises:

- attendance and cleaning of the tools,
- checking and, if necessary, replacement of the handle,
- sharpening of the cutting edges of the tools.

The general attendance of carving tools is similar to that of other chip-producing tools.

Sharpening of splitting and carving tools, however, features some peculiarities which are explained in the following.

Sharpening of splitting tools

Splitting tools are sharpened by grinding. The axe is ground to the specified wedge shape by rotating grindstones or emery wheels with the cutting edge to be held against the direction of rotation of the grinding tool. The burr produced is removed by alternately stoning the two bevels of the cutting edge with circulating movements of a wetted oilstone.

Steel wedges are not ground nor stoned. By beating with the sledge hammer, burr maybe produced at the rear side of the wedges which is to be removed by grinding.

Attention: Burr particles of the wedge may split off when the wedge is driven in and cause injuries!

Wooden wedges are used until they split up or break, and then they are replaced.

Sharpening of carving tools

Carving tools are also sharpened by grinding.

Grinding and stoning of carving knives and carving chisels requires great care and a lot of experience. Trainees should not sharpen carving tools until they master the sharpening process of simple wood-working tools.

Because of the great variety of shapes of the carving chisel cutting edges, each tool is to be treated differently.

Grinding is similar to grinding of planing tools or fimer and mortise chisels. With round chisels, guidance by hand is to be steady, smooth and with little pressure. Constant cooling is required during grinding to avoid annealing.

Grinding is to be done carefully to prevent excessive abrasion!

For stoning of the cutting edges (removal of burrs), different oilstones are to be used, the cross-sectional shape of which must correspond to the shape of the cutting edge.

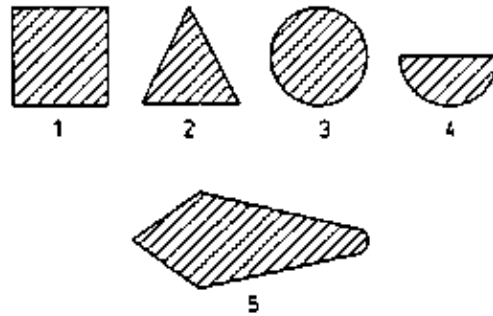


Figure 8 Cross sections of oilstones

1 square, 3 triangular, 3 round, 4 half-round, 5 wedge-shaped

The reciprocating movement of the tool on the oilstone or vice versa is continued until the burr is removed and the cutting edge has a bright appearance.

Carving tools are generally to be stored so as to prevent them from rusting and hitting of hard objects.

When the tools are not used, the best way of storing them is in a suspension device in a wall chest.

During carving the tools should be orderly arranged side by side on the workbench with the cutting edge showing towards the trainees.

Which tools are used for sharpening of carving chisels?

3. Preparation of Splitting and Carving

The preparations for splitting and carving include:

- selection of suitable material,
- selection of the necessary tools,
- preparation of the working place,
- taking the necessary measures for labour safety.

Special preparations for splitting of logs include:

- securing the logs from rolling off,
- making available a sufficient number of steel and hardwood wedges as well as a sledge hammer,
- making available an axe and supporting block for splitting of round timber.

Special preparations for carving include:

- selection of wood with suitable properties (dry, preferably knotless, soft, sound),
- making available sketches and drawings,
- checking and, if necessary, sharpening the tools,
- selection of clamping devices.

4. Splitting and Carving Techniques

Splitting involves the following sequence of operations:

- The log is to be secured from rolling off by placing wooden wedges under it at both sides.
- The steel wedge is to be placed and made "grip" with a gentle hammer blow.
- Then the wedge is to be driven into the wood with powerful blows until the log splits.
- If necessary, another steel wedge is to be driven into the other end of the log.
- The splits are to be enlarged using thicker hardwood wedges until the log is split up into halves.
- If the log halves are to be quartered, the steel wedges are to be placed in the heart at the inside of the log halves.

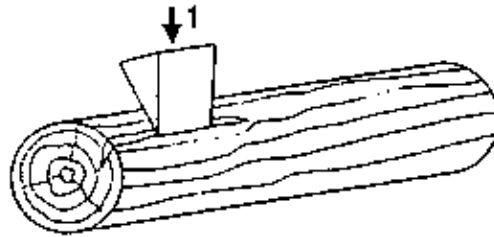


Figure 9 Placing of the wedge

1 hammer blow (force F)

Wood cannot be split transversely to the grain direction!

Carving involves the following sequence of operations:

- The outer shape is to be transferred from the drawing onto the blank. In figure carving, the longer side should be in grain direction.
- The shape is to be sawn out with the fret saw.
- Larger cavities are to be bored out with a boring bit.
- Rough-carving is to be done with a bigger chisel and mortise cudgel.
- If no mortise cudgel is used, one hand is to guide the chisel while the other hand is exerting pressure.
- If the workpiece cannot be clamped, the chisel is to be held in the hand as short as to make the ball of the thumb touch the workpiece so that the hand holding the workpiece cannot be injured.
- The cutting direction should be with the grain, if possible.



Figure 10 Correct cutting direction

1 cutting direction

- Finish-carving is to be done with smooth movements of the hand. Dirty surfaces of the wood are to be avoided. Otherwise the surface is to be sanded to remove the dirt. In that

case it is important to sand the entire face or figure.

The carving technique requires much practising, a good eye and safe hand. The above points imply the basic rules of carving. If the trainee is familiar with such basic rules and with handling the tools, and is talented too, he will improve his skills by repeated practising.

Why must logs to be split be secured from rolling off?

Why must the carving chisel be held by both hands when carving without mortise cudgel?

What are the features of sharp and dull cutting edges of carving tools?

Maintenance and Storage of Wood – Course: Manual woodworking techniques. Instruction examples for practical vocational training

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Maintenance and Storage of Wood – Course: Manual woodworking techniques. Instruction examples for practical vocational training

**Institut für berufliche Entwicklung e.V.
Berlin**

Original title:

Lehrbeispiele für die berufspraktische Ausbildung
"Holzpflege und Holzlagerung"

Author: Rolf Jakoby

First edition © IBE

Institut für berufliche Entwicklung e.V.
Parkstraße 23
13187 Berlin

Order No.: 93–33–3308/2

Preliminary Remarks

The present booklet contains 3 selected instruction examples to acquire the necessary knowledge and skills for the maintenance and storage of wood.

These particular examples are preferably intended for application of the manual technique of natural open–air drying of wood. But with slight modifications, the examples 2 and 3 can also be used for technical drying of wood in drying kilns.

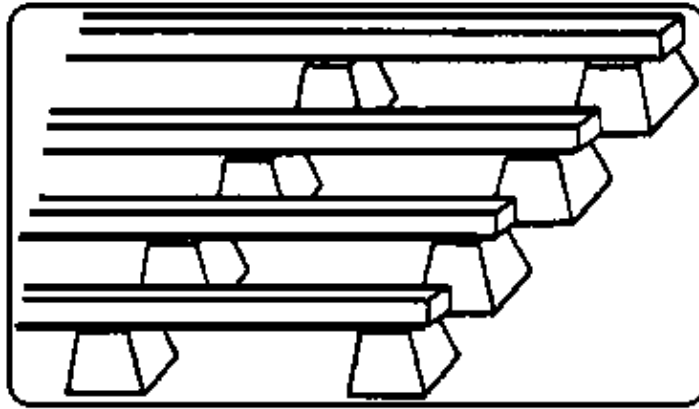
For each example, the necessary materials, tools, measuring and testing means, auxiliary accessories and previous knowledge of the trainees are specified to facilitate the preparation and execution of the work.

The sequence of operations given for each example contains the order of working steps leading to the correct completion of the task. Peculiarities of craftsmanship are pointed out. A working drawing showing the recommended sizes is attached to each instruction example for better understanding of the task. Depending on the local and climatic conditions at the timber yard as well as on specific properties and dimensions of the wood to be stored, modifications thereto can be made by the instructor.

Instruction Example 8.1.: Sawn Timber Storage Yard

This example serves to practise the preparation of a storage yard for sawn timber for natural open–air drying of the piled up wood.

Material



Pile stones of concrete or natural stone

Dimensions:

Width: at least 400 mm

Length: at least 400 mm

Height: at least 300 mm

Squared timbers (impregnated with preservatives)

Dimensions:

Width: at least 100 mm

Length: at least 1000 mm

Thickness: at least 100 mm

Tools

If necessary, earthwork tools like pick, shovel, spade, hoe

Measuring and testing means

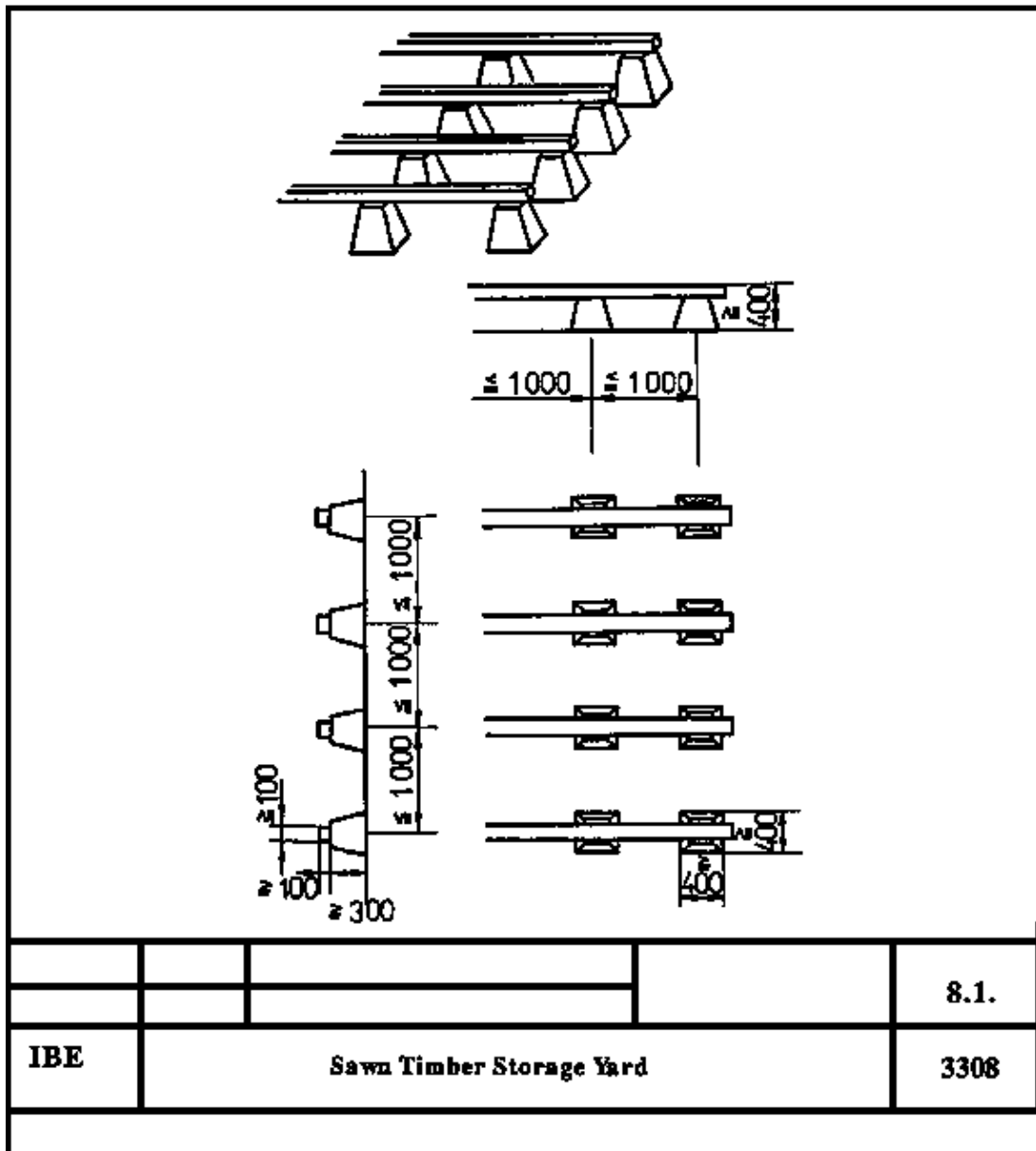
Measuring tape, folding or solid rule, long straightedge, water level, stretching line

Necessary previous knowledge

Types of wood, properties of wood, measuring, testing

Sequence of operations	Comments
1. Decide on the location of the sawn timber storage yard.	Take into account the necessary distances to neighbouring premises and the main wind direction.
2. If necessary, clean the yard to remove dirt, wood and bark waste.	
3. Plane the yard (if necessary).	
4. Lay out the pile stones on the yard with equal length and width distances.	Make sure that the centre-to-centre distance are correct with respect to the dimensions and type (different weights) of the wood to be stored.
5. Check the position of the pile stones for horizontal position and alignment in height as well as straightness in length and width by means	Put the straightedge on the pile stones in longitudinal and transverse directions and compare or tightly stretch the line over the pile stones and compare. Put water

of long straightedge or stretching line and water level.	level on the straightedge or hold it at the line.
6. If necessary, change the position of the pile stones until the required position as per 5. above is achieved.	Adjust the height alignment of the pile stones by adding or removing soil on the yard.
7. Put the squared timbers on the aligned pile stones in a straight line and in parallel with each other.	The longitudinal grain direction to be in main wind direction.
8. Check the position of the squared timbers as per steps 5. and 6. above.	Similarly take into account the comments on steps 5. and 6. above.

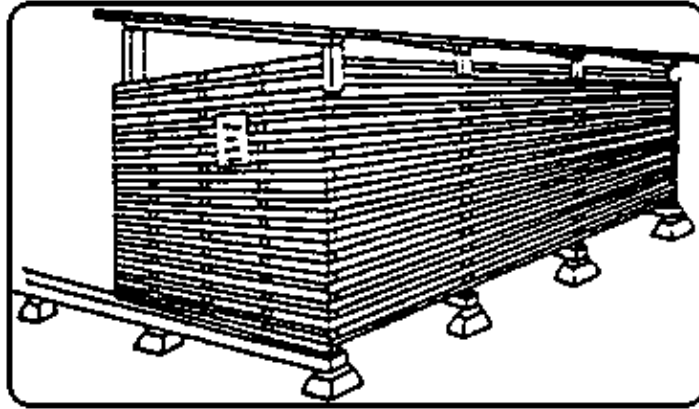


Sawn Timber Storage Yard

Instruction Example 8.2.: Box-type Pile

This example serves to practise the construction of a box-type pile. Box-type piles are applied for sawn timber sorted boardwise or blockwise.

Material



Non-edged or edged boards

Dimensions:

Width: as available
 Length: at least 2000 mm
 Equal thickness: at least 25 mm

Tools

Metal hammer 250 to 500 g

Measuring and testing means

Measuring tape or folding rule, long straightedge, stretching line, water level

Auxiliary accessories

Pile strips (width: 25 mm to 50 mm)

Dimensions:

Width: 25 mm to 50 mm
 Length: at least 1000 mm
 Thickness: at least 25 mm

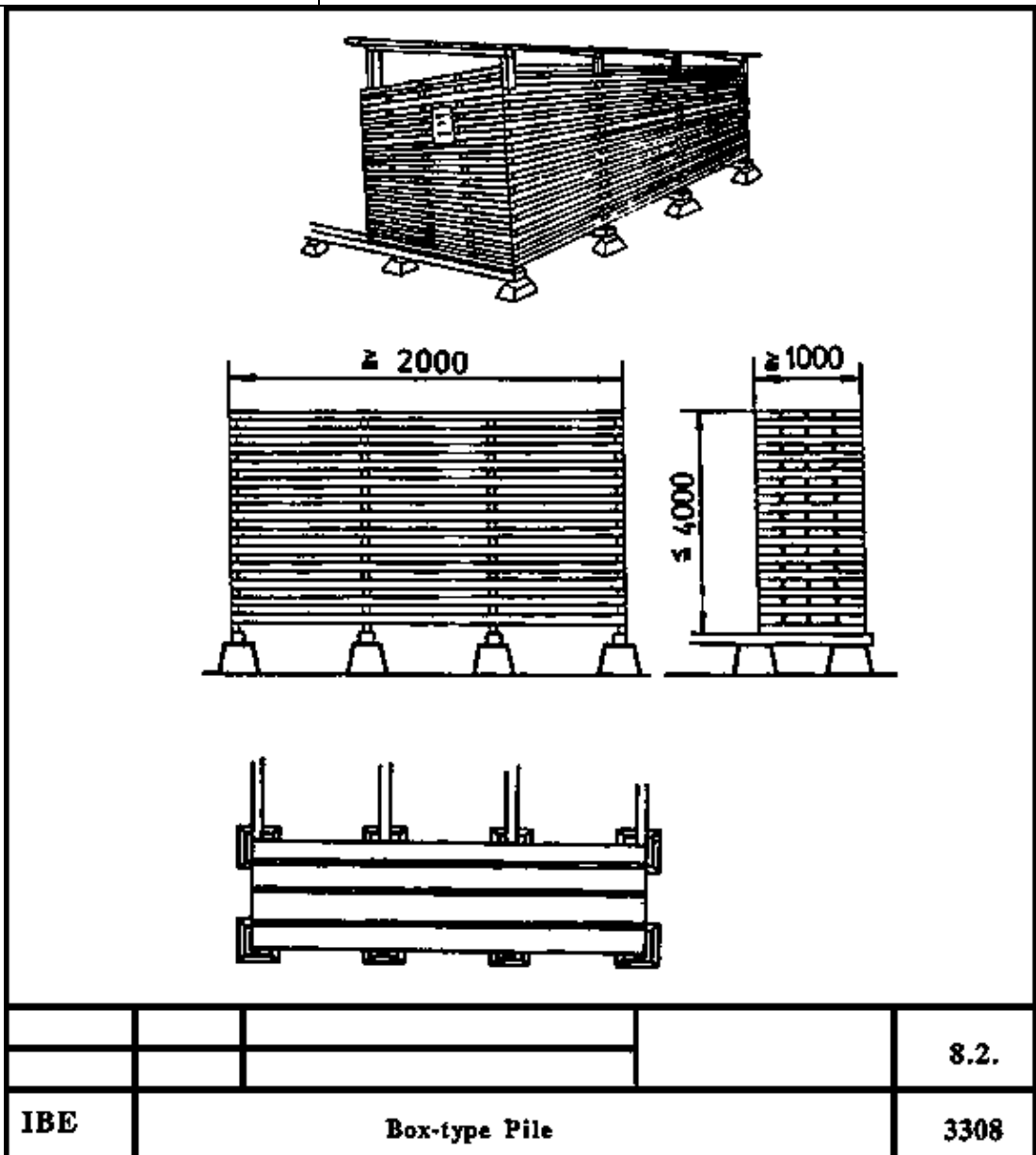
Ladder (scaffold), covering plates, identification plate, nails

Necessary previous knowledge

Types of wood, properties of wood, measuring, testing, preparation of a sawn timber storage yard

Sequence of operations	Comments
1. Check the prepared timber yard and pile base for meeting of requirements.	Check the position of the pile stones for joint horizontal and aligned height and for straight-ness in length and width by means of long straightedge or stretching line with water level. If necessary, adjust the position of the pile stones until the required position is achieved.
2. Put pile strips longitudinally on the squared timbers of the pile base.	The grains of the squared timbers and of the pile strips to have the same direction. Put one pile strip on each squared timber. Make sure that the pile strips have the same thickness.

3. Put several boards side by side and transversely on the pile strips until the intended pile width is reached.	The faces of the boards nearer to the heart to show upwards. Always let the edges of one cross-grained face (cross-sectional area) of all boards end with the edges of an outer pile strip.
4. Put the second layer of pile strips on the first layer of boards according to step 2. above.	Put the pile strips exactly vertically above the pile strips beneath (check with water level).
5. Put on the second layer of boards according to step 3. above.	Take into account the comments on step 3. above. Put the frontal longitudinal narrow face of the first board and one cross-grained face each vertically above the narrow faces of the boards-beneath (check with water level).
6. Repeat the steps 4. and 5. above until the intended pile height is reached.	Use safe ladder or scaffold when working in bigger height. Secure covering plates by fixing against weather influences.
7. Cover the top of the box-type pile with covering plates.	
8. Identify the pile by fixing an identification plate.	

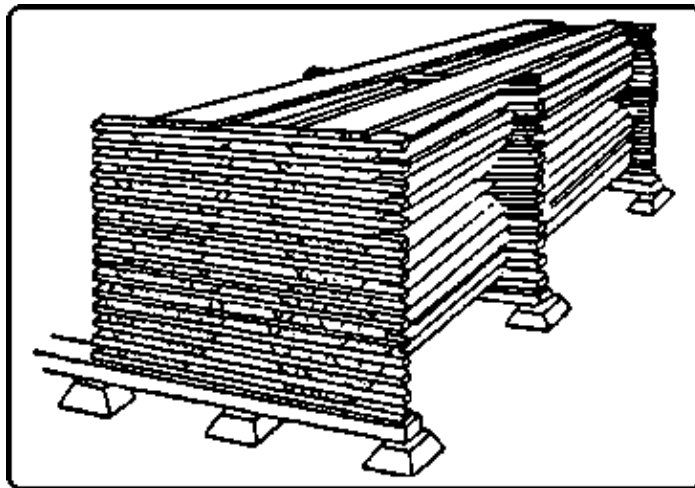


Box-Type Pile

Instruction Example 8.3.: Double-block Pile

This example serves to practise the construction of a double-block pile. Block-type piles are applied for high-quality timber only.

Material



Unedged-sawn boards completely belonging together, originating from at least two tree trunks or partial lengths from one tree trunk

Dimensions:

Width: as available

Length: at least 2000 mm

Thickness: at least 25 mm

Tools

Metal hammer 250 g to 500 g

Measuring and testing means

Measuring tape or folding rule, long straightedge, stretching line, water level

Auxiliary accessories

Pile strips

Dimensions:

Width: 25 mm to 50 mm

Length: double the bigger board width (trunk diameter) + 200 mm

Thickness: at least 25 mm

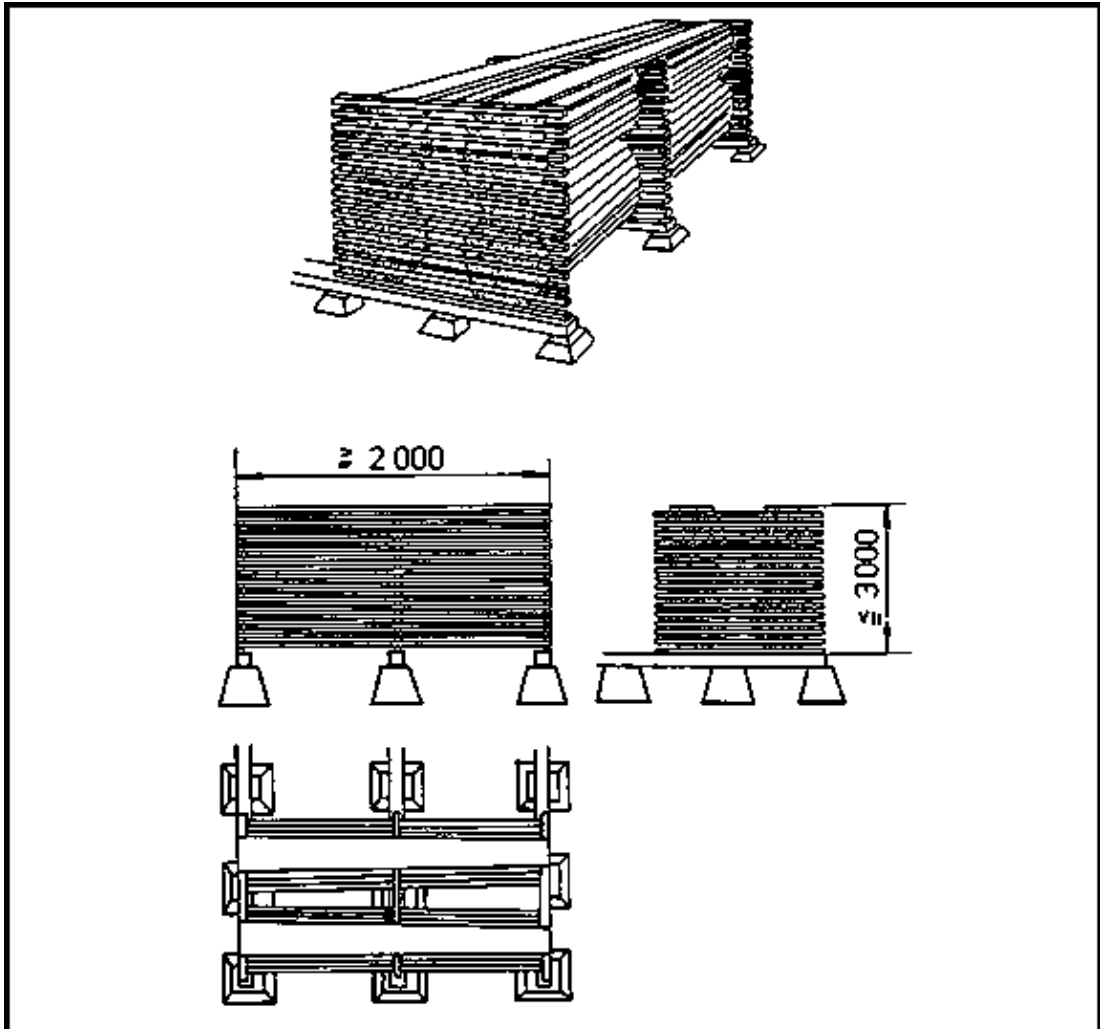
Ladders (scaffold), covering plates, identification plate, nails

Necessary previous knowledge

Types of wood, properties of wood, measuring, testing, preparation of a sawn timber storage yard

Sequence of operations	Comments
------------------------	----------

1. Check the prepared timber yard and pile base for meeting of requirements.	Check the position of the pile stones for joint horizontal and aligned height as well as for straightness in length and width by means of long straightedge or stretching line and water level. Check the position of the squared timbers.
2. Arrange the boards to origin with respect to tree trunk and to order of sequence.	Measure and compare the width of the boards. Visually check and compare the course of the longitudinal edges of the boards and of the annual rings (at the cross-sectional areas).
3. Put pile strips longitudinally on the squared timbers of the pile base.	
4. Put two outer boards from different trunks (blocks) side by side and transversely on the pile strips.	The faces of the boards nearer to the heart to show upwards. Ensure a sufficient centre distance of the boards to each other and to the outside in accordance with the biggest board width of the trunks (blocks).
5.. Put the second layer of pile strips on the first layer of boards as per step 3. above.	Put the pile strips exactly vertically above the pile strips beneath (check with water level).
6. Put on the next two boards according to step 4. above.	Take into account the comments on step 4. above.
7. Repeat steps 5. and 6. above until the last two outer boards of the different blocks are stored.	
8. Continue storing boards from other trunks on the lower blocks according to steps 3. to 7. above until the intended pile height is reached.	
9. Cover the top of the double-block pile with covering plates.	Secure the covering plates by fixing them against weather influences.
10. Identify the pile by fixing an identification plate.	



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Double-block Pile

Maintenance and Storage of Wood – Course: Manual woodworking techniques. Trainees' handbook of lessons

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Institut für berufliche Entwicklung e.V.
Berlin

Original title:

Arbeitsmaterial für den Lernenden
"Holzpflege und Holzlagerung"

Author: Rolf Jakoby

First edition © IBE

Institut für berufliche Entwicklung e.V.
Parkstraße 23
13187 Berlin

Order No.: 93–35–3308/2

1. Purpose and Meaning of Maintenance and Drying of Wood

Wood is an important and precious raw material. It can be used for many purposes, such as for the manufacture of

- furniture,
- window frames,
- doors,
- interior furnishings,
- vehicle and ship components.

Depending on the intended purpose of use, the logs cut down in the woods are

- processed in veneer mills into veneer by chip-forming and chip less cutting,
- sawn in saw mills by cutting with the grain. Cutting-off of the rough edges is called edging.

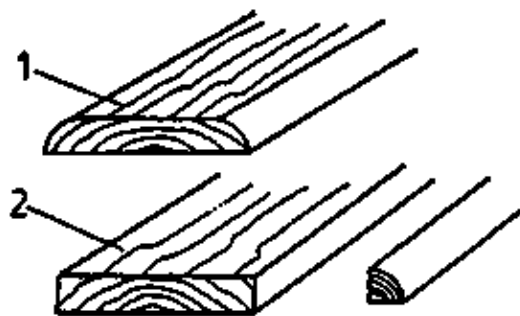
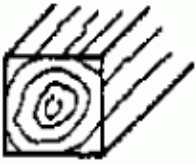


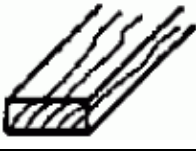

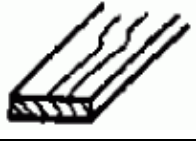


Figure 1 Cutting-off of the rough edges (1 unedged-sawn, 2 edged)

The sawn wood is called sawn timber which, depending on the different size and shape, is classified in the types of sawn timber as per table 1:

Table 1: Types of Sawn Timber

Sectional shape		Designation	Features	Thickness in mm	Width in mm
-----------------	--	-------------	----------	-----------------	-------------

1/1		squared timber	edge	100	100
1/2		frame timber	edged	38 up to 100	2 × thickness
1/3		board	unedged–sawn	16	2 × thickness
			edged	16 up to 100	75
1/4		lath	edge	16 up to 100	75
1/5		ply	unedged–sawn or edged	6 up to 15	75
1/6		strip	edged	6 up to 15	75

After cutting–down and sawing the logs, the wood contains a considerable quantity of water.

The water contained in the wood (wood moisture content) influences the physicotchnical properties of the wood.

Wet wood is difficult to work and changes its shape.

Any change of the relative air humidity, at a certain temperature, results in a change of the wood moisture content. This law applies to any type of wood and is the basis for maintenance, storage and drying of wood as well as for processing and working/machining of wood.

The moisture content in the wood is measured by means of the following methods and measuring instruments:

- Electrical measuring methods with resistance measuring instruments acc. to the principle of D.C. resistance measurement.
- Kiln method (weighing method), where the water quantity contained in wood samples (small pieces of wood) is evaporated at 105°C in special drying kilns and determined by comparison weighing of the wood samples before and after evaporation.

The measure of the wood moisture content is the *moisture expressed as a percentage (in %) of dry wood substance* (weight in g). It can be calculated acc. to the following formula:

$$\text{Moisture content of wood} = \frac{\text{wet weight of wood} - \text{dry weight of wood}}{\text{dry weight of wood}} \cdot 100\%$$

Task:

Calculate the moisture content of wood (in g and per cent) when

- the wet weight of a wood sample is 350 g,
 - the dry weight of the sample is 200 g!
-
-
-

Depending on the purpose of use, the wood must have a certain moisture content when being worked/machined to retain

- its usability,
- its shape,
- its size.

Therefore, the excessive water is to be removed. This is done by controlled drying of the sawn timber.

2. Ways of Drying and Storage of Sawn Timber

Basically there are two ways of drying sawn timber:

– Evaporation of the water contained in the wood ensues in the open air under natural climatic conditions until the moisture equilibrium is achieved. The period required for natural drying of wood until achievement of such state depends on the following factors:

- average local climate,
- type of wood,
- thickness of wood,
- type of storage.

The state of wood achieved in this way is called *air-dry*.

Evaporation of the water contained in the wood ensues in drying kilns under controlled conditions of heat, steam, air circulation.

Controlled drying of wood also calls for correct storage and maintenance of the sawn timber and protection against detrimental influences, such as:

- fungi changing and destroying the wood,
- animal pests like insects or insect larvae,
- weather influences (rain, heavy solar radiation, storm).

There are different ways of storing sawn timber, depending on the moisture content and purpose of use:

- open-air timber yards,
- open or semi-open storage sheds,
- closed buildings.

3. Preparation of Storage of Sawn Timber

Sawn timber is stored in piles of different types and sizes by putting the timbers side by side and one upon the other in a well-arranged order, normally using pile strips of wood. The pile is arranged on a prepared base ensuring a plane position of the timber and the necessary ground clearance for escape of humid air near the ground. Such base is made of pile stones and pile supports.

3.1. Preparation of Sawn Timber

Before the sawn timber is stored in piles, it is arranged and preliminarily stored for a short time, considering

- the type of wood,
- the origin with respect to the trunk,
- the dimensions,
- quality features.

Timbers infested with insects must be separated or prepared by cutting off the infested parts.

3.2. Preparation of the Pile Base

Pile stones and pile supports are to be made available.

Pile stones are made of concrete or of natural stone and have a large bearing surface. Recommended dimensions are:

- length = 400 mm,
- width = 400 mm.

The pile supports are made of steel sections or of squared timbers impregnated with wood preservatives. The dimensions are as follows:

- length = up to 1000 mm, depending on the pile width,
- width = 100 mm,
- thickness = 100 mm.

The total height of the pile base is

- 300 mm on paved storage yards,
- 400 mm on unsurfaced storage yards.

The number of pile stones and pile supports depends on

- the pile length,
- the pile width,
- the centre-to-centre distance of the pile stones.

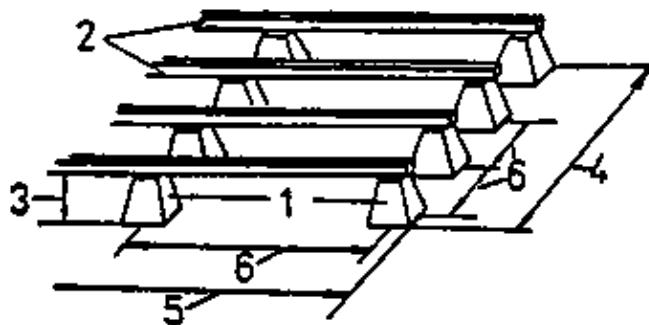


Figure 2 Pile base 1 pile stones, 2 squared timbers, 3 height of pile base, 4 pile length, 5 pile width, 6 centre-to-centre distance of pile stones

Pile strips are very important. They guarantee proper airing of the pile and prevent the sawn timber from changing its shape. They must be carefully arranged according to their dimensions:

- length = 1000 mm,
- width = 25 mm up to 50 mm,
- thickness = 25 mm.

Impregnation with wood preservatives improves their usability and prolongs their working life. Pile strips are to be stored under a roof to protect them from weather influences.

4. Construction of an Open-air Timber Storage Yard

Open-air timber storage yards consist of:

– Pile areas

They are used for timber storage and must permit the longitudinal pile length to be arranged at an angle of 45 degrees up to 90 degrees to the main wind direction. Moreover, they must have a minimum distance of 10 m to the next public road and of 30 m to 50 m to neighbouring premises.

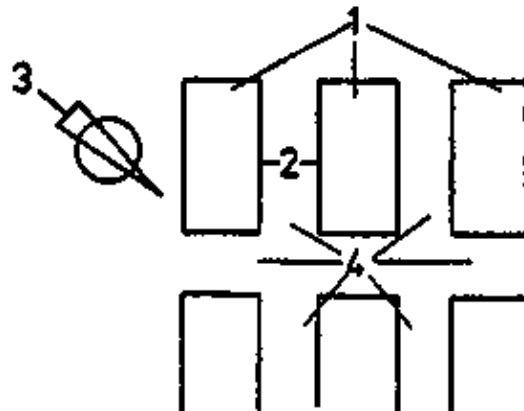


Figure 3 Components of timber storage yards 1 pile areas, 2 longitudinal pile sides, 3 main wind direction, 4 roads between the piles and lanes to prevent the spreading of fire

– Roads between the piles and lanes to prevent the spreading of fire

They are free areas between the pile areas for the purpose of:

- stacker-truck traffic,
- walkways,
- fire-fighting.

Their width depends on:

- the width of the stacker trucks,
- the size of the neighbouring pile areas,
- the type of raw material and sawn timber stored.

– Airing ways

They are gaps between the individual piles necessary for airing of the piles.

The ground of the pile areas has also to meet certain requirements. It should be plane and slightly inclined in the longitudinal direction of the pile (for the drainage of rainwater). Moreover, the ground should be free from growth, dirt, shifting sand, wood and bark waste.

Suitable ground surfacings are:

- gravel,
- crushed rock,
- concrete.

Clay or loam soil must be dewatered.

When constructing the pile base on the pile it is essential to make sure that it is of correct size and quality to guarantee the necessary stability of the pile and favourable storing and drying conditions for the sawn timber.

The pile stones are arranged on the pile area acc. to the following criteria:

– alignment (straightness) in

- height,
- pile length,
- pile width,

– horizontal position in pile width,

– equal spacing in

- pile length,
- pile width.

The centre-to-centre distance of the pile stones in longitudinal direction of the pile depends on the type of wood, the length and thickness of the sawn timber. It should amount to 1000 mm up to 1400 mm. The maximum centre-to-centre distance in the pile width should be 1000 mm.

Checking of the alignment of the pile stones in longitudinal direction of the pile and in pile width direction ensues by:

- putting a long straightedge on the pile stones,
- putting the straightedge to the sides of the pile stones or
- by stretching a line over and besides the pile stones and
- by visual comparison of the pile stones with the testing means.

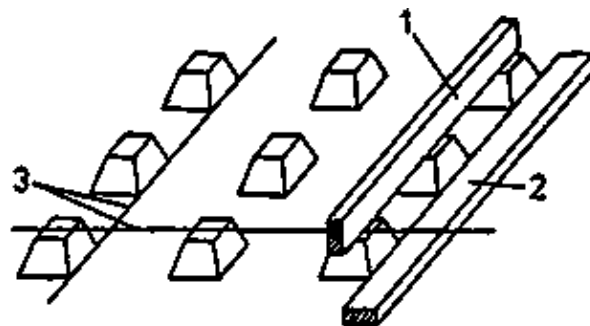


Figure 4 Checking of alignment of the pile stones 1 straightedge put on pile stones, 2 straight edge put to the sides of pile stones, 3 stretched line

The pile stones are in alignment when there are no visible gaps between the tested surfaces and the testing means.

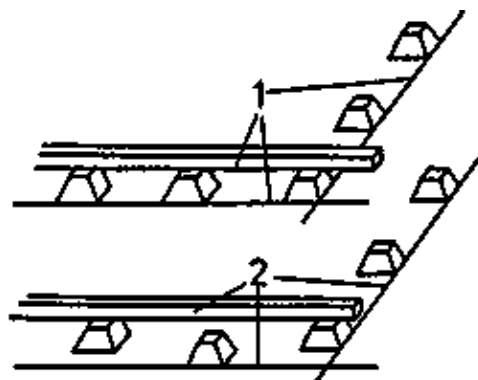


Figure 5 Checking of alignment of the pile stones 1 in alignment, 2 not in alignment

The horizontal position of the pile stones in pile width direction is checked by putting a water level onto the straightedge.

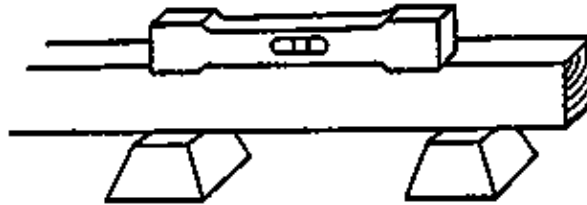


Figure 6

The pile supports are put on the pile stones with their longitudinal direction in pile width direction and in parallel to each other. The alignment and horizontal position of the pile supports are checked in the same way as checking of the position of the pile stones.

5. Construction of Sawn Timber Piles

Piles of different types are constructed for open-air storage and drying of sawn timber. The type of pile depends on:

- the type of sawn timber,
- the dimensions,
- the moisture content,
- the intended period of storage

of the sawn timber to be stored.

The construction of the pile must guarantee storage and drying of the sawn timber free from damage and meet the requirements of labour safety. Therefore, the following rules must be observed:

- Sawn timber of equal type, equal thickness, equal type of wood and, if possible, equal length only should be stored in each pile.
- When horizontally storing sawn timber of different length, the longest timbers should be stored at the bottom and the shortest timbers on the top of the pile.
- The outsides of the piles should be vertical.
- Boards should be stored with the wide face near the heart showing upwards.

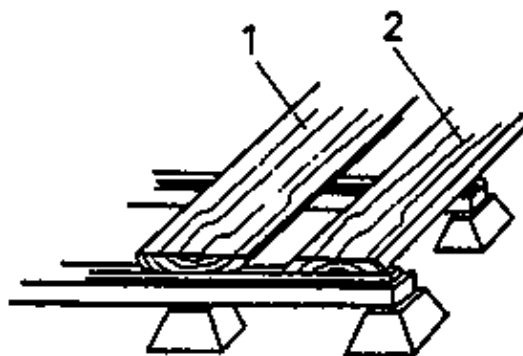


Figure 7 Storage of boards in piles of sawn timber 1 correct storage, 2 wrong storage

- The lateral distance between edged boards and frame timbers should be at least 30 mm.
- Piles with high-quality sawn timber should be covered on top to protect the wood against detrimental weather influences. The covering plates must be firmly secured.
- For identification of the stored timber, identification plates should be fixed to sawn-timber piles showing features like:

- type of wood,
- board thickness,
- pile volume in m³,
- date of storage...

Wet timber is stored and dried in the following types of piles: *box-type piles*, *package-type piles* and *block-type piles* using pile strips. Pile strips of equal length only are to be used for this purpose.

The pile strips at the bottom are to be put directly on the pile supports, the next strips are to be put exactly in vertical alignment with the pile strips beneath and between the layers of sawn timber.

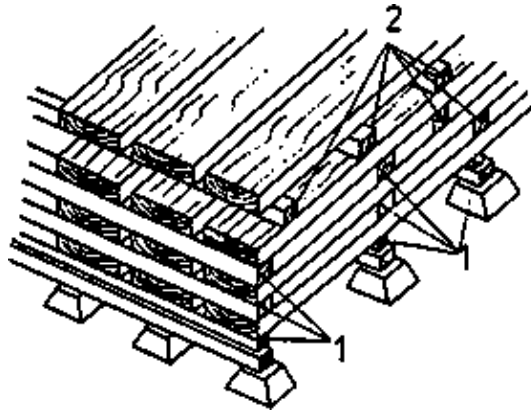


Figure 8 Position of pile strips in piles of sawn timber 1 correct position, 2 wrong position

Moreover, it is important that the edges of the pile strips, at least at one wide side of the pile, are in alignment or slightly projecting only with respect to the cross-grained faces of the sawn timber (except for package-type piles).

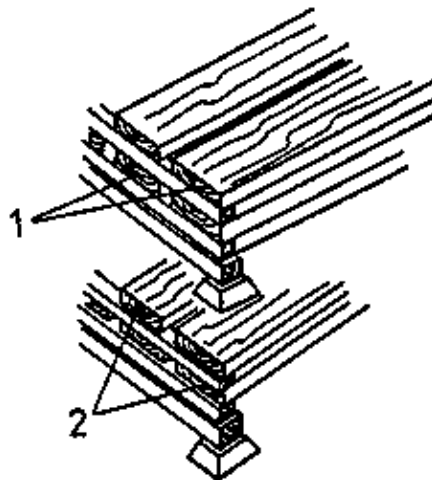


Figure 9 Position of pile strips at the wide side of piles 1 edges in alignment, 2 projecting

At least at one longitudinal side of the pile, the pile strips must be arranged so as to end or be in alignment with the sawn timber.

Task:

Why must the pile strips be arranged exactly vertically above the pile supports and above each other?

If no pile strips are used, wet and dry sawn timber is stored in the following types of *piles*: *cross-type piles*, *triangular piles*, *shear-type piles*.

Dry sawn timber is stored without pile strips in closed, dry rooms.

The different types of piles are constructed, as follows:

– Box-type pile

Edged or unedged-sawn boards or frame timbers of equal thickness and approximately the same length are well arranged side by side and piled up in layers in a box-type form using pile strips. The dimensions are:

- pile height = 4000 mm
- pile width = 1000 mm
- lateral distance to the next pile = 300 mm

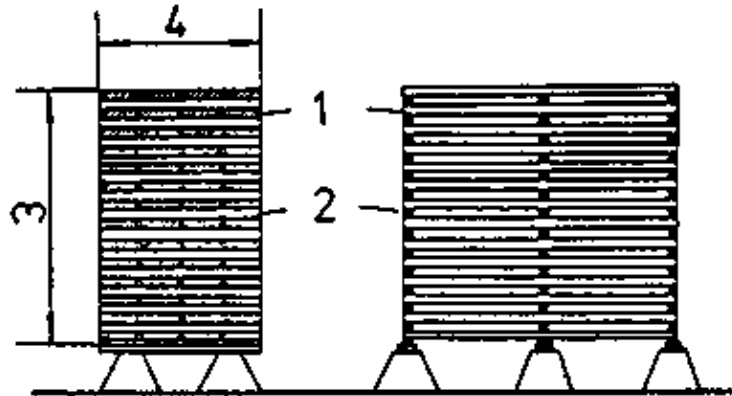


Figure 10 Construction of a box-type pile 1 boards, 2 pile strips, 3 pile height, 4 pile width

– Package-type pile

Edged or unedged-sawn timbers of equal thickness and approximately the same length are tied up in packages or piled up with intermediate pile strips. This is done by means of stacker trucks.

Moreover, 60 mm to 80 mm thick spacers are used. The pile height is in accordance with internal works' rules and with the labour safety requirements.

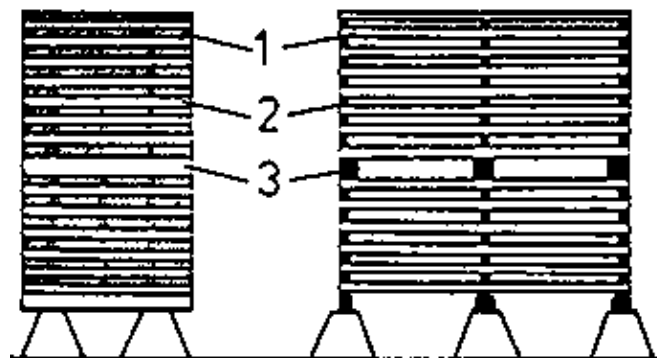


Figure 11 Construction of a package-type pile 1 boards, 2 pile strips, 3 spacers

– Block-type pile

Unedged-sawn boards, arranged ace. to their origin of trunks, are piled up in blocks using pile strips. The width of the bottom board must be one third of the trunk diameter. Neighbouring blocks are connected with common pile strips.

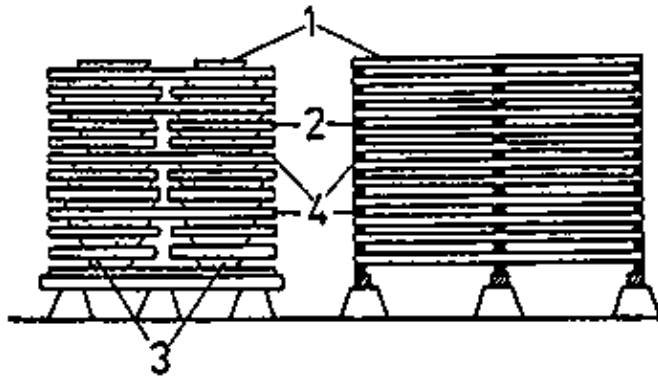


Figure 12 Construction of a block-type pile 1 unedged-sawn boards, 2 pile strips, 3 bottom boards, 4 common pile strips of neighbouring blocks

– Cross-type pile

Edged boards or squared timbers of equal length are piled up at right angles to each other without any pile strips.

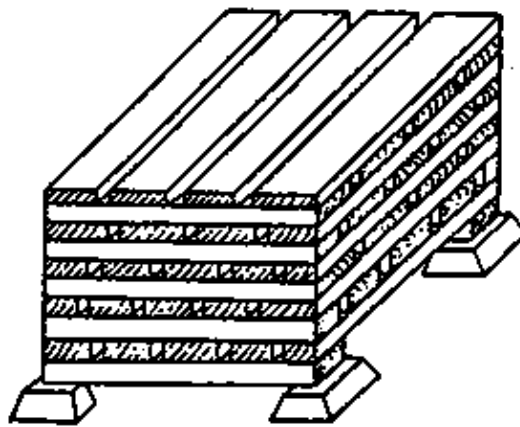


Figure 13

– Triangular pile

Edged or unedged-sawn boards of equal length are piled up in the form of equilateral triangles without any pile strips.

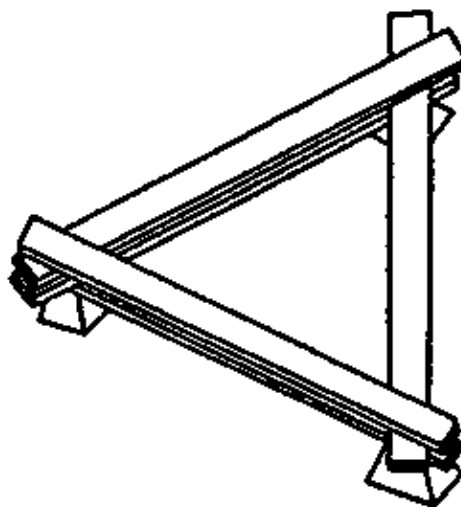


Figure 14

– Shear-type pile

Edged boards or squared timbers are erected with their gross-grained ends standing on the ground of the pile area. They are supported by a frame in a shear-type arrangement.

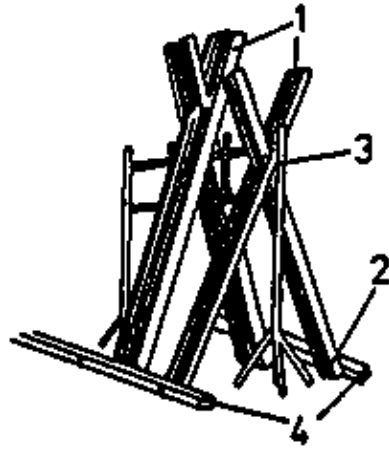


Figure 15 Shear-type pile 1 *edged boards*, 2 *pile area*, 3 *frame*, 4 *securing of boards from slipping off*

The timbers must be secured from slipping off on the ground.

