

**Working on Grinding Machines (Belt Grinding Machines) – Course:
Mechanical Woodworking Techniques. Instruction Examples for
Practical Vocational Training (12 pages)**

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Working on Grinding Machines (Belt Grinding Machines) – Course: Mechanical Woodworking Techniques. Instruction Examples for Practical Vocational Training (12 pages)

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

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Lehrbeispiele für die berufspraktische Ausbildung
“Arbeiten an Schleifmaschinen” (Bandschleifmaschinen)

Author: Johannes Schollbach

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Preliminary Remarks

The present material includes 4 instruction examples where you can train polishing of wide surfaces by grinding of different pieces of work.

The manufacturing of a good surface is the precondition for a further working on surfaces by varnishing, dulling, veneering and polishing.

To ease the preparation and realization of the exercises for each instruction example the necessary materials, machines and tools, measuring and testing means and the auxiliaries are mentioned.

The basic knowledge which is necessary to prepare and to carry through the instruction examples is mentioned, too. The working process includes the steps for the realization of the exercises.

The remarks give hints on the separate steps of the working process and on the control of the realized exercise.

Because the instruction examples are not intended to manufacture pieces of work but to treat their surfaces only, working sketches were renounced.

As instruction examples pieces of exercise were selected which after finishing will give useful things.

Instruction Example 07.1.: Stool Plate

The polishing of wide surfaces by grinding as a first step for further surface treatment (dulling, varnishing) is carried out on a glued board of solid wood.

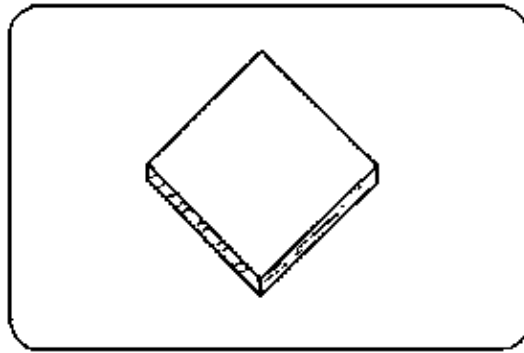
Material

a glued board of solid wood

length: 480 mm

width: 480 mm

thickness: 20 mm



Machines and tools

Normal belt grinding machine, sand belt with a corundum NK 25 or NK 32

Measuring and testing means

Folding rule

Necessary basic knowledge

Manufacturing of width joints, manual wood working – polishing and grinding

| Sequence of operations | Comments |
|--|---|
| 1. Placing and fastening the sand belt with a selected corundum NK 25 or NK 32 | Abrasives of normal corundum, abbreviation NK, are applied with the grinding of soft wood. The grain size 25 or 32 results in the necessary smoothness of the wide surface. |
| 2. Placing the piece of work and adjusting the height of the sliding table. | The distance between the piece of work and the sand belt should be approximately 5 mm. |
| 3. Switching–on the machine. | |
| 4. First grinding Grinding of wide surfaces across the grain | The wide surfaces are grinded by co–ordinated movement of the sliding table cross the sand belt and the pressure shoe lengthwise to the sand belt. |
| 5. Second grinding Grinding of wide surfaces with the grain. | Sticking out wooden fibres and remnants of previous treatment are removed by grinding. |
| 6. Switching–off the machine. | |
| 7. Checking the ground wide surface. | Checking is carried out visually and gently rubbing over it with the hand. Thus uneven–nesses can be determined. |

Finishing

Grinding of narrow surfaces manually, chamfering the edges. Application as a stool plate.

Instruction Example 07.2.: Stool Plate

Smooth and thickness grinding of the wide surfaces by grinding as the prerequisite for sticking with veneer is carried out on a fibre board.

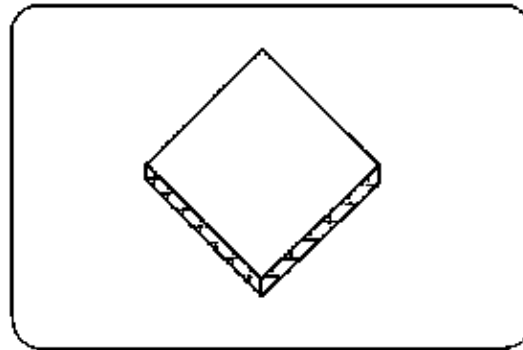
Material

a fibre board

length: 480 mm

width: 480 mm

thickness: 18 mm



Machines and tools

Normal belt grinding machine, sand belt with a corundum EK 32 or EK 40

Measuring and testing means

Folding rule

Necessary basic knowledge

Working on circular sawing machines

| Sequence of operations | Comments |
|---|---|
| 1. Placing and fastening the sand belt with a selected corundum EK 32 or EK 40 | Abrasives of precious corundum, abbreviation EK, are applied with the grinding of fibre boards and veneer material. The grain size is selected according to the desired surface smoothness. The fastened belt should be able to be pressed by hand only slightly. Cover the belt rollers and the upper part of the sand belt. |
| 2. Placing the piece of work on the stop of the sliding table and fixing the height of the table. | The piece of work should sit fast with the stop to avoid a slinging off by the draft of the sand belt. |
| 3. Switching–on the machine. | |
| 4. Grinding the wide surfaces with the pressure shoe. | Be careful when grinding the edges, the pressure shoe can topple over. Do not lead the pressure shoe to far over the edges otherwise they will be round ground. |
| 5. Switching–off the machine. | |
| 6. Checking the grinded wide surfaces | The wide surfaces should be even and slightly rough. |

Finishing

Sticking the wide and narrow surfaces with veneer, grinding and chamfering the edges. Application as a stool plate.

Instruction Example 07.3.: Stool Plate

Polishing of the veneered wide surfaces by coarse and fine grinding is carried out on a fibre board which wide and narrow surfaces are glued with veneer.

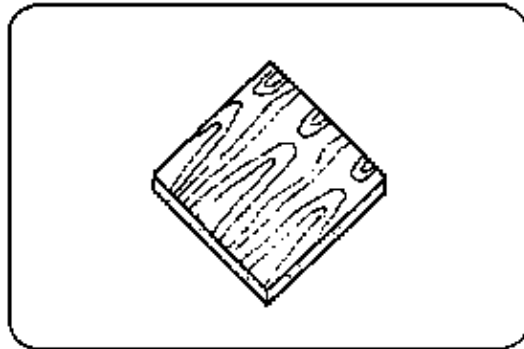
Material

a fibre board wide and narrow surfaces are glued with veneer

length: 480 mm

width: 480 mm

thickness: 18 mm



Machines and tools

Normal belt grinding machine, sand belt of medium corundum EK 25 or EK 32, sand belt of fine corundum EK 20 or EK 16.

Necessary basic knowledge

Manufacturing of boards with veneer technology

| Sequence of operations | Comments |
|--|---|
| 1. Placing the sand belt of medium corundum EK 25 or EK 32. | Grind first the veneered surfaces with medium corundum, do not place too much pressure on the grinding shoe to prevent a grinding-through through the veneer. |
| 2. Carrying out the coarse and fine grinding on the wide surfaces. | By this first grinding glue residues and the taping paper are ground off. |
| 3. Placing the sand belt of fine corundum EK 20 or EK 16. | A fine corundum of the abrasive gives a smooth surface. |
| 4. Carrying out a fine or second grinding on the wide surfaces. | Carry out coarse and fine grinding always with the grain. Be careful when going over the edges. The pressure is easy to topple over and the veneer can be ground through. |
| 5. Checking the ground wide surfaces. | The surface should be evenly smooth and without ground hollows. |

Finishing

Polishing the narrow surfaces with a free hand grinding chunk and abrasive paper. Chamfering the edges.
Application as a stool plate.

Instruction Example 07.4.: Door-Frame

Polishing of the wide surfaces by coarse and fine grinding is carried out on a frame of solid wood.

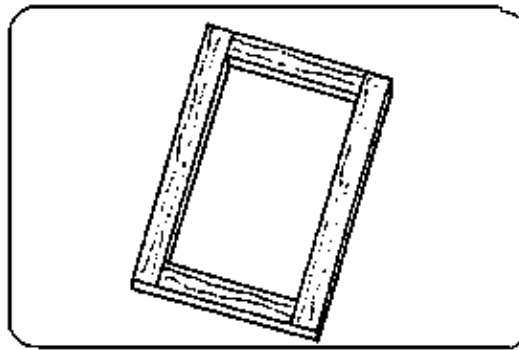
Material

frame of solid wood

length: 800 mm

width: 560 mm

thickness: 24 mm



Machines and tools

Normal belt grinding machine, sand belt of medium corundum EK 25 or EK 32, sand belt of fine corundum EK 20 or EK 16.

Auxiliaries

Free hand grinding chuck

Necessary basic knowledge

Manufacturing of frame joints, manual wood working – polishing and grinding

| Sequence of operations | Comments |
|--|---|
| 1. Placing the sand belt of medium Corundum EK 25 or EK 32. | When placing the sand belt it should not be split and not be torn at the edges. |
| 2. Grinding first the wide surfaces of the frame. Use a free hand grinding chuck. | Be careful when grinding the narrow framing timber. The pressure shoe topples over at the edges, better to use a free hand grinding chuck here. |
| 3. Placing a sand belt of fine corundum. | The grain size is selected according to the hardness of the material to be ground. |
| 4. Grind once more the wide surfaces of the frame. Use a free hand grinding chuck. | By the repeated grinding the necessary smoothness for further treatment of the surface is reached. |
| 5. Checking the ground surfaces. | The wide surfaces should be evenly polished and the traces of previous working steps must be ground off. |

Finishing

Grind the narrow surfaces manually, chamfer the edges.

Application as a door-frame for a tool cabinet.

**Working on Grinding Machines (Belt Grinding Machines) – Course:
Mechanical Woodworking Techniques. Trainees' Handbook of Lessons
(10 pages)**

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Working on Grinding Machines (Belt Grinding Machines) – Course: Mechanical Woodworking

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Institut für berufliche Entwicklung e.V.
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Original title:
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“Arbeiten an Schleifmaschinen (Bandschleifmaschinen)”

Author: Johannes Schollbach

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1. The Purpose of Grinding on a Belt Grinding Machine

Belt grinding machines are grinding machines for wood-working which grinding tools are an endless sand belt. They are applied for:

- Thickness grinding and roughing up of wide surfaces of support plates to be stucked with veneer or foils.
- Polishing of wide surfaces of solid wood and chip boards for further surface treatment.
- Polishing of veneered wide surface.

There are several types of belt grinding machines. The classification is done according to different points of view, e.g. according to the position of the sand belt.

What is the purpose of grinding on a belt grinding machine?

2. Construction of a Belt Grinding Machine

The construction of a belt grinding machine is explained on the example of a horizontal belt grinding machine as follows.

The horizontal belt grinding machine is a belt grinding machine with a horizontal flat belt run.

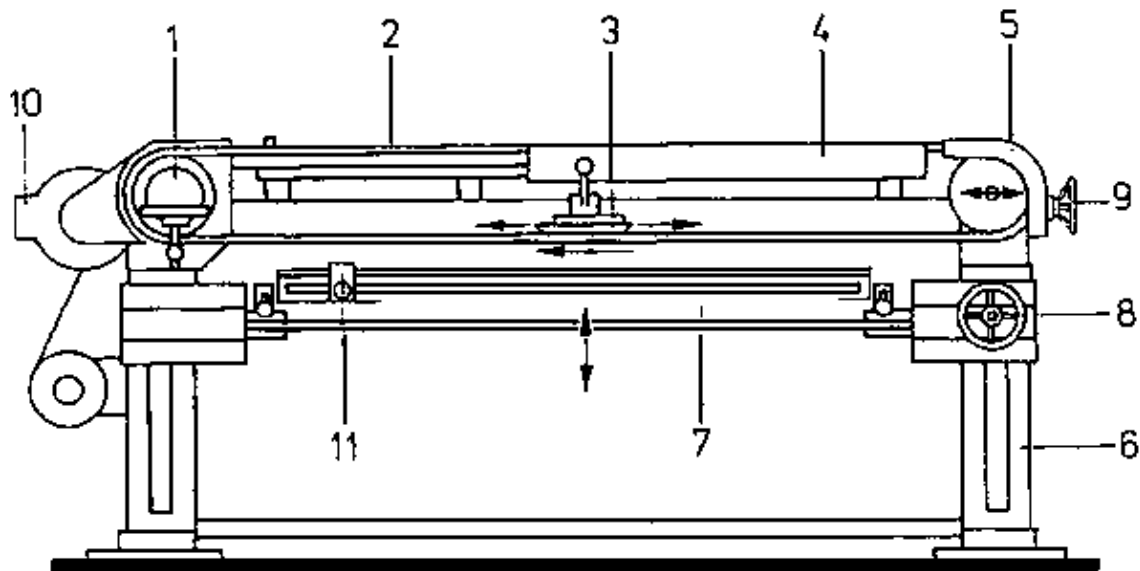


Figure 1 – Construction of the belt grinding machine

1 sand belt roller, 2 sand belt, 3 pressure shoe, 4 cover of the sand belt, 5 covering of the belt rollers, 6 stands, 7 sliding table, 8 hand wheel for fixing the height of the sliding table, 9 hand wheel for fixing the tension of the sand belt, 10 abrasive dust exhaustion, 11 stop bar

The construction includes:

The stands

Two grey cast iron stands are fast screwed together by rails. Between the two stands run the vertically adjustable sliding table and the pressure shoe on round bars. The motor with the driven belt roller is rigidly fastened on the left stand. The second belt roller for fixing the sand belt runs on bearings of the right stand.

The sliding table

The sliding table moves on round bars transverse the sand belt.

Depending on the thickness of the piece of work it is adjustable in height by a hand wheel (see Fig. 1).

Lockable recesses for grinding box shaped pieces of work are manufactured in the sliding table.

The pressure shoe

The pressure shoe is carried in pendulum bearings and movable along the sand belt.

Grinding felt is stuck to the sole of the pressure shoe. Because of the swinging bearing the grinding felt adapts to the surface of the piece of work.

Safety devices

The covering of the belt rollers and the cover of the upper free belt run belong to them.

Which belt roller runs on bearing?

Why does this belt roller run on bearings?

Why is the sliding table adjustable in height?

Why is the pressure shoe carried in pendulum bearings?

3. The Grinding Tools

The sand belt is a bendable grinding tool.

It consists of:

The support (support material)

The support is coated with glue which takes up the abrasive grains. It has a high stability and bendability in order to resist the strains during the grinding process.

Binding agent (glue)

The binding agent serves to stick the abrasive to the support.

The abrasives

The abrasives are shaped edged, mineral or synthetic abrasive tools of different size and hardness. The abrasive carries out the cutting process. There are abrasives of different type and grain size.

According to the grain size different grain groups are distinguished.

The maximum size of the abrasive grains is indicated in 1/100 mm.

| grain group | indication of the graining |
|--------------------|-----------------------------------|
| fine | 16 |
| | 20 |
| | 25 |
| medium | 32 |
| | 40 |
| | 50 |
| coarse | 80 |
| | 100 |
| | 125 |

The sand belt is roller ware with a roller width of 120 mm to 200 mm. It is cut to the necessary length and fixed together as a transverse or tooth shaped joint. The joint will be stuck on the back with solid thin cloth.

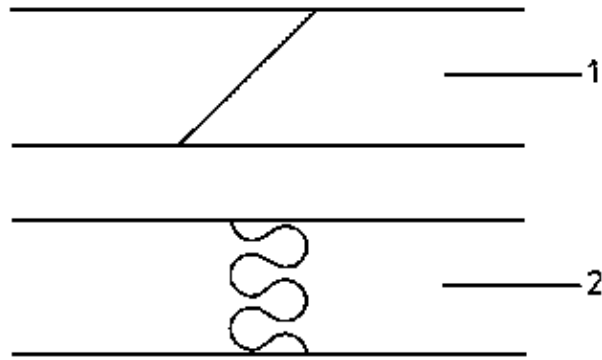


Figure 2 – Sand belt joining

- 1 transverse glued joint*
- 2 tooth shaped joint*

The sand belt should be stored dry. The belts should not be bent or teared on the edges.

The abrasive type and the graining are printed on the sand belt, e.g. NK 32, NK = normal corundum, 32 = medium grain group.

The sand belt must be covered at the belt rollers and at the front edge of the upper belt run.

What does the sand belt consist of?

What types of abrasives are there to be found?

How is the sand belt fixed to an endless belt?

4. The Operation of a Belt Grinding Machine

The sand belt is put into straight-lined motion by the motor over the belt roller.

The sand belt is pressed on the piece of work by the pressure shoe. Thereby the abrasive grains remove very fine shavings in form of abrasive dust from the piece of work. Because of the movability of the grinding table and the pressure shoe all parts of the surface of the piece of work are reachable.

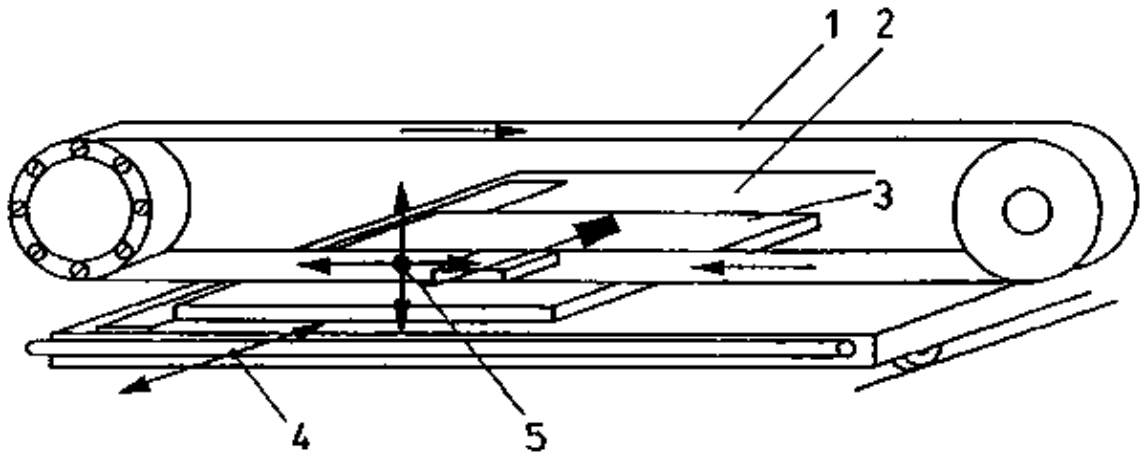


Figure 3

1 sand belt with indication of running direction, 2 machine table, 3 piece of work, 4 hand grip on the machine table, 5 ball grip on the pressure shoe

5. The Technological Processes of Grinding

5.1. Setting up the Belt Grinding Machine

The grinding machine is clean and without current (the mains are switched-off). The safety devices are removed. The required sand belt is placed on the belt roller carefully, in order not to damage the edges. With the hand wheel the necessary belt tension is adjusted. The belt should be able to be pressed only slightly.

All safety devices are fixed according to the directions. The coverings of the belt rollers and the cover of the upper free belt run belong to it.

In a short test run the running of the sand belt is checked. A run off center belt is adjusted by means of the belt running correction.

Now the machine table can be adjusted in the right height. Thus the piece of work is placed on the sliding table and driven under the sand belt. The right table height is reached if between sand belt and the piece of work are 5 mm of space.

Via the selection switch the running direction of the sand belt is adjusted. By switching on the exhaust device the machine is ready to use.

5.2. Grinding of Wide Surface

The piece of work is placed on the machine table, adjusted and set to the stop bar. For different processes it is possible to make the coarse grinding across the grain. Thus the surface first is evened up. The following length grinding is mainly for smoothing. The co-ordinated movement of the left and the right hand is important with grinding.

The left hand takes the grip bar of the machine table and carries through the to and from movement. The right hand takes the grip of the pressure shoe.

By the movement of the grinding table and the pressure shoe every part of the surface can be treated. You should pay attention that the pressure shoe is not guided too far over the edges in order to avoid a toppling over.

Guide the pressure shoe under constant pressure over the surface. Thus the grinded material is cut evenly and an even surface is reached.

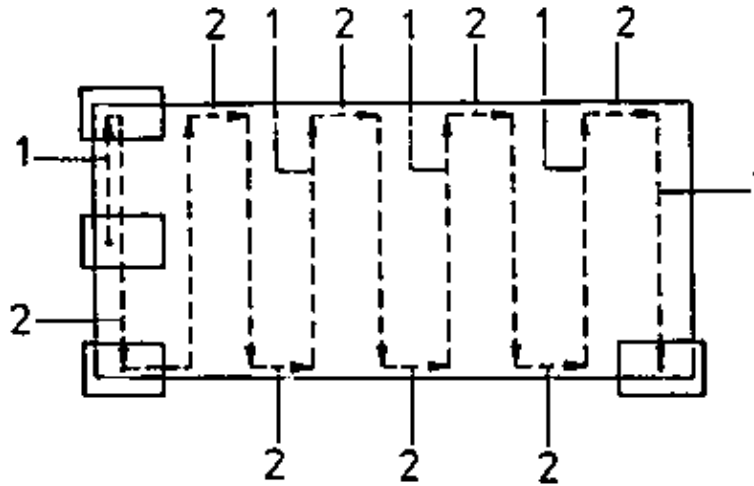


Figure 4 – Technology of grinding – cross feed

- 1 movement of the left hand (machine table)
- 2 movement of the right hand

With the grinding of support plates for a further sticking with veneer you will grind with a coarse sand belt lengthwise and transverse.

With the grinding of solid wood and veneered surfaces you first grind with a medium sand belt and then with a fine one. These two grindings are carried out with the grain. With the grinding traces of former working stages are removed and a smooth surface is reached. Quality control is carried out visually and by rubbing gently with the hand over the surface of the piece of work.

You must pay attention that the table guiding hand should not get into the area of the sand belt.

The pressure shoe should lift up itself when not in use.

The recesses on the table should be closed after being used.

- The abrasive dust should be exhausted separately from the shavings and stored separately.
- No metallic objects should be ground on the machine because of the sparking there can occur explosion fire danger.

Which safety devices are situated on the belt grinding machine?

How is the quality control of the ground pieces of work carried out?

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

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

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Preliminary Remarks

The present booklet contains 5 selected examples of workpieces to be produced by the trainees in order to acquire fundamental knowledge and skills in the working technique of boring. In order to facilitate the preparation and accomplishment of the work, the necessary materials, cutting tools, measuring and testing tools and auxiliary accessories are specified for each instruction example.

Boring calls for knowledge of measuring and scribing. Therefore, such knowledge previously acquired is to be repeated at the beginning.

The sequence of operations specified for each example gives the steps necessary for acquiring the working technique and producing the workpiece. This sequence of operations is to be strictly observed if good quality is to be achieved.

A working drawing showing the required shapes and dimensions of the workpiece is attached to each example.

Instruction Example 5.1.: Holes of Limited Depth

This example serves to practise boring out of faulty spots in solid wood for subsequent setting of end grain dowels.

Material

Planed boards of deciduous (hard) wood and coniferous (soft) wood for various operations.

The boards may have any dimensions but should have defects like loose knots, black knots, resin galls, etc.

Tools

Bit brace and Forstner auger bits of various diameters

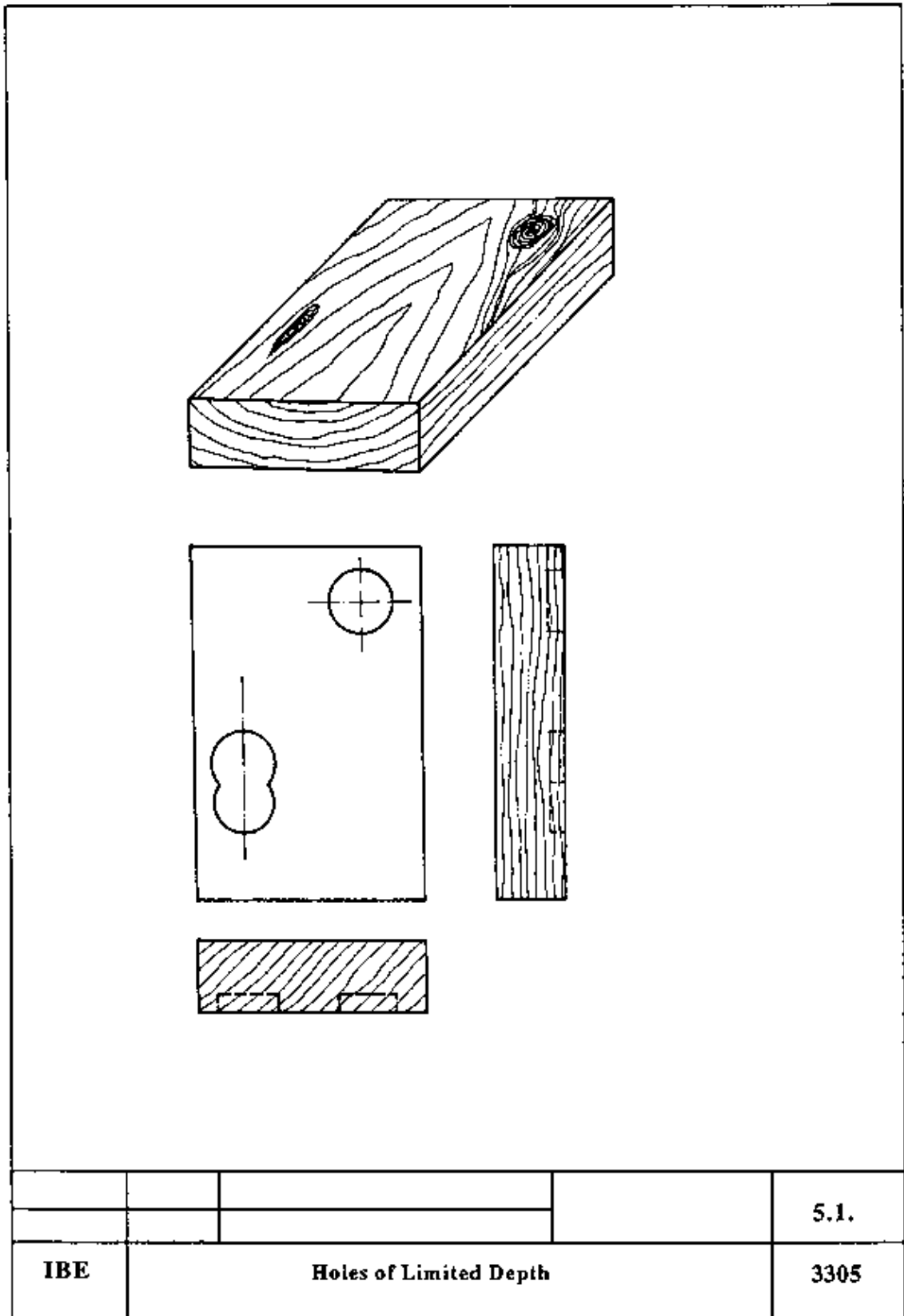
Auxiliary accessories

Work bench or carpenter's bench, adhesive, end grain dowels of various diameters

Necessary previous knowledge

Properties of wood, influence of wood defects on the use–value properties of the finished workpieces

| Sequence of operations | Comments |
|--|---|
| 1. Prepare the working place. | Check the boring tools. |
| 2. Put the defective board or part on the work bench. | Surface to be bored must be in horizontal position. |
| 3. Check the right and left sides of the wood for defects. | Find out the wood defects to be bored out. |
| 4. Chuck the Forstner auger bit with the required diameter into the bit brace. | |
| 5. Bore out the defective spot. | Hold the boring tools in vertical position and bore out to the necessary depth only (depending on the defects). |
| 6. Glue in the end grain dowel. | Make sure that the direction of the wood grains is correct. |
| 7. Check the surfaces. | |



Holes of Limited Depth

Instruction Example 5.2.: Bit Stand

To practise the manufacture of a device for storing bits at the working place.

Material

A piece of hard or soft wood without branches, if possible.

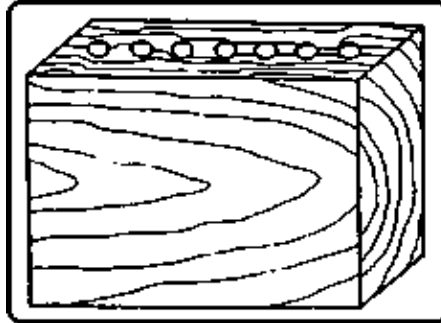
Dimensions:

Thickness: 40 mm

Width: 150 mm

Length: 400 mm

The piece of wood is planed and sawn to size.



Tools, measuring and testing means

Bit brace, auger bits of various diameter, marking gauge, folding rule or measuring tape, try square, awl

Auxiliary accessories

Carpenter's bench, scriber or pencil

Necessary previous knowledge

Measuring and scribing, units of measurement, properties of wood

Explanations to the working drawing

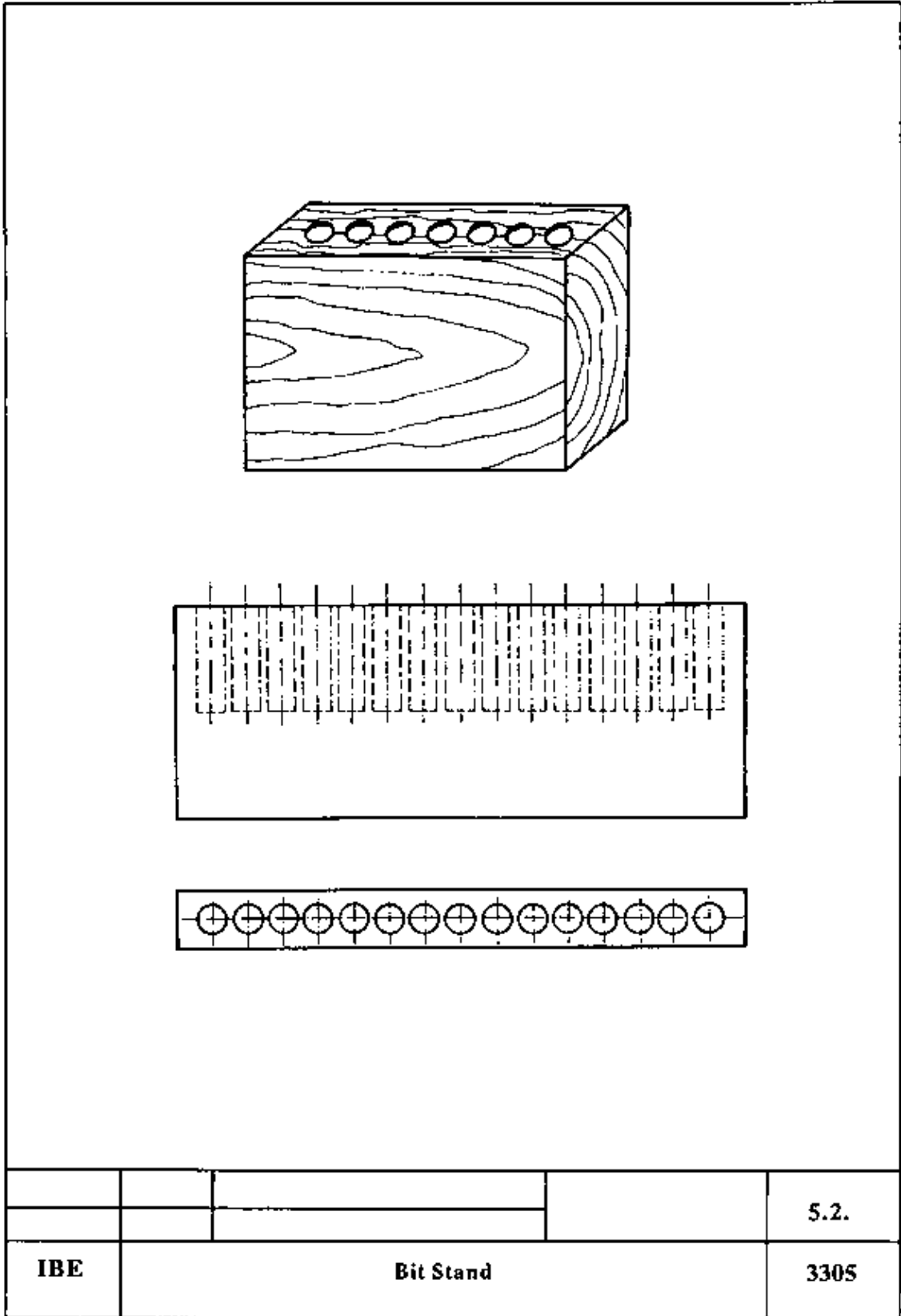
Front view and top view of the workpiece, scale 1 : 2.5

Sequence of operations

1. Prepare the working place.
2. Clamp the workpiece.
3. Scribe the centre line by means of the marking gauge.
4. Determine and scribe the hole distances and hole diameters.
5. Select the bit and chuck it in the bit brace.
6. Mount the hole depth setter.
7. Bore holes of equal diameters.
8. Replace the bit.
9. Mount the hole depth setter.
10. Bore the holes.
11. Check the results.

Comments

- Check the boring tools.
- Make sure that it is in horizontal position.
- Hole diameter to be specified by the instructor or bit shank/square tang to be measured at the real bit.
- Use auger bits, if possible.
- Hole depth depends on the bit to be stored.
- Vertical hole axis is important!
- Smaller holes are to be bored for bits of smaller diameter.
- Repeat replacement of bits and boring until all holes are produced.



Bit Stand

Instruction Example 5.3.: Screw Holes

Wood screws of larger diameter and greater length call for pre-bored holes in the wood. This is necessary for many workpieces. Instead of the board door described here, any other workpiece with wood screws maybe used for practising.

Material

Boards, cross and diagonal braces of soft or hard wood

Dimensions:

| Designation | Pcs. | Thickness | Width | Length |
|----------------|------|-----------|-------|--------|
| | | mm | mm | mm |
| Boards | 6 | 20 | 150 | 1900 |
| Cross braces | 2 | 25 | 120 | 860 |
| Diagonal brace | 1 | 25 | 120 | 1600 |

All parts are planed and sawn to size, the diagonal brace is fitted to the cross braces.

Tools, measuring and testing means

Bit brace, twist drills, gimlet with ring handle, wood countersink, marking gauge, folding rule or measuring tape, try square, pencil, hole depth setter

Auxiliary accessories

Workbench or trestles, screw clamps, supporting pieces of wood

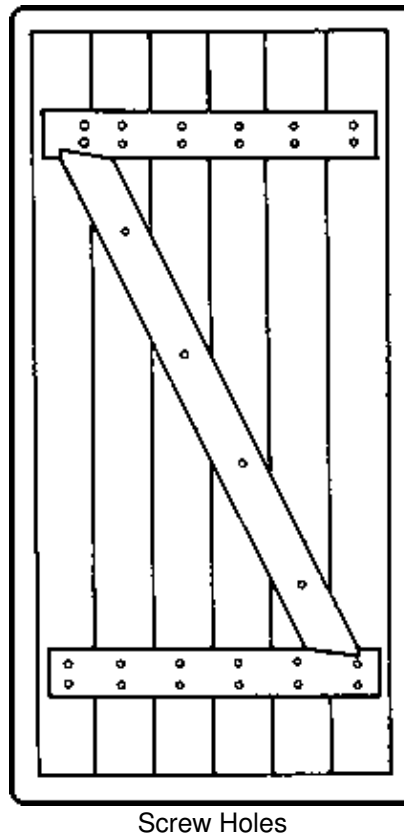
Necessary previous knowledge

Measuring and scribing, mode of action of wood screws

Explanations to the marking drawing

Board door with 2 cross braces and 1 diagonal brace, scale 1:10

| Sequence of operations | Comments |
|--|---|
| 1. Prepare the working place. | Check the tools. |
| 2. Put the individual parts of the board door on the work bench or on trestles, arrange them and clamp them by screw clamps. | Check the arranged boards for squareness by means of the try square. |
| 3. Put the cross and diagonal braces on the board door, arrange them acc. to the given sizes and clamp them by screw clamps. | Diagonal brace must be tightly fitting between the cross braces. |
| 4. Scribe the screw line with the marking gauge and determine the hole points. | Distances and arrangement of the screw holes are given in the drawing. |
| 5. Select the drill and chuck is in the bit brace. | Drill diameter to be 2 mm less than the diameter of the wood screws used. If a gimlet with ring handle is used, chucking in the bit brace is not necessary. |
| 6. Mount the hole depth setter. | Hole depth to be 5 mm less than the screw length. |
| 7. Drill the holes. | Vertical boring axis is important! |
| 8. Release the drill and chuck the countersink (rose bit). | If screws with countersunk heads are used, countersink the holes according to the size of the screw head. |
| 9. Countersink the holes. | |
| 10. Check the results. | Check if the wood screws can be easily screwed into the wood. |



Instruction Example 5.4.: Through Holes

Through holes in wooden materials are required wherever fittings are to be mounted. In this example, the board door from instruction example 5.3. shall be provided with a screw-on lock as lock fitting.

Material

Board door from instruction example no. 3.

The door may already be screwed together.

But it is also possible to just use the outer board, where the lock shall be fitted, as single part.

Tools, measuring and testing means

Bit brace, auger bit or Forstner auger bit with twist drill, marking gauge, try square, folding rule or measuring tape, pencil

Auxiliary accessories

Work bench or trestles, screw clamps, supporting pieces of wood

Necessary previous knowledge

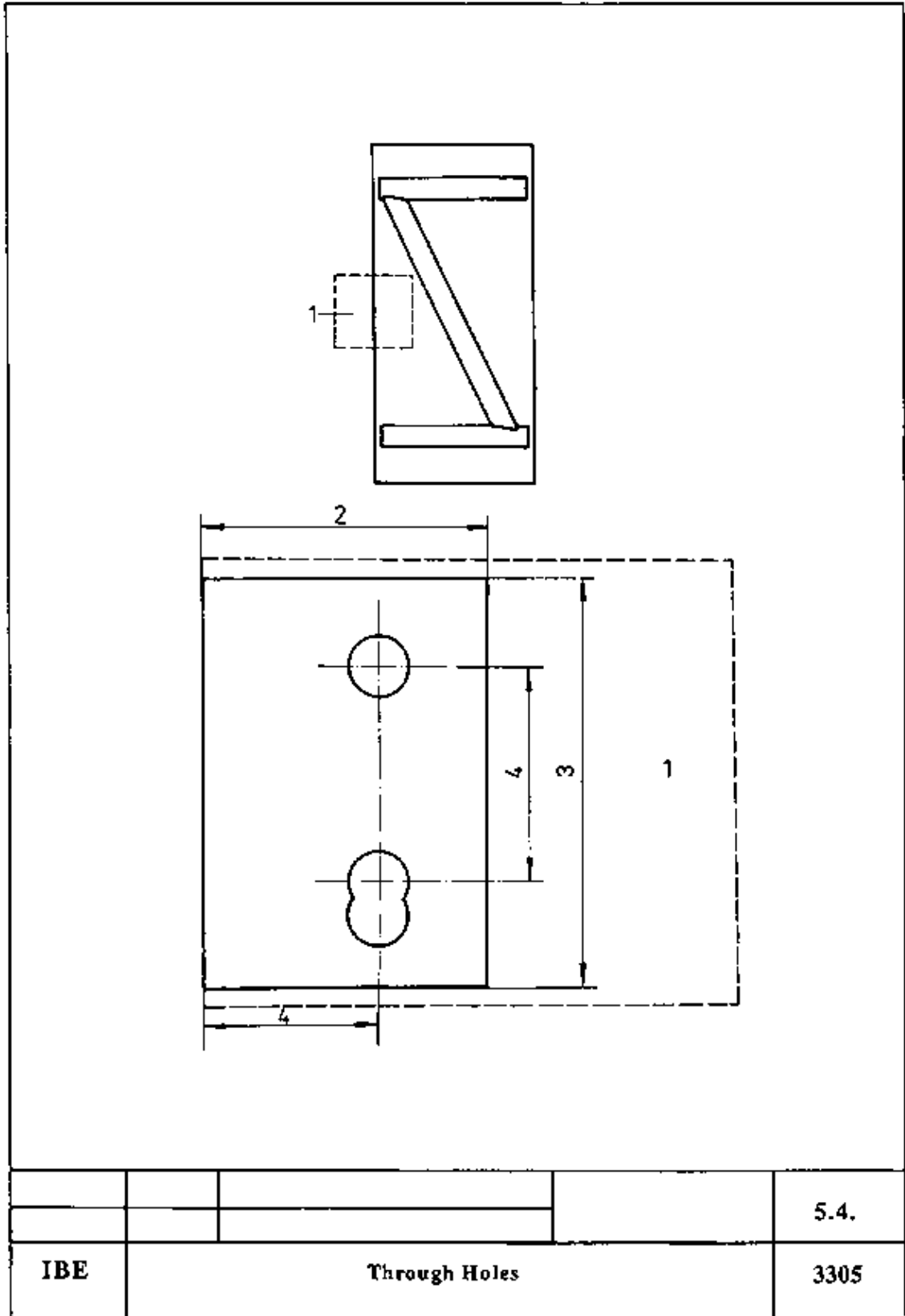
Measuring and scribing

Explanations to the working drawing

1 screw-on lock (lock fitting), 2 lock width, 3 lock height, 4 plug size

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

1. Prepare the working place. Check the tools for completeness.
2. Put the board door on the work bench or on trestles.
3. Take the dimensions of the screw-on lock. Dimensions are shown in the drawing.
4. Scribe the plug size, nut square and centre distance by means of the try square and marking gauge. Height of door handle according to local conditions.
5. Select the proper auger bit or Forstner auger bit and chuck it in the bit brace. Bit diameter depends on the dimensions on the screw-on lock.
6. Bore the holes for the key and for the nut square. Bore the scribed boring points with the auger bit until the brad point penetrates at the other side of the door, then turn the door over and start boring again at the brad point hole. If a Forstner auger bit is used, drill a guide hole with a thin twist drill first and then bore with the Forstner bit from both sides.
7. Bore a second hole for the key hole, if necessary, to achieve the necessary hole heights.
8. Check the results.



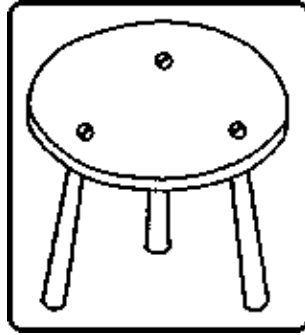
Through Holes

Instruction Example 5.5.: Stool

Conical holes are used for wood connection the tenons of which are prevented from slipping off by keying. This example is an exercise for the trainees to practise the manufacture of a simple stool with three legs keyed with their tenons in conical holes.

Material

One wooden disk (seat) and three round bars of hard wood.



Dimensions:

| Designation | Pcs. | Thickness | Width | Length |
|-------------|------|-----------|-------|--------|
| | | mm | mm | mm |
| Seat (disk) | 1 | 30 | 350 | 350 |
| Legs | 3 | 40 | 40 | 450 |

All parts maybe in rough or finished condition.

Tools, measuring and testing means

Bit brace, spoon bit, dividers, straight edge, folding rule or measuring tape, bevel rule, pencil

Auxiliary accessories

Carpenter's bench or work bench

Necessary previous knowledge

Measuring and scribing, fundamentals of geometrical designs

Explanations to the working drawing

1 seat (disk) – scale 1:2.5, 2 leg – scale 1:1
Ø = diameter

Sequence of operations

1. Prepare the working place.
2. Clamp the seat.
3. Scribe the holes:
 - determine the centre,
 - draw the circular arc,
 - divide the circular arc into three thirds,
 - scribe the centres of the holes.
4. Select the auger bit and chuck it in the bit brace.
5. Bore the holes.

Comments

Check the cutting edges of the spoon bit.

Dimensions are given in the drawing.

Select a bit diameter to suit the lower hole diameter, if available, otherwise use a smaller diameter.

Boring axis must correspond to the leg position.
When practising for the first time, vertical position should be preferred.

6. Select the spoon bit and chuck it. Bit with handle need not be chucked.

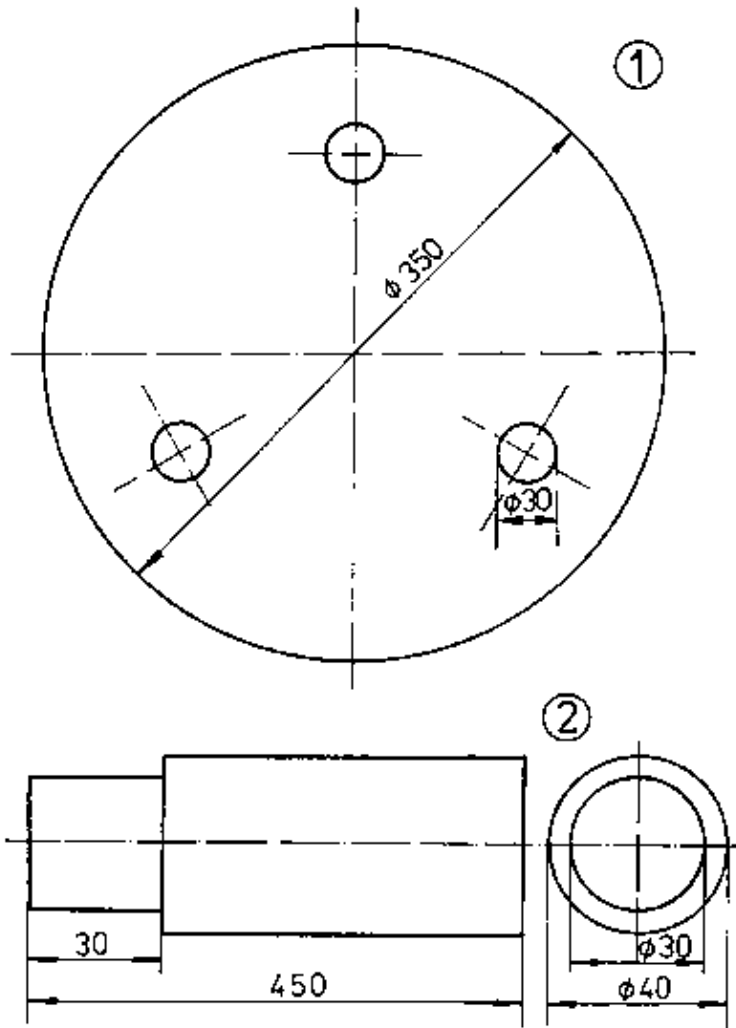
7. Conically enlarge the existing holes.

Enlarge the holes up to the upper hole diameter.

8. Measure the enlarged holes.

9. Continue boring until the specified diameter is reached.

10. Check the results.



| | | | | |
|------------|--|--------------|--|-------------|
| | | | | 5.5. |
| IBE | | Stool | | 3305 |

Stool

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

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

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1. Purpose and Meaning of Boring

Wood boring is a cutting operation to produce round holes in wood. Boring is either vertical, parallel or at an angle to the wood grain direction or panel plane.

Boring serves different purposes:

- Boring of through holes for mounting of screws, fitting or nails.
- Boring of holes of limited depth for end grain dowels or dowel joints.
- Pre-boring of wood screw holes.
- Boring of conical holes.

The precision and accuracy to size of the holes is decisive for the quality and durability of the component produced.

2. Construction and Mode of Action of Bore Bits

Bore bits are cutting tools to produce holes in wood. Normally the bore bit is rotated around its axis. During such rotation it advances in axial direction. The wood to be removed must not be squeezed off or torn off but be removed by a clean cut. A bore bit consists of various parts (see Fig. 1).

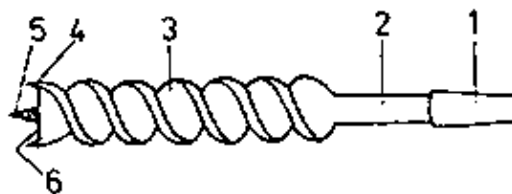


Figure 1 Bit

1 square tang, 2 shank, 3 chip-removing screw, 4 pre-cutters, 5 brad point, 6 cutting edge

- The chip-removing screw presses the cut chips out of the bore hole.
- The parallel shank carries the cutting edges and the drill screw.
- The square tang is chucked in the jaw chuck of the bit brace.
- The brad point serves for exact location of the bit in the centre point. Bits intended for boring of holes vertically to the board plane have a very small brad point. Brad points of bits

for boring of holes parallel to the wood grain have a draw-in thread.

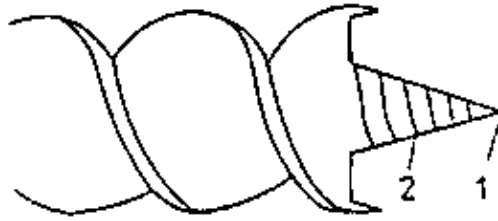


Figure 2 Bore bit head

1 brad point, 2 draw-in thread

- The cutting edges (also called cutters) cut the chip between the brad point and the pre-cut circumference of the bore hole.
- Compared to the cutting edges, the pre-cutters (also called pre-cutting edges) are in advanced cutting position and cut the wood grains already before the chip is removed by the cutting edges.

Most bore bits are held in and rotated by means of a boring appliance, i.e. an electric hand gun drill or a mechanical bit brace.

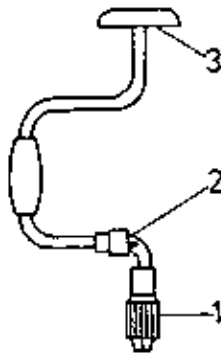


Figure 3 Bit brace

1 steel sweep handle with chuck, 2 ratchet, 3 supporting handle

The bit brace consists of a steel sweep handle with chuck, a supporting handle and a ratchet.

The ratchet is used for holes which are accessible from one side only and where a full rotation of the steel sweep handle is not possible. It is provided with idle gear for clockwise or counterclockwise rotation, which can be set.

The chuck serves for holding the bore bit.

What are the parts of a bore bit?

What is the advantage of a bit brace with ratchet?

3. Types of Bore Bits

Bore bits have a wide field of application.

The different properties of wood cut parallel with or across the grain or of cross-grained wood and wood fibreboards call for different types of boring tools.

– The types of bore bits described in Table 1 are tools which can be used in manually operated boring appliances only, except for the Forstner auger bits and twist drills which can be operated manually and on machines.



Figure 4-1 Types of bore bits: auger bit (Douglas type),

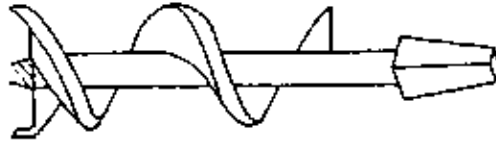


Figure 4-2 Types of bore bits: auger bit (Irwin type),

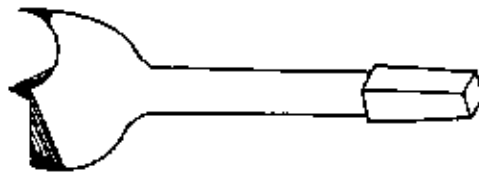


Figure 4-3 Types of bore bits: centre bit,

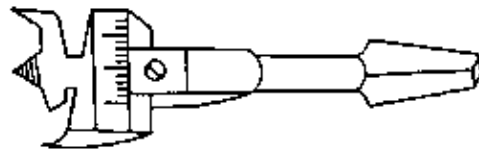


Figure 4-4 Types of bore bits: expansive centre bit,

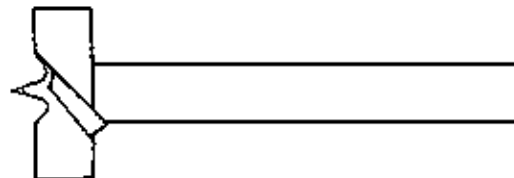


Figure 4-5 Types of bore bits: Forstner auger bit,

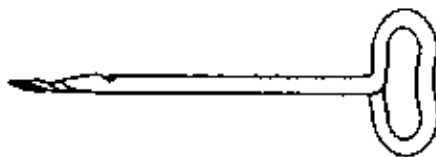


Figure 4-6 Types of bore bits: gimlet with ring handle,



Figure 4-7 Types of bore bits: twist drill,

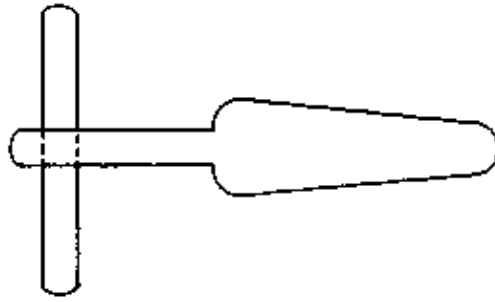


Figure 4–8 Types of bore bits: spoon bit,

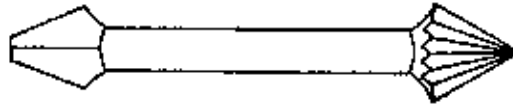


Figure 4–9 Types of bore bits: wood countersink (rose bit),

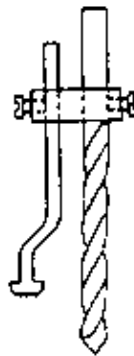


Figure 4–10 Types of bore bits: depth setter

Table 1: Types of Bore Bits

| Designation | Features | Application |
|----------------------|--|--|
| Auger bit | <ul style="list-style-type: none"> – Diameter 6 mm ... 30 mm – Length 185 ... 250 mm – Brad point with draw-in thread – Two pre-cutters – Douglas double twist type – Irwin single twist type | <ul style="list-style-type: none"> – Boring of long-grained wood – Boring of end-grained wood – Deep holes – Particularly for holes in hard wood – Particularly for holes in wet wood |
| Centre bit | <ul style="list-style-type: none"> – Diameter 10 mm ... 40 mm – Brad point without draw-in thread – One pre-cutter | <ul style="list-style-type: none"> – For holes of small depth in cross-grained wood (not suitable for end-grained wood) |
| Expansive centre bit | <ul style="list-style-type: none"> – Diameter 16 mm ... 40 mm – Brad point with draw-in thread – Pre-cutter and cutting edge are adjustable inserts – Pre-boring bit | <ul style="list-style-type: none"> – For holes of varying sizes (not suitable for hard wood) |
| Forstner auger bit | <ul style="list-style-type: none"> – Diameter 8 mm ... 40 mm – Length 80 mm ... 125 mm – Minimum brad point – Cylinder circumference serves as pre-cutter – Two cutting edges between brad point and pre-cutter | <ul style="list-style-type: none"> – For flat and very clean-cut holes with plane bottom for mounting of fittings – For boring out of defective spots |

| | | |
|-------------------------|--|--|
| Gimlet with ring handle | <ul style="list-style-type: none"> - Diameter 2 mm... 10 mm - Length 110 mm ... 200 mm - No pre-cutter - Helical transition from draw-in point to main cutting edge removes chips at hole circumference | <ul style="list-style-type: none"> - Pre-boring of nail and screw holes in end-grained wood and long-grained wood |
| Twist drill | <ul style="list-style-type: none"> - Diameter 2 mm ... 12 mm - Length 120 mm ... 170 mm - Taper brad point - No pre-cutter | <ul style="list-style-type: none"> - For holes in thin material - Dowel holes |
| Spoon bit | <ul style="list-style-type: none"> - Diameter 10 mm ... 60 mm - Length 220 mm ... 490 mm - No brad point - No pre-cutter - Spoon type cutting body - Cutting edge removes chips at hole circumference - No pre-cutter | <ul style="list-style-type: none"> - For producing conical holes - For enlarging conical holes - Boring of end-grained wood |
| Rose bit | <ul style="list-style-type: none"> - Diameter 16 mm and 20 mm - Length 100 mm - Conical arrangement of main cutting edges | <ul style="list-style-type: none"> - For reaming of screw holes - Holes are provided with a chamfer |
| Depth setter | <ul style="list-style-type: none"> - Appliance as boring aid - Is bolted to the bit | <ul style="list-style-type: none"> - Helps to observe the required depth of hole |

All bore bits specified in the table are to be classified according to the following criteria!

| | | | | | |
|------------|------|---------|------|-------------|------|
| without | with | without | with | without | with |
| brad point | | thread | | pre-cutters | |
| | | | | | |
| | | | | | |

In addition to the various types of bore bits, auxiliary tools are used for boring to safely guide the boring tool in the desired position of the bore hole axis.

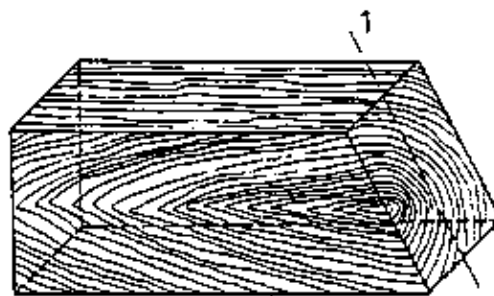


Figure 5 Piece of wood as boring aid

1 bit center line

Depth setters guarantee that the specified depth of the hole is not exceeded.

4. Maintenance of Bore Bits

The quality of the holes and the performance depend on the sharpness of the cutting edges and on the state of the boring tools and boring appliances.

Knife, three–square or square files with fine cut are used for sharpening. Correct sharpening of the boring tools requires utmost care, a lot of experience and exact knowledge of the mode of action of the individual types of bore bits.

The brad point, draw–in thread, pre–cutters and cutting edges are sharpened.

The sharpening process involves the following operations:

- Brad points without draw–in thread are uniformly filed from all sides so as to remain in the centre of the axis of rotation of the bit.
- Draw–in threads are carefully filed by means of a knife file while the bit is rotating. No steps must be produced.
- Pre–cutters are sharpened on the inside only and against the direction of rotation of the bit.
- The cutting edge is sharpened so that the edge angles are not changed.
- All filed areas are stoned with an oil stone until no filing marks are left. This considerably increases the life of the boring tools.

What tools are used for sharpening of boring tools?

Why must pre–cutters not be sharpened on the outside?

On completion of boring, resin and dirt deposits are to be removed by means of hot water, petroleum or thinner. A thin film of acid–free grease will protect the boring tools against corrosion.

The bore bits are to be stored so as not to touch each other.

Three possible ways of storing are:

- The bits are stored in lying position in a box with several compartments.

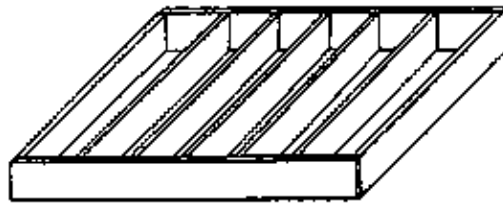


Figure 6 Box with compartments for storing bits

- The bits are suspended on a wooden suspension stand by means of the square tangs.

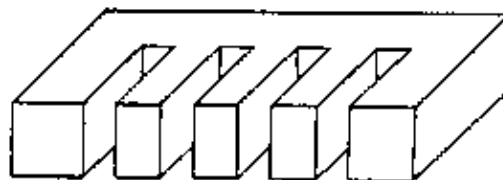


Figure 7 Bit suspension device

- The bits are stored in a wooden block with holes with the bits standing in upright position and their points pointing upwards.

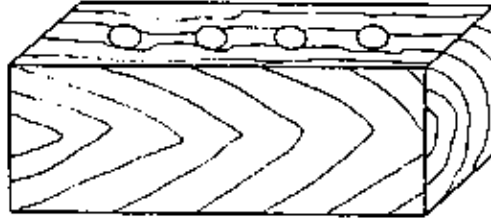


Figure 8 Bit stand

Why must the bits not touch each other during storage?

5. Working Rules for Boring

According to the mode of action of the bits, forces are required for the rotary motion of the bit brace and for the feed motion in the in the direction of the bore hole depth.

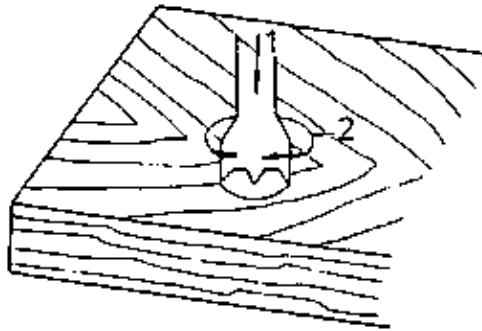


Figure 9 Boring forces

1 feed motion, 2 working motion

The magnitude of the required force depends on

- the strength of the material to be cut,
- the diameter of the bit,
- the cutting edge geometry of the bit,
- the desired quality of cutting and
- the feed rate.

All bits with brad point and pre-cutters are a potential source of accidents unless they are properly handled. Therefore, specific rules of labour safety are to be defined and observed.

Bits must not be left lying around but be stored in proper holders! Bits must not be used for scribe-marking or similar purposes!

Boring is to be carried out as follows:

- The part to be bored is to be clamped, if possible, in order to prevent it from being moved by the rotary motion of the bit.
- If it is not possible to clamp the workpiece, assistance by a second worker is required.
- The face to be bored must be horizontal to permit the bit to cut vertically from top to bottom. In that case less feed force is required.
- Before boring the scribe-marked centre of the hole (pencil or scriber marking) should be punched to prevent the bit from running off centre.

- During boring the position of the bit with the boring appliance is to be constantly checked from all sides to make sure that the hole is produced in the correct position.
- A boring fixture should be used, if possible, to facilitate keeping up the correct position.
- When using bits with brad points without draw-in thread, the feed rate is to be selected so as to achieve favourable chip thicknesses.
- When boring through holes it is to be made sure that no wood fibres are torn off at the bottom side of the workpiece. This can be prevented in two different ways:
 - . Clamp a piece of waste wood under the bottom side and bore through into such piece of wood.
 - . Check during boring whether the brad point has reached the bottom side. If that is the case, stop boring, turn the workpiece over and complete boring from the second side.

Why is it necessary to constantly check the position of the boring tool during boring?

Working with Driling Machines – Course: Mechanical woodworking techniques. Trainees' handbook of lessons

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Working with Drilling Machines – Course: Mechanical woodworking techniques. Trainees' handbook of lessons

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Author: Frank Wenghöfer

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1. The Purpose of Drilling with Drilling Machines

In the field of wood working, drilling machines are applied to produce bores with special tasks.

Selection of the machines according to their application:

| Application | Type of machine |
|--------------------------------|---|
| bores with free assembly works | bench, pillar drilling machines, knot drilling machines, routing machines |
| horizontal bores | long hole milling cutters |
| several adjacent bores | dowel–hole drilling machines |

Bores are produced in order to

- manufacture through holes and countersinks to locate screws and mountings;
- manufacture bottom and through holes for dowel joints;
- eliminate defects in wooden parts.

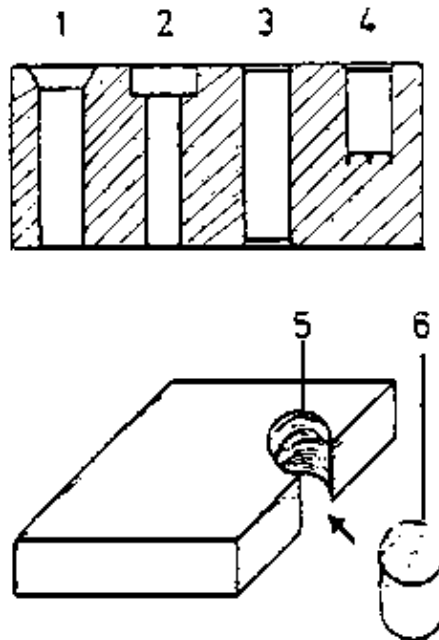


Figure 1 – Bore types

1 bore for flat head screws, 2 bore for cylinder head screws, 3 through hole, 4 bottom bore for dowels, 5 drilled out defect, 6 wood disk to be inserted

2. Construction of Selected Drilling Machines

2.1. Electrical Hand Drilling Machine

The light metal or plastic case contains the motor on whose prolonged arbor a whose chuck is placed to locate the drillers. Between the chuck and the case an additional hand grip can be mounted which can accommodate a depth stop. Switching on and off is done by a switch above the hand grip which can be adjusted for a short time standing operation. In addition there can be switches to change the number of revolutions according to the type of drilling machine.

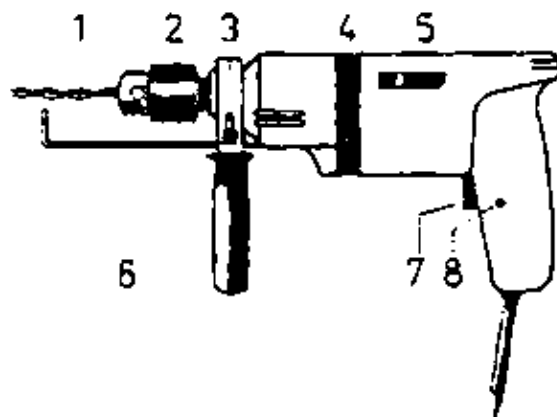


Figure 2 – Electrical hand drilling machine

1 drill, 2 chuck, 3 additional hand grip, 4 case, 5 switch to select the number of revolutions, 6 depth stop, 7 on/off switch, 8 lock switch

The drilling machine should only be connected to a safety wall socket!

Damaged cables must not be applied!

The condition of the cable should be checked regularly and the clamp chuck must be kept clean!

2.2. Bench and Pillar Drilling Machines

These drilling machines are applied to manufacture single vertical round bores for mountings and countersinks at screw holes for mountings or single dowel bits.

Joint features as to construction:

A stable pillar carries in its upper part the driving mechanism with the motor and the gear as well as the operating elements to fix the number of revolutions and to carry out the feed. It is followed by the vertically flexible drill spindle for the accommodation of the drilling tools. Below the pillar there is the machine table where the workpieces can be fastened by different clamping means.

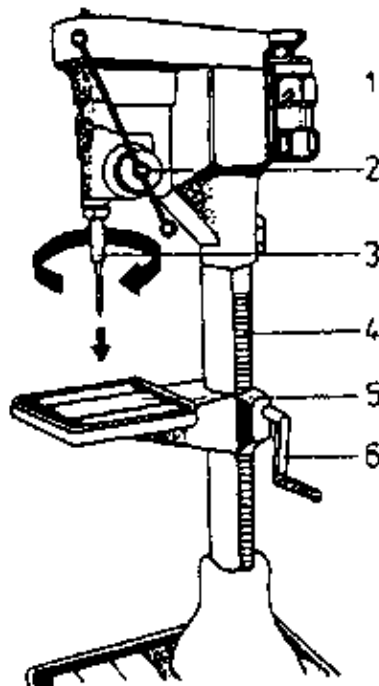


Figure 3 – Pillar drilling machine

1 case with driving mechanism, 2 feed lever, 3 chuck, 4 pillar, 5 machine table (adjustable), 6 wheel for adjusting the height of the machine table

The clamping devices must guarantee a perfect and firm seat of the tools and the workpieces!

Existing eye protecting woods should be adjustable to the different heights of the drilling tools, they must not be removed!

Drill chuck and drill shank should be kept clean. The workpiece support and the clamping devices should be cleaned regularly!

The machine should be lubricated regularly according to the lubrication chart!

When do you apply bench or pillar drilling machines for wood working?

What requirements must be met by the clamping devices for the tools and workpieces?

3. Tools

Twist drill

Twist drills with a roof-shaped point and a short robust shank are mainly applied for dowel bit bores in solid wood or cross grain wood.

Special dowel bit drills for multiple bores (which can be carried out with dowel bit drilling machines) have a screw on the robust shank.

Twist drills with a backed centre point (with 2 cutting edges) are applied for exact and clean through holes mostly across the grain.

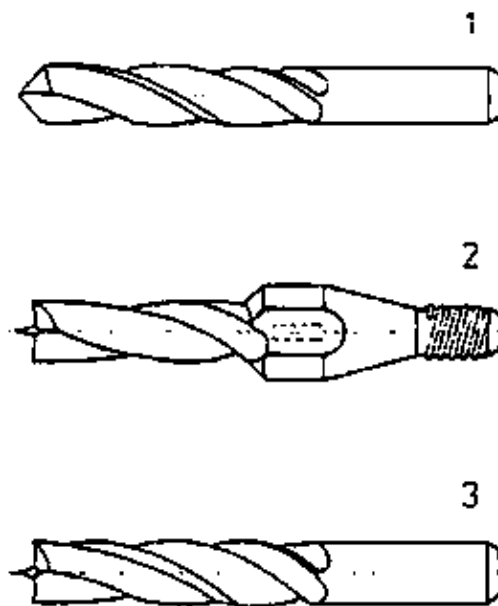


Figure 4 – Twist drill

1 twist drill with roof-shaped point, 2 dowel bit drill, 3 twist drill with centre point

Auger bit drill

They are mainly applied in hand drilling machines for deep bores.



Figure 5 – Auger bit drill

Cylinder drill

They have a cylindrical bore head with which and dimensionally stable plain bores are carried out on even bore ground. They mainly have a larger diameter. They are suitable for boring out of defective parts and knots.

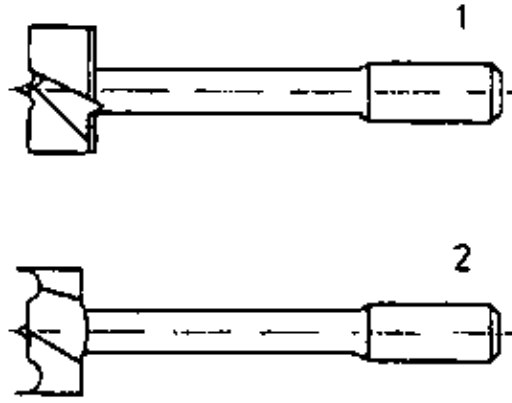


Figure 6 – Cylinder drill

1 round shank Forstner bit drill, 2 circular rim auger bit drill

Wood disk drill

They are also suitable for boring out of knots; but are mainly applied for manufacturing wood disks (cross wood dowels) which are placed instead of a drilled out knot.

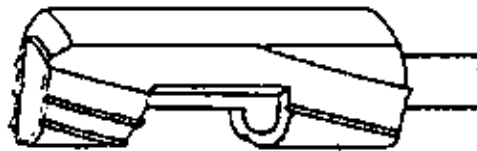


Figure 7 – Wooden disk drill

Countersinks

Depending on the form of head, conic bores for flat head screws can be manufactured or bores can be cylindrically enlarged in order to countersink screw heads.

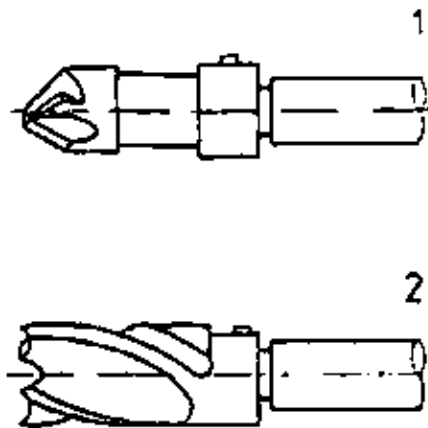


Figure 8 – Countersink

1 countersink, 2 counterbore

After having finished drilling resin and dirt residues must be removed with hot water, petroleum or thinner!

Slight lubrication with acid-free grease protects the drilling tools against corrosion!

With which type of drill can be large bores on a even bore ground manufactured?

What are countersinks applied for?

4. Mode of Operation of Drilling Machines

The switched-on electric motor puts the drill spindle through a gear into revolving movement. If by the feed lever the drill spindle together with the clamped tool is moved into the feed direction the drilling tool can penetrate into the workpiece which is fastened on the machine table or being hold tight.

The revolving movement together with the feed movement effects the cutting by the drilling tool.

5. The Technological Process of Drilling

Marking the workpiece

According to the measures in the technical drawing the marking is transmitted by a pencil and a marking gauge onto the piece of work. Thereafter the bore centre is prepunched to achieve an accurate placing of the drill point.

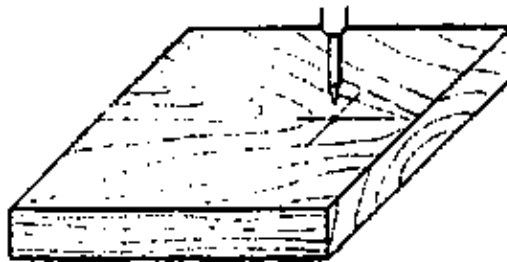


Figure 9 – Marking and punching the bore centre

Selecting and clamping the drill

According to the type of the bore and the material the suitable drill shall be clamped.

Pay attention to a firm clamping of the drill!

Clamping or placing of the piece of work

Smaller workpieces are fastened on the machine table to avoid a snatching up or a twisting during drilling. Large workpieces are placed on the machine table and held by an assistant.

To avoid fraying out of wood fibres on the off-side of the bore a solid wood support should be placed under the workpiece.

In any case the workpiece should be secured against snatching up or twisting!

The prepunched bore centre must be adjusted exactly under the drill point.

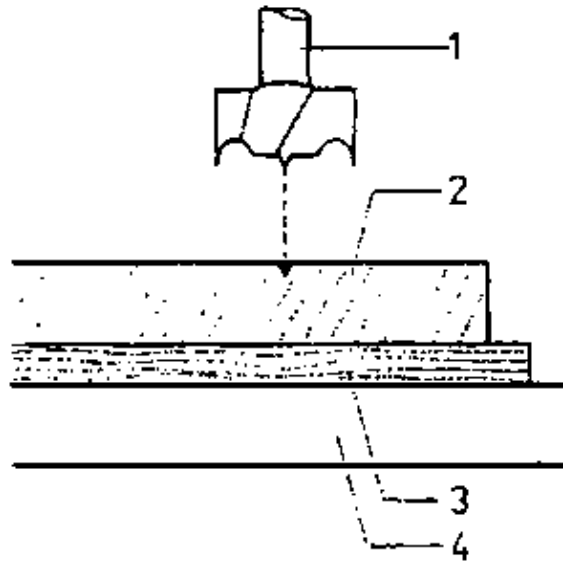


Figure 10 – Adjusting the bore centre under the drill point

1 drill, 2 workpiece, 3 solid wood support, 4 machine table

Carrying out the bore

Switching on the machine the drill is put into revolving movement. Now the drill is pressed on the workpiece by the feed lever. After having finished drilling the machine should be switched off.

Pay attention to a good chip flow during drilling!
Only sharp drilling tools should be applied!

Why are bore centres prepunched?

What should be paid attention to when placing the workpiece on the machine table?

How can fraying out of wood fibres on the off-side of the bore be avoided?

Checking the bore

After drilling the dimensional stability of the bore, its diameter and depth as well as the quality of the bore edges are checked. Wood particles and unclean bore edges are faults which must be eliminated. In that case the bore should be countersunk slightly.

Working with Driling Machines – Course: Mechanical woodworking techniques. Instruction examples for practical vocational training

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Working with Drilling Machines – Course: Mechanical woodworking techniques. Instruction examples for practical vocational training

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Preliminary Remarks

The present material includes 3 instruction examples where the drilling of bottom bores and through hole bores of smaller and larger diameters can be practised. Thereby a brush stand for workshop use and decorative boards for a wall shelf are being manufactured. The wall shelf should be mounted by dowel and screw joints.

In order to ease the preparation and the execution of the jobs for each instruction example the necessary materials, machines and tools, measuring and testing means and auxiliaries are mentioned to carry out the exercises. The added working steps include the sequences of operations to carry out the exercises.

To each instruction example a working sketch is added where the measures and forms of the work pieces can be taken from.

The bore distances shall be determined on the pieces themselves.

Pay attention to the fact that Instruction Example 03.2. is to be manufactured as component part for Instruction Example 03.3.

Be accurate with the external measures in this case.

Instruction Example 03.1.: Brush Stand

Manufacturing of simple bottom bores to produce a stand to store brushes.

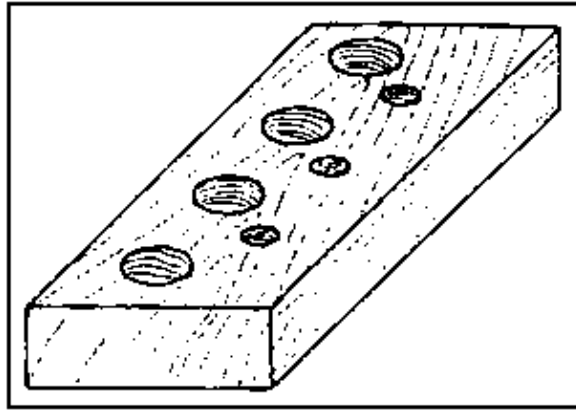
Material

Piece of squared timber with all faces being planed

length: 120 mm

width: 70 mm

thickness: 70 mm



Machines and tools

Bench drilling machine, twist drill with centering drill point \varnothing 10 mm and \varnothing 15 mm, pencil, marking gauge, countersink, awl

Measuring and testing means

Folding rule, steel square

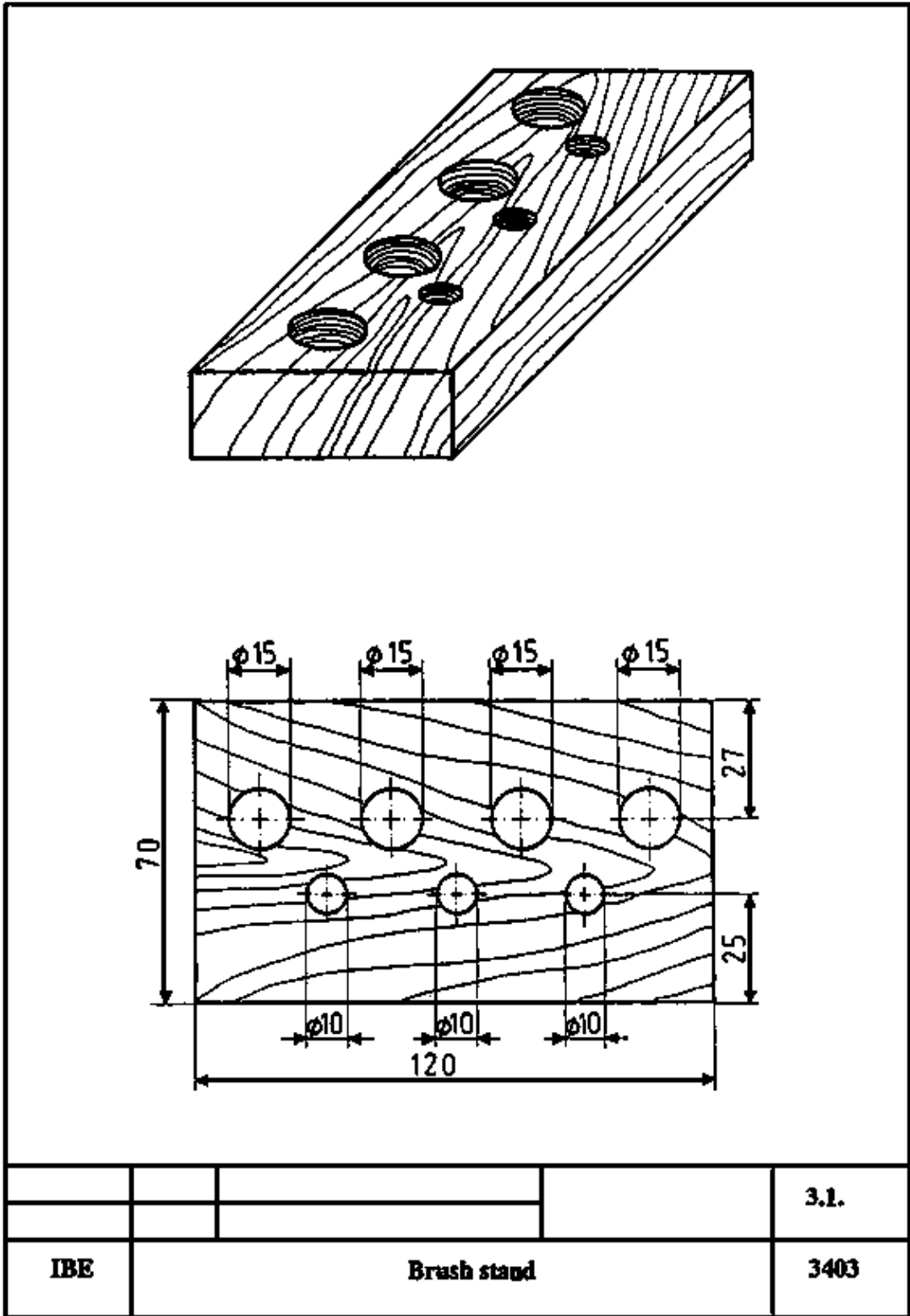
Auxiliaries

Clamping means

Necessary basic knowledge

Measuring and marking

| Sequence of operations | Comments |
|---|---|
| 1. Preparing the working material Checking the machine for functioning | Check for completeness |
| 2. Marking the piece of squared timber, determining the bore centres | Pay attention to the bore distances to be regular! |
| 3. Clamping the drill \varnothing 10 mm and fastening the piece of squared timber | Adjust the bore centre exactly beneath the drill point then fasten! |
| 4. Manufacturing the bores to a depth of 50 mm. | Adjust the piece of work after every bore again and fasten! |
| 5. Manufacturing the bores of \varnothing 15 mm in the same way | |
| 6. Slightly countersinking the bores with the countersink | |
| 7. Cleaning the workpiece+ | |
| 8. Checking all bores | <ul style="list-style-type: none"> – regularity of the bore distances – dimensional accuracy of the depth – clean bore edges |



Brush stand

Instruction Example 03.2.: Decorative Board

Manufacturing of large through holes to produce a decorative board.

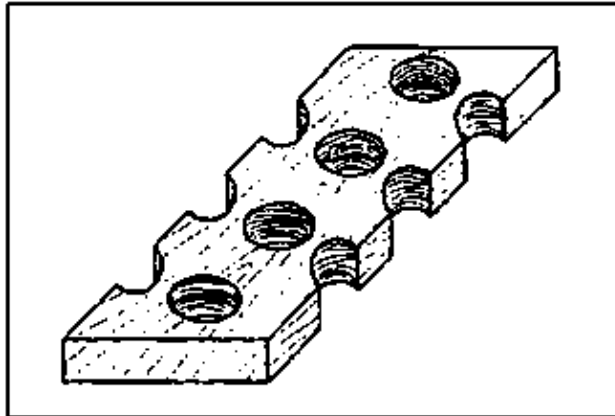
Material

A planed board

length: 500 mm

width: 70 mm

thickness: 20 mm



Machines and tools

Bench or pillar drilling machine, pencil, marking gauge, awl, round shank Forstner bit \varnothing 30 mm

Measuring and testing means

Folding rule, steel square

Auxiliaries

Clamping means

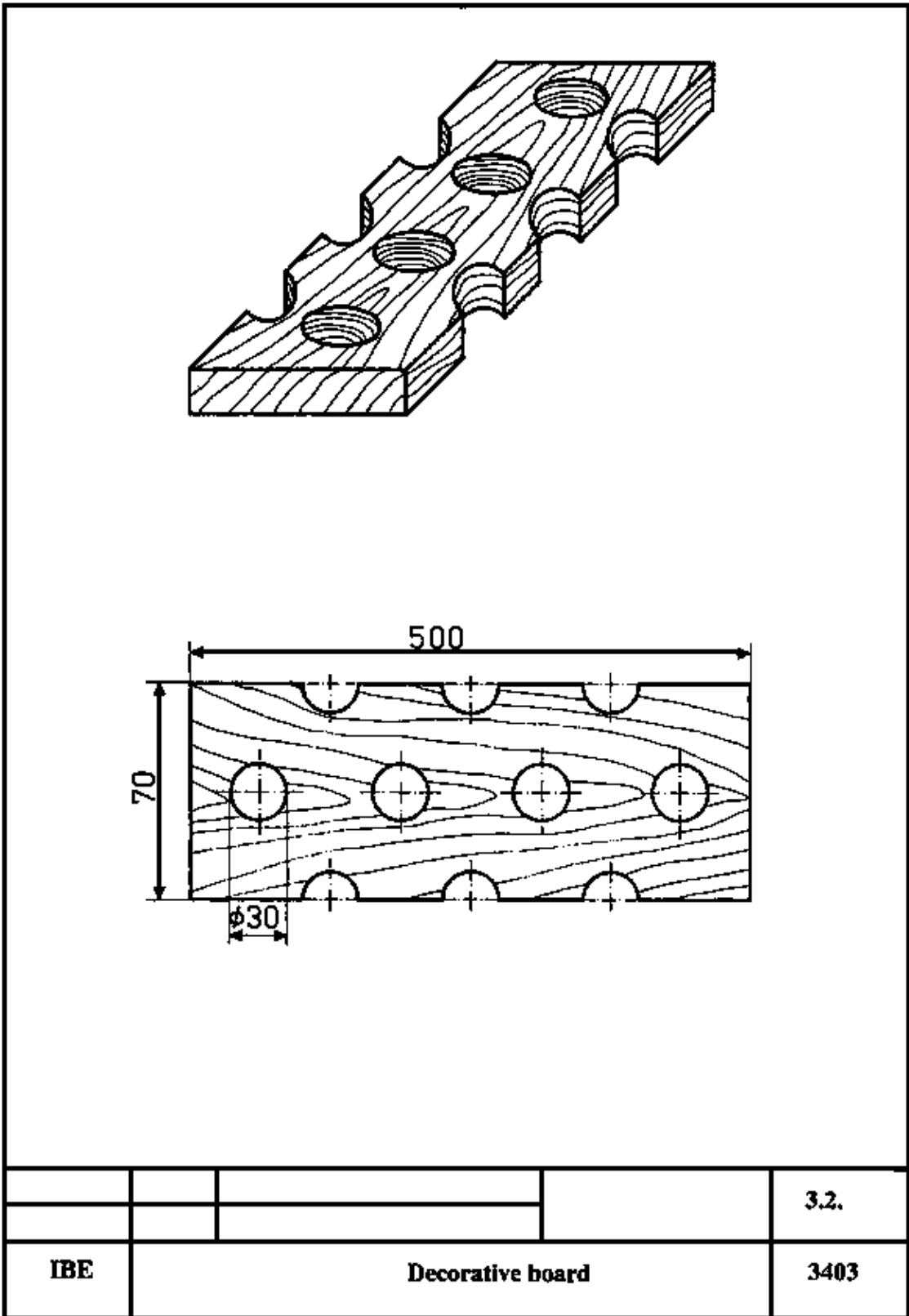
Necessary basic knowledge

Measuring and marking

Sequence of operations

Comments

- | | |
|--|--|
| 1. Preparing the working material Checking the machine for functioning | Check for completeness |
| 2. Marking the board, determine the bore distances yourself, marking out the bore centres | Pay attention to the bore distances to be regular! |
| 3. Clamping the drill and placing the board | Adjusting the bore centres exactly! |
| 4. Carrying out the bores | |
| 5. Cleaning the board | |
| 6. Checking the bores | – regularity of the bore distances – clean bore edges |
| 7. Manufacturing a second decorative board | |



Decorative board

Instruction Example 03.3.: Wall Shelf

Manufacturing of bores for dowel and screw joints to mount a wall shelf.

Material

- 2 prefabricated decorative boards (Instruction Example 03.2.)

length: 500 mm

width: 70 mm

thickness: 20 mm

– 1 planed board

length: 500 mm

width: 80 mm

thickness: 20 mm

– 2 planed and half-round cut boards

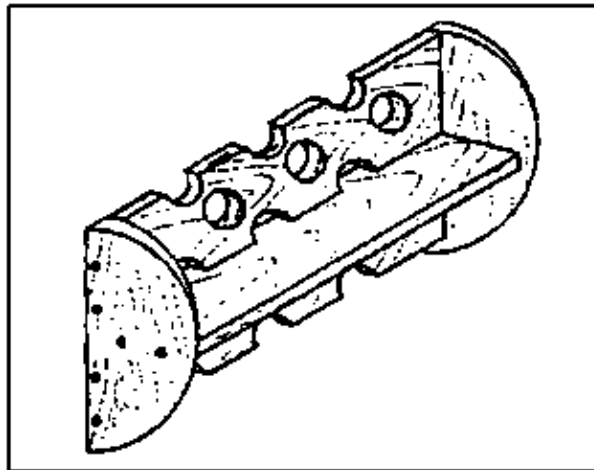
length: 160 mm

width: 80 mm

thickness: 20 mm

– 12 flat head wood screws

– 4 wooden dowels



Machines and tools

Bench or pillar drilling machine, pencil, awl, drill with centering drill point according to the dowel and screw size, countersink, screwdriver, wooden hammer

Measuring and testing means

Folding rule, marking gauge

Auxiliaries

Clamping means, cold glue

Necessary basic knowledge

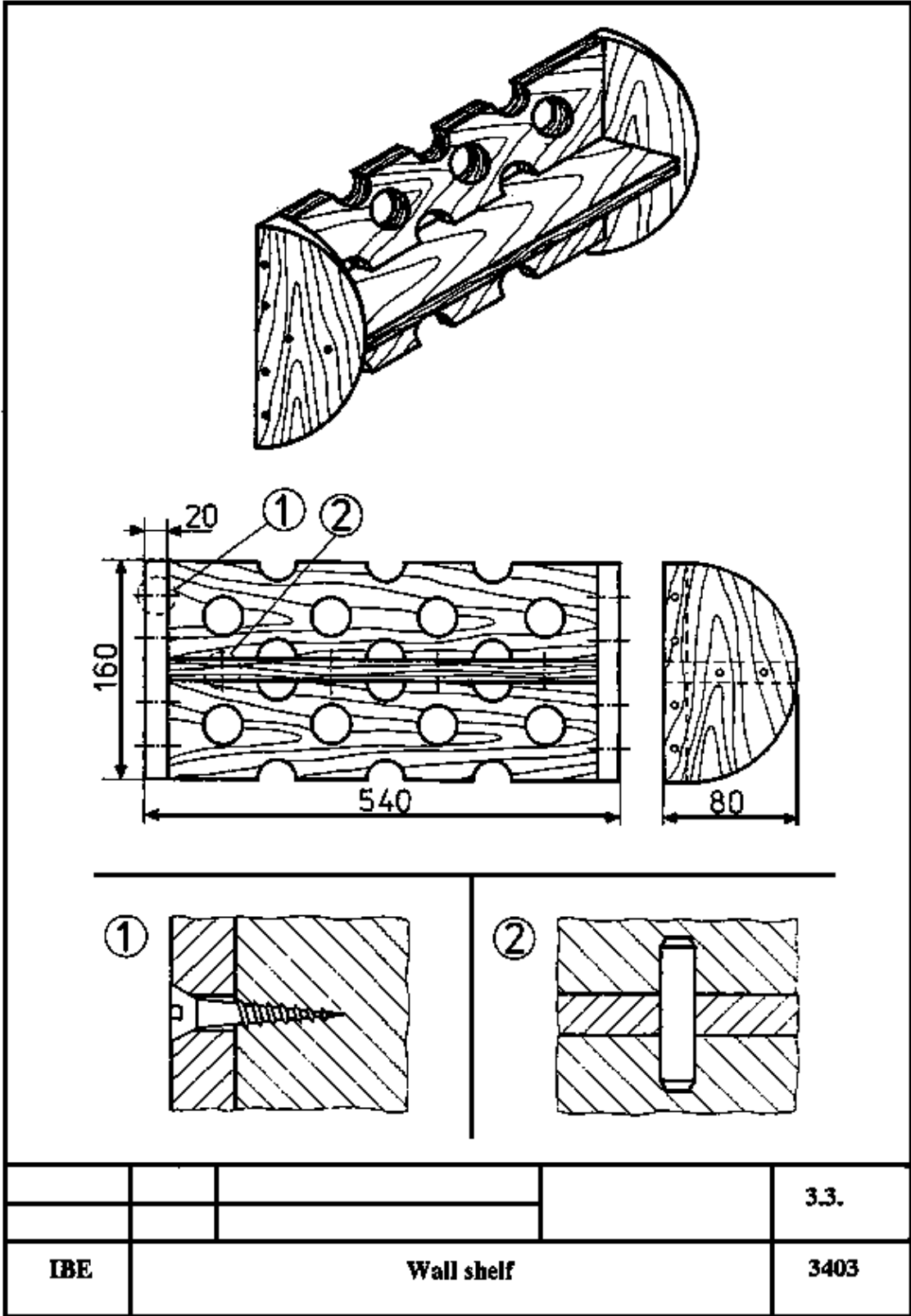
Measuring and marking

Sequence of operations

Comments

1. Preparing the working material Checking the machine for functioning Check for completeness

2. Marking and marking out the bores for the wood joints Determine the bore distance yourself!
3. Clamping the drill and drilling the through hole and bottom bores Selecting the drill according to the size of the screw and dowel diameters!
4. Clamping the countersink and countersinking the side boards for accommodating in the screw head
5. Manufacturing the dowel joints
6. Manufacturing the screw joints
7. Checking the joints for stability and cleanliness



Wall shelf

Surface Finish by Dyeing, Staining, Pigmenting, Matting and Polishing
– Course: Manual woodworking techniques. Instruction examples for
practical vocational training

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Surface Finish by Dyeing, Staining, Pigmenting, Matting and Polishing – Course: Manual woodworking techniques. Instruction examples for practical vocational training

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

Original title:

Lehrbeispiele für die berufspraktische Ausbildung
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Author: Rolf Köllner

Gerhard Piele

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13187 Berlin

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Preliminary Remarks

The present material contains 4 selected instruction examples, with which the finishing of wood surfaces can be practised.

In this connection, simple and prepared wood surfaces are to be worked, which have been manufactured by means of manual or mechanical woodworking techniques. The following surface finishing methods will be described in individual steps:

- Washing, sanding and dedusting
- Extracting resin, bleaching
- Dyeing, staining, pigmenting
- Filling pores
- Matting, varnishing, polishing.

To facilitate the preparation and execution of work, each instruction example states the necessary materials, tools, testing means and auxiliaries. Furthermore, the previous knowledge needed to perform the exercises is mentioned.

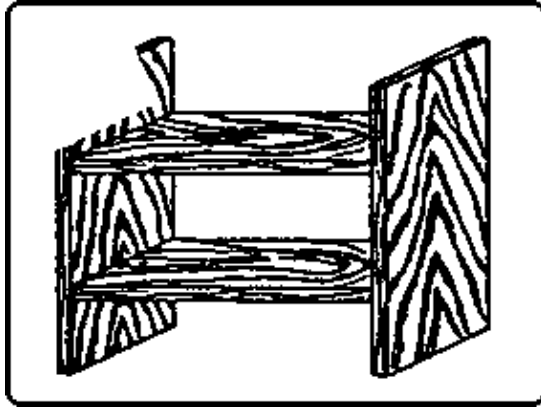
The given sequence of operations for each instruction example contains the individual steps leading to the respective surface finishing. This order of working steps should be followed, in order to obtain a good quality.

The working drawings contain the practising pieces with rough dimensions. They may be supplemented with other practising pieces or substituted, if not available in the pre-set dimensions or forms.

Instruction Example 9.1.: Rack

Surface finishing of wood pieces by bleaching, dyeing and matting.

Material



- Prepared rack made from wood poor in tanning agent, with spotty boards
- Bleaching agent solution:
 - 500 gr. – 30 % hydrogen peroxide, 400 gr. water and 100 gr. 10 % ammonia solution
- Dyeing agent:
 - turpentine oil stain (fat-soluble coal-tar dyes dissolved in oil of turpentine)
- Nitrocellulose matting agent

Tools

Wood scraper with cloth covering, sponge, several vegetable bristle brushes, distributing paintbrushes, linen cloths, hard-bristle brush

Measuring and testing means

Visual inspection (measuring by the eye)

Auxiliary accessories

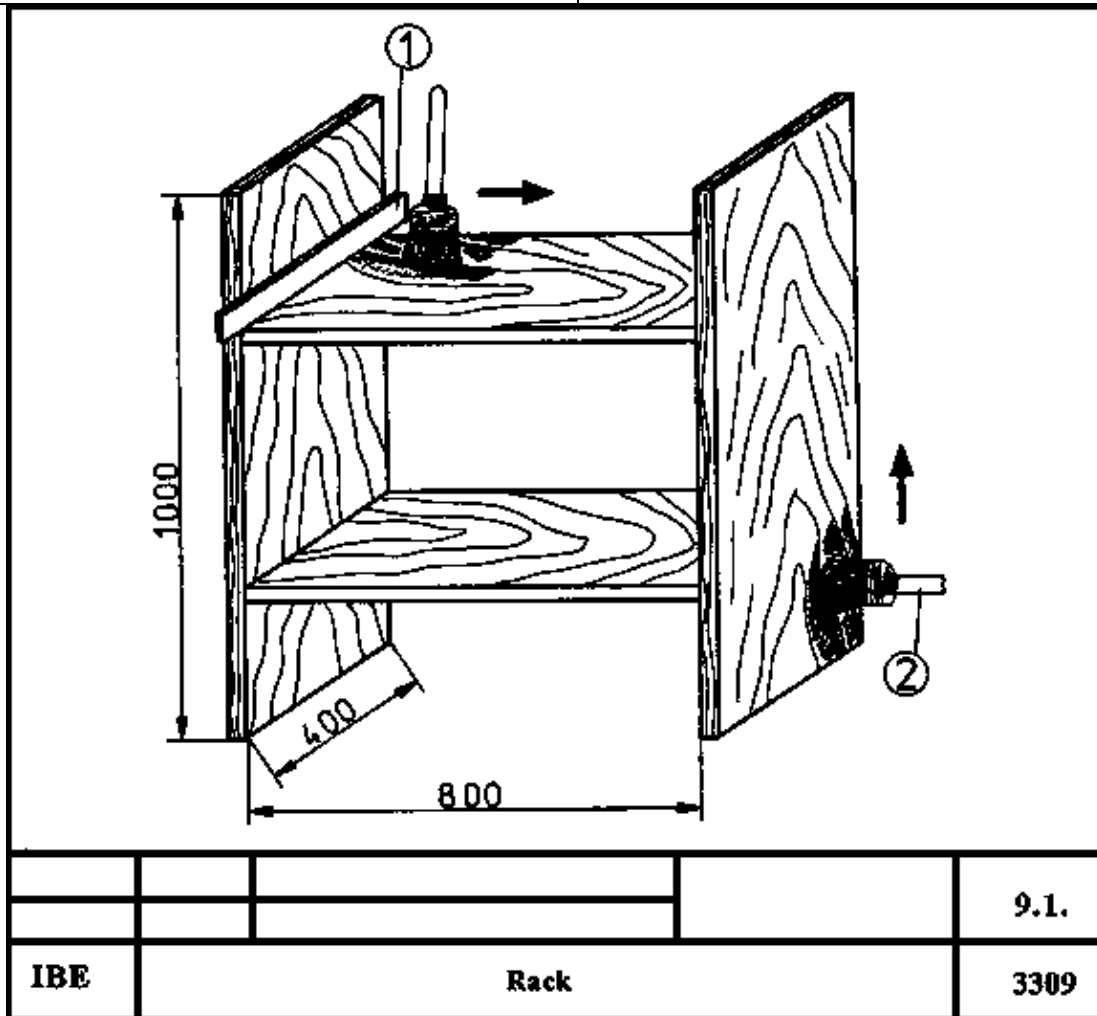
Earthenware pot, thin cover of foil or cardboard, rubber gloves

Necessary previous knowledge

Fundamentals of manual woodworking

| Sequence of operations | Comments |
|---|--|
| 1. Prepare the workplace. Make working available. | Check completeness. |
| 2. Put the prepared rack on a clean support. | |
| 3. Apply bleaching agent in wood grain direction to the entire surface of the spotted boards. | Richly apply solution with covered wood scraper several times. Foam must remain. |
| 4. Brush surface with hard brush, then wash thoroughly with warm water. | Use sponge to wash. |
| 5. Let it dry at ambient temperature for 24 hours. | |
| 6. Wetly apply dye with paintbrush to the surfaces and distribute it uniformly. | 1 – Cover adjoining board edges (with foil or cardboard) on one side. |
| | 2 – Coat vertical surfaces from bottom to top. |
| 7. Let it dry at ambient temperature for 24 hours. | |

| | |
|--|-----------------------------------|
| 8. Apply highly fluid matting agent to the surface and let it dry. | Use linen cloth. |
| 9. Slightly sand the hardened surfaces, brush them and apply semi-fluid matting agent. | Do not touch the same spot twice. |
| 10. Check finally. | |

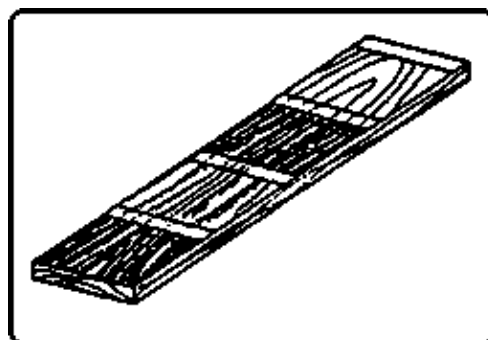


Rack

Instruction Example 9.2.: Staining Test Board

Surfacing of a board by washing, sanding and dedusting, staining as single staining procedure and matting.

Material



– Board containing tanning agent

Thickness: 10 to 20 mm
 Width: 200 mm
 Length: 500 mm

- Single stains of several colour shades
- Nitrocellulose matting agent

Tools

Sponge, sanding pad with fine coated abrasives, bench brush and pore brush, soft paintbrushes without metal rings for each staining procedure, linen cloth for matting.

Measuring and testing means

Visual inspection (measuring by the eye)

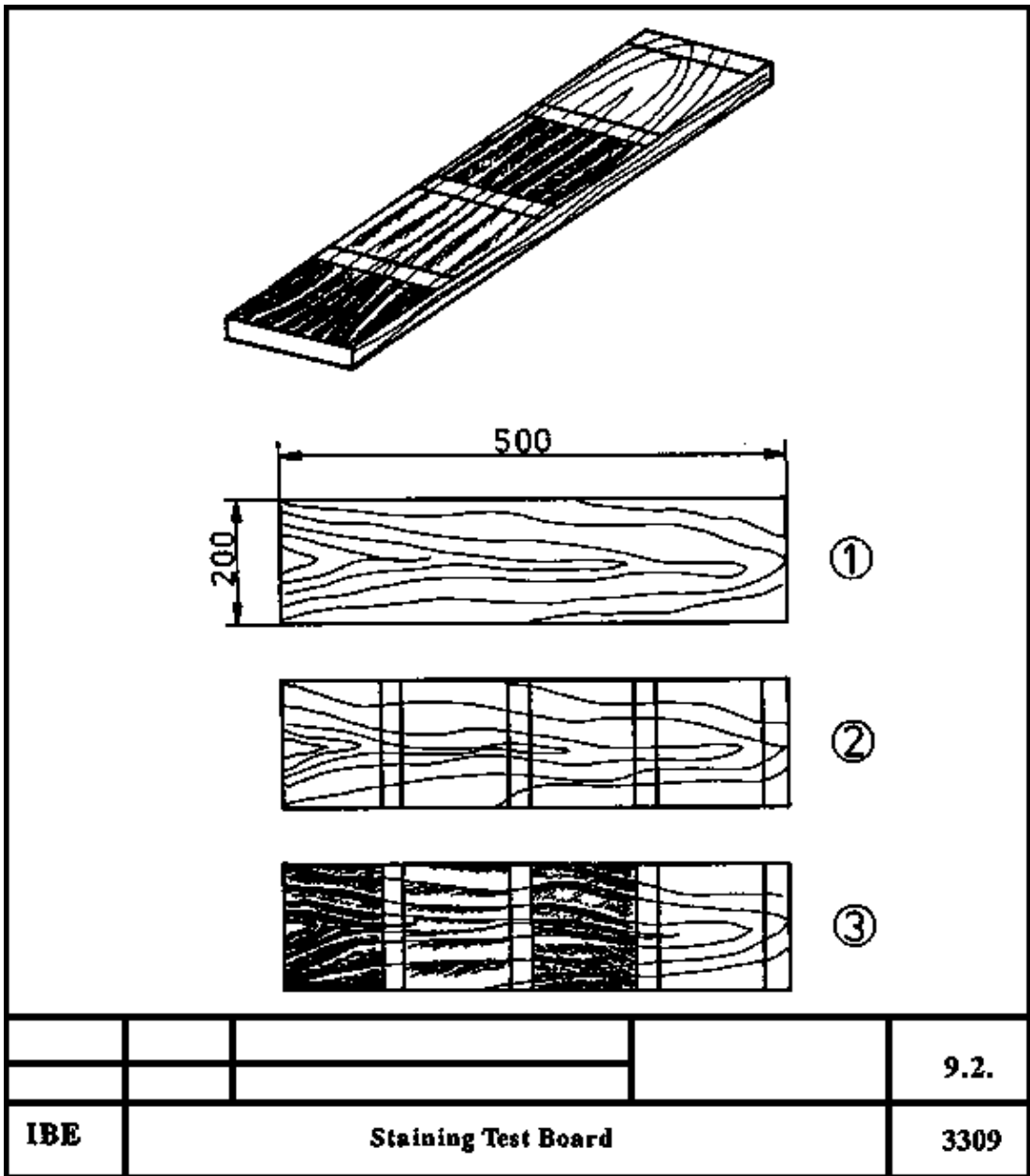
Auxiliary accessories

Supporting table

Necessary previous knowledge

Fundamentals of manual woodworking

| Sequence of operations | Comments |
|---|---|
| 1. Prepare the workplace. Make working material available. | Check completeness. |
| 2. Place on support the prepared, planed board pre-sanded on edges and surfaces. | Stage 1 |
| 3. Wash board on one surface. | Sponge the surface wetly and uniformly. |
| 4. After material has dried, finely sand in longitudinal direction and de-dust thoroughly. | Strongly brush the surface with the pore brush. |
| 5. Apply marks for different staining shades. | Stage 2 |
| | Mark surfaces with graphite pencil. |
| 6. Richly apply the single stains of different colours to each of the marked fields and repeat it after 2 to 4 minutes. | Stage 3 |
| | Use another paintbrush for each staining agent. |
| 7. After another 2 to 4 minutes, equally distribute excessive staining agent. | |
| 8. Brush surface after it has completely dried. | |
| 9. Apply highly fluid matting agent to the surface and let it dry. | Do matting at 20°C at least. |
| 10. Slightly sand the hardened surface, brush it and apply semi-fluid matting agent. | Do not touch the same spot twice. |
| 11. Check finally. | |

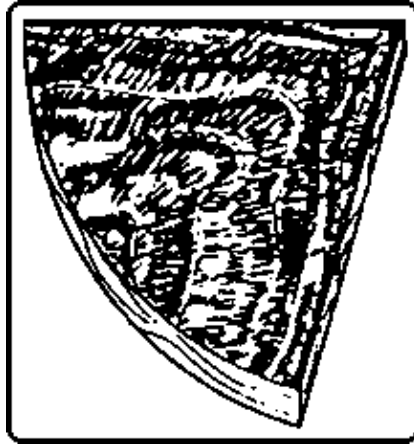


Staining Test Board

Instruction Example 9.3.: Corner Shelf Board

Surfacing of a board by extracting resin, pigment staining and varnishing.

Material



– Resinous board:

thickness: 20 mm
width: 300 mm
length: 300 mm

– Saponification agent:

Curd soap solution or 10% ammonium chloride solution

– Neutralizing agent:

10 to 15 % acetic acid

– Pigment staining agent

– Oil or alkyd resin varnish

Tools

Sponge, hard brush, various vegetable fibre paintbrushes without metal rings, bench brush, sanding pad with fine coated abrasives

Measuring and testing means

Visual inspection (measuring by the eye)

Auxiliary accessories

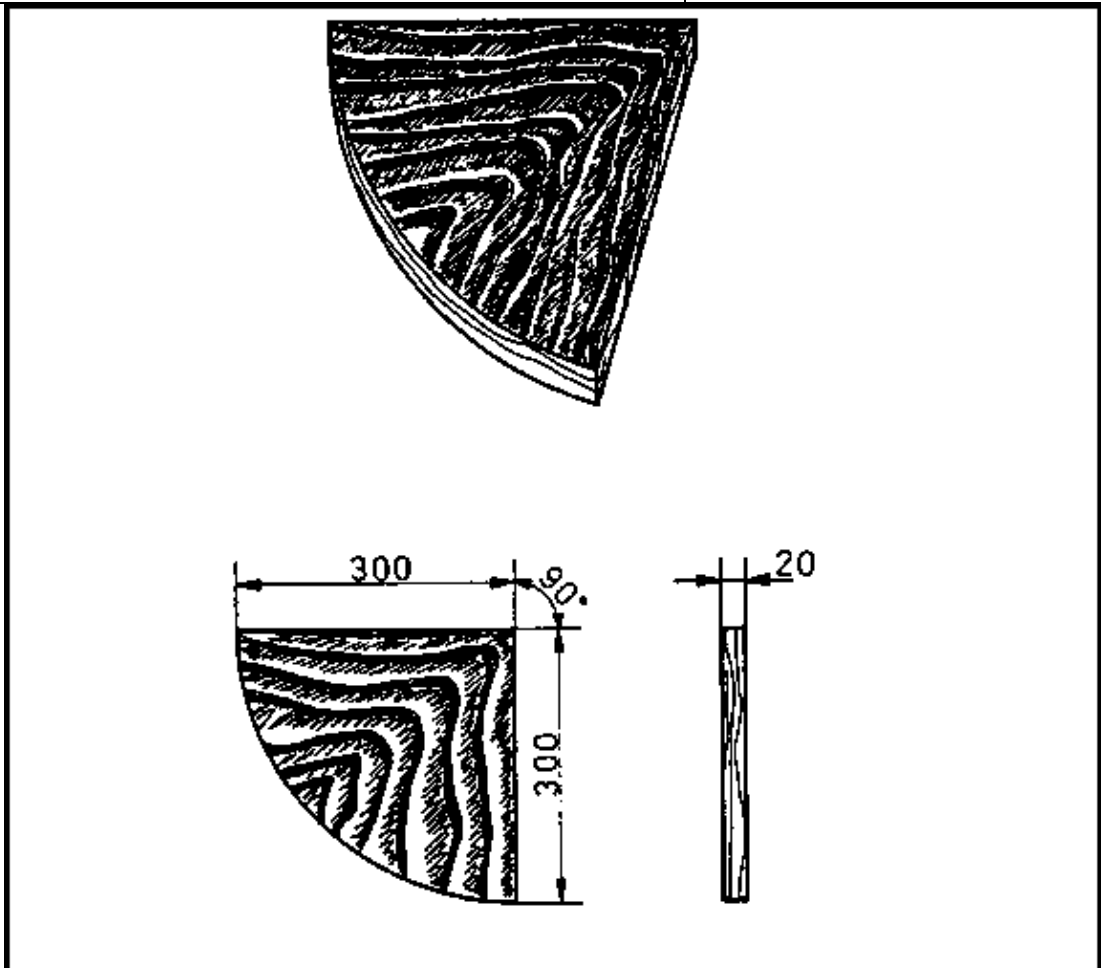
Supporting table, earthenware pots for saponification and neutralizing agents, rubber gloves, sawdust

Necessary previous knowledge

Fundamentals of manual woodworking

| Sequence of operations | Comments |
|---|--|
| 1. Prepare the workplace. Make working material available. | Check completeness. |
| 2. Place on support the prepared, planed board pre-sanded on edges and surface. | |
| 3. Wetly apply saponification agent to both surfaces. | Sponge the entire surface with the solution several times. |
| 4. After a reaction time of 15 minutes, strongly brush in wood grain direction. | |

| | |
|---|--|
| 5. Wash immediately, rub down with sawdust and clean. | |
| 6. Neutralize the surface. | Apply 10 to 15 % acetic acid. |
| 7. Wash the surface with warm water and finely sand after it has dried. | |
| 8. Apply pigment staining agent to the surface and distribute it. | Thoroughly rub the staining agent into the pores. |
| 9. After the surface has dried, brush it. | |
| 10. Apply three varnish coats to the surface until it has closed pores and becomes shining. | After the first coat has dried, intermediately sand it with fine coated abrasives. |
| 11. Check finally. | |



| | | | | |
|------------|---------------------------|--|--|-------------|
| | | | | |
| | | | | 9.3. |
| IBE | Corner Shelf Board | | | 3309 |

Corner Shelf Board

Instruction Example 9.4.: Round Table Board

Surfacing of a board by filling the pores and polishing.

Material



– Wooden table board

thickness: 20 mm
diameter: 300 mm

- Shellac polishing agent
- spirit
- pumice powder
- polishing oil
- tincture of benzoin stryax benzoin solution
- polish-off solution polishing down solution

Tools

Pore brush, polishing cloth, sanding pad with felt covering, soft cloths

Measuring and testing means

Visual inspection (measuring by the eye)

Auxiliary accessories

Supporting table

Necessary previous knowledge

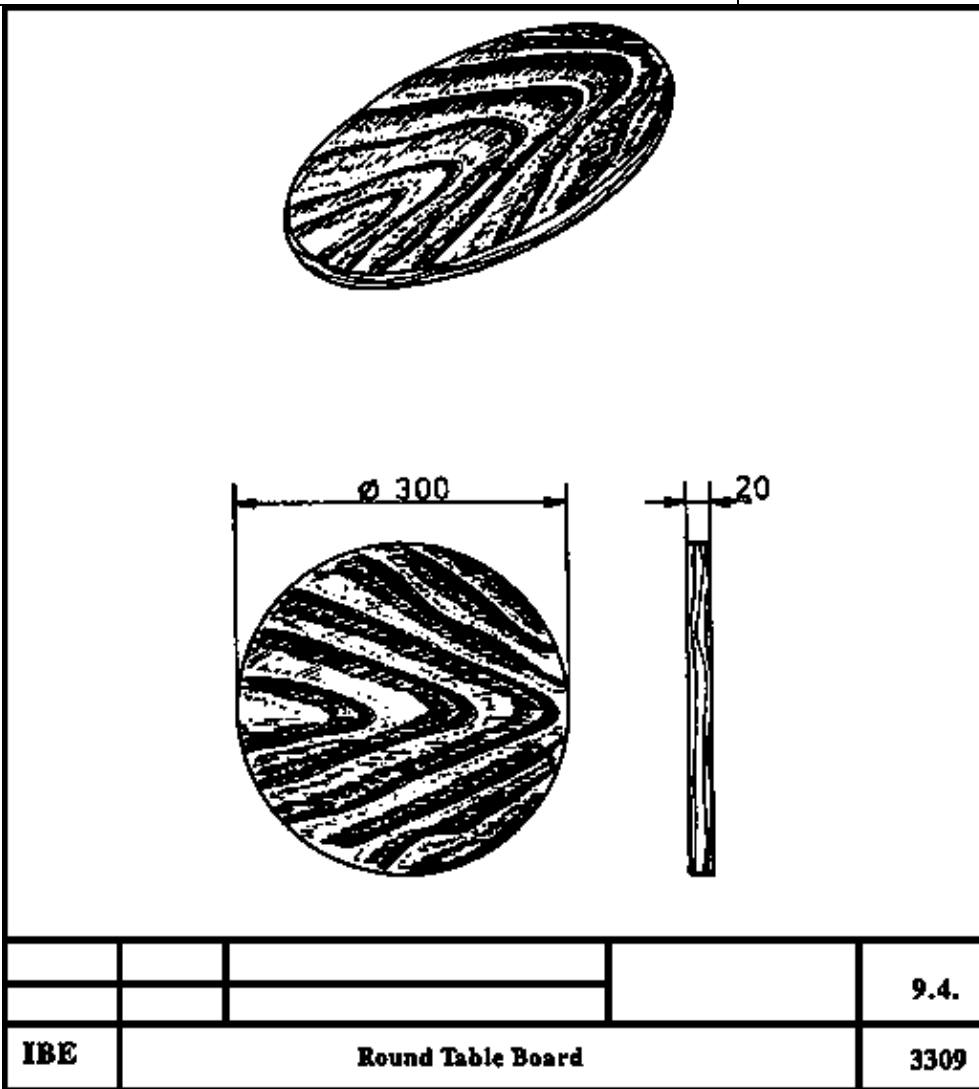
Fundamentals of manual woodworking

| Sequence of operations | Comments |
|---|--|
| 1– Prepare the workplace. Make working material available. | Check completeness. |
| 2. Put the prepared wooden table board on clean support and brush it. | |
| 3. Fill the pores with a mixture of diluted polishing agent and pumice powder. | Rub it into the pores at pressure. |
| 4. Apply the primary coat without polishing oil. | Apply the coat to the entire surface by circularly moving the polishing ball. |
| 5. Let it dry in a warm room for 24 hours. | |
| 6. Apply the first finishing layer, at first without polishing oil, afterwards with polishing oil. | Polishing ball must not stick to the surface. Circularly move the ball without interruption. |
| 7. Sand the first finishing layer, then apply the second finishing layer. | Give enough time for intermediate drying. |
| 8. Finally polish down with styrax benzoin solution and remove polishing oil with polishing down solution until last polishing oil residues disappear | Apply tincture with a soft cloth, wipe down the surface with dry |

and the surface becomes crystal-clear.

cloth, change cloths several times.

9. Check finally.



Round Table Board

**Surface Finish by Dyeing, Staining, Pigmenting, Matting and Polishing
– Course: Manual woodworking techniques. Trainees' handbook of
lessons**

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Surface Finish by Dyeing, Staining, Pigmenting, Matting and Polishing – Course: Manual woodworking techniques. Trainees' handbook of lessons

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Gerhard Piele

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13187 Berlin

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1. Purpose of Surface Treatment of Wood

There are various techniques of surface treatment

- to change, as desired, the appearance of the surface of articles made from wood,
- to make the surfaces more resistant to mechanical and chemical influences.

In general one distinguishes:

- Pretreatment techniques, such as washing, sanding and de-dusting, deresinifying, bleaching, dyeing, staining, pigmenting and filling of pores,
- Coating techniques, such as matting, varnishing and polishing.

What is the purpose of surface treatment of wood?

2. Pretreatment Processes

2.1. Washing, Sanding and De-dusting

After having preworked the wooden parts, their surfaces are to be checked carefully. Surface that externally remain invisible may have faulty spots, if they do not warp later on. Those surfaces need not be treated. Surfaces which are externally visible should have uniform grain and uniform colour shades as well as be completely free from defects.

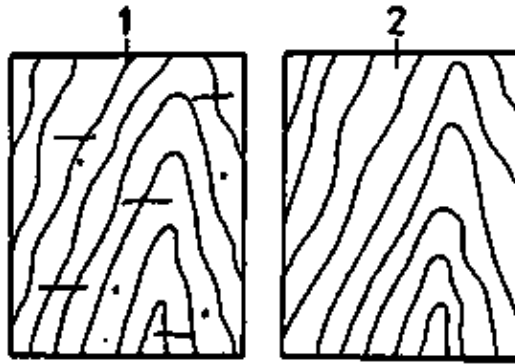


Figure 1 Checking the surfaces for faulty spots 1 fissures and holes in wood, 2 faultless wood

A proper surface finish is only then possible, when all the surfaces are completely clean, especially even and smooth as well as free from holes and imprints.

When staining agents or solvents are applied to wooden surfaces, wood fibres and pore brims of sanded surfaces straighten up again. Imprints caused by pressure on the wood may rise again and have a spoiling effect, too.

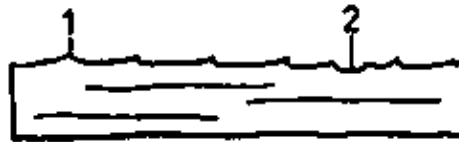


Figure 2 Enlarged cross-section of a board 1 upright wood fibres, 2 imprints

Therefore, wooden surfaces are to be washed with hot water without additives before they are finally sanded.

Procedure:

Washing is done with a sponge being rubbed with slight pressure over the surface. After having dried completely, the surfaces are to be re-ground and de-dusted.

The dry wooden surfaces are sanded with moderate pressure and coarse sandpaper, so that the risen pore brims are not pressed down, but ground off.

Much material is removed by sanding across the wood grain. In that case the surface shows, however, a great roughness.

Only a small amount of material is removed by sanding with the grain. Here the surface is, however, very fine.

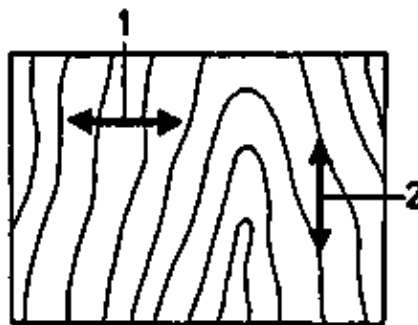


Figure 3 Sanding the surface 1 "across the grain", 2 "with the grain"

First grind "across the grain", then "with the grain". Use finer paper for each grinding process. Well ground is half polished.

After being washed and ground, the surfaces must be de-dusted thoroughly.

If surfaces are not correctly de-dusted, bright pores will show up, even after staining, having a detrimental effect. Moreover, adhesion of subsequent varnish coats is affected.

Why are wooden surfaces washed?

Which grinding direction results in a fine surface?

Why must the surfaces be freed from dust thoroughly?

2.2. Deresinification

Lightwood, especially coniferous wood, is to be treated in a particular way, since the resin components are water-repellent (staining-agent-repellent) and varnish-damaging. This may result in the appearance of spots later on. Solvents (acetone, fuel alcohol, diluent for cellulose lacquers) or saponifiers (curd soap solution, 10 % ammonium solution) help to deresinify the wood.

Application of solvents:

- Place wooden workpieces on a clean support.
- Apply solvent with cotton wad or sponge in stripes several times.

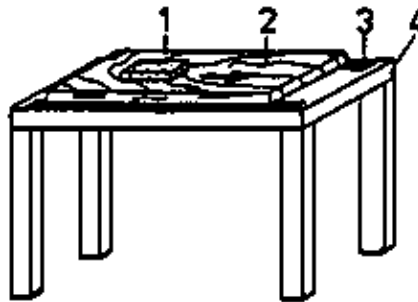


Figure 4 Applying a solvent 1 sponge, 2 board, 3 felt strip, 4 support

- Rub again with a clean, folded up piece of cloth or with a brush.
- Wash with warm water.
- Re-grind the surface with fine-grained abrasive paper.

Note – solvents are inflammable and detrimental to health.

Application of saponifiers:

- Place wooden workpieces on a clean support.
- Liberally apply the solution with a sponge several times and allow it to react for 10 to 15 minutes.
- Strongly brush the surface in wood grain direction.

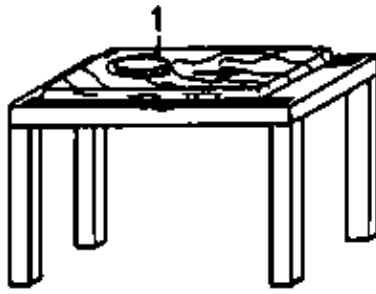


Figure 5 Brushing the wood surface *1 brush*

- Thoroughly wash the surface.
- Rub the wet surface with saw dust and clean it.
- Neutralize with 10% acetic acid and wash down with warm water.
- Re-grind the surface with fine-grained abrasive paper.

Recommendations:

- Wooden workpieces deresinified with solvents are not affected or changed in colour as is the case with saponifiers.
- After alkaline deresinifying agents have been used, the surface must be well washed and neutral otherwise undesired changes in colour occur during the staining process.
- Do not extract resin from light-coloured wood species with ammonia solution, otherwise the surfaces will darken.

Why must highly resinous wood species be deresinified before being stained?

What is the advantage of using solvents compared to saponifiers?

2.3. Bleaching

Discolourations and spots having developed during the growth of the wood or due to improper storage, as well as spots and stripes as a result of improper staining can be brightened up again or removed. The bleaching agents chemically destroy tannic acids or dyes.

Basic rule:

Always treat the entire surface.

Procedure:

- Place the wooden workpieces on a clean support.
- Mix bleaching agents, e.g. 30% hydrogen peroxide solution with 10% ammonia solution in small quantities as they are usable for a limited time only.
- Liberally apply the bleaching agent with a scraper covered with a white cloth or with a plant-fibre paintbrush without metal parts.

Bleaching agents are toxic and very caustic.
Protect your hands with rubber gloves.

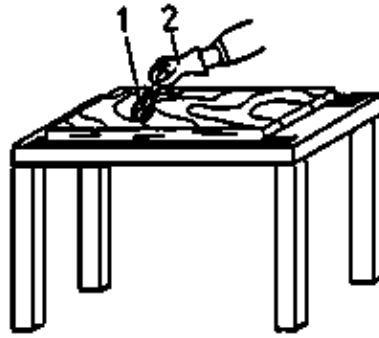


Figure 6 Applying the bleaching agent 1 scraper covered with a cloth, 2 rubber glove

- Leave the foam untouched for some time.
- Brush the surface with a hard brush.
- Thoroughly remove the bleaching agent with warm water.
- Let the material dry at ambient temperature for about 24 hours.

Recommendations:

- Spots that came about by rottenness cannot be removed with bleaching agents.
- If bleached wood is not coated immediately, it may darken again due to atmospheric oxygen influence.

Which wooden surfaces have to be bleached prior to subsequent treatment?

What is the basic rule for bleaching?

Why must the surfaces be thoroughly washed after having been bleached?

2.4. Dyeing

Dyes are dissolved in liquids such as spirit, water, oils, etc. and applied to wood in order to change its original colour tone.

In practice, this procedure is also called "staining", although the mode of action is different compared to the actual staining. When the solution penetrates the material, the colouring agents cause the dyes to precipitate in the structure and on the surface of the wood. The great absorptive capacity of soft spring wood tissues brings about a negative image of the texture:

After being dyed, lighter and softer wood spots become darker than denser and more solid ones.



Figure 7 Negative image of the texture after dyeing

Most dyes veil the wooden surface, so that the grain does not fully show to advantage. Therefore, dyeing is done in such a case when wooden surfaces without clearly visible texture are to be changed in their original colour tone.

The following colouring agents are used:

- water-soluble acid coaltar dyes
- alcohol-soluble alkaline coaltar dyes
- fat-soluble and oil-soluble coaltar and earthy dyes.

Acid and alkaline dye solutions must not be mixed together, otherwise the dye becomes ineffective.

Procedure:

- Place the wood on a clean support.
- Apply the colouring agent wetly and without interruption in wood grain direction.
- Distribute the dyeing agent uniformly.
- Put the wood aside and let it dry for about 24 hours.

Why are wooden surfaces without attractive texture dyed?

2.5. Staining

When liquids are applied to wood being rich in tanning agent, staining causes a chemical reaction in the wood.

Compared to dyeing, generally no dyes are introduced into the wood.

The chemical reaction starts when different salts combine, when acids and lyes are brought together or when salts are mixed with lyes or acids.

The full formation of the actual colour shade will only end after some time has passed. Staining underlines the wood texture optically and compensates different colour shades in the raw wood. Thus, the natural colour tone due to aging of the wood is imitated artificially.

The chemical deposition of the staining agents is light-fast, rubbing-fast and resistant to water.

The good penetrativeness of the solution, even into the dense autumn wood tissues, brings about a positive structural image:

After being stained, denser and more solid wood spots become darker than lighter and softer ones.



Figure 8 Positive image of the texture after staining

Types of stains

Stains for double-staining (pre-staining and re-staining):

Due to age, location and uneven distribution in the wood, the tannic content is different in various wood species. When the material is pre-stained, tannic acid is added and evenly distributed.

After drying, a metallic salt stain is applied as re-staining agent, the salt of which develops certain colour shades with the now existing tannic acid.

Different pre-staining agents, together with different re-staining agents, produce various colour shades.

Prepare only as much pre-staining agent as being used a day. Light influence disintegrates the pre-stain.

Stains for single staining:

They are heavy metal salt solutions enriched with additional dyes, but only suitable for tanniferous wood species.

Wood treated with double and single stains must not be varnished with polyester varnishes. Otherwise solidification of the wood would be impeded.

Wax stains:

They are solutions containing undissolved metal salts, dyes or pigments and wax additives.

Due to the wax portion, a dull shine will be obtained, with the grain, however, being slightly veiled by the dye portion. Wax stains are only suited for small-size parts of all kinds of wood, but not for furniture industry.

Staining with single stain:

- Place wooden workpieces on clean support.
- Check whether all fittings (locks, bolts, plates) have been removed.
- Apply staining agent in grain direction with great wetness and without intermitting, if possible.
- Again apply staining agent after a reaction time of 2 to 4 minutes, in order to ascertain the envisaged staining effect (Surfaces should still be throughout wet and must not have dry spots.)
- A frse direction and then in longitudinal direction, so that excess staining agent is sucked up and no streaks being left.

Often squeeze out the paintbrush.

- After drying smooth the surface by brushing with a hard brush in grain direction. Why are wooden surfaces with clearly visible texture stained?

What is the difference in the reaction of dyeing agents compared to staining agents?

Staining rules

- Leave any workpiece, before being worked, untouched for 24 hours, at least, at a temperature of 20°C, so that all the pores are opened and the staining solution can penetrate well. Make the staining agent available at the same temperature.

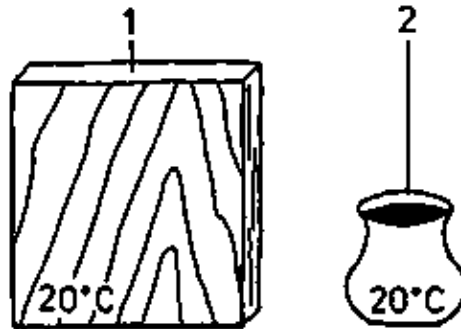


Figure 9 Making the board and staining agent available at same temperature of at least 20°C 1 board, 2 staining agent bin

- Use boiled water to prepare the staining agent. If tap water is used, staining defects may occur due to lime and iron substances contained in water.
- Remove all the metal parts, before staining, so that changes in colour may not occur.
- Before the staining solution is distributed, remove abrasive dust from all surfaces with a hard brush.
- Only use paintbrushes or sponges for staining. Paintbrushes should not have any iron parts, otherwise the staining agent would change in colour.
- Broad paintbrushes with well absorbent bristles are suitable to distribute the staining agent.
- Before applying the staining agent, undertake a stain test on a material as determined for the piece of furniture.

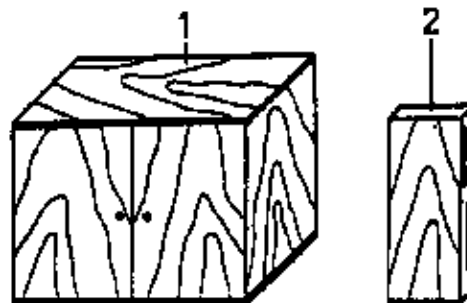


Figure 10 Staining test on a material of the same kind 1 piece of furniture, 2 staining test

- After the paintbrush has been dipped into the solution, let it drip off, in order to avoid spatters during its application.
- Brush upright surfaces from bottom to top, so that the staining solution may run down the wetted surface.

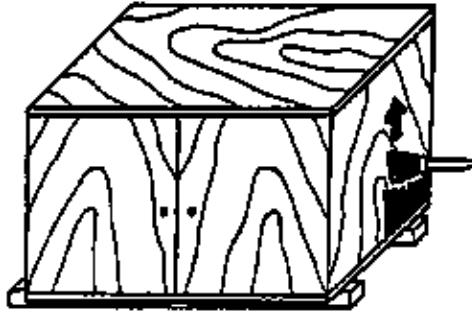


Figure 11 Applying the staining agent to vertical surfaces from bottom to top

- Cross-cut wood surfaces, before being stained, are brushed with clear water, so that they do not become too dark.
- Staining utensils should not be used for different solutions at the same time – the stained surface might become spotty.
- Do not return stain residues to the vessel, otherwise changes in colour may occur.
- Keep finish-stained parts away from drying in the sun – water and alcohol evaporate too quickly and prevent the development of the colour tone.
- After the staining agent has dried, soon apply the coat so that atmospheric oxygen does not change the colours any more.
- Store liquid stains in well closed bottles or earthenware bins, as atmospheric oxygen and light can change the colour tone of the stain.

Why is a staining test necessary before a piece of furniture is stained?

Why must the sample piece for the staining test be made of the same material and have the same coating as the piece of furniture itself?

Why must upright surfaces be stained from bottom to top?

2.6. Pigmenting

As for pigmenting, wood surfaces are coated with covering dyes or varnishes, with the texture being hardly visible afterwards or not at all.

Pigments are insoluble, finely ground paint particles of anorganic (metallic oxides) or organic (coaltar dyes) compounds to be added to staining agents or varnishes.

- Pigment stains give a slightly covering coat to the wood surface.
- Pigmented dull or glossy varnishes cover the wood texture completely.

Pigment staining procedure:

- Place the wood on a clean support.

- Thoroughly work the pigment staining agent into the surface.
- After complete saturation, the pigment staining agent is to be distributed under slight pressure, so that the covering effect of the coat can be fully reached.
- Give sufficient time to dry.

2.7. Filling the Pores

To obtain a smooth wood surface for varnishing and polishing, the existing surface cavities (pores) have to be filled up.

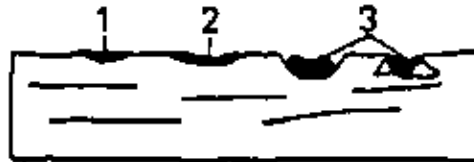


Figure 12 Enlarged cross-section of a board with filled pores *1 well filled, 2 incompletely filled, 3 incompletely filled and badly adherent*

Pore fillers to be used are 40 to 50 % of binding agents (dry oils or varnishes) and 50 to 60 % of pore filling powders (pumice powder, finely ground barium sulphate, powdered quartz, etc).

The colour tone of the pore filler is to be selected somewhat darker than that of the wood surface stained. Surfaces that are to be polished must be preferably filled with transparent fillers.

Sequence of operations:

- Brush the surface.
- Rub in the pore filler by circularly and at high pressure moving a rough linen ball over the wood surface.
- After drying wipe off the residual filler with a soft rag.

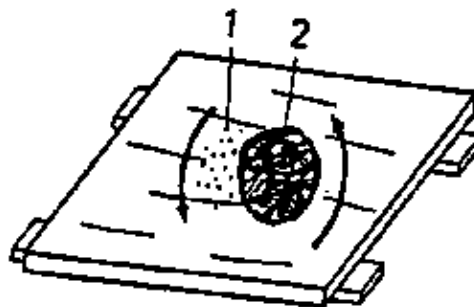


Figure 13 Rubbing in the pore filler *1 pore filler, 2 linen ball*

Recommendation:

Before the pore filler is rubbed in, the surfaces are to be thoroughly brushed in grain direction, so that the pore rim tips are torn off and the pore filler can be completely pressed into the cavity comers.

Why should pores on surfaces to be polished filled with transparent fillers?

3. Coating Processes

3.1. Basic Terms

Lacquers or varnish paints that dry physically or harden chemically form a solid coating film improving the wood surface appearance and protecting it against mechanical and chemical influences. Stained or natural-coloured surfaces require transparent coats, so that the wood texture appears clearly and distinctly. The varnishes used are solutions of solid substances (natural or artificial resins) that, after being distributed are drying or hardening and thus, forming a solid film on the wood surface. The coating film consists of one or several layers to be applied shortly one after the other and partially "wet in wet" or after intermediate drying, respectively.

Coat layers

1st) *Priming coat:*

Priming agents, fillers or pre-stains even up slightly rough surfaces, close wood pores and form a pre-requisite for the varnish to adhere properly to the wood.

2nd) *Intermediate coat:*

Varnish layer thicknesses are enlarged and adhesiveness between prime and final coats are improved by priming paints or interlayer varnishes.

3rd) *Finishing or top coat:*

The required surface effect or the envisaged colour is obtained with matting agents or glossy varnishes.

Coating of surfaces

With open pores:

Pores have not been filled, but internal walls of pores have been coated with coating film.

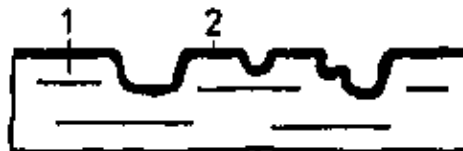


Figure 14 Surface with open pores 1 board, 2 coating

With semi-closed pores:

Pores have been filled only partially, while the remaining surface has been coated with a thin coating film.

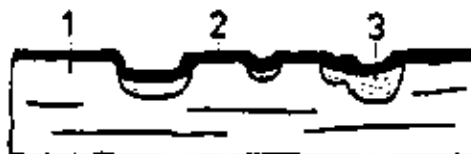


Figure 15 Surface with semi-closed pores 1 board, 2 coating, 3 pore filling

With closed pores:

Pores have been completely filled and are covered by a closed coating film.



Figure 16 Surface with closed pores

The desired porosity is obtained through various coating methods:

Matting:

Surface coated with transparent coating film. Its final appearance is yielded by a finishing procedure. Surface remains with open pores and is dull to dull–lustre.

Varnishing:

Surface coated with transparent or pigmented material. No further treatment of the surface. Surface has closed pores and is dull or shining, depending on the varnish constitution.

Polishing:

Surface coated with transparent or pigmented material. Final surface effect is reached not until after further operations (e.g. buffing or polishing with a cloth) and may be high–gloss, slightly polished or dull.

According to the finishing methods applied and the coating materials used, the following gloss grades are distinguished:

high–gloss:

Surface reflecting objects approximately without distortions.

dull–shiny:

Surface reflecting objects only unclearly and in a subdued manner.

slightly polished:

Surface reflecting objects distortedly or unclearly.

dull:

Surface reflecting objects not at all or only weakly and blurredly.

What is the task of cleanly carried out prime coats?

What is the porosity difference of matted surfaces compared to varnished ones?

3.2. Matting

All varnishes dry up with a special shine. In order not to produce a mirror like gloss with certain varnishes, but dull and silky lustre surfaces, matting agents are added to the varnishes. Such agents are finest ground substances (inorganic or organic compounds) added to the varnish at the amount of 5 to 20 %.

Coating operations:

- Spread the highly diluted matting agent with a paintbrush in grain direction at ambient temperature.
- Slightly grind the hardened prime coat with fine sandpaper with your LI LL
- Brush the surfaces until dust is removed.

- Apply hardly diluted matting agent with a cloth in wood grain direction until a uniform dull surface is obtained.

Recommendations:

- When wiping the surface, avoid touching the same spot twice, otherwise irritating glossy stripes will appear.
- If several coats are applied, the commensurate previous film must be properly dried, otherwise it may rise up and be torn off.

Along with the manual coating the mechanical spraying method may be applied.

Spraying operations:

- Prepare varnish, ensure its proper temperature and mix it. Make sure if the varnish is sufficiently diluted.
- Select spraying gun nozzle opening of about 1.8 mm; air pressure of about 3 at. overpressure; nozzle distance from surface of 250 to 300 mm approximately, hold spraying gun at an angle of about 45°.
- Spraying ensues cross-wise (i.e. "with the grain" and "across the grain"), pay attention to the surface edges.

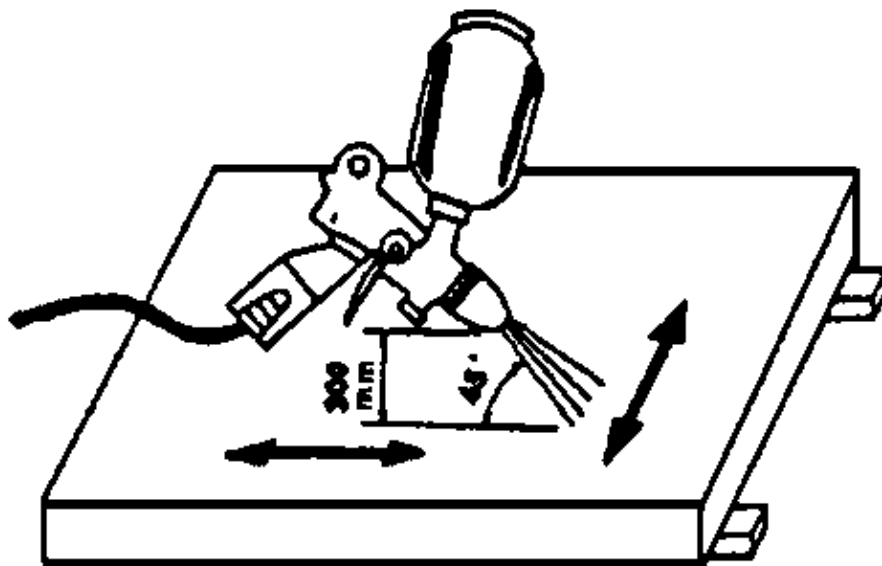


Figure 17 Crisscross spraying

Recommendations:

- Check varnish vessel for safety.
- Filter varnish, if required.
- Check whether compressed-air connection is leakproof.
- Apply a test coat.
- Select round jet for narrow faces and flat jet for wide faces.
- Observe respiratory protection while spraying.

What has to be especially observed when the matting agent is applied to the surface?

3.3. Varnishing

"Varnishes" are liquid coating agents without dyestuff additives. After drying they form a well-adhering film of particular gloss effect. Despite of the partially yellowish or brownish colour tone they are transparent. "Varnish

paints" are varnishes which pigments and dyes are added to.

Varnishes and varnish paints are mainly used as:

- Shellacs
for house furniture, casings
- Oil and alkyd resin varnishes
for kitchen furniture, garden furniture, windows and doors, wooden structures
- Nitrocellulose varnishes
for interior furnishings, house furniture, rack and shelf furniture, toys, casings
- Acid-hardening varnishes
for interior furnishings, house furniture, rack and shelf furniture, kitchen furniture, office and school furniture, garden furniture, casings, windows, doors, parquet
- Polyester varnishes
for interior furnishings, house furniture, kitchen furniture, casings
- Polyurethane varnishes
for interior furnishings, all kinds of furniture, doors, staircases, parquet

Varnishing ensues in a making up process:

After the first varnish coat has dried and a possible intermediate grinding has been carried out, the next varnish coat is applied. This procedure is repeated several times until the required quality is obtained. Commonly used coating methods are, above all, painting, spraying, rolling, dipping, pouring.

Recommendations:

- Previous oiling of wood surfaces may cause damages, because oil is seldom compatible with coating agents.
- Wood to be covered with coating agents must have moisture content of 8 to 10 %. More moisture would ooze to the surface later on and destroy the varnish film.
- Prior to the coating of wood surfaces, varnishing tests are to be carried out, in order to find out the reaction of the materials.
- Prime coats are to be made as lean as possible (highly diluted), with each subsequent coat having to be made less diluted than the previous one.
- The required drying spells of 6 hours must be adhered to following each spraying operation (except in case of "wet-in-wet" application of polyester varnishes).
- Wooden workpieces the surface of which is coated with polyester varnishes, have to be laid down horizontally for at least one hour, so that the varnish film will have a uniform thickness and does not run off. The second varnish coat should be applied "wet-in-wet" after 20 minutes, – just at the moment when the previous coat begins to jelly.
- After the final coating with nitrocellulose varnishes, a drying period of 4 days is needed.

Which damage may be caused, when too damp a wood is varnished?

3.4. Polishing

During the polishing process rough, dull and uneven surfaces are treated so that they will become extremely smooth and high-gloss. The objects being reflected on the polished surfaces should be mirrored as undistorted as possible. High-gloss surfaces must have a permanent shine – without any streaks or greyish shades. In this way the decorative aesthetic effect of the wood texture is particularly emphasized.

If the humidity in the polishing rooms is higher than 60 %, surface defects may be expected (greyish shades and "clouds").

If it is positive that a wooden workpiece is to be polished, it must be ensured that there are not any protruding edges on the wooden structure, so that the polishing balls and brushes can slide on the surfaces without interruption. If this condition cannot be fulfilled, the individual parts must be polished before being assembled. Wood with fine pores is especially suited for high-gloss varnish coats. Should, however, wood with large pores be used, its pores would have to be filled prior to the varnish application. Polishing always necessitates a closing of the wood pores with transparent fillers.

Making up process:

After the wood pores have been closed, the polish varnish layers are generally applied coat by coat manually until a film thickness is obtained, showing the desired shine.

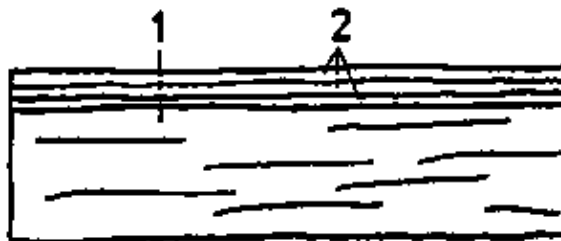


Figure 18 Making up process 1 board, 2 varnish layers individually applied

Smoothing process:

Film thicknesses excessively applied by spraying, rolling or pouring are removed by mechanical fine-grinding (buffing) with special grinding means and polishing brushes until the high lustre is obtained.

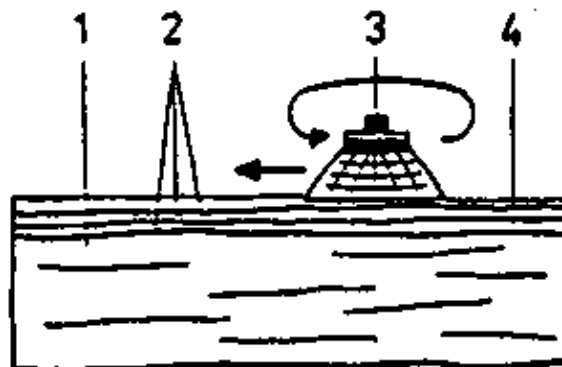


Figure 19 Smoothing process 1 board, 2 varnish layers individually applied, 3 polishing brush, 4 varnish coat polished down

The varnishes used should have special properties. They must be resistant to heat and moisture, drying quickly and well grindable. They must not be brittle or sticky. Such varnishes must be labelled as being able to be sprayed on and ground.

Polishing rules for shellac polishes

- Polish completely dried wood only.
- In order to visually underline wood texture sparingly distribute drying oils on the surface – not too strongly, otherwise oil spots appear later on and the pores cannot be closed any more. Use pumice > I L Id polishing agent to fill the pores.
- A better priming may be effected with cellulose compounds, with the danger of oil bloom being avoided.
- Rub in pore filler at pressure (dyeing pumice with adhesive, diluted polish matching the polish).
- Use light-resisting colours to dye the pore fillers.
- Apply shellac polish coat by coat, let it dry inbetween and grind and smooth it always.
- Apply the first cover coating (the same applies to intermediate polishing too) without polishing oil in order not to include the polishing oil in the polish, by circularly moving the polishing ball. First, use coarser, then finer linen for the polishing ball.
- As for further coating, polishing oil must be added moderately to prevent the ball from aing to the surface. Let enough time pass for drying.
- After the drying process, intermediate polishing has to be done to make the surface resistant and to close it.
- Wipe the polishing ball uniformly and without interruptions.
- In order to remove the polish oil from the surface, final polishing has to be done. For that purpose, drops of styrax benzoin solution are to be sprinkled onto the working surface of the polishing ball. The gum benzoin takes the polish oil up to the surface top. Subsequently, remove the polish oil with diluted sulphuric acid, magnesium oxide or with polishing down solution.

Polishing down agents

After the lacquer-coated surfaces have been given a high-gloss finish through polishing or other polishes have been completely polished down, the oil or polish wax residues must be removed in a final operation. Polishing down agents may also be solutions enriched with finest abrasive. As for shellac polishes, benzo dyestuff serves as polishing down agent. For that purpose, gum benzoin is dissolved with alcohol. It has an anti-rot effect and improves the elasticity of shellac polishes.

What is the difference between the smoothing and making up processes?

Why must the first cover coating (the same applies to intermediate polishing too) be always applied without polishing oil?

4. Selection of Chemicals

4.1. Acids

As for wood surface treatment, many acids are of importance, which are used either, due to their caustic effect, to remove old coating material or, due to the salt formation, to produce staining agents.

- Acetic acid (CH_3COOH):

Acetic acid (caustic) is used to produce staining agents and as bleaching agent. It ranks as best neutralizing agent for wood surface treatment.

- Hydrochloric acid (HCl):

Chemically pure hydrochloric acid (caustic and toxic) is a good neutralizing agent for wood surfaces. It is used to brighten up staining agents and to bleach wood.

4.2. Solutions

Solutions are soapy and caustic and have other properties than acids. Salts arise in connection with acids. Solutions dissolve organic matters, such as textiles and paintbrush bristles.

Saponification

When organic matters (resins, waxes, oils) are decomposed by inorganic solutions, one speaks of "saponification".

- Caustic–soda solution (NaOH):

Caustic–soda solution dissolves fats, oil and varnish paint coats and is used as deresinifying agent.

- Liquid ammonia (NH_4OH – ammonia water solution):

Ammonia water solution (caustic) is used as an additive to water–soluble staining agents (except iron salt staining agents). It can also be employed for tanning wood and removing fat and acid spots, as well as saponification means for the purpose of deresinification.

Neutralization

When acids and solutions are mixed in a certain ratio, a reaction occurs that is neither acid nor basic. Here, water is set free and a salt being formed.

4.3. Salts

Salts are formed when acids and solutions, as well as acids and metals are brought into contact.

Salts are needed to produce colour shades on the wood surface. They react with tanning agents inherent in wood or added by re–staining.

- Potash (K_2CO_3 – potassium carbonate):

It is used as an additive for pre–staining and re–staining processes, as a bleaching agent as well as for removing solutions and extracting resins.

- Glauber salt (Na_2SO_4 – sodium sulphate):

It is used to stain coniferous wood and as a filler for dyes and staining agents.

- Soda (Na_2CO_3 – sodium carbonate):

It is used for wood surfaces as an agent to remove stains and resins.

- with boric acid and is used as a bleaching agent. It is also used to clean one's hands from dyes and to produce water-proof staining agents as well as shellac compounds.

4.4. Bleaching Agents

Various acids and salts are able to remove spots and streaks from the wood surface. After having been bleached, the surfaces have to be thoroughly washed and neutralized.

- Iron-free hydrochloric acid:

to be diluted with water as an aqueous solution in the ratio of 1: 2 or 1: 4.

Hydrogen peroxide (H_2O_2) –

30 % hydrogen peroxide with 10 % liquid ammonia results in a strong bleaching agent. The bleaching process starts under heat development and foam formation.

- Saccharic acid ($(\text{CO}_2\text{H})_2$ – oxalic acid):

It brightens up all spots that have formed through oxidation. The wood must not be treated with oil afterwards, otherwise there would be greyish shades and spots. Oxalic acid is very toxic.

**Operations on Wood Turning Lathes – Course: Mechanical
woodworking techniques. Instruction examples for practical vocational
training**

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Operations on Wood Turning Lathes – Course: Mechanical woodworking techniques. Instruction examples for practical vocational training

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Preliminary Remarks

This material features five selected instruction examples for turning long trunks and cross pieces.

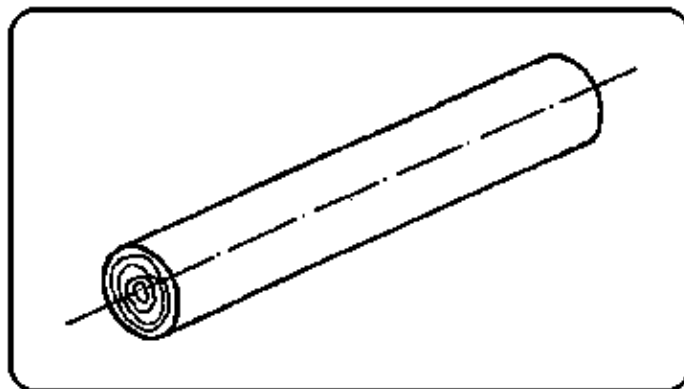
The necessary materials and tools, measuring and testing means, equally aids have been cited in each case to facilitate preparations and exercises. Preliminary knowledge required for the instruction examples has also been detailed.

The exercises may be undertaken independently utilising the workshop drawings and the commensurate work sequences.

Exercises have been selected as Instruction Examples which, upon completion, yield usable objects resp. can be combined with other elements into small piece of furniture and other bigger items.

Instruction Example 06.1.: Long Trunk Section

Bent turning of squared wood to yield a cylindrical workpiece as necessary preliminary operation for many turning jobs.



Material

Hard wood piece, squared 45 x 45 mm length: 450 mm grain ends rectangular, cut

Machines and tools

Wood turning lathe, broad roughing tool, straight planer, chucking facility, driving tongue (trifurcate) 30 mm

Measuring and testing means

Folding rule, caliper or vernier caliper

Auxiliary accessories

Pencil, punch mark, hammer

Necessary preliminary knowledge

Assembly and function of a wood turning lathe.
Labour safety provisions when operating a wood turning lathe.
Chucking processes for wood turning.
Read drawings, marking, measuring and checking.

Explanation of workshop drawing

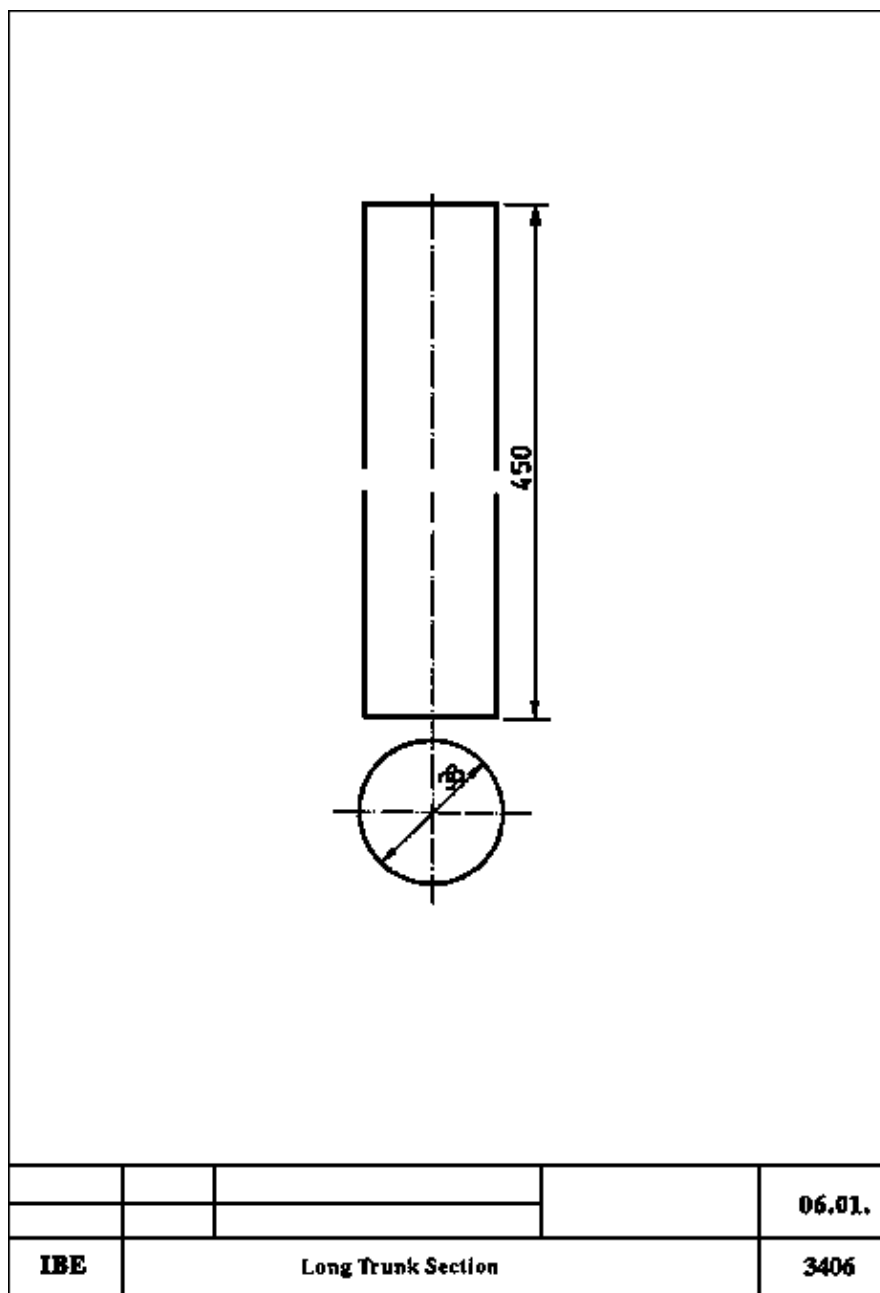
Scale 1:1

| Sequence of operations | Comments |
|--|--|
| 1. Position work materials and check machine for proper operating condition. | Check completeness of work materials, sharpness of tools and cleanliness of the machine. |
| 2. Mark the chucking points on the workpiece. | Determine the centre point at the grain ends by marking the diagonals. |
| 3. Punch–mark the centre point. | Only punch–mark the centre point slightly on the drive side. |
| 4. Link up the workpiece to the trifurcate. | By turning the spindle bring the trifurcate to horizontale position, place the trifurcate laterally to the annual rings of the wood. |
| 5. Position tailstock with tailstock centre to the right workpiece end and, employing slight pressure, arrest to the workpiece. | Apply a few drops of oil to the tailstock centre without ball bearings. |
| 6. Attach the support strip a few mm above the centre line of the workpiece in working position. | Check the unimpeded running of the workpiece. |
| 7. Set the machine gears to a rotational speed of 2000 min ⁻¹ . | Thereby, at the same time again check the functional safety of the machine. |
| 8. Switch on the machine. | |
| 9. Turning with roughing tool. Proceed slowly and carefully to within 3 mm of the finished size pertaining to the length dependent on the support strip. | <i>Work carefully with minimal chip removal and grip tool firmly. Turning down the workpiece edges causes blows to the tool – accident danger!</i> |
| 10. Switch off the machine, check size, reset the support strip for further workpiece processing and switch on the machine. Repeat the turning operation. This operation is repeated until the entire workpiece length has been worked. | Heed the hints on “Joining by twisting” in the Trainees’ Handbook of Lessons. |
| 11. Attach the support strip 2 mm above the workpiece centre line and 2 mm from the workpiece. | |
| 12. Turning with flat planer. | |

| | |
|---|---|
| | Process the workpiece surface carefully along the length of the support strip with minimal chip removal. Thereby determine the most favourable angle between tool and workpiece. |
| 13. Size control with caliper or vernier caliper. | Switch off the machine for size control! |
| 14. Reposition the support strip. Repeat turning and size control until the workpiece has been uniformly processed along its entire length. | When turning ensure minimal chip removal. Always turn from the thicker to the thinner workpiece section. |
| 15. Size control and processing quality checking. | |
| 16. Unchuck workpiece from machine. Remove turning chips from machine. | |

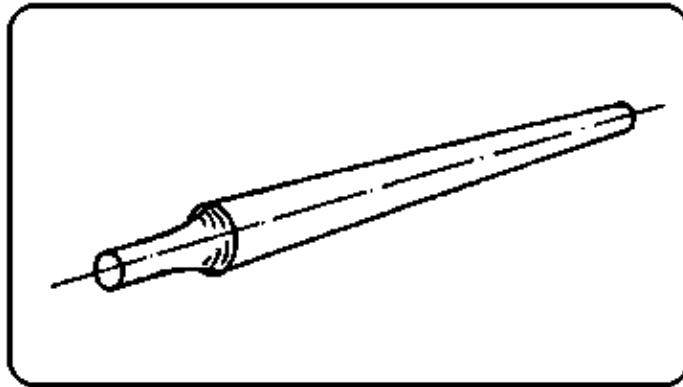
Possible additions

Turning further like sized workpieces. (The workpiece from this Instruction Example is processed further in the 2. Instruction Example into a stool leg.)



Instruction Example 06.2.: Stool Leg

A stool leg is made from the long trunk piece turned in Instruction Example 06.1.



Material

Round wood (hard wood)
diameter: 38 mm
length: 450 mm
(workpiece from first instruction example)

Machines and tools

Wood turning lathe, straight planer, wide forming tool, chucking facility: trifurcate

Measuring and testing means

Folding rule, caliper or vernier caliper

Auxiliary accessories

Pencil, hammer, medium–fine abrasive paper

Necessary preliminary knowledge

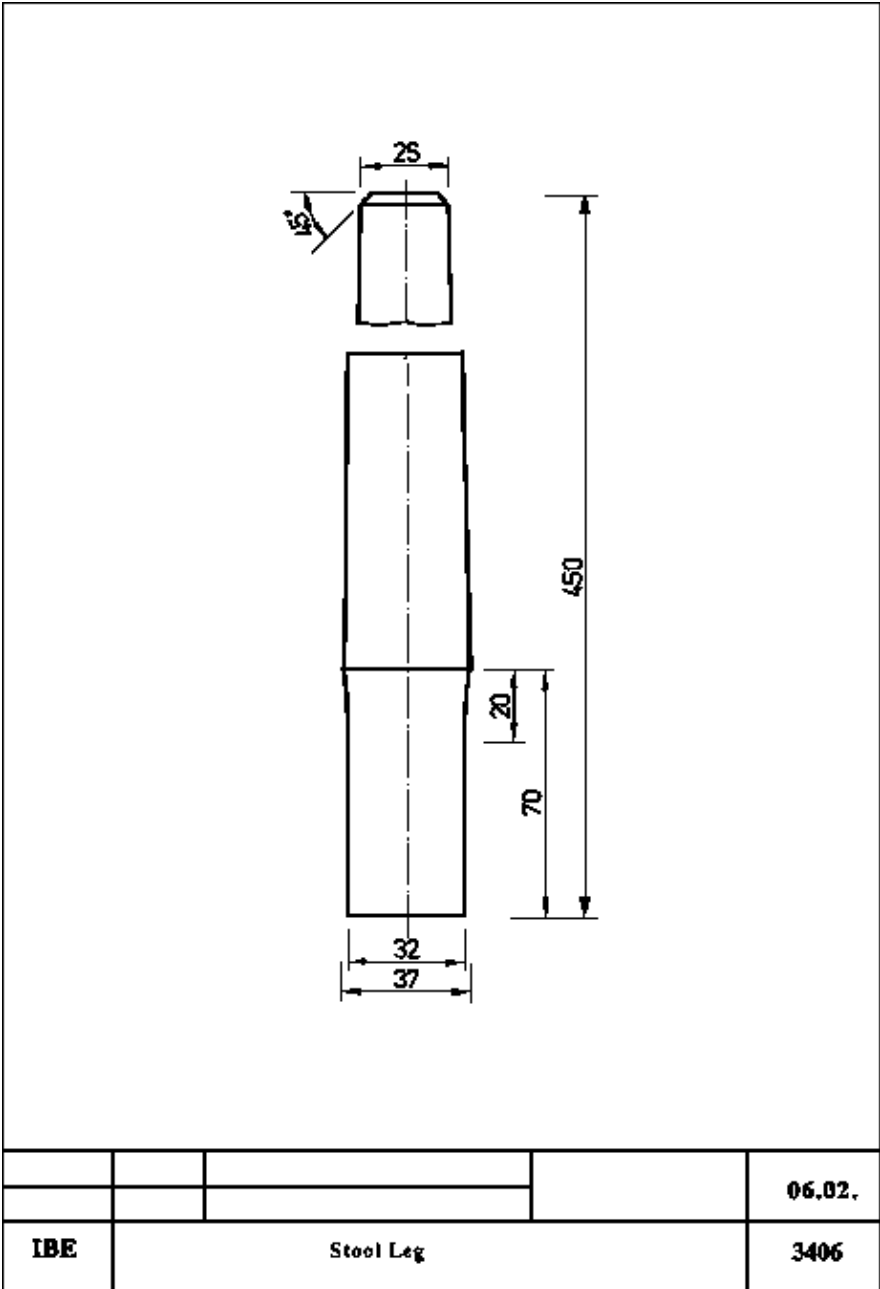
Assembly and function of a wood turning lathe.
Labour safety provisions when operating a wood turning lathe.
Chuck long trunk workpiece and set up the machine.
Chucking processes when turning wood.
Read drawing, marking, measuring and testing.

| Sequence of operations | Comments |
|--|--|
| 1. Position the work materials and check machine for proper operating condition. | Check completeness of work materials, sharpness of tools and cleanliness of the machine. |
| 2. Chuck the workpiece. | Engage the trifurcate and tailstock centre in the existing workpiece impressions. Only strike round wood lightly at the plugging chisel. |
| 3. Support strip positioned and firmly chucked at left workpiece end (approx. 3 mm above the workpiece centre line 2 mm distant from the workpiece). | Check the round and unimpeded workpiece running by means of manual turning. |
| 4. Set the machine gears to a rotational speed of 2000 min ⁻¹ . | Recheck proper machine function. |

| | |
|--|--|
| 5. Mark the tenon length = 70 mm on the left workpiece end. | Mark size with pencil in workpiece, position pencil again on the fissure and position on support strip. By turning the workpiece by hand the pencil fissure is transferred to the workpiece circumference. |
| 6. Switch on the machine. | |
| 7. Join chamfer by twisting and the tenon to the wide forming tool. Pay attention! If the tenon size is not heeded the tool can touch the trifurcate. – Danger of accidents. Tool and machine damage unavoidable. | On the left workpiece end join a chamfer by twisting to a tenon thickness = 32 mm. Then by means of repeated further turning displace to fissure on the right. Do not fall below the tenon size! |
| 8. Switch off the machine, size control and position the stop strip to the right workpiece end. | Size correction by repeated further turning possible given oversize. |
| 9. Switch on the machine and, using a straight planer, turn down workpiece slightly cone-like to a diameter = 25 mm. | Always turn down from the thicker to the thinner workpiece end. Check inclination by rule at the conical leg. |
| 10. Join chamfer by twisting. | |
| 11. Position the support strip anew according to workpiece length and repeat turning operation until the leg is 37 mm from the tenon chamfer = 25 mm thus evidencing a uniform degree of taper. | Switch off machine whilst measuring and checking the workpiece. |
| 12. Grind the workpiece surface with abrasive paper whilst machine is running. | Only grind the tenon slightly otherwise undersize results. Pay attention! Abrasive paper must not wind itself around the workpiece. Danger of accidents! |
| 13. Switch off the machine, check processing quality. | |
| 14. Unchuck workpiece from the machine, clean the machine. | |

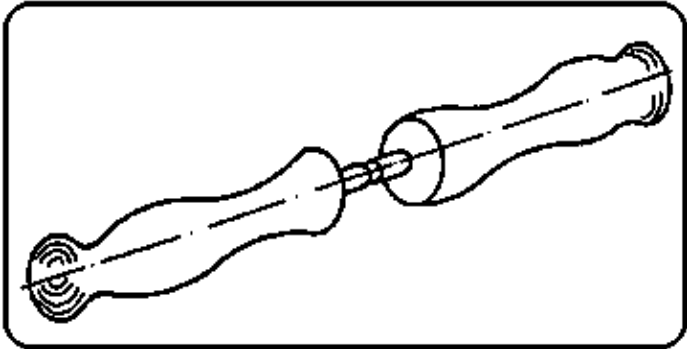
Possible additions

Turning out more stool legs.



Instruction Example 06.3.: Rods for Clothing Holders

Rods for clothing holders stem from form turning according to a templet. Two rods are turned from one work-piece and subsequently separated.



Material

Squared wood, machine finished
35 mm x 35 mm, 270 mm long

Machines and tools

Wood turning lathe, roughing Tool, wide forming tool, narrow forming tool, straight planer, cutting tool, fine saw, chucking means: small trifurcate

Measuring and testing means

Folding rule, caliper or vernier caliper, templet

Auxiliary accessories

Pencil, hammer, medium–fine abrasive paper, punch mark

Necessary preliminary knowledge

Assembly and function of a wood turning lathe. Labour safety provisions when operating a wood tuning lathe. Chuck workpiece and set up machine. Cutting processes when turning wood. Experience in handling turning tools. Read drawings, marking, measuring and testing.

Necessary work preparations

Prepare a templet of drawing cardboard or thin carton according to works drawing.

Mark the centre points of the squared wood and punch mark, subsequently, by planing off, yield eight instead of previously four edges.

| Sequence of operations | Comments |
|---|--|
| 1. Position the work materials and check machine for proper working condition. | Check completeness of work materials, sharpness of tools and cleanliness of machine. |
| 2. Punch mark the workpiece and chuck into the machine. | Do not chuck too tightly otherwise the workpiece splits. |
| 3. Position the support strip and check unimpeded running of the machine. | Strip top edge about 3 mm above the workpiece centre line. |
| 4. Round turning of workpiece with roughing tool. Reset support strip. | Turn workpiece uniformly to 31 mm diameter (final measure + 1 mm processing addition). |
| 5. Mark workpiece according to paper templet. | Begin at the right hand workpiece end with a 2 mm processing addition, mark the three highest profile points and the tenon length by means of circulating workpiece fissure, turn templet and mark left hand workpiece part. |
| 6. Turn the extended partial profile in the middle section of the workpiece using the wide roughing tool. | Commence at the deepest profile point by alternate turning in, always turn from the thick to the thin workpiece section. Hold templet behind workpiece when checking. The pencil fissures should remain visible if possible. |
| 7. Roughly pre–turn both tenons with the narrow roughing tool. | Slightly undercut the tenon shoulder when turning. |
| 8. Finish cut tenon with straight planer and turn in notch at the tenon ends (2 x 45°). | Adhere precisely to tenon thickness of 20 mm! |
| 9. Turn the knob at the workpiece end using the narrow forming tool, begin at the right. | Pay attention! |

| | |
|--|---|
| | Leave some 20 mm round wood at the left workpiece end, a workpiece core of some 10 mm remains. |
| 10. Machine–finish the curves and the flat chamfer with the straight planer. | If possible, remove chips whilst cutting, check shape and knob diameter = 28 mm according to templet. |
| 11. Grind workpiece with medium–fine abrasive paper. | Do not change the shape when grinding. Do not grind tenons. |
| 12. Complete turning of right knob by means of the cutting tool, extending towards the tailstock centre. | |
| 13. Cut workpiece at left knob. | |
| 14 Separate the workpiece parts in the notch using a fine saw. | |
| 15. Quality control and chip removal from machine. | Manually regrind the knobs at the cutting point. |

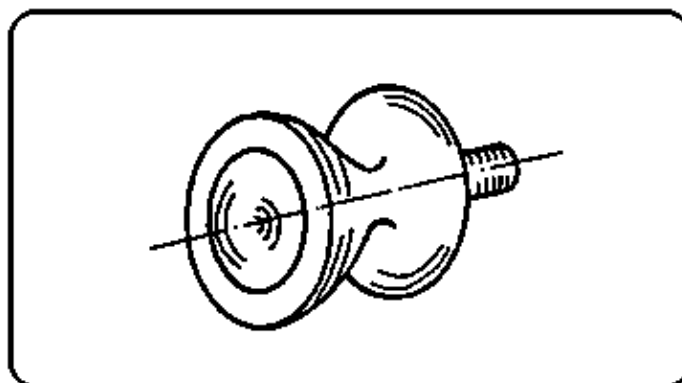
Possible additions

Turning out further rods for clothing holders.

| | | | |
|------------|----------------------------------|--|-------------|
| | | | |
| | | | 06.03. |
| IBE | Rods for Clothing Holders | | 3406 |

Instruction Example 06.4.: Furniture Knob

Turning a hard wood piece to yield a furniture knob



Material

Hard wood, approx. 500 mm long
 cross-section: 50 x 50
 round turning and sawing to length as preliminary operations

Machines and tools

Wood turning lathe, small forming tool, small and straight planer, finishing tool, chucking facility, three-jaw chuck

Measuring and testing means

Folding rule, caliper or vernier caliper, paper templet

Auxiliary accessories

Pencil, medium-fine abrasive paper

Necessary preliminary knowledge

Assembly and function of a wood turning lathe. Labour safety provision when operating a wood turning lathe. Chuck workpiece and set up machine. Chucking processes when undertaking wood turning. Experience in handling turning tools. Reading drawings, marking, measuring and testing.

Necessary work preparations

Round turning of workpiece as described in Instruction Example 06.1. Diameter = 48 mm.

The round piece is cut into 60 mm long rolls using a hand or belt saw (ensure rectangular cuts).

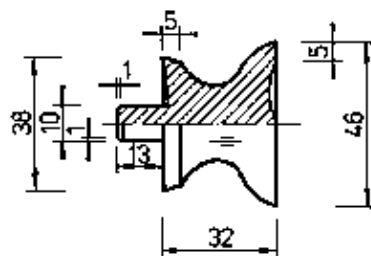
Prepare a templet of the side profile of the furniture knob on drawing carton or thin cardboard according to works drawing.

| Sequence of operations | Comments |
|--|---|
| 1. Position work materials and check machine for proper working condition. | Check completeness of work materials, sharpness of tools and cleanliness of machine. |
| 2. Reset the machine. Screw on three-jaw chuck. Employ external jaws! | Only necessary when switching from round turning to turning the furniture knobs. |
| 3. Chuck workpiece into clamp. | Check the uniform running of the workpiece. Align chucking forces to wood hardness. |
| 4. Position the support strip to workpiece end face. | 5 mm below the centre line. |
| 5. Use finishing tool to surface the workpiece end faces. | Only minimal cut with scraping tool motion. |
| 6. Mark handle diameter by means of pencil fissure = 23 mm from the centre point. Mark the 5 mm board with a pencil. | |
| 7. Turn the flat chamfer with the small forming tool. | Constant grain sequence changes, therefore only minimal chip removal to be undertaken. |
| 8. Reposition the support strip. | Support strip parallel to rotational axis, some 3 mm above the centre line. |
| 9. Turn the side profile with the small forming tool – diameter = 46 mm – turn after fissure at the end face – diameter = 38 mm join by twisting | Setting out from both diameters turn the profile reciprocally into the depth. Check with templet. |

| | |
|---|---|
| – profile turning. | |
| 10. Preturn tenon with small forming tool and finish cut with small, straight planer. | Pay attention! Retain sufficient distance to chucking jaws. Danger of accidents. Do not fall below the tenon size. |
| 11. Notch in a groove with the planer given a 13 mm tenon length. | |
| 12. Grind the workpiece. | Workpiece edges at the end faces must not be ground round, otherwise the visual effect of the profile is lost. |
| 13. Cut the workpiece in the tenon notch. | |
| 14. Quality control and remove chips from machine. | |

Possible additions

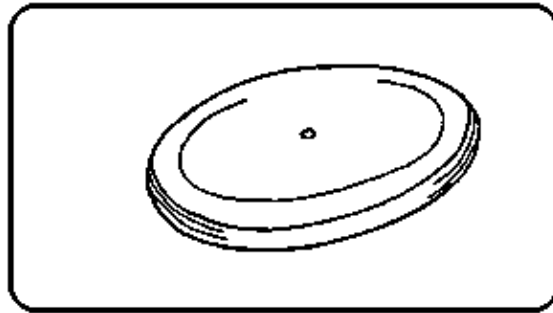
Turn further furniture knobs. Similar handles in different forms and other dimensions can also be turned according to a new drawing.



| | | | | |
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| | | | | 06.04. |
| IBE | Furniture Knob | | | 3406 |

Instruction Example 06.5.: Stool Seat

A stool seat results from machine-finishing and rounding off the edges of a hard wood seat.



Material

Hard wood seat = 24 mm thick
diameter = 380 mm

Machines and tools

Wood turning lathe, big forming tool, finishing tool, screwdriver, 4 mm gimlet, chucking facility, big driving plate

Measuring and testing means

Folding rule, ruler (wood) 400 mm

Auxiliary accessories

Abrasive paper, pencil, four wood screws (4 x 20 mm cheese-head)

Necessary preliminary knowledge

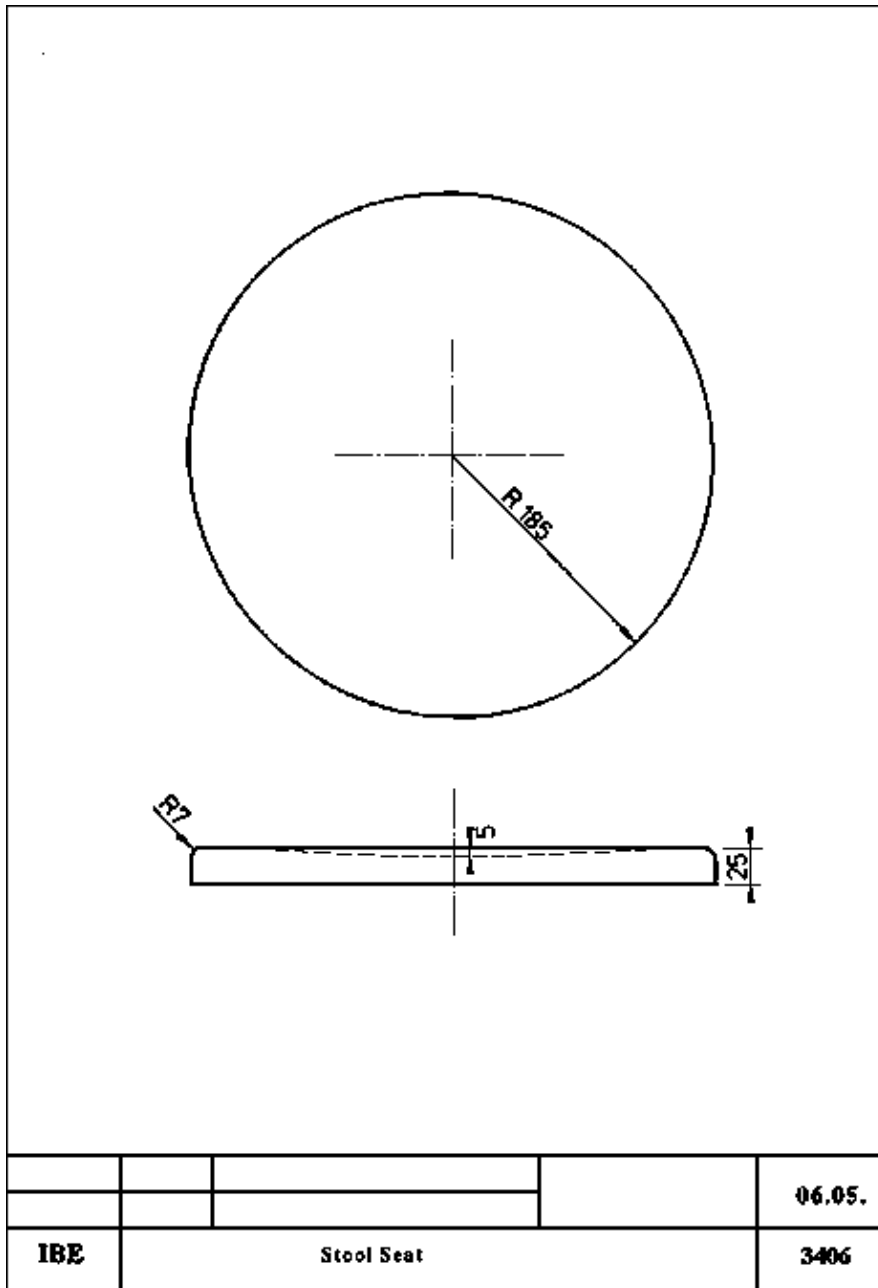
Sound skills and expertise in handling turning tools on the turning lathe. Knowledge of all necessary labour safety measures. Reading drawing, measuring and testing.

Necessary work preparations

A stool plate is required as flat workpiece glued from hard wood to a thickness of 25 mm measuring 400 x 400 mm. Subsequently, after the centre point has been marked on the lower seat side, a circular seat is marked and sawn out with the band sawing machine. Further processing ensues on the wood turning lathe.

| Sequence of operations | Comments |
|---|---|
| 1. Position work materials and check machine for proper working order. | Check completeness of work materials, sharpness of tools and cleanliness of machine. |
| 2. Mark a penciled rectangular cross at the centre point on the lower plate side. | Seat grain sequence must run diagonally to the marked cross (seat can more easily be chucked flat). |
| 3. Driving plate is attached centrally by four wood screws to the workpiece. | Pre-drill screw holes with a gimlet. |
| 4. Attach driving plate with workpiece to the spindle of the wood turning lathe. | |
| 5. Position support strip to the front radius of the workpiece wide face. | Support strip is about 4 mm below the centre line some 10 mm from the workpiece. During turning the tool cutter must strike the centre of rotation. |

| | |
|--|--|
| 6. Check the unimpeded and central running of workpiece. | |
| 7. Set a slow spindle speed and carefully face the surface using a finishing tool. | Pay attention! The spindle speed is too low for the plate centre but still too great for the seat edge. Be careful at seat edge. |
| 8. Turn out the hollow of the seating surface with a big forming tube. | Size control: measure the size of the seating surface. |
| 9. Turn the curve at the plate edge by means of the forming tool. | Pay attention! Only with minimal chip removal for the speed is unfavourably high for the circumference. |
| 10. Cut the narrow face by means of the finishing tool vertically to the wide surface. | Use the finishing tool as for surfacing. Subsequently re-work the curve. |
| 11. Grind the workpiece. | |
| 12. Check quality, unchuck the workpiece and remove chips from the machine. | |



**Operations on Wood Turning Lathes – Course: Mechanical
woodworking techniques. Trainees' handbook of lessons**

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1. Purpose of Turning

Turning is a cutting process. The workpiece encompasses a turn. Chips are removed by the hand-wielded tool. This process is also called turning and is one of the oldest wood processing techniques. This technology is used to yield a great variety of shaped workpieces.

The two main types of bent turning, namely turning long trunks and cross sections, constitute the principal forms of turning.

Thereby virtually all turned products can be made.

What is the purpose of turning?

2. Assembly of a Lathe

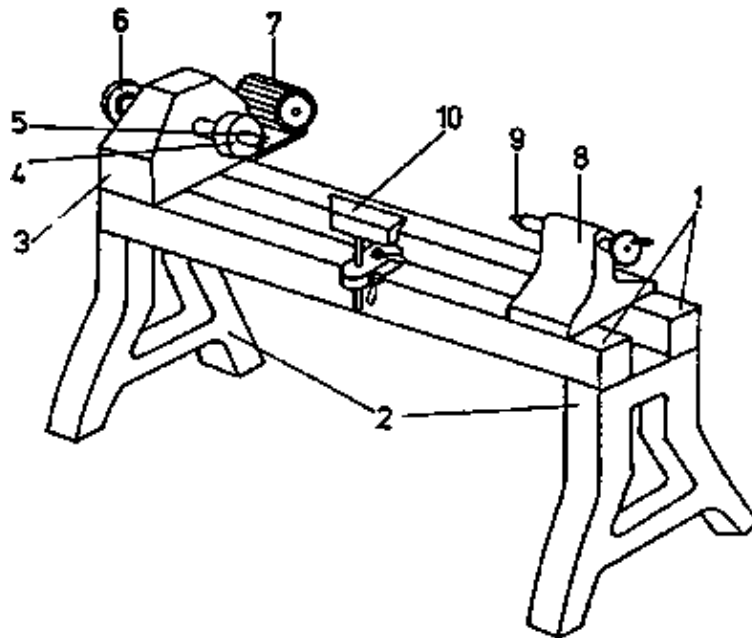


Figure 1 – Wood turning lathe

1 cheeks, 2 stand, 3 spindle stock, 4 spindle, 5 chucking device, 6 gears, 7 motor, 8 tailstock, 9 tailstock centre, 10 support strip

The basic machine frame consists of two cheeks to which all the other elements have been attached. The cheeks hinge on two stands, the most important machine part is the headstock. It has been arranged on the left end of the cheeks and contains the spindle to which various chucking aids can be attached. The spindle is driven via gears from the motor. The gears make possible a rotational speed alignment to the respective workpiece diameter. A tailstock with tailstock centre serves as end support to the chucking device when processing longer workpieces. The turning tools held by hand are placed onto the support strip which can be adjusted in three directions and set in line with the respective tasks in hand.

2.1. Chucking Facilities for Workpieces

Turning out differently shaped workpieces and the utilisation of various kinds of materials presupposes the employment of various chucking facilities for clamping the workpieces to the machine spindle.

A number of frequently used chucking facilities feature among the basic accessories of a wood turning lathe. Further chucking devices can be provided for special processing technologies.

Chucking devices for long trunk turning

Trifurcate

The trifurcate consists of a centre point and two driving spikes. The workpiece is clamped between the trifurcate and the tailstock centre. Thereby, the workpiece is fixed to the trifurcate with a light hammer blow.

Avoid splitting the workpiece at all costs. Otherwise the workpiece breaks during processing – danger of accidents –.

Turning whilst employing this chucking method is termed *“turning between the centres”* and is mainly utilised for processing longer workpieces.

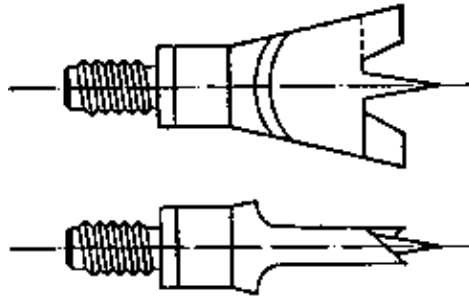


Figure 2 – Trifurcate

Tongue or hollow chuck

This serves to chuck short trunk pieces without using the tailstock centre. By means of the previously twisted tenons the workpiece is driven into the conical bore of the chuck. The workpiece fits more snugly if the tenons are moistened somewhat beforehand.

Tongue and hollow chucks can also be used for certain hard wood turning operations. Turning without a tail-stock is known as “free-hand turning” or “overhead turning”.

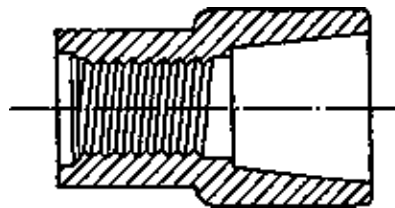


Figure 3 – Hollow chuck with fastening screw thread

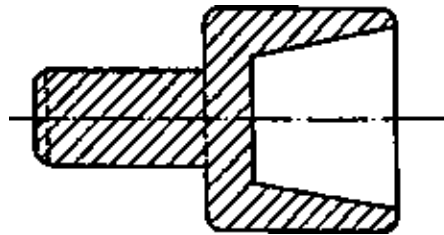


Figure 4 – Hollow chuck for clamping into a three-jaw chuck

Jaw chuck

Three- and four-jaw chucks can be used for chucking both long trunks and cross pieces. Jaw chucks comprise two sets of chucking jaws:

- a set of chucking jaws to chuck thin or hollow workpieces
- a set of chucking jaws to chuck thick workpieces.

When chucking heed the differing compressive strengths of the woods in various grain directions. During turning operations the workpiece must not be chucked again otherwise it no longer runs exactly true.

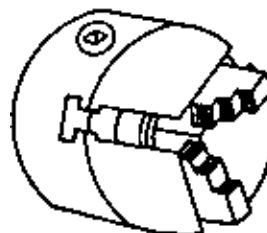


Figure 5 – Three-jaw chuck

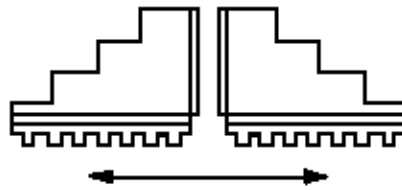


Figure 6 – Internal jaws

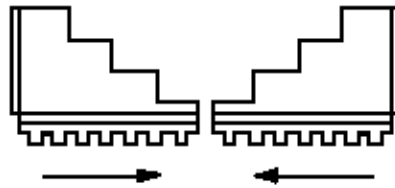


Figure 7 – External jaws

Chucking facilities for cross piece turning

Screw chuck

The screw chuck augments the jaw chuck and is subsequently supplied for the driving or face plate. It comprises multi-layer wooden disks. This wooden disk is attached to the envisaged chuck and then level-turned. An inserted wooden screw for chucking the workpiece is in the centre. During turning the chuck cannot absorb too great chucking forces.

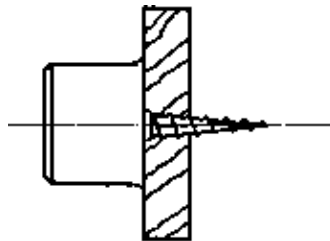


Figure 8 – Screw chuck

Driving and face plate

Bigger, flat workpieces can be attached to these chucking facilities by means of wooden screws. Beforehand the holding points are marked on the workpiece. Thereby, ensure that the screw holes do not impair future utilisation. If the workpiece diameter is less than that of the plate a 5 mm or so thick dummy disk is positioned between the workpiece and the chucking device. Thereby the workpiece narrow surface can be processed without damaging the disk.

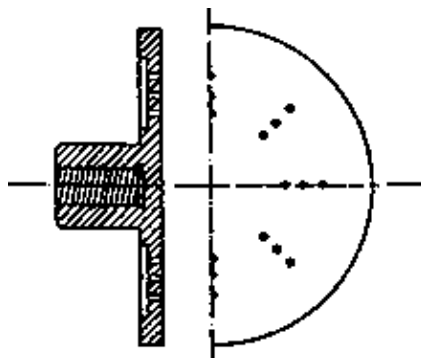


Figure 9 – Chucking plate, faceplate

Why are different chucking facilities used for turning?

When is a trifurcate used as a chucking means?

Why must the workpiece not split when hitting the plugging chisel grippers?

Why should be jaw chuck not be rechucked during turning operations?

What is the task of the face plate?

3. Tools

Turning out variously shaped workpieces makes necessary the processing of materials in different grain directions and in varying profiles. Commensurately, a number of special tools are required. The faces, edges and angles of the turning tool are presented in Figure 10.

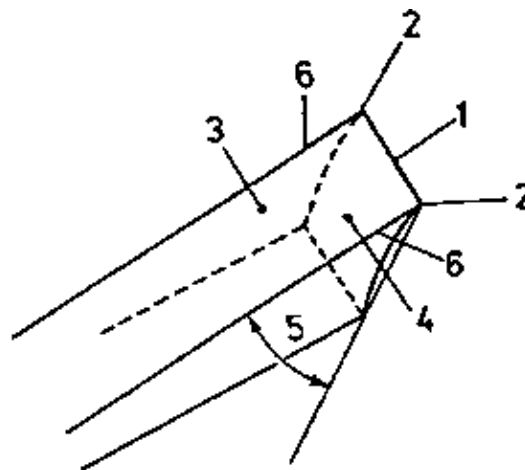


Figure 10 – Faces, edges and angles of turning tools

1 main cutter, 2 corner, 3 chipping face, 4 flank, 5 taper angle, 6 trail cutter

The basic equipment of a wood turning lathe includes the following items:

Tubes

These tubes are used for long trunk and cross piece operations. Basically we differentiate between two types, roughing and forming tools. The roughing tool is used for preturning a cornered workpiece. It has a wide and flat shape. The cutter is straight and has lightly rounded comers. The taper angle of the cutter is, as applies to all turning tools, ground in line with wood hardness.

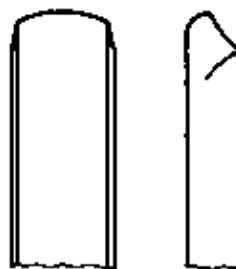


Figure 11 – Roughing tool

The *forming tool* is used to turn all rounded shapes of the workpiece. It is mainly used for long trunk operations. Tools of differing widths are employed for various workpiece shapes. As opposed to the jack tube, the cross-section of the form tube is not uniform. As a result varying angles arise at differing tool cutter points during chip removal. This feature exerts a positive influence on handling the tool when turning chamfers and curves. The cutter is ground slightly curved and the comers are somewhat rounded.

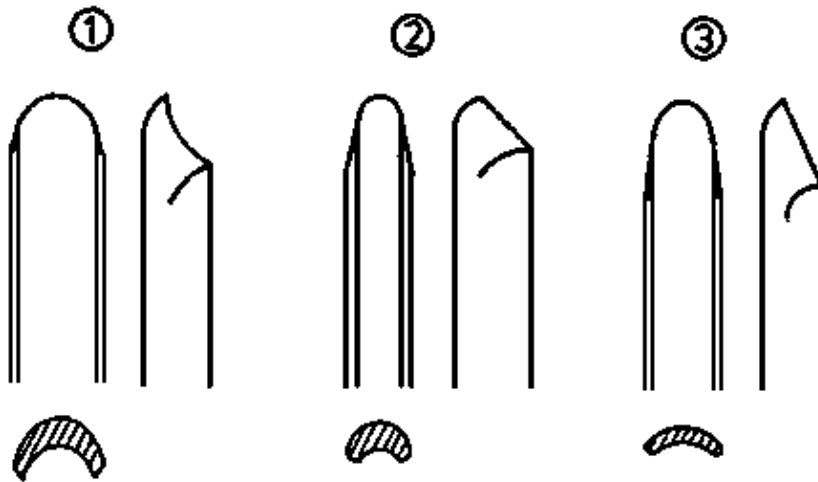


Figure 12 – Forming tool

(1) wide forming tool, (2) narrow forming tool, (3) forming tools ground for soft wood processing

Planer

A planer is used exclusively for long trunk turning. Because of its shape it is also known as a square-nosed tool.

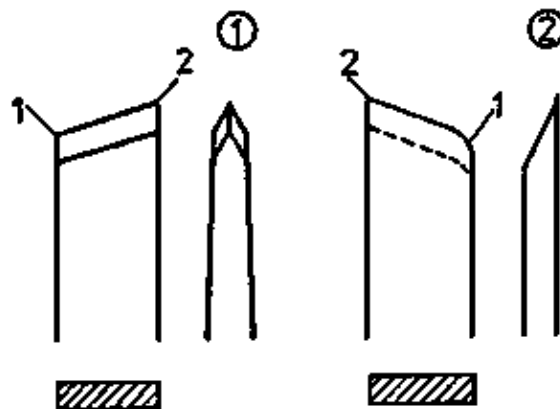


Figure 13 – Planer

(1) double edge ground planer
1 burr, 2 tip

(2) single edge ground planer with rounded burr
1 burr, 2 tip

The blunt-angled corner of the cutter, the burr, is for turning small curves. The burr can easily be round-ground. The sharp corner can be used for turning notches.

Tubes and planers are the main tool types for manual turning. Whereas the tubes (also called wood planers) are used for long trunk and cross piece work, the planer is only employed for long trunk operations.

Finishing tool

This finishing tool is used for smoothing and facing the cross pieces of disk-shaped workpieces. The finishing tool is only ground on one side. This tool is not really suitable for form turning. Chip removal is mainly through scraping whilst the taper angle must be selected in accordance with the material. A very unclean top surface results when this tool is used for long trunk operations.



Figure 14 – Finishing tool

Steel section

The steel section is very similar to the finishing tool. It is somewhat smaller and, through the addition of various profiles, can be prepared for special tasks.

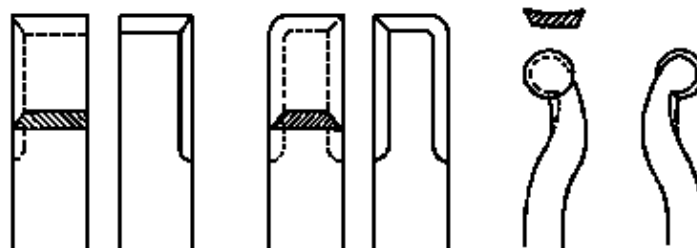


Figure 15 – Steel sections (various forms)

Cutting tool

This tool is solely for cutting long trunk turned parts. The cross-section form must resemble a knife or sword. Its advantage is that the wood grain surfaces are cut cleanly and wood losses are kept down to a minimum. It is difficult to rework the workpiece on these surfaces. When grinding the tool, heed the clearance angle adjacent cutters.

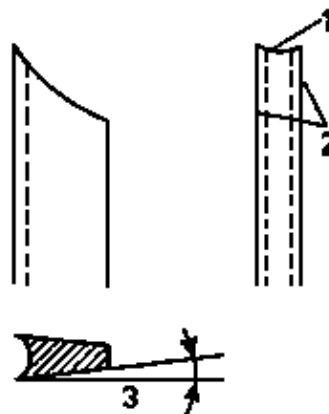


Figure 16 – Cutting tool

1 main cutter, 2 trail cutter, 3 clearance angle

Which tools are used for turning?

What is the purpose of the cutting tool?

4. Tool Maintenance

Turning tools are subject to considerable albeit varying strain when processing differing wood types. Thus, certain basic requirements must be met by sound tools.

- It must be of high-grade steel which is sufficiently hard and elastic.
- The most suitable taper angle must be ground for the respective wood type.
- The tool must possess sufficient heat conductivity capacity. The subsequently arising frictional heat can cause structural changes to the tool cutting edge. This would denote a softening of the tool.
- The tool must be extremely sharp.
- The tool must be easy to handle as regards its form and size.

Table 1: Tool plane angle related to material and its raw thickness

| Processing material | Raw thickness in g/cm ³ | Taper angle in degrees (°) |
|---------------------|------------------------------------|----------------------------|
| soft wood | 0.35... 0.50 | 20... 25 |
| hard wood | 0.51... 0.70 | 25... 35 |
| very hard wood | 0.71... 0.90 | 35... 40 |

Clean and properly sharpened tools are an essential precondition for sound quality of the workpieces being processed and for accident-free operations.

Tools subject to considerable wear and tear are ground on the abrasive wheel. When grinding by means of dry-operating abrasive wheels the tools should be placed in water at short intervals otherwise they can easily anneal.

The taper edge must be heeded according to table one. First of all those tools with straight cutters are ground on the grinding disk (abrasive wheel). Because of the uneven wear and tear of the grinding disk the steel sections and tubes are the last items to be ground. Grinding is completed when all dents and gaps in the cutting edge have been removed and a small burr has formed on the cutter edge. Tool oilstoning is undertaken by a wet oilstone. Thereby the oilstone is moved by hand in a circular motion on the tool cutting edge.

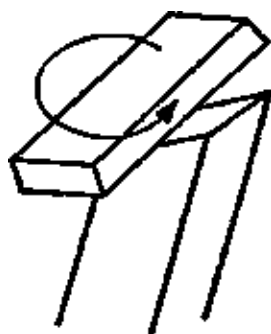


Figure 17 – Oilstone

Flanks and cutting faces are oilstoned reciprocally. If possible, the oilstone should have a fine grain. A specially shaped oilstone is required for sharpening the tubes.

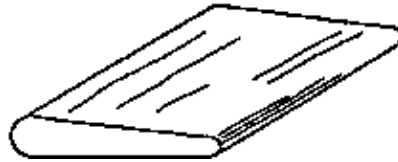


Figure 18 – Shaped oilstone

Oilstoning continues until no grinding traces are perceptible in the cutting edge area. A burr must not emerge during oilstoning.

Tools are only ground anew once resharpener by means of oilstoning is no longer possible.

Blunt tools require considerable cutting forces.

This increases the risk of accidents and inferior surface quality results.

5. Mode of Operation of a Wood Turning Lathe

The chucked workpiece begins turning as the machine is switched on. Spindle rotational speed is chosen in line with the wood processing underway. Chips are removed by means of the manually-used turning tools.

6. Turning Technology

6.1. Wood Selection

When selecting wood for turning operations the following requirements vis-a-vis material must be heeded:

- According to its purpose and subsequent further processing the wood shall possess sufficient stability and the necessary grain and colour standards.
- Only select properly dried wood.
- The workpiece must not have any fissures. Otherwise it may splinter during processing – danger of accidents!
- Long trunk workpieces with knots and knot ends may break during processing.
- Ensure no alien bodies (nails, screws,...) are in the wood.

Straight, round woods (branches or thin trunk pieces) can be used for long trunk turning operations. Such woods, however, require special care. Fissures arise at the grain ends if drying ensues too quickly. Such tearing can be prevented if:

- the grain ends are coated with cold glue,
- the bark around the trunk is notched,
- no too thick round wood is selected,
- the wood dries slowly and not in the sun.

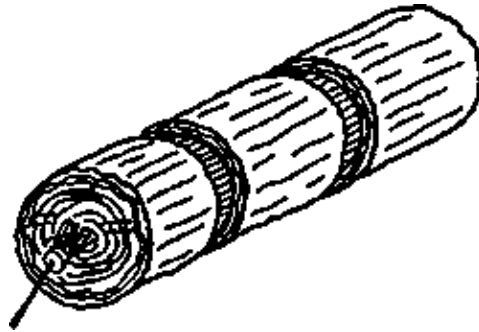


Figure 19 – Round piece of wood prepared for drying

Thick trunks are split once, thrice or four times and the grain ends protected from too rapid drying. This prevents to a marked degree the emergence of drying fissures.

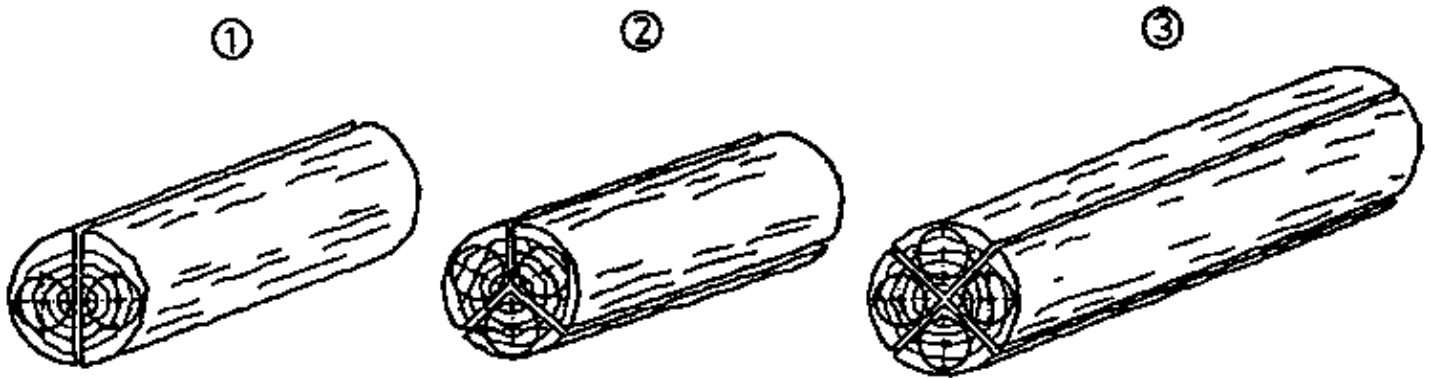


Figure 20 – Splitting trunks

- (1) split simply
- (2) split threefold
- (3) split fourfold

The partial sections, after drying, are set up as blanks for turning operations. This ensues through splitting, sawing or planing.

Blanks of considerable diameter can also be yielded by sticking together thin board pieces with joints. These joints should, if possible, not be visible. Heed the wood structure of the various partial pieces (Figure 21). Blanks for various operations can be simply yielded by ripping up thick sawn timber (Figure 22).

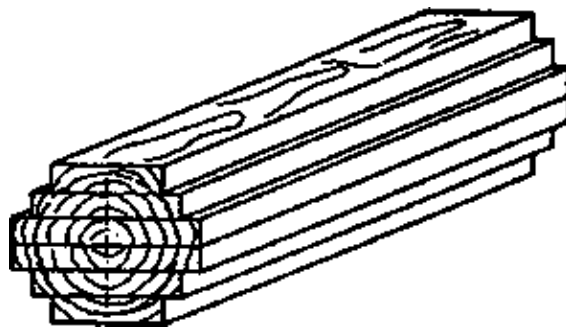


Figure 21 – Blanks made of board pieces



Figure 22 – Blanks which arise by splitting up thick sawn timber

Much care is required when marking workpiece centre points. Workpieces which have not been centrally chucked may easily, because of the unevenly influencing centrifugal forces, detach themselves from the machine. – Danger of accidents!

Furthermore, material consumption increases given inaccurate marking and chucking.

How can dry fissures be prevented at the grain ends of raw woods?

Why should a workpiece be chucked centrally in the machine?

6.2. Turning Long Trunks

Round turning

After workpiece marking and punching the plugging chisel (trifurcate) is lightly struck with a hammer and chucked with the tailstock centre under medium pressure. Thereby the driving tongue of the chucking device shall engage the diagonal lines of the grain end wood faces. This reduces the danger of splitting and, unimpeded by the tailstock, the hammer can be directed to the top, right-hand corner of the workpiece.

The support strip should be positioned close to the workpiece without, however, restricting the movement of the turning workpiece. The height of the support strip is determined by the necessary cutting rake for the various wood types.

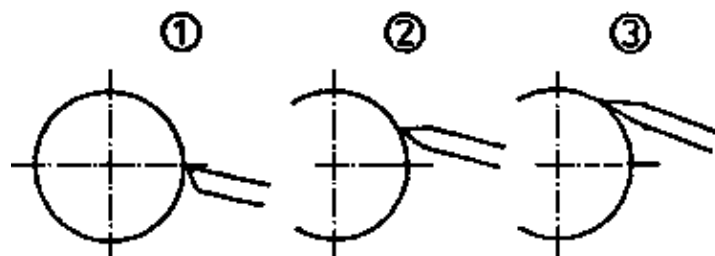


Figure 23 – Arrangement of wood during long trunk turning

(1) very hard wood, (2) hard wood, (3) soft wood

When turning, select the most favourable cutting speed for the wood being processed. This ensues by selecting the proper spindle rotational speed.

Table 2: Spindle rotational figures related to tool diameter

| Workpiece diameter in mm | Revolutions per min ⁻¹ | |
|--------------------------|-----------------------------------|-----------|
| | soft wood | hard wood |
| to 50 | 2500 | 2000 |
| to 80 | 2000 | 1400 |
| to 200 | 700 | 700 |

Prevent bigger workpieces from splitting by applying suitable chucking means.

Initially turning is undertaken using the roughing tool. The tube is thereby placed firmly on the support strip at roughly right-angles to the rotational axis of the workpiece. The right hand seizes the grip whilst the left hand directs it to the strip. If turning is undertaken carefully the tube with the hollow side is somewhat inclined in

direction of feed. The feed can be reciprocal depending on the length of the support strip, respectively the workpiece length.

Once the workpiece has been turned uniformly round it is smoothed by means of a planer which is held at some 65° to the rotational axis of the workpiece.

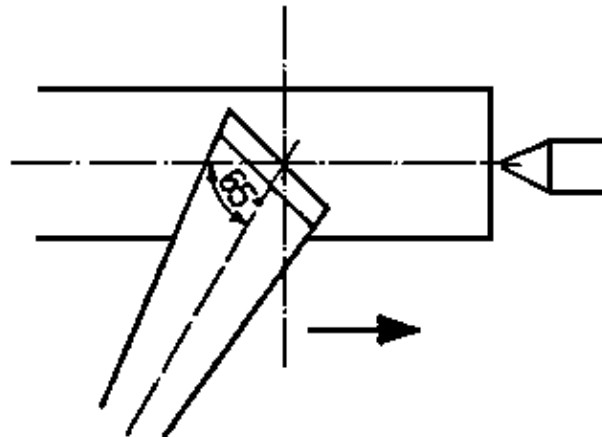


Figure 24 – Handling a turning tool

Position the planer higher up so that the cutter does not yet engage. Then the workpiece is slowly pulled back until chip removal takes place. The most favourable cutting angle is determined by trial and error depending of wood hardness. The tool shall cut rather than chisel. Cut chip removal yields a smooth top surface which requires little reworking. Turning by means of a planer requires a great deal of practise.

The turning process is over once the necessary size and required surface quality have been attained.

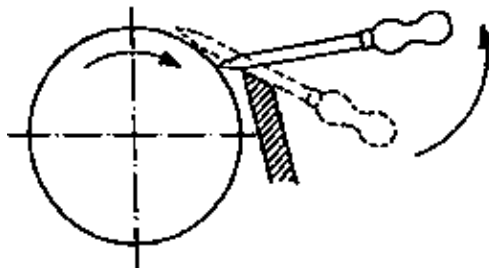


Figure 25 – Tool positioning as turning process commences

At which height, related to the rotational axis of the workpiece, must the support strip be set when turning soft wood?

Form turning

This work technique presupposes prior round turning with a roughing tool. Frequently profiles are presented in Figure 26.

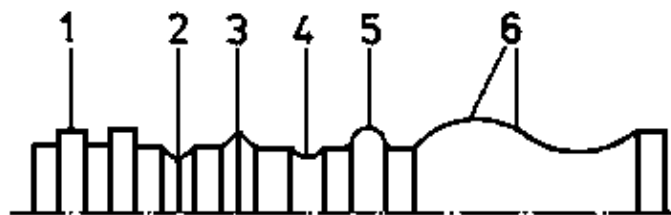


Figure 26 – Frequent profiles during form tuning

1 rod, 2 candle, 3 sharp rod, 4 chamfer, 5 round rod, 6 curve and chamfer

A templet of cardboard or a templet drawing is prepared. This aid is often held behind the workpiece during turning whereby the forms are compared. Prior to turning all profile limitation lines are carried over to the

workpiece. The templet is positioned onto the support strip and the pencil point is held carefully to the rotating workpiece.

Turning is undertaken by means of the forming tool. The tool is held like a roughing tool. However, turning is only permissible from the greater to the smaller workpiece diameter section, thereby ensuring clean cutting faces.

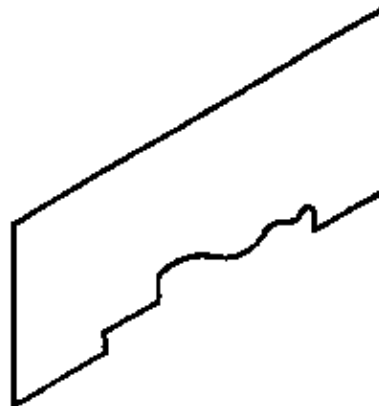


Figure 27 – Profile templet

Cutting-off

A special cutting-off tool is required for this purpose. This tool is not part of the basic equipment of the wood turning lathe, however it can be easily made from a kitchen knife or a thin, flat file.

This operation serves to split up workpieces to precise lengths and also to separate small parts.

The support strip must be so set that the tool cutter is brought into play at the workpiece rotational axis level. Workpieces chucked inbetween the centres should not be completely cut off. Otherwise the workpiece may jam with the tool at the separation point and become damaged. This possibility denotes an additional accident danger with bigger workpieces.

Prior to cutting off the workpiece must be completely processed unless a special chuck, for instance a tongue clamp, is available for further working.

6.3. Turning Cross Pieces

Here the wood processing direction constantly changes. Mainly used are the roughing and finishing tools. The support strip is so set that the tool cutter engages at centre of rotation level. Initially the roughing tool is employed for preturning. The tool is moved from the workpiece centre to the edge and back again. Thereby the roughing tool with cavity is somewhat inclined to the respective direction of feed.

Next the surface is processed with the finishing tool until the required quality has been attained. Chamfers and curved sections cannot be processed using a finishing tool. Instead a tube must be used.

In the case of thin workpieces the narrow faces are processed from the wide face. Chip removal must ensue in the workpiece centre with minimal feed movement. Cutting conditions near the rotational axis also worsen due to cutting speed reductions towards the workpiece centrepoint. In the case of complicated turning operations in the centre section of the workpiece face, a slight increase in spindle rotational speed can improve cutting conditions. However, increasing the rotations speed is not possible with bigger workpieces for then too great centrifugal forces might cause the workpiece to splinter. This is extremely dangerous!

6.4. Grinding Surfaces

Grinding seeks to improve surface quality. According to wood variety grinding is undertaken with middle-fine to fine abrasive paper commonly used in wood processing work. The abrasive paper pieces are folded, bent

of formed into thin strips depending on the profile size. Employing the prescribed processing rotational speed the workpiece is treated as for turning. When grinding the abrasive paper is always moved counter to the rotational movement of the workpiece. Consequently, no abrasive dust can collect between the abrasive agents. Nor are any burnt spots caused through too great frictional heat.

Always hold the abrasive paper so that it cannot wind itself around the rotating workpiece. –
Danger of accidents!

Only grind the workpieces slightly. The workpiece shape must not be altered through grinding!

Why must the prescribed rotational speed not be exceeded given extreme workpiece diameters?

7. Basic Labour Safety Provisions for Turning

As applies to all wood-working machines, as regards the wood turning lathe, order and cleanliness are essential precondition for accident-free operations. Heed the following requirements:

- Only use sharp tools with snugly fitting handles.
- Encase chucking devices with protruding parts.
- Never leave locking wrenches in position.
- Do not check the measurements of workpieces whilst the machine is switched on.
- Do not remove chips as the machine is running.
- Position the support strip as closely as possible to the workpiece.
- Do not place tools on the machine cheeks.
- Wear clothing with closely fitting sleeves.
- Ensure that long hair is under a head covering.
- When turning never wear watches, bracelets, finger rings and long necklaces.
- Never chuck workpieces with dried out fissures for they can crack during turning.
- Do not exceed the rotational speeds as set out in table 2 for otherwise bigger workpieces cannot cope with the centrifugal forces.

Broken log pieces present a serious danger of injury.

**Working on Long-hole Cutting Machines – Course: Mechanical
woodworking techniques. Instruction examples for practical vocational
training**

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Working on Long-hole Cutting Machines – Course: Mechanical woodworking techniques. Instruction examples for practical vocational training

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Preliminary Remarks

The present material includes 5 Instruction Examples where the drilling of round-hole bores and the drilling and cutting of long holes with long-hole cutters will be practised on different pieces of work.

In order to ease the preparation and realization of the exercises for each instruction example the necessary material, machines and tools, measuring and testing devices and auxiliaries are named. The necessary basic knowledge for the preparation and the realization of the instruction examples are mentioned, too.

With the help of working sketches and working descriptions the exercises can be carried out independently.

As instruction examples there were selected pieces of exercise which give applicable objects after their manufacturing:

A stool plate and a stool frame as single parts of a workshop stool, two frames for different purposes, a frame part with an insert lock for a door.

The long measures are standard and can be adapted to the local conditions by the trainee.

Instruction Example 09.1.: Stool Plate

Drilling of long-hole bores for long wood dowel pins to manufacture wide doweled joints.

Material

– 3 boards with milled narrow faces (1)

length: 500 mm

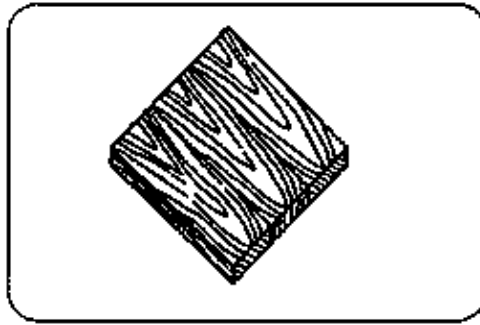
width: 170 mm

thickness: 24 mm

– 6 long wood dowel pins (2)

diameter: 8 mm

length: 55 mm



Machines and tools

long-hole cutter, twist drill with a centre point \varnothing 8 mm, pencil, scribe, awl, wooden hammer

Measuring and testing means

folding rule, steel square

Auxiliaries

working desk

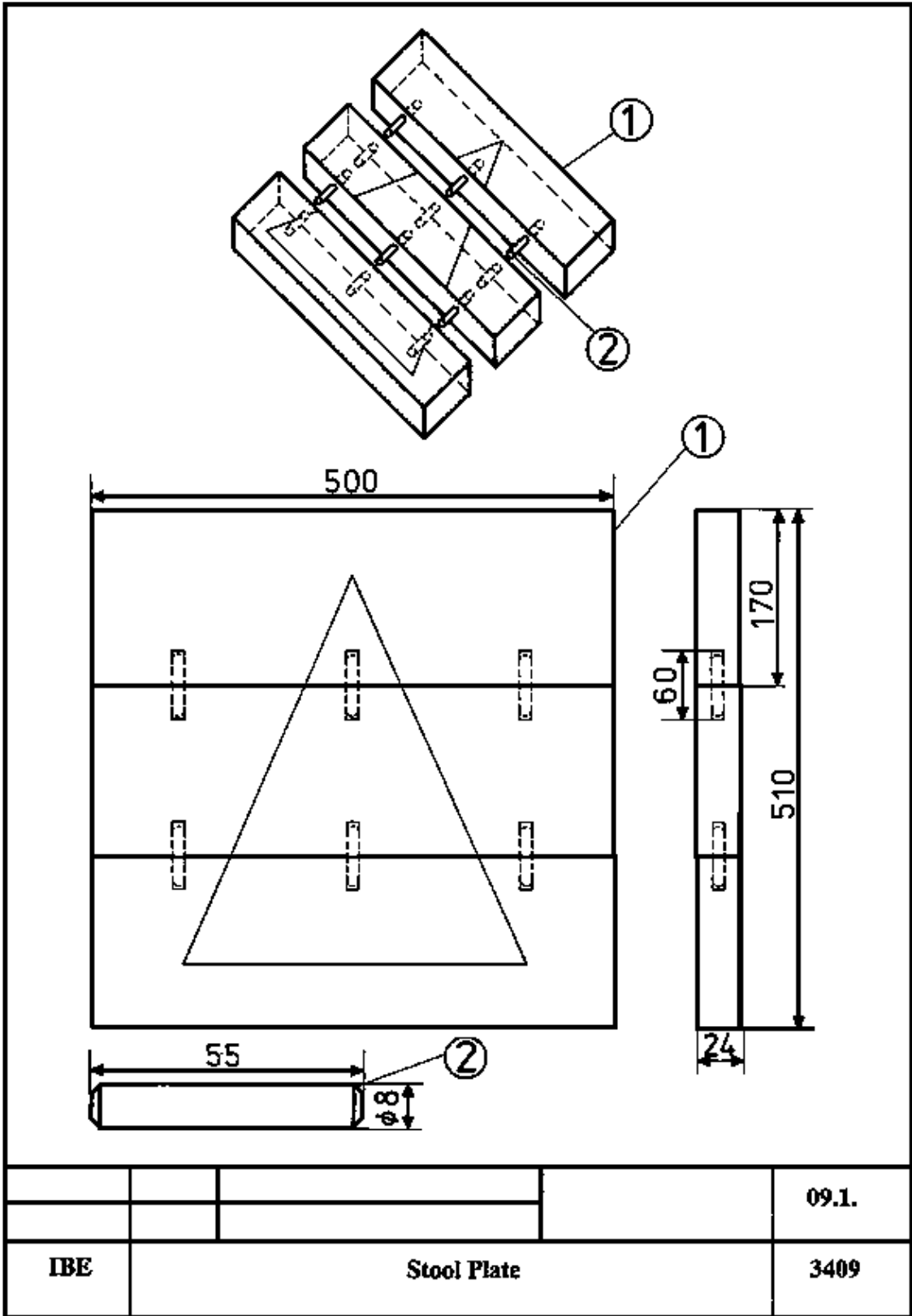
Necessary basic knowledge

measuring and marking, working on circular sawing machines and smooth planing milling machines

| Sequence of operations | Comments |
|---|---|
| 1. Marking the bore centres on the narrow faces. | Punching the bore centre with the awl for placing the centre point of the drill. |
| 2. Clamping the drill bit. | Insert the drill shank into the drill chuck to the stop. |
| 3. Adjusting the necessary bore depth. | The fixing of the bore depth is carried out with the adjustable stop on the machine. |
| 4. Clamping the piece of work. | Placing the piece of work on the stop bar the working table and fastening it. |
| 5. Adjusting the table height to the bore centre. | The adjusting of the table height is carried out with the hand wheel. |
| 6. Switching on the machine. | |
| 7. Drilling the dowel holes. | The bore shaft with drill chuck and drill bit is moved to the fixed bore depth by the lever. |
| 8. Switching off the machine. | |
| 9. Checking the dimensional accuracy. | Checking the bore edges, inaccurate bore edges result from – a too high tool feed – a dull drilling tool. |

Finishing:

Sticking in the dowel pins, glueing the joints, smooth planing of the wide faces and milling to thickness.



Stool Plate

Instruction Example 09.2.: Stool Frame

Drilling of round-hole bores for long wood dowel pins to manufacture doweled edge joints.

Material

– 4 edges with milled wide and narrow faces (1)

length: 350 mm

width: 80 mm

thickness: 24 mm

– 4 square bars with all faces milled (2)

length: 480 mm

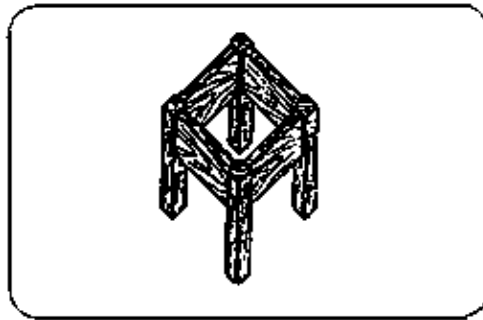
width: 40 mm

thickness: 40 mm

– 16 long wood dowel pins (3)

diameter: 8 mm

length: 55 mm



Machines and tools

long-hole cutter, twist drill with a centre point \varnothing 8 mm, scriber, pencil, awl, wooden hammer

Measuring and testing means

folding rule, steel square

Auxiliaries

working desk

Necessary basic knowledge

measuring and marking, working on circular sawing machines, smooth planing milling and thickness milling machines

| Sequence of operations | Comments |
|---|--|
| 1. Marking and punching the bore centres on the stool legs and the edges. | Mark the measures precisely – otherwise off-centre running of the bore possible. |
| 2. Clamping the twist drill. | Clamp the shank fast and secure. |
| 3. Fixing the bore depth. | Setting the stop. |
| 4. Clamping the piece of work on the working table. | Placing the piece of work on the stop and clamping with the eccentric lever. |
| 5. Fixing the table height to the bore centre. | |

6. Drilling the dowel pin holes into the legs and the edges according to the marking.

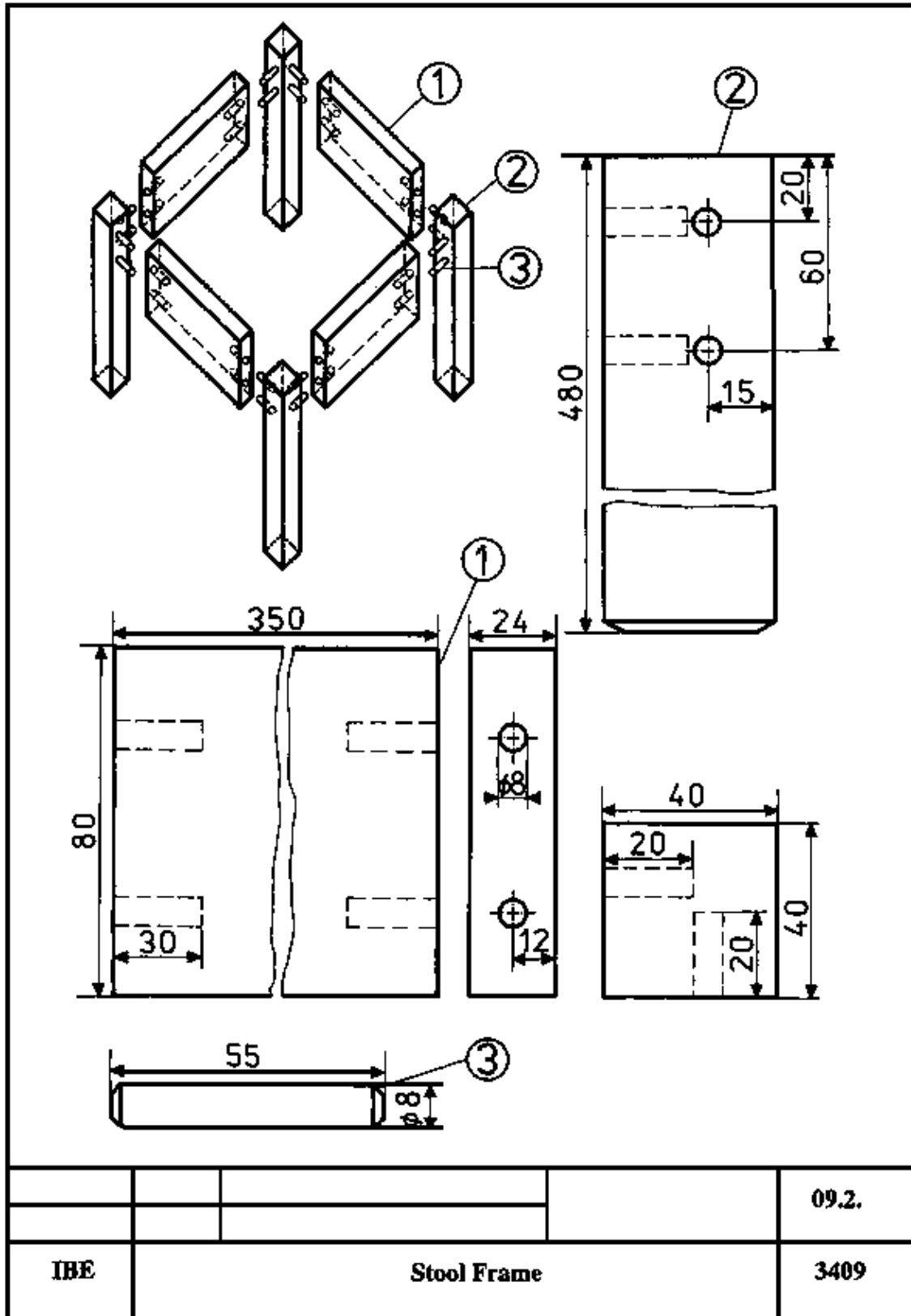
Drilling at the marking should be carried out precisely to ensure true-to-size.

7. Checking the dimensional accuracy.

Checking the dimensional accuracy of the bore distances and the bore depth.

Finishing:

Grinding the wide and narrow faces of the legs and edges. Glueing the leg frame together. Fastening the stool plate manufactured in the Instruction Example 09.1.



Stool Frame

Instruction Example 09.3.: Frames

Drilling of round-hole bores for long wood dowel pins to manufacture a doweled frame corner joint

Material

– 2 strips with milled wide and narrow faces (1)

length: 400 mm

width: 80 mm

thickness: 24 mm

– 2 strips, milled (2)

length: 800 mm

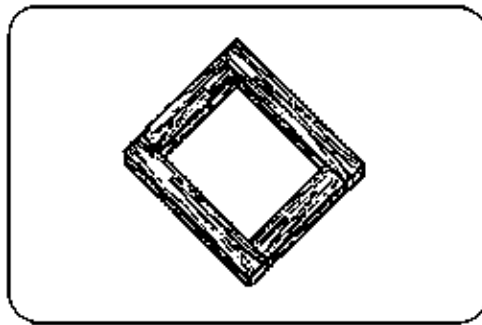
width: 80 mm

thickness: 24 mm

– 8 long wood dowel pins (3)

diameter: 8 mm

length: 55 mm



Machines and tools

long-hole cutter, twist drill with a centre point \varnothing 8 mm, scriber, pencil, awl, wooden hammer

Measuring and testing means

folding rule, steel square

Auxiliaries

working desk

Necessary basic knowledge

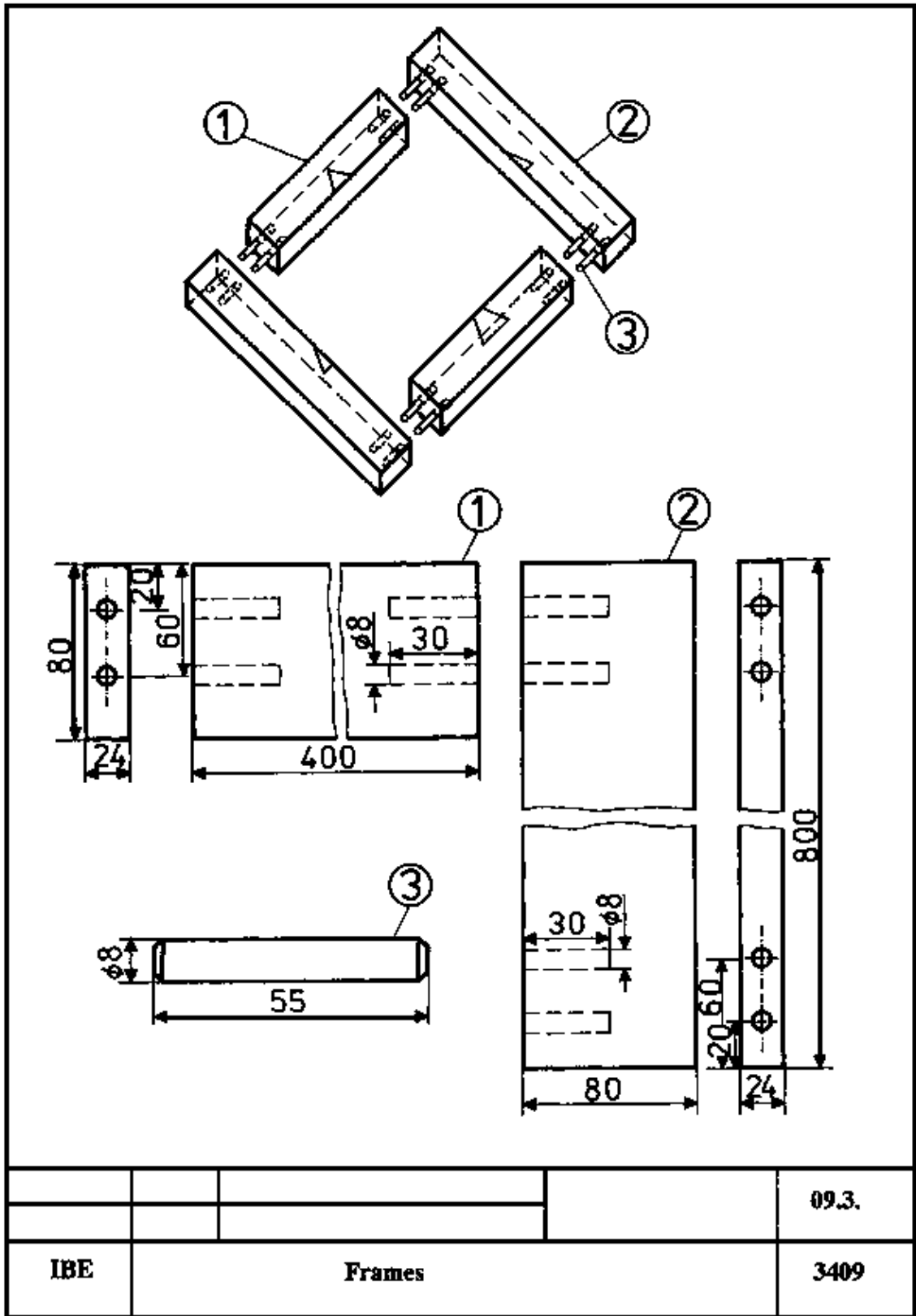
Measuring and marking, working on circular sawing machines, smooth planing milling and thickness milling machines.

| Sequence of operations | Comments |
|--|--|
| 1. Marking and punching the bore centres on the centers of the narrow faces and the cross grain edges. | It is enough to mark one corner joint. All bores will be performed true to size repeatedly by the fixed stops. |
| 2. Clamping the twist drill. | |
| 3. Fixing the bore depth. | |
| 4. Clamping the piece of work on the working table. | Use inset wooden pieces if necessary. |
| 5. Screwing the dog on the working table. | A dog is screwed on the working table with 2 machine screws where the pieces of work are placed. |

- | | |
|--|---|
| 6. Fixing the centre distances of the bores with the two dogs. | The dogs make it possible to drill always at the same bore distance without marking the bore centres. |
| 7. Fixing the table height to the bore centre. | |
| 8. Drilling the dowel pin holes into the narrow faces and the cross grain edges. | Place the square side of the frame parts onto the working table. |
| 9. Checking in the dimensional accuracy. | Checking the true-to-sizeness of the bores. Fixing the frame together without glue for a check. |

Finishing:

Glueing the frames together. Grinding the faces and edges.



Frames

Instruction Example 09.4.: Frames

Milling of long holes for placing a mortise of a caulked frame corner joint.

Material

– 2 strips with milled wide and narrow faces (1)

length: 800 mm

width: 80 mm

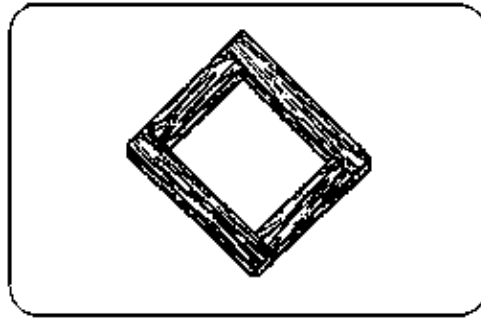
thickness: 24 mm

– 2 strips with a caulked or milled mortise (2)

length: 510 mm

width: 80 mm

thickness: 24 mm



Machines and tools

long-hole cutter, long-hole cutting tool \varnothing 8 mm, scriber, pencil

Measuring and testing means

folding rule, steel square

Auxiliaries

working desk

Necessary basic knowledge

Measuring and marking, caulking, working on circular sawing machines, smooth planing milling, thickness milling and universal milling machines.

Sequence of operations

Comments

1. Marking the length of the long hole on the narrow faces. Marking the outline of the long holes precisely.

2. Clamping the long-hole cutter in the bore chuck.

3. Fixing the bore hole depth.

4. Clamping the piece of work on the working table.

5. Adjusting the table height.

6. Between the markings of the long hole round holes are drilled closely side by side. Thereafter the remaining stretchers between the round holes are milled by the cross feed of the working table.

The straight cutting groove of the long-hole cutter throws the shavings out badly. The bore can tamp and the cutter can break. Therefore do not make deep round bores in one go. With the cross feed of the working table the length cutting edges mill away the remaining stretchers between the round

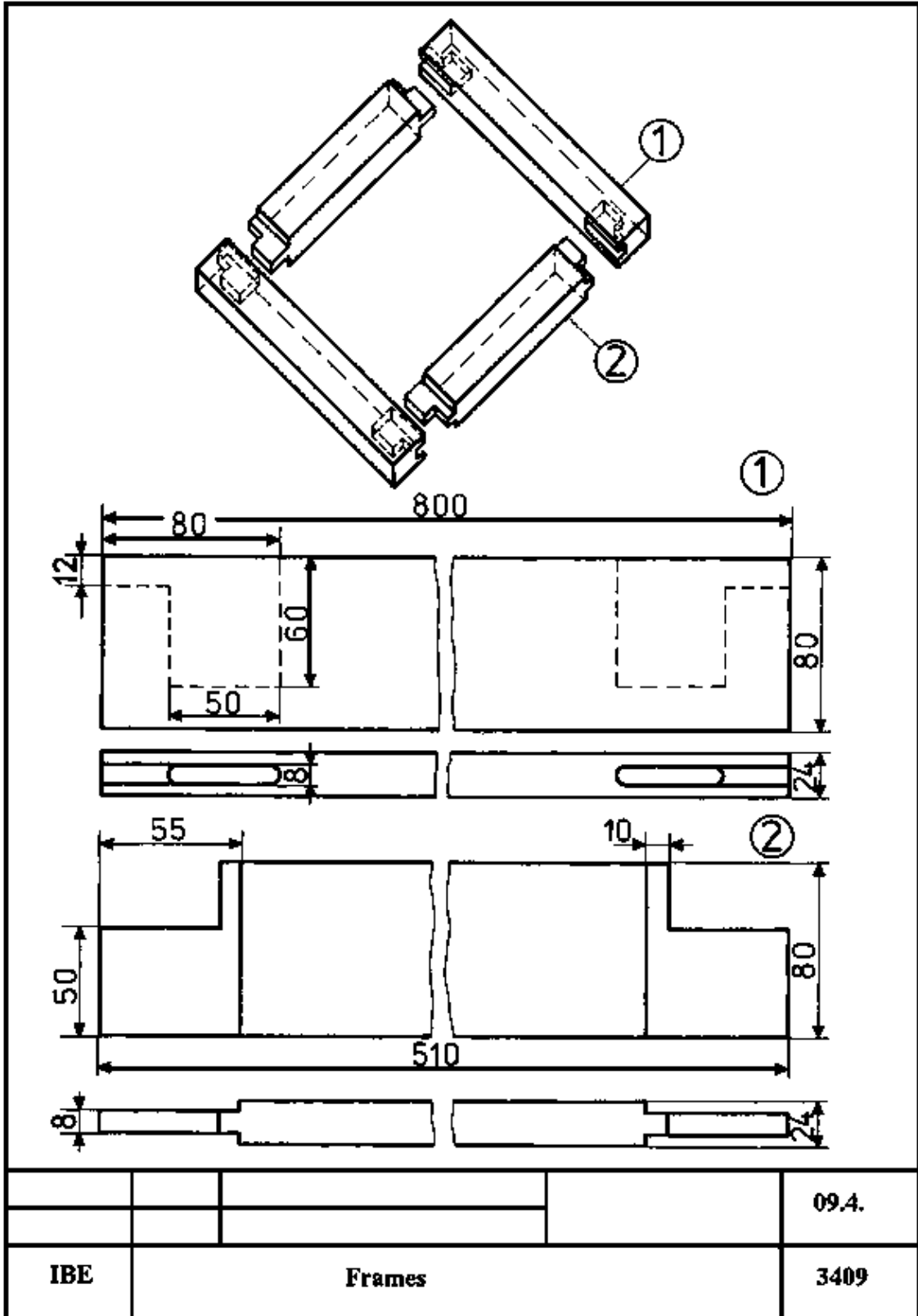
bores. Here too, do not mill deep long holes in one go. Inaccurate long holes occur because of rapid feed or of dull tools.

7. Checking the dimensional accuracy.

Checking the dimensional accuracy and cleanliness of the long holes.

Finishing:

Grinding the wide narrow faces. Glueing the frames together and grinding.



Frames

Instruction Example 09.5.: Frame Part with Mortise Dead Lock

Milling a long hole for an apron and milling a long hole for the cover of the mortise dead lock.

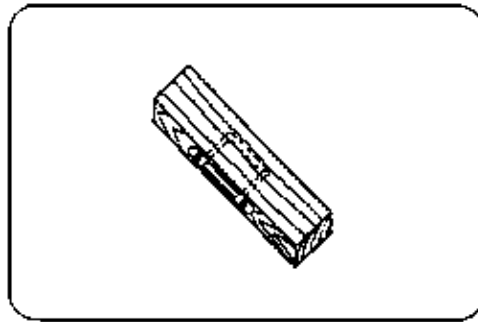
Material

- 1 furniture mortise dead lock (1)
- 1 strip with milled wide and narrow faces

length: variable

width: 80 mm

thickness: 24 mm



Machines and tools

long-hole cutter, long-hole cutting tool, scriber, pencil

Measuring and testing means

folding rule, steel square

Auxiliaries

working desk

Necessary basic knowledge

Marking and measuring, working on circular sawing machines, smooth planing milling and thickness milling machines.

Sequence of operations

Comments

1. Marking the length of the long hole for the apron and the cover on the narrow.

2. Select the long-hole cutting tool according to the thickness of the apron and clamp.

3. Switching on the machine.

4. Drilling and milling the long hole for the apron.

5. Select a long-hole cutting for the cover width and clamp it.

6. Fixing the cutting depth (x) for the cover thickness.

Milling the long hole a bit larger. The apron should sit loose in the hole.

The diameter of the cutter should respond to the cover width, it should sit without allowance in the hole.

7. Milling out the cover thickness between the markings.

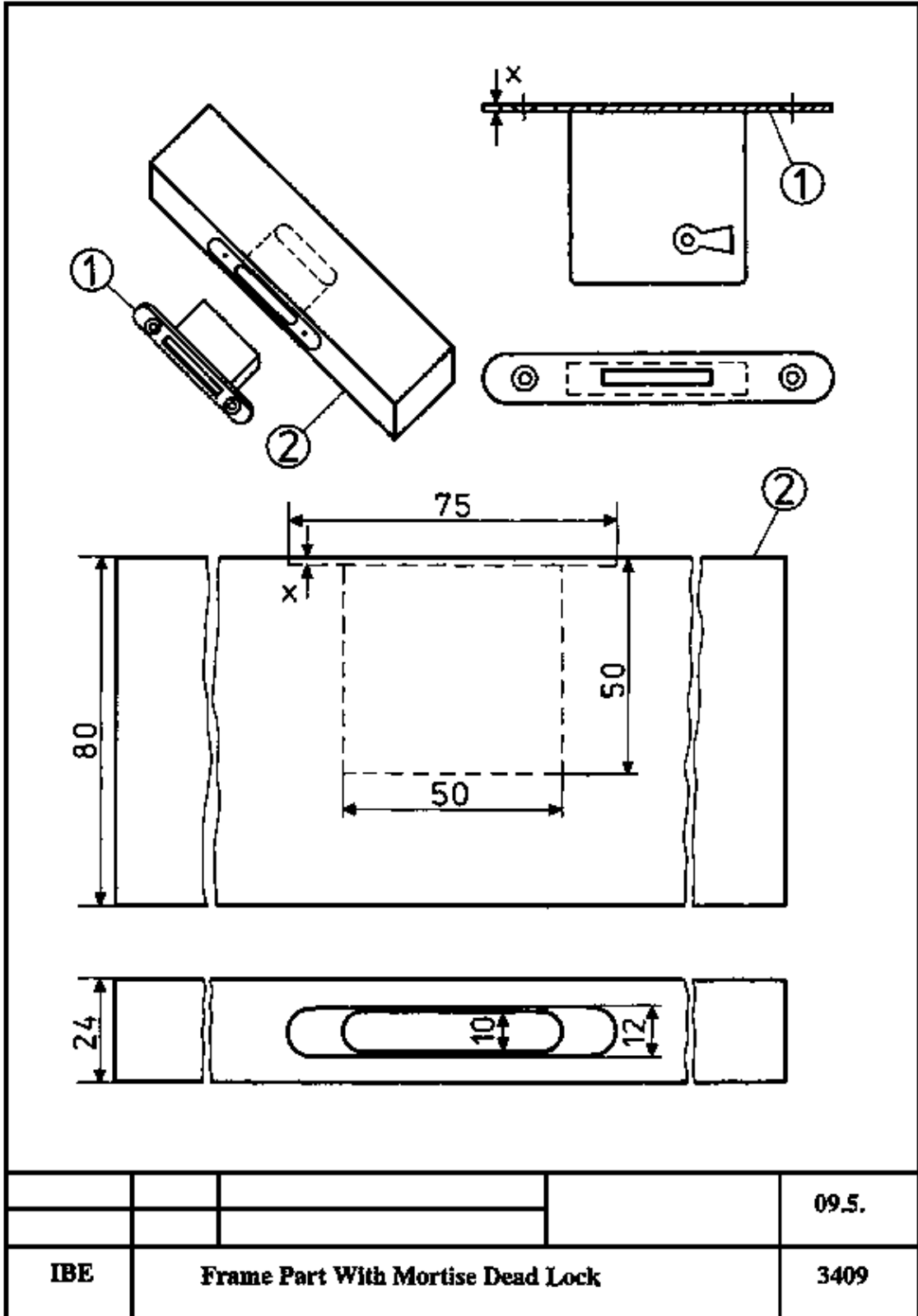
Pay attention to sharp tools and slow feed.

8. Clean the long hole from shavings and place the dead lock for checking the true-to-sizeness.

The apron should sit loose in the hole. The cover should fit close to joint into the hole.

Finishing:

Screwing the mortise dead lock into the frame part with two wood screws.



Frame Part With Mortise Dead Lock

**Working on Long-hole Cutting Machines – Course: Mechanical
woodworking techniques. Trainees' handbook of lessons**

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Working on Long-hole Cutting Machines – Course: Mechanical woodworking techniques. Trainees' handbook of lessons

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1. The Purpose of Drilling and Cutting with Long-hole Cutters

Long-hole cutting machines (also called longitudinal drilling machines) are applied for drilling of round-hole bores and for drilling and cutting of long holes. According to the type of the machine you can reach maximum bore depths of 200 mm and maximum lengths of the long holes of 200 mm. The diameter of the tools can be up to 25 mm.

Round bores and long holes are the basis of wooden joints: e.g. a doweled groove, a doweled frame joint, a caulked frame joint or cutting-outs for placing mountings.

Round bores and long holes can be manufactured with long-hole cutters across and with the grain of the pieces of work.

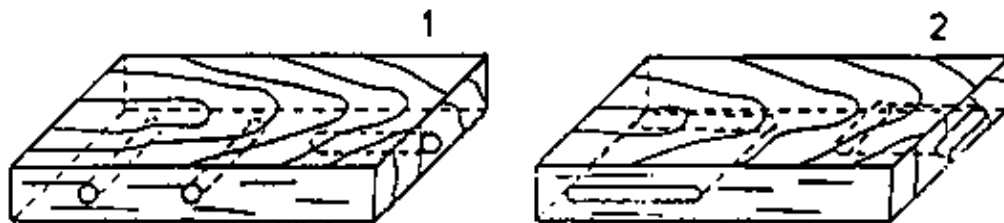


Figure 1 – Working on long-hole cutting machines

1 round bores, 2 long holes

What is the purpose of drilling with a long-hole cutting machine?

What is the purpose of drilling and cutting with a long-hole cutting machine?

2. The Construction of a Long-hole Cutting Machine

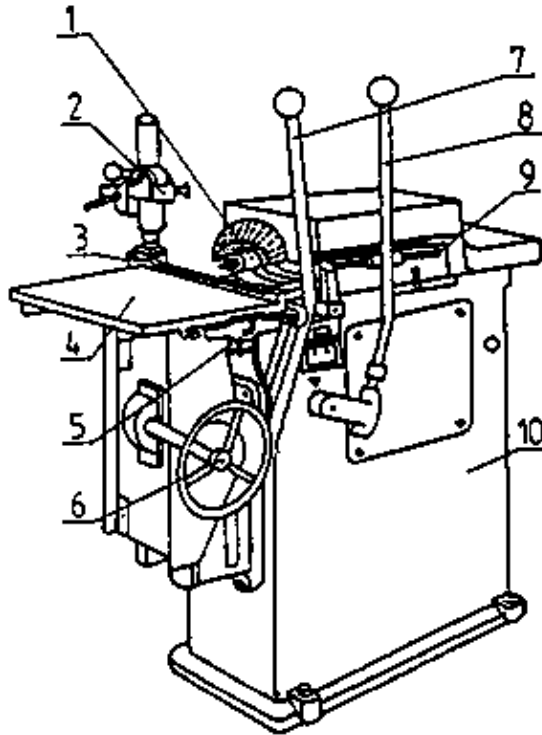


Figure 2 – Construction of a long-hole cutting machine

1 bore chuck with safety basket, 2 fixture, 3 stop edge, 4 working table, 5 stops for fixing the cutting length, 6 hand wheel for adjusting the table height, 7 cutting lever (cross feed), 8 drilling lever (axial feed), 9 stop for fixing the bore depth, 10 stand

The stand

The stand accommodates the motor with the bore shaft and the bore chuck which can be moved in axial direction by a lever. The length of the axial movement determines the bore hole depth and can be fixed by a stop. The working table with the movement mechanism and the lever for the cross feed are fixed on the front side of the stand. The working table can be adjusted in height by a hand wheel.

The working table

The piece of work is clamped on the working table. The working table with the fixture moves on a guideway. The cross feed is carried out by a lever which determines the length of the long hole. The length of the cross feed can be adjusted by two stops.

The stop edge

The stop edge is fixed at a right angle (90°) to the axis of the bore shaft. Fixing the piece of work at that edge the right angularity of the round bore or of the long hole towards the edge of the piece of work is guaranteed.

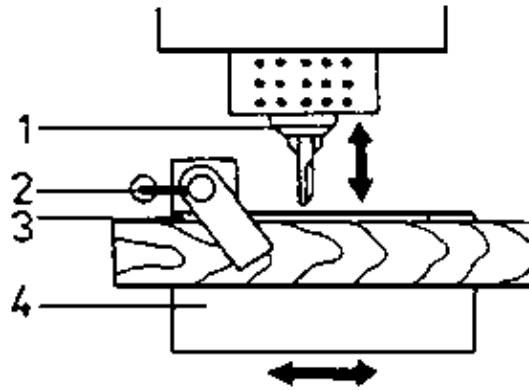


Figure 3 – Fastened wooden boards

1 bore chuck, 2 fixture, 3 stop edge, 4 working table

The fixture

With this machine type the fixture has got an eccentric lever which clamps the piece of work with its pressure plate onto the working table.

Safety devices

Motor and bore shaft are covered. The bore chuck is smooth without projecting edges. A cover basket is placed over the bore chuck.

The fixture should be regularly checked for operation!

The bore chuck and the tool shanks should be kept clean, as well as the surface of the machine table and the stop edge!

The machine should be lubricated according to a lubrication plan regularly!

What is the working table used for?

Why has the working table got a fixture?

Why has the working table got a stop edge?

How can the length of the cross feed of the working table be fixed?

3. The Tools

For drilling of round bores twist drills with a roof-shaped point or with a centre point are applied. The spiral shaped cutting notches cause a fast throwing out of the shavings. The centre point supports the guideway of the drill.

An especially good guideway with simultaneously clean bore edges without torn out particles is reached by a twist drill with a staggered centre point where the external edges of the main cutting edges are in the cut first and thus support the guideway of the driller.

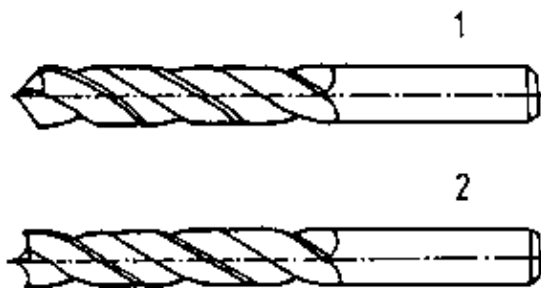


Figure 4 – Twist driller

1 with roof shaped point, 2 with staggered centre point

For cutting of long holes long-hole cutters (also called longitudinal drillers) with straight lengthwise cutting edges, one or two cutting notches and front cutting edges are applied. The straight lengthwise cutting edges cause the main cutting off. Because straight cutting notches are throwing out shaving worse than the spiral shaped ones deep cuttings are to be carried out with a long-hole cutter always in several steps.

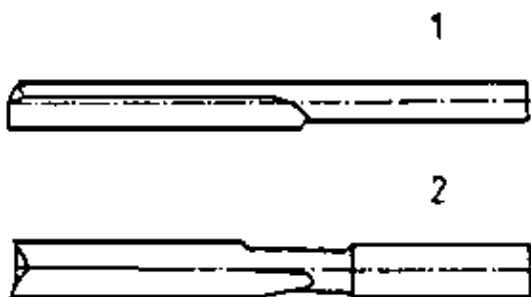


Figure 5 – Long-hole cutter

1 with one cutting notch, 2 with two cutting notches

Clean the tools carefully from resin, varnish and glue after application!

For cleaning use solvents only, no metallic auxiliaries are to be applied!

Keep the tool in containers to protect the cutting edges against any kind of damage!

Which tool is mainly applied for drilling of round bores?

What is the purpose of the centre point of the driller?

Which tool is applied for drilling and cutting of long holes?

4. The Operation of the Long-hole Cutting Machine

Switching on the machine the bore chuck with the clamped tool is set into rotation, depending on the type of the machine from 1400 up to 11000 revolutions per minute. Now the drilling tool is pressed against the piece of work. By shaving off the piece of work round bores and long holes across and with the grain of the wood are manufactured.

Round bores up to a maximum depth of 200 mm are drilled by the axial movement of the bore shaft.

Long holes up to a maximum length of 200 mm are manufactured by lining up several round bores and cutting out the remaining wood stays.

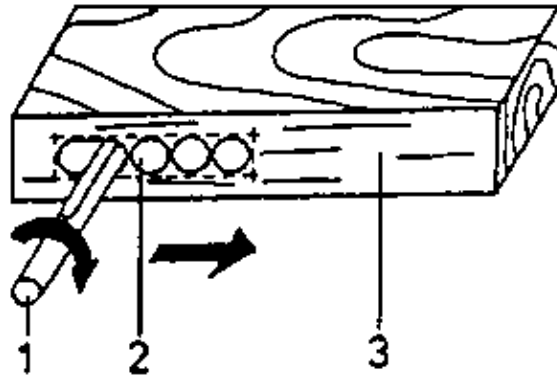


Figure 6 – Cutting out of lined up round bores to form a long hole

1 long-hole cutter, 2 round bores, 3 wooden board

In which way are manufactured long holes with long-hole cutting machines?

5. Technological Processes of Drilling and Cutting

5.1. The Manufacturing of Round Bores

Marking the piece of work

According to the measures taken from the technical drawing the bore centres are marked and punched with the awl so that the bore point can be placed precisely when drilling.

Be careful when handling the awl!

Risk of accident!

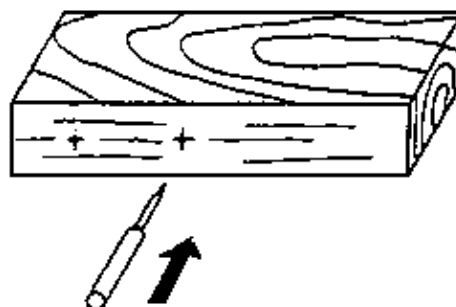


Figure 7 – Marking and punching of the bore centres

Clamping the drill

After the selection of the necessary twist drill the latter is clamped in the bore chuck where the shank is placed in the bore chuck to the stop and clamped.

Pay attention to a secure clamping and to true running!

Only tools with an undamaged shank should be applied!

Adjusting the bore depth

The necessary bore depth is adjusted on the stop.

Clamping the piece of work

The piece of work is placed on the stop edge of the working table and clamped with the fixture.

Check for secure clamping!

Adjusting the table height

The working table is adjusted with the hand wheel till the pre-punched bore centre of the piece of work corresponds with the height of the bore point.

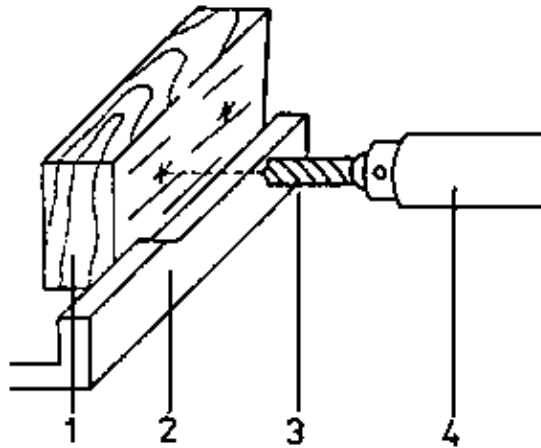


Figure 8 – Adjusting the table height

1 wooden board with marked and pre-punched bore centres, 2 stop edge, 3 drill, 4 bore chuck

Drilling

The machine is switched on, now the drilling tool is pressed against the piece of work with the lever until stop the stops the axial movement. Now the required bore depth is reached.

When drilling the axial feed is carried out with the right hand while the left hand has to ensure the adjustment of the piece of work on the bore hole centre with the cross feed.

Please do wear a head cover and tight-fitting clothes!

Do not grip with your hand over the bore chuck – risk of injuries!

Switching off and checking

After having resed the drill the machine is switched off. After removing the shavings the quality of the bore is checked with suitable measuring means.

Why must the bore centres be pre-punched after marking?

What should be payed attention to when clamping the drill?

What is the necessary bore depth fixed with?

How can you find out if the right table height is adjusted?

How is the drilling operation carried out?

5.2. The Manufacturing of Long-holes

Marking the piece of work

With single manufactured pieces of work the form of the long hole is marked in width and length. Now single bores lined up side by side filling out the long hole are pre-punched according to the bore diameter.

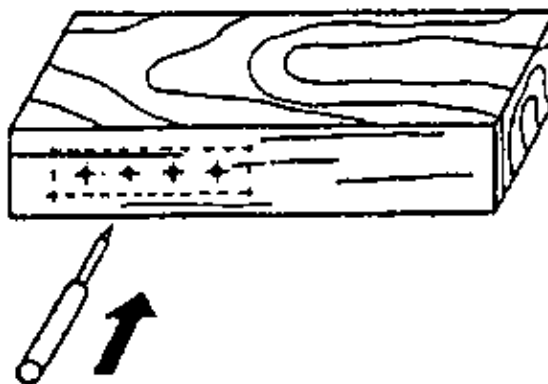


Figure 9 – Marking the long hole and punching the bores

Clamping the long-hole cutting tool

The long-hole cutter is clamped in the bore chuck securely.

Check for secure clamping!

Adjusting the long hole's depth

The necessary depth of the long hole is adjusted on the stop – with the first cutting of deep long holes the total depth is not fixed yet.

Clamping the piece of work

The piece of work is placed on the slop edge of the working table and clamped securely with the fixture.

Check for secure clamping!

Adjusting the table height

The working table is adjusted with the hand wheel so that the bore centres correspond with the centre of the long-hole cutter. The table alignment should correspond with the alignment of the long hole.

Adjusting the length of the long hole

This length is adjusted by two stops. When manufacturing several pieces of work of the same type an extra stop chunk is fixed on the working table, so the marking of the long hole can be dropped and the dimensional accuracy is ensured. The stops are adjusted once for the first piece of work after which many pieces of work of the same type can be manufactured without time wasting marking and adjusting jobs being necessary.

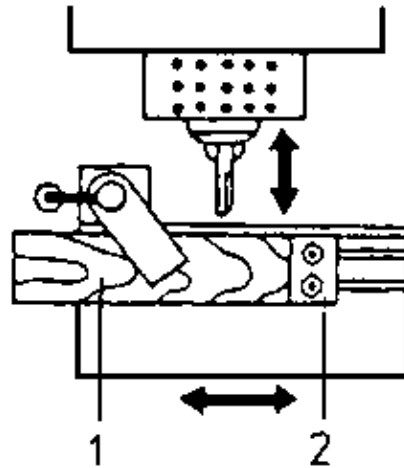


Figure 10 – Fastening the wooden board with the help of a stop chunk

1 wooden board, 2 stop chunk

Drilling and cutting

The machine is switched on and now the single bores lined up side by side are drilled out step by step. With the last bore operation the stop should be adjusted for the final depth of the long hole.



Figure 11 – Single bores to fill the long hole

Finally the remaining wooden stays are cut off with the cross feed of the working table. With deep long holes the cutting should also be carried out in several steps in order not to overstress the cutting tool.

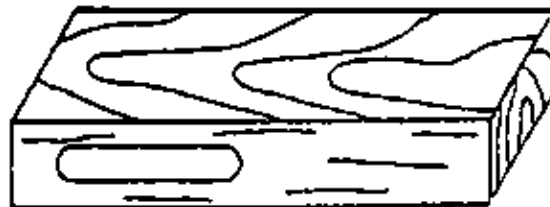


Figure 12 – Finish-cut long hole

Switching off and checking

After having reset the long-hole cutter the machine is switched off. After removing the shavings the quality of the long hole is checked.

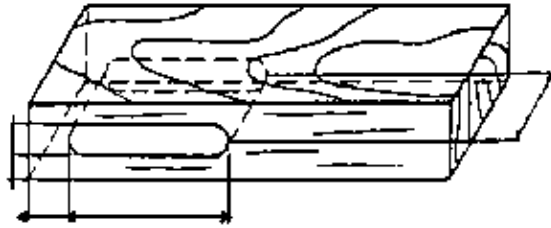


Figure 13 – Checking the long hole

How do you mark single manufactured pieces of work for long-hole cutting?

How do you adjust the length of the long hole if several pieces of work of the same type are to be manufactured?

Why must drilling and cutting of deep long holes be carried out in steps?

**Measuring and Scribing – Course: Manual woodworking techniques.
Instruction examples for practical vocational training**

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Measuring and Scribing – Course: Manual woodworking techniques. Instruction examples for practical vocational training

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Preliminary Remarks

The present booklet includes three instruction examples by means of which measuring and scribing exercises with sawn timber and panels can be carried out.

The mastering of these working techniques is the precondition for

- a professional cutting of wood-based materials
- the sawing to final size
- the planing to width and thickness and
- the manufacturing of wood joints of all kinds.

To facilitate the preparation and execution of the work, the necessary materials, tools and auxiliaries are specified for each instruction example. Necessary previous knowledge of the features of the wood-based materials as well as of wood defects and their consideration when scribing is mentioned. The sequence of operations for each instruction example includes the order of the working steps which should be followed in the working techniques of “Measuring and Scribing” in order to reach an economical use of the working materials and a high dimensional accuracy.

A working drawing is added to each instruction example showing the required shapes and dimensions of the workpiece to be manufactured.

In the instruction examples preparatory works on the workpieces are carried out which after further working steps like sawing, planing, manufacturing of joints and so on result in ready-made commodities.

Instruction Example 1.1.: Board

Measuring and scribing of wide faces is practised on the board.

Material

Unedged-sawn boards of hard- or softwood.

Measures depend on the work order but should be no less than

thickness: 30 mm

width: 200 mm

length: 1500 mm

Tools/Measuring and testing means

Folding or steel rule or measuring tape, working square

Auxiliary accessories

Working stands, work or carpenter's bench, straightedge, pencil, coloured chalk (if available)

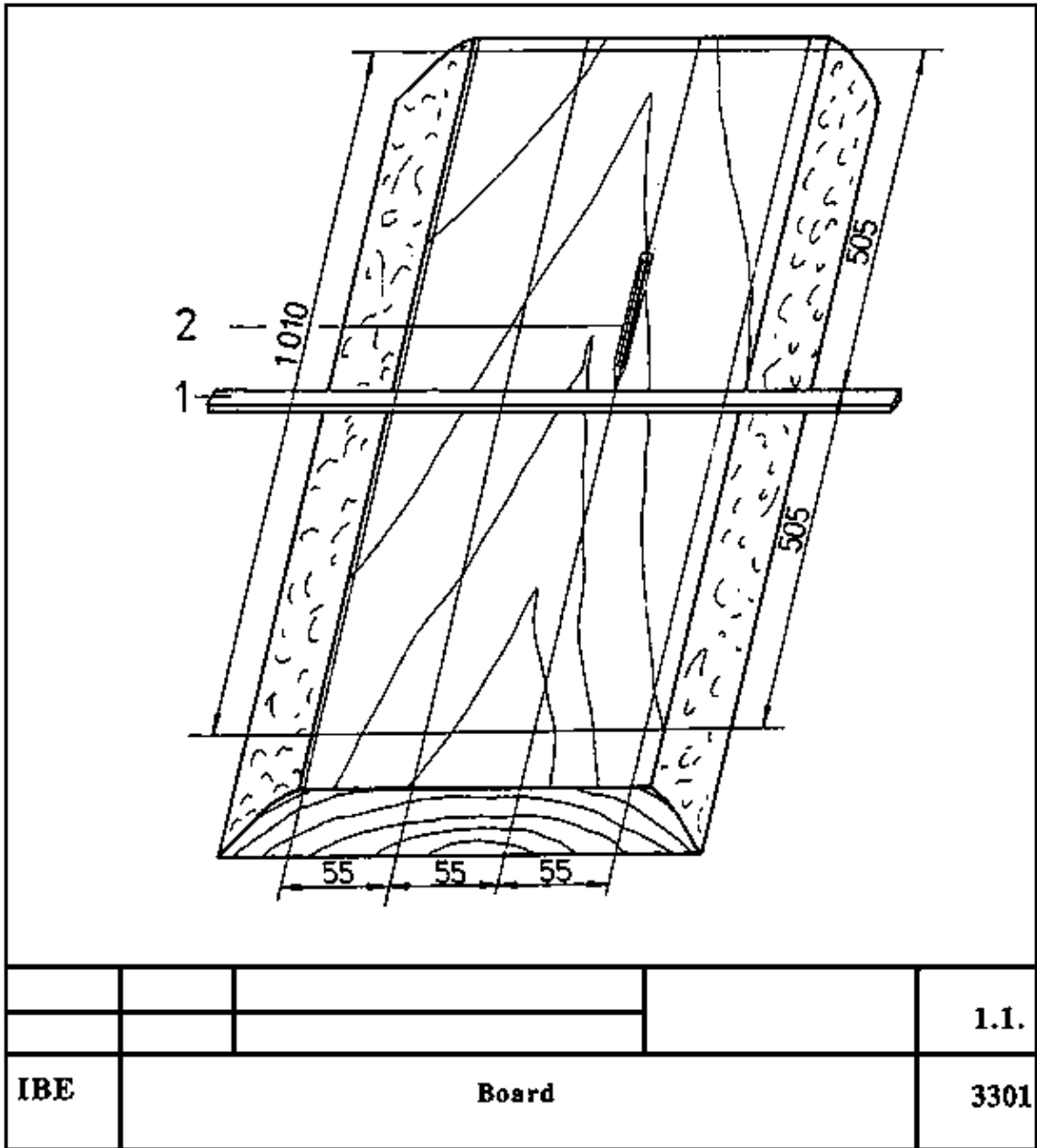
Required previous knowledge

Use for measuring units, reading of drawings, knowledge of the features and defects of the species of wood

Explanations to the working drawing

1 straightedge, 2 pencil

| | Sequence of operations | Comments |
|----|--|---|
| 1. | Prepare the working place. | Check for the completeness of the working materials. |
| 2. | Put the board on the stands or on the work bench. | The number of the stands depends on the board's length. |
| 3. | Check the board for wood defects. | Check which defects can be processed without loss of quality. |
| 4. | Determine and scribe the length reference edge with the straightedge and the pencil. | Consider if a part of the natural bevel can be included in the workpiece. |
| 5. | Mark off the width sizes and scribe them with the straightedge and the pencil. | Pay attention to the additional working allowance. |
| 6. | Mark off the length sizes and scribe them with the working square and the pencil. | Pay attention to the additional working allowances. |
| 7. | Check the marked off sizes and compare with the working drawing. | |



Instruction Example 1.2.: Frame Timbers

Measuring and scribing of wide and narrow faces of frame timbers is to be practised.

Material

Cut and planed strips of hard- or softwood. Measures depend on the work order, e.g.: final sizes:

- thickness: 24 mm
- width: 50 mm
- 1st length: 1000 mm
- 2nd length: 500 mm

Tools/Measuring and testing means

Folding rule, scribe, try square, marking gauge

Auxiliary accessories

Work bench or carpenter's bench, screw clamp, pencil

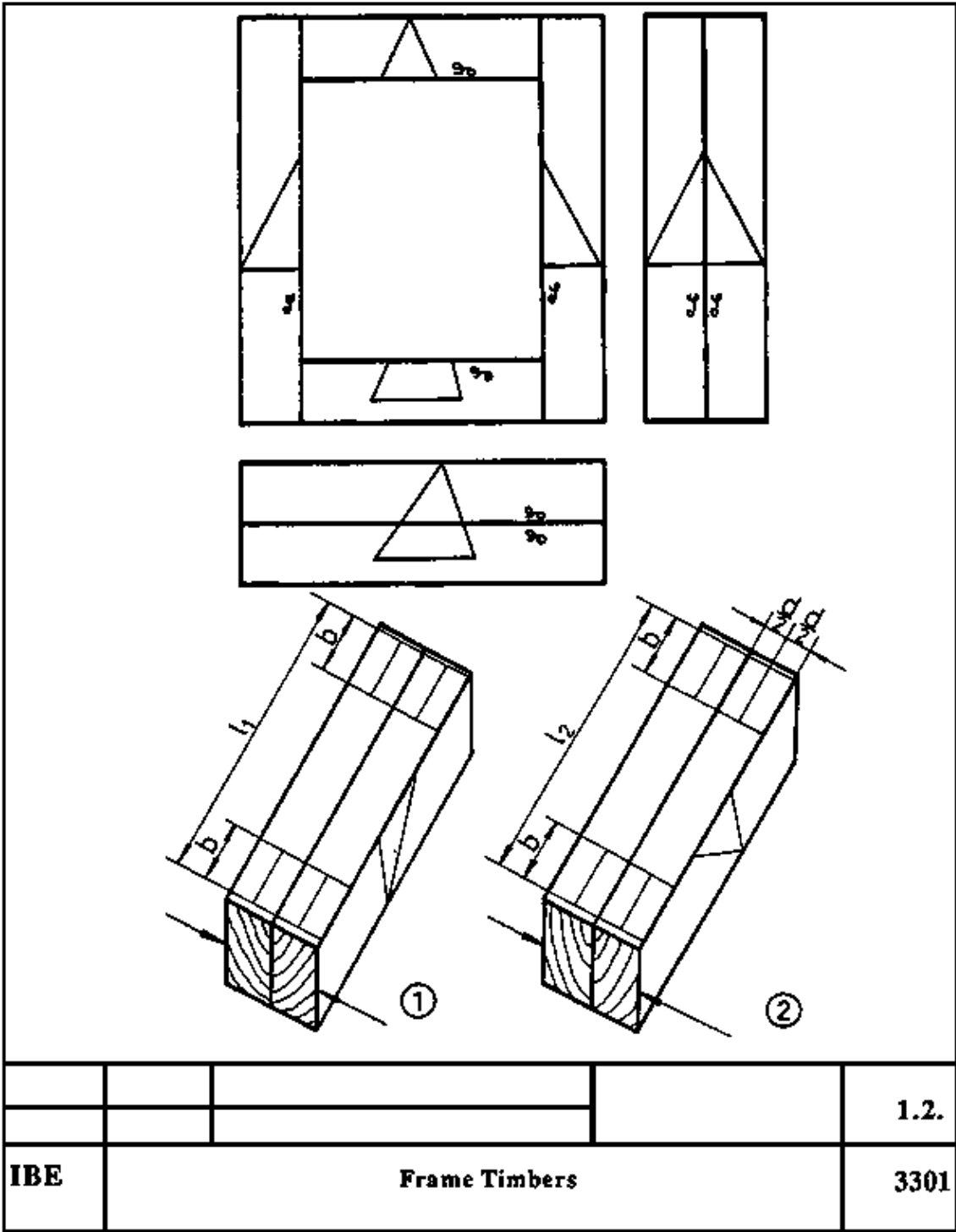
Required previous knowledge

Use of measuring units, reading of drawings

Explanations to the working drawing

- (1) upright timbers
- (2) crosspieces
- ? angle at the reference edge
- d thickness
- b width
- l length

| Sequence of operations | Comments |
|--|---|
| 1. Prepare the working place. | Check the tools. |
| 2. Mark the reference edges. | The best side of the timbers points inwards. |
| 3. Draw the timbers together. | Mistakes are avoided. |
| 4. Parallel timbers are clamped together with a screw clamp. | In this way uniform marking off of sizes is possible. |
| 5. Mark the final length size and the finished dimensions with the try square and the scribe on the reference narrow face. | Use the scribe only there where later chip-forming processes are carried out, otherwise use a sharp pencil. |
| 6. Unclamp the timbers and transfer the marking onto the wide face by means of the scribe and the try square. | |
| 7. Set the marking gauge and scribe the finished dimensions. | The finished dimensions depend on the type of wood joints. |
| 8. Check all markings. | |
| 9. Compare with the drawing. | |



Instruction Example 1.3.: Scribing with Templates

Practise the scribing of curved lines with templates for curves of all kinds.

Material

According to their application solid wood strips or plies (plywood).

Measures:

solid wood

thickness: 20 mm

width: 100 mm

length: 1000 mm

ply

thickness: 6 mm

width: 100 mm

length: 1000 mm

Tools

Folding rule, pair of compasses, try square

Auxiliary accessories

Work bench or carpenter's bench, pasteboard, pencil, scissors, template (to be made if necessary)

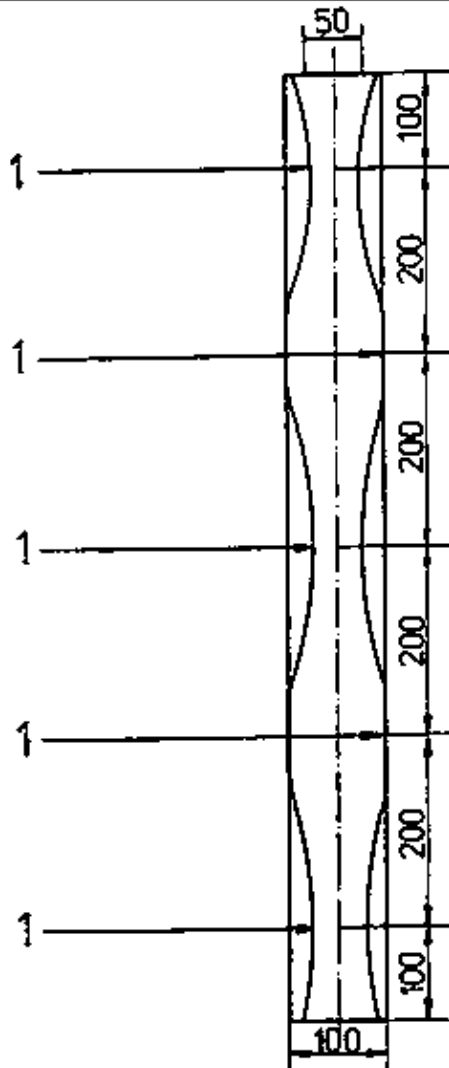
Required previous knowledge

Knowledge of wood features (pay attention to the grain direction), reading of drawings

Explanations to the working drawing

1 equal to radius R 400

| | Sequence of operations | Comments |
|----|---|--|
| 1. | Preparation of the working place. | Check for the completeness. |
| 2. | Construct the template on pasteboard (or transfer it from the drawing). | Determine if a working allowance has to be taken into account. |
| 3. | Cut out the template. | |
| 4. | Put the template on the workpiece. | Place it so that a large part of the workpiece surface has a continuous grain direction. |
| 5. | Mark the form of the template with a pencil. | |
| 6. | Check the markings. | |



| | | | | |
|-----|-------------------------|--|--|------|
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| | | | | 1.3. |
| IBE | Scribing with Templates | | | 3301 |

**Measuring and Scribing – Course: Manual woodworking techniques.
Trainees' handbook of lessons**

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Measuring and Scribing – Course: Manual woodworking techniques. Trainees' handbook of lessons

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1. The Purpose of Measuring and Scribing

Measuring and scribing are essential working operations of woodworking techniques. They are necessary to guarantee accuracy of fit of wood joints as well as dimensional stability and the design of the workpieces.

Lengths or angles of an object are measured by comparing with a measuring instrument (e.g. a folding rule) on the scale of which the exact measuring rate can be read off. Scribing is transferring the required sizes on the workpieces.

2. Tools for Measuring and Scribing

2.1. Measuring Tools

In manual woodworking it is necessary to measure lengths, widths and thicknesses as well as bevels (angles) of workpieces.

Table 1 shows the most usual length measuring tools with their features and possibilities of application.

Table 1: Length Measuring Tools

| Name | Features | Application |
|----------------|--|--|
| Folding rule | – 1.....2 m – graduation – 1 mm – less accuracy due to hinged connection | – taking off constructional dimensions – scribing when cutting to size solid wood, panels and veneers |
| Steel rule | – 0.....300 mm – graduation – 1 mm – inflexible steel tapes with etched graduation | – scribing for wood joints – check measurements |
| Measuring tape | – 0.....2 m | – scribing before cutting to size |

| | | |
|-----------------|---|--|
| | <ul style="list-style-type: none"> – graduation – 1 mm – flexible steel blade of stainless steel medium – accuracy | <ul style="list-style-type: none"> – scribing and checking for finish cutting – scribing for wood joints |
| Measuring staff | <ul style="list-style-type: none"> – 0.....3 m – graduation – 1 m – inflexible wood rods – only for minimum accuracy requirements | <ul style="list-style-type: none"> – first check of arriving sawn timber and panels – scribing for rough cutting |
| Vernier caliper | <ul style="list-style-type: none"> – 0.....300 mm – graduation – 0.1 mm – the workpiece is placed between the measuring faces | <ul style="list-style-type: none"> – exact measuring of thickness – measuring of radiuses and bore hole depths |

In case of often appearing sizes fixed length gauges and angle gauges are used for scribing and checking. Gauges represent only special sizes. They don't have any moving parts, i.e. they are fixed on a certain size. Table 2 shows the mostly used gauges with their features and application possibilities.

Table 2: Gauges

| Name | Features | Application |
|------------------|---|---|
| Distance gauge | – self-manufactured woods indicating the distance between an edge and the working area to be recessed | – scribing of several parts of the same kind |
| Curve gauge | – curved templates | – scribing of rounded corners and surface roundings |
| Working square | – angle of 90° | – checking the angularity and transferring the markings angularly |
| Mitre rule | – angle of 45° | – scribing of frame mitres |
| Bevel protractor | – any angle can be fixed | – scribing of all kinds of mitres |

2.2. Scribing Tools

Besides the already mentioned measuring tools

- the marking gauge,
- the pencil and
- the scriber are needed for scribing.

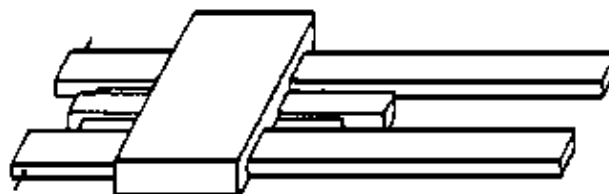


Figure 1 Marking gauge



Figure 2 Scribe

Attention – the scribe is a sharp tool and careless handling can lead to injuries!

Name at least six tools for measuring and scribing.

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

3. Measuring and Scribing

Exact knowledge of the working techniques “Measuring and Scribing” is essential for good working results. Therefore they have to be carried out carefully and to be checked conscientiously. The following activities are distinguished with regard to the techniques:

- drawing of parts belonging together
- measuring and scribing on one plane (mainly on wide faces)
- measuring and scribing on two planes (wide and narrow faces)

For making wide face joints the piece parts are marked with a triangle. Thus mixing up or incorrect joining is avoided.

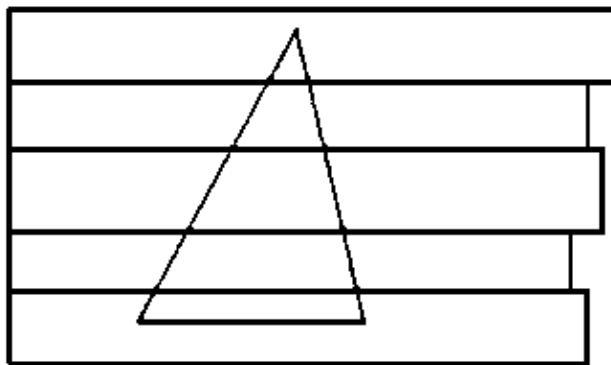


Figure 3 Drawing of piece parts of a wide face joint

The drawing of frame joints and face corner joints is done in two stages:

- marking the reference edge (bevelled edge) with an angle sign
- after selecting and placing together the parts, the parallel parts are marked with a triangle.

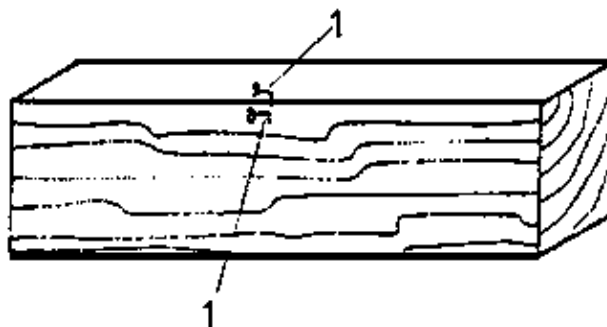


Figure 4 Marking of an angle reference edge

1 angle reference edge with angle sign

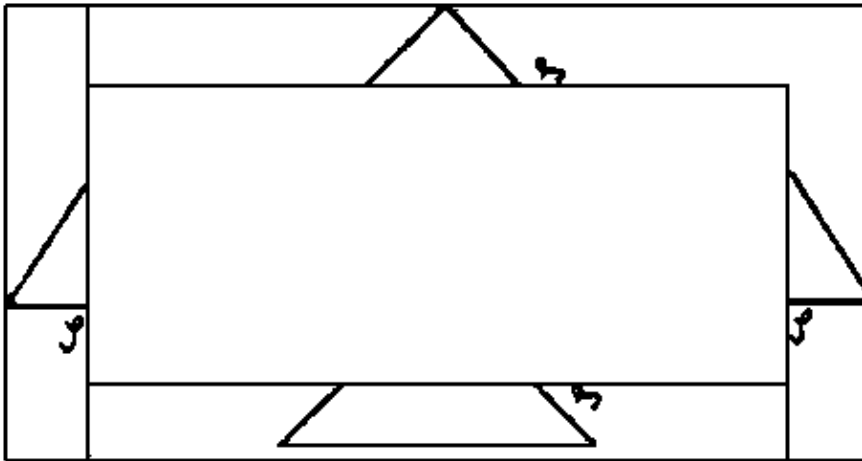


Figure 5 Marking of frame parts belonging together

3.1. Measuring and Scribing on one Plane

When measuring sawn timber panels, pay attention to small losses with regard to the use of these materials. The sequence of operations includes the following activities:

- Prepare the necessary tools and materials (e.g. drawings).
- Put the board on the work bench (best side to the top).
- Mark the length reference edge with a pencil and a straightedge.
- Measure the width of the workpiece (pay regard to the working allowance and the cut) on three places and scribe with the straightedge and the pencil.
- Measure the workpiece length at the length reference edge (pay regard to the working allowance) and scribe with the working square and the pencil.
- When drawing the pencil line, pay attention to the exact leading of the pencil.
- Check the measurings.

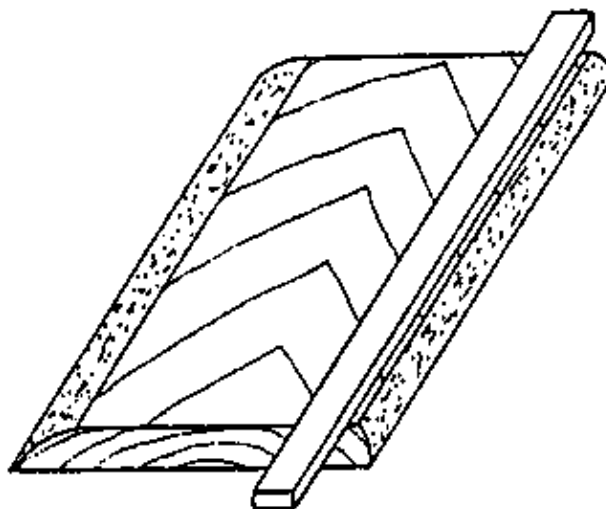


Figure 6 Scribing of a length reference edge

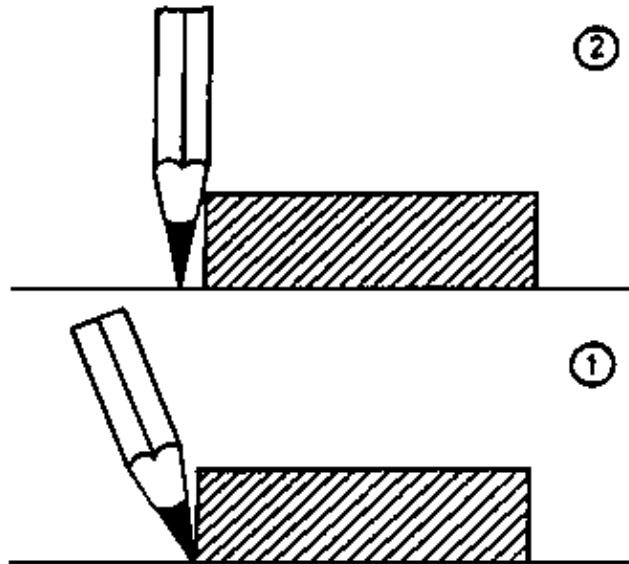


Figure 7 False and right leading of the pencil

(1) right, (2) false

Why must the workpieces be scribed before being processed?

When can wanes (or parts of them) remain in the workpiece?

3.2. Measuring and Scribing on two Planes

When sawing to final size and scribing wood joints, it is necessary to mark two or more faces (wide and narrow faces) with scribed lines and dots.

According to the required accuracy the measuring can be carried out with a folding rule, a measuring tape or a steel rule. For scribing are used: a scriber, a marking gauge and in case of faces which are visible after being worked a sharp pencil. The wood to be scribed is smoothed, planed to width and thickness, marked with angle signs and drawn together.

The sequence of operations includes the following activities:

- Prepare the necessary tools and materials (drawings or front view).
- Clamp together parallel running woods with a screw clamp (angle signs to the top).
- Measure the finished size length and scribe with the scriber and the working square.
- Measure the finished dimensions and scribe them with the scriber and the working square.
- Unclamp the woods.
- Transfer the necessary markings angularly.
- Set the marking gauge to the required sizes.
- Put the marking gauge against the angle face of the work-piece and scribe as many faces as necessary.

– Compare the sizes of workpiece and drawing.

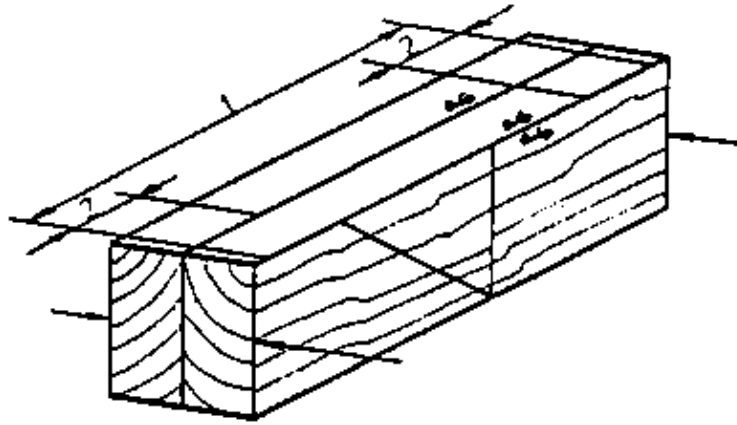


Figure 8 Scribing the finished dimensions

1 inside length, 2 width of the cross frame woods

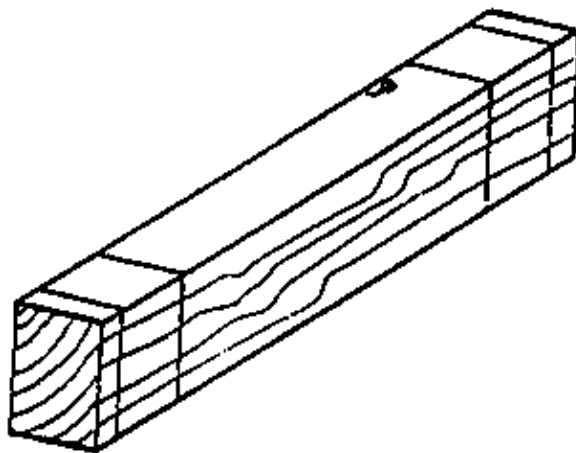


Figure 9 Transferring the markings angularly

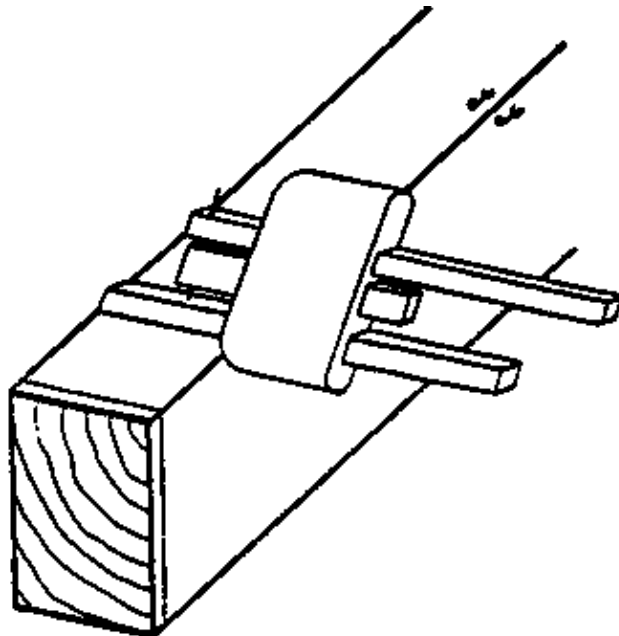


Figure 10 Scribing of the parallel markings with a marking gauge

Why are the visible faces scribed only with a pencil?

3.3. Scribing with Templates

When manufacturing workpieces with rounded edges (rounded comers and surface roundings), in case of single-part production the form can be constructed and scribed directly on the face of the parts. If several forms of the same kind are required, scribing should be carried out with templates. Before preparing the templates it is to be decided whether they should get a working allowance or not. When preparing the templates you should work carefully because possible inaccuracies recur on all parts being scribed afterwards.

Scribing with a template is relatively simple and includes the following activities:

- Prepare the necessary tools and templates.
- Put the workpieces on the work bench.
- Place the templates so that the flow of the wood fibres guarantees greatest consistency and that possible wood defects can be cut off.
- Scribe the form of the template with a pencil.
- Check the scribed lines.

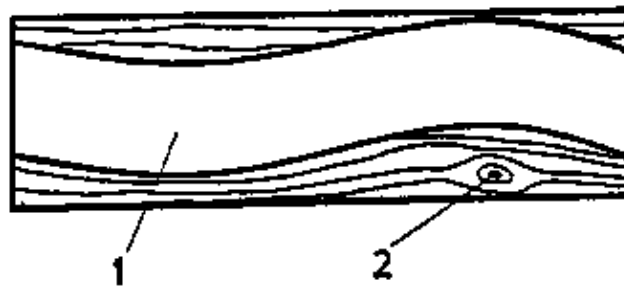


Figure 11 Scribing with a template

1 flow of the wood fibres, 2 wood defects

Which advantages has the application of templates for making equally curved parts?

4. Working Rules for Measuring and Scribing

Handling of measuring tools:

- The ambient temperature should be 90° C if possible.
- Put the line rules parallel to the measured length.
- Read off the measured value at an optical angle of 90°.
- The joints of the folding rule must be fully stretched.
- Put on and use the vernier caliper carefully.

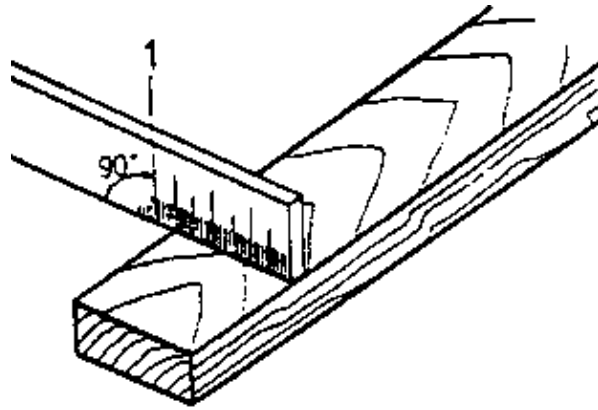


Figure 12 Reading off the measured value vertically

1 reading off the measured value at an optical angle of 90°

Scribing parallel to the edge:

- Scribe by marking off measures on two or three points.
- Link the markings with the straightedge and the pencil.
- Scribe with the marking gauge:
 - Set the steel points of the marking gauge to the finished dimensions.
 - Put the marking gauge against the angle edge (reference edge) of the workpiece.
 - Lead the marking gauge along the edge and scribe with the steel points.

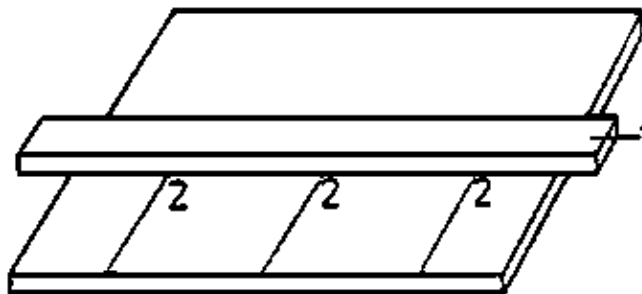


Figure 13 Marking off measures for a parallel marking

1 straightedge, 2 points for marking off the measures

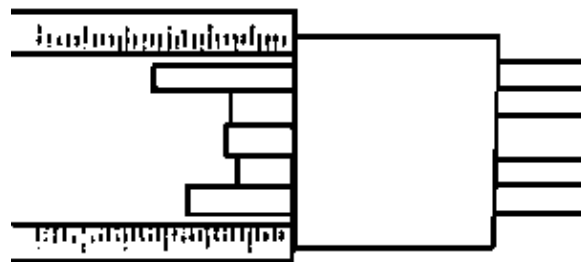


Figure 14 Setting the marking gauge

Scribing at right angles to the edge:

- Apply a working square.
- For markings over or under 90° use a mitre square or a bevel protractor.

Handle the bevel protractor carefully – check the set angle from time to time!

Scribing with templates:

- Handle and preserve the templates carefully for reuse.
- In case of longish forms of the workpiece pay regard to the fibre flow of the wood.

Why must the joints of the folding rule be fully stretched?

Why should the marking gauge always be put against the angle face of the workpiece?

Why must the angle of bevel protractors be checked from time to time?
