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Filing – Course: Technique for Manual Working of Materials. Methodical Guide for Instructors

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Filing – Course: Technique for Manual Working of Materials. Methodical Guide for Instructors

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Original title:
Methodische Anleitung für den Lehrenden
“Feilen”

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Order No.: 90–32–3105/2

1. Objectives and contents of practical vocational training in the working technique of “Filing”

By concluding their training the trainees shall have a good command of the working technique of “Filing”. Therefore, the following objectives are to be achieved:

Objectives

– Knowledge of purpose and application of the filing technique.

– Proper handling of files and capability of filing all surfaces, edges and break–throughs to size.

– Capability of selecting and properly using the appropriate tools and accessories.

– Capability of making decisions on quality independently.

The following contents have to be imparted to the trainees:

Contents

– Purpose of filing
– Tools and accessories
– Effects and handling of files.

2. Organizational preparations

In order to guarantee a trouble–free development of the instructions, exercises and practical work it is necessary to prepare this training appropriately.

The following steps have to be taken:

2.1. Preparations for instructions on labour safety

Prior to the exercises, a brief instruction on the proper use of tools and equipment has to be given. This comprises also hints for accident–free work.

The main emphasis is to be laid on:

– Files with crack–free file handles must be used only.

– New file handles are to be drilled and enlarged in relation to the tang of the file and then fixed by light blows with the hammer.

– Files are to be protected from dropping and must not be laid one above the other.

– Hardened components must not be filed – danger of slipping!

Familiarity with these hints has to be confirmed by the trainees' signatures in a control book,

2.2. Provision of teaching aids

– For demonstration purposes during the instructions, a vice has to be firmly installed at the place.

– The "Trainees' Handbook of Lessons – Filing" is to be handed out to the trainees in sufficient numbers.

– When using the transparencies series of "Filing", check whether they are complete (transparencies nos. 5.1. – 5.5.) and whether the overhead projector is functioning. (Check the operating conditions at the place of use and make sure of the proper mains supply!)

– Surveys etc. which are to be written on the blackboard have to be completed prior to the instruction,

– All the tools and accessories mentioned in section 3 (for filing purposes) should be kept ready for illustration purposes.

2.3. Provision of working tools and materials

– The "Instruction Examples for Practical Vocational Training – Filing" must be handed out to the trainees in sufficient copies to provide them with the theoretical foundations for the exercises to be carried out.

– The initial materials necessary for the exercises have to be prepared and laid out in sufficient numbers according to the materials mentioned in the "Instruction Examples ..."

– Each trainee is to be provided with a workbench at which a vice is firmly installed (check the proper height of this vice!)

– The trainees' workbenches have to be fully equipped with tools and accessories according to the envisaged exercises.

Recommended basic equipment:

– steel rule, vernier caliper, bevelled edge square, protractor

– steel scriber, prick punch, dividers

– hand hacksaw, locksmith's hammer

– bastard and smooth files 200 – 300 mm (flat, three–square, round)

– warding file (flat)

– In order to carry out the necessary preliminary work (drilling), bench–type or column–type drilling machines with necessary clamping devices (machine vices, holding clamps, C–clamps) are necessary.

– Before the exercises are carried out, the drilling machines must be checked in order to find out whether their functionality complies with the requirements of labour safety.

2.4. Time schedule

Time planning is recommended for the following training stages:

– introduction to the working technique in the form of instructions
– necessary demonstrations
– job–related instructions to prepare the exercises
– carrying–out the exercises
– recapitulations and tests.

The necessary time–share depends on the respective training conditions. Most of the time is to be allocated to the exercises.

3. Recommendations for practical training in the working technique of "Filing"

The following paragraphs comprise proposals on conducting trainee instruction, the demonstration of working techniques as well as the exercises and tests.

The following sequence of stages is recommended:

– Introductory instruction with demonstrations from the "Trainees' Handbook of Lessons"
– Exercises in "Filing" based on the "Instruction examples 5.1. to 5.6."
– Final test of theory knowledge based on the contents of "Examples for Recapitulations and Tests"

Practical skills should be evaluated immediately after having received the trainees' test workpieces. Knowledge of theory should be constantly checked, however, it is recommended that a final test paper should be written after concluding the exercises.

3.1. Introductory instruction

If possible, this instruction should be conducted in a classroom.

Make sure, that the trainees put down necessary and supplementary notes or answers to questions in their "Trainees' Handbook of Lessons".

Instruction can be carried out on the basis of the main points contained in the "Trainees' Handbook of Lessons".

The two major subjects of "Purpose of Filing" and "Tools and Accessories for Filing" should be taught in such a way that all the teaching aids available are employed.

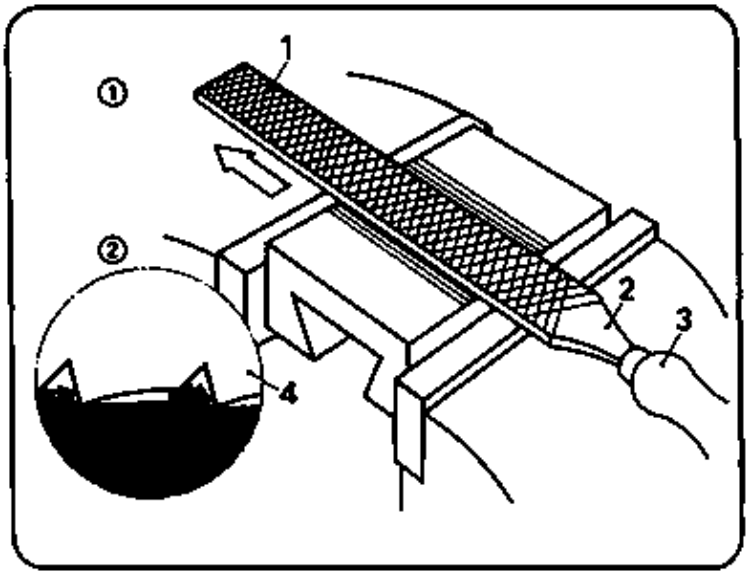
Purpose of filing

This subject can be explained to the trainees by employing work–pieces which had been worked with files. The trainees will learn that these workpieces reveal all the signs of a single–piece production.

The trainees will learn – and this is to be emphasised – that the finishing of surfaces or shapes is one of the major applications of the filing technique and that they must have a good command of this skill.

Tools and accessories

Introducing the subject of files should be begun with a flat file. The design of this tool can be illustrated by referring to the original tool and to the illustrations contained in transparency no. 5.1.

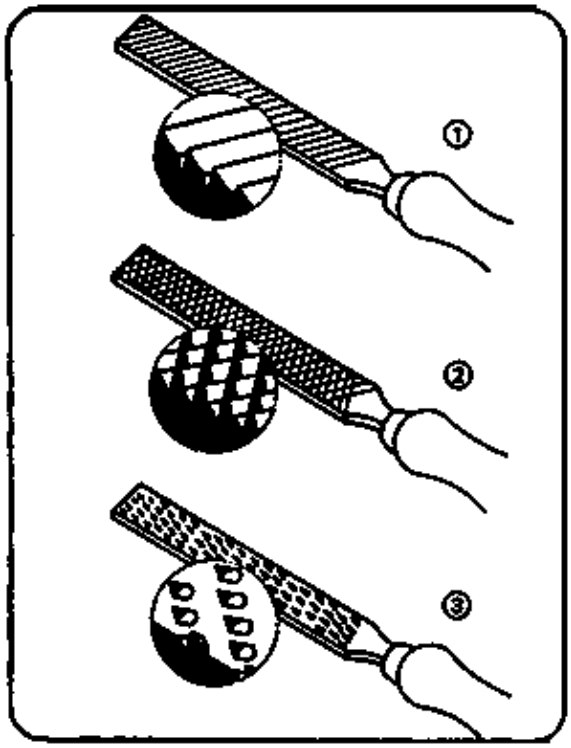


5.1

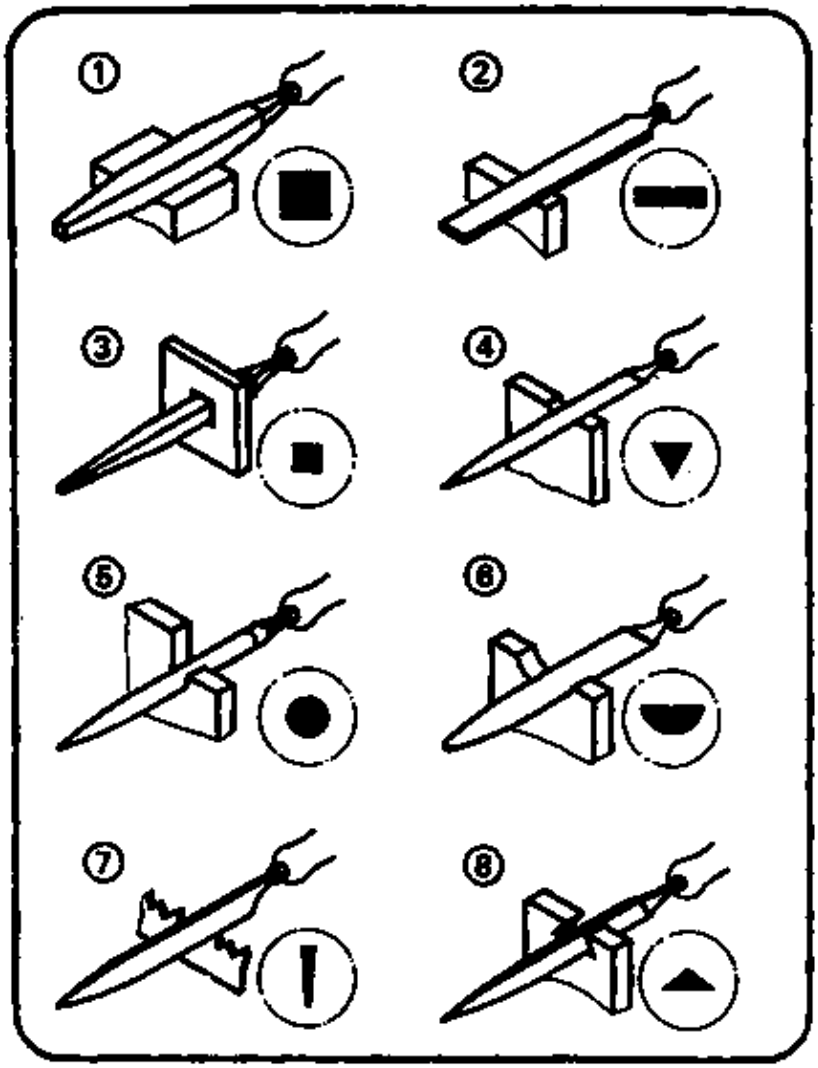
This is also the time to demonstrate the kinds of fixing file handles to the file blade. This will be followed by introducing the other types of files contained in the list of the "Trainees' Handbook of Lessons":

– flat file
– square file
– triangular file (three–square file)
– round file
– half–round file
– crossing file
– barrette file
– knife–edge file.

The demonstration of original tools can be supported by showing the illustrations contained in the transparencies nos. 5.2. and 5.3.



5.2



5.3

The trainees have not only to know the types of files but also how to use them. In this context the instructor has to mention that the use of files depends on their sizes and kinds of cut (single–cut, double–cut, rasp–cut).

The following survey (written on the blackboard) can be employed to finalise the instruction:

Designation Cut	**no.**	**File surface**	**Use of file**	**Fineness of file**
rough–cut file (roughing file)	0	rough (stroke of file tangible and visible)	for oversize of 0,5 mm and more	very coarse
bastard file	1			
second–cut file (coarse finishing file)	2	fine (file stroke no longer tangible but still visible)	for oversize of less than 0.1 mm	

smooth–cut (finishing file)	3			
dead–smooth file (fine finishing file)	4	very fine (file stroke neither tangible nor visible)	for fits and best surface finish	
super–smooth file (superfine finishing file)	5			very fine

The introduction of accessories should be linked with remarks on their respective application:

– vice
– vee clamps
– angle clamps
– protective jaws
– clamping jaws for round material
– clamping jaws for bolts and thread clamps
– saw sharpening vice
– hand vice and pin vice
– sheet metal dog vice

This is also the appropriate moment to mention that such accessories can be easily produced by everybody.

The subsequent working techniques contained in this course wilt give some ideas of how to manufacture these accessories during practical exercises.

Action of filing, postures of trainees and guidance of files

Transparency no. 5.1. as well as the illustrations contained in the "Trainees' Handbook of Lessons" can be employed to describe the action of filing. The different actions of milled and chiselled files should be explained. It is to be mentioned that the use of chalk on surfaces will support the job of fine finishing.

The instructor must demonstrate the correct posture and guidance of the file when instructing the group. This can be demonstrated very effectively, if a vice is available in the classroom. If this is not the case, the sequence of motions has to be demonstrated quite clearly.

The instructor has to emphasise that the file must be moved by the motion of the arms only and that it roust work in pushing direction only.

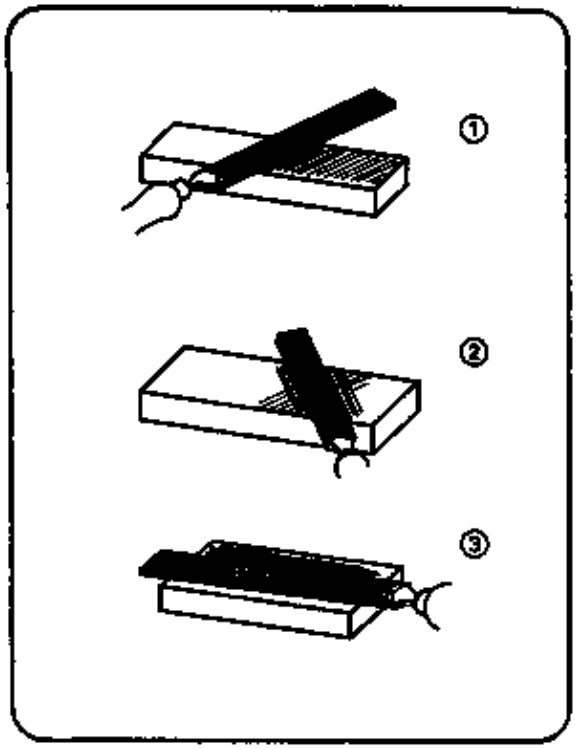
After these demonstrations each trainee should demonstrate the filing movement and posture. The instructor should see to it that all the trainees take part in evaluating the performance of their fellow–trainees.

Handling of files

If there is a vice available in the classroom, the following major subjects should be Imparted to the trainees within the framework of the introductory instruction. The main method Involved in these instructions should be that of demonstrating the practical use of these files. If such a demonstration cannot be given in the classroom, the instruction is to be continued in the workshop.

The instructor has to show how differently large, medium–size and small files have to be handled. Special emphasis is to be laid on the correct handling of file blades by the guiding hand.

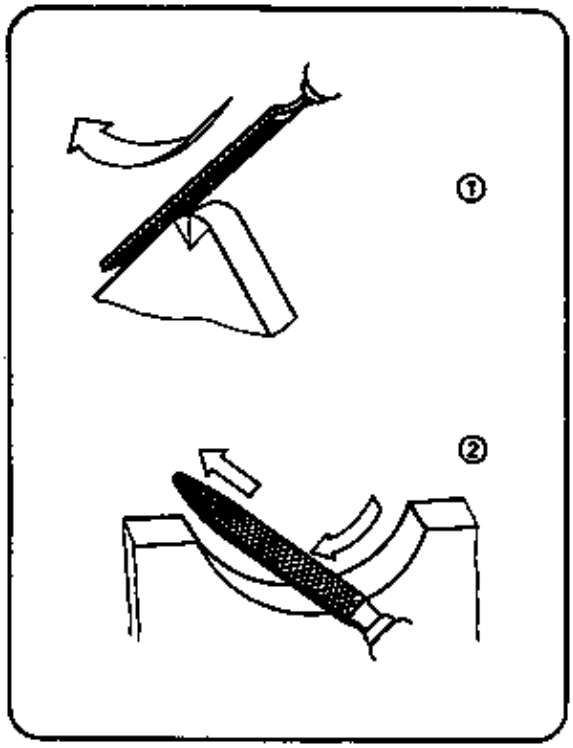
Subsequently, the kinds of stroke (oblique stroke, cross stroke, longitudinal stroke) have to be demonstrated when filing flat surfaces. The trainees have to see that these kinds of stroke, when applied step by step, will improve the degree of evenness and surface finish.



5.4

Transparency no. 5.4. should be employed as an additional teaching aid. Subsequently, testing of faces by means of bevelled steel straight−edge and bevelled edge square should be demonstrated.

There should be separate demonstrations of filing curved surfaces on small− and large−size external radii materials, stressing the different way of handling the file.



5.5

This fact is also illustrated by transparency no. 5.5. and illustrations in the “Trainees’ Handbook of Lessons”.

The instructor has to show how internal round surfaces have to be filed with different files depending on the size of the internal radii (round file, half−round file, crossing file). This should be followed by instructions in checking these radii with radius gauges and fillet gauges.

Pre−finished workpieces (sawn or drilled) must be prepared to demonstrate the working technique of filing cuts and breakthroughs. Depending on the shape of the cut or break−through the instructor has to select the appropriate form of the file. A separate section of instruction serves to demonstrate the filing of chamfers on large−size and small−size workpieces (employing a saw sharpening vice) as well as on round materials (bolts). The different ways of handling the files have to be underlined. This is also supported by the illustrations contained in the "Trainees' Handbook of Lessons".

The instructions should be concluded by the trainees' answers to questions asked in the "Trainees' Handbook of Lessons".

3.2. Exercises

If it has not been possible to include the individual demonstrations in the instructions, this should be done right now prior to the exercises. Subsequently, it will be possible to commence with the first exercise contained in the "Instruction Examples for Practical Vocational Training". However, it is necessary to prepare every individual exercise by a "job−related instruction" during which the trainees are shown a finished workpiece in order to demonstrate the objectives and purpose of the exercise.

The instructor must have made such a workpiece himself in order to be familiar with all the problems which might arise in producing such a workpiece.

Thus, the instructor can mention the criteria for evaluation as well as the problems involved in manufacturing such a workpiece, During these instructions the sequences of operation and the working drawings of the "Instruction Examples" should be placed on the desks so that the trainees can make notes therein. All the trainees can carry out these exercises simultaneously, if the material prerequisites are given (availability of a sufficient number of tools etc.). This being the case, any individual exercise should be carried out individually with each trainee being allowed to take the time he needs.

If this is not the case, the trainees have to be grouped in teams depending on the subject of work and number of the available working tools.

Trainees who cannot begin with filing should do other jobs in the workshop:

- selection and preparation of initial materials,
- checking and minor repair work on working tools under the supervision of the instructor,
- exercises which consolidate skills in the working techniques acquired in the past.

3.3. Examples for recapitulation and tests

This section comprises questions which are to consolidate and test the acquired skills and knowledge. Each question is provided with the respective answers. Questions which are also contained in the "Trainees' Handbook of Lessons" are marked with the letter "A".

1. What is the purpose of filing?

   (To change flat or curved surfaces or edges of pre−worked components in terms of dimensions, forms and surface finish).

2. When is it useful to employ files?

"A" (In case of single−piece production, for repair work, and sometimes for assembly work).

3. Which of the file forms is the mainly used form?

"A" (Flat file).

4. Which type of cut is used for filing general steel grades and cast iron?

“A” (Double−cut file).

5. What is the order of files form coarse to fine surface finish?

   (Roughing file – bastard file – coarse finishing file – finishing file – fine finishing file – superfine finishing file).

6. How do we select files?

   (We have to consider the form of the surfaces or edges to be filed, the hardness of the material to be filed, the size of the surface to be filed, the amount of work and the surface finish).

7. How does a file act?

   (Its many wedge−shaped teeth penetrate into the workpiece by means of pressure from above and to the front and remove chips).

8. Why are milled files well−suited to soft materials?

“A” (They are provided with very sharp teeth and small wedge−angles resulting in a cutting action).

9. Why are chiselled files well−suited to hard materials?

“A” (Their teeth have large wedge angles and exert a shaving effect).

10. Why must the files be operated with the arms in motion and the upper part of the body kept steady?

“A” (Otherwise the motion of the file would become arch−like instead of being horizontal and the filed surface would not be flat).

11. What is the difference in handling large and medium−size files?

    (In the case of large−size files the guiding hand rests completely on the file blade, whereas thumb and finger of the guiding hand will grip the file blade of medium−size files).

12. Which kinds of strokes have to be employed successively when filing flat surfaces?

“A” (Oblique stroke, cross stroke, longitudinal stroke).

13. Why can only cross−stroke files be used to achieve flat surfaces of good surface finish?

“A” (The alteration in the direction of working makes it possible to recognize elevations and depressions on the worked surface very well by the working tracks left on it).

14. What is typical of file movements when filing small external radii?

“A” (Rocking feed movement opposite to the radius in the longitudinal direction of the curvature).

15. Which are the requirements to be met when using files for working internal radii?

"A" (The file roust have a smaller radius than the curvature of the workpiece).

16. What is the difference in filing chamfers on large and small components?

"A" (With large–size components the file position will be 45° upwards; with small–size components the file position will be horizontal – the component should be fixed in a saw sharpening vice).

17. Which are the conditions to be met when clamping the work–piece?

"A" (You must clamp the workpieces so firmly and safely that the components will not spring or slip. The file position must be horizontal).

18. Which are the proper devices for clamping workpieces?

"A" (Vice, sheet metal dog vice, protective jaws of soft metal, clamping jaws for round pieces, vee clamps, thread jaws).

4. Application of the working technique of "Filing"

The sequence of exercises can follow the order of the 6 exercises mentioned in the "Instruction Examples for Practical Vocational Training".

These "Instruction Examples ..." comprise a list of materials (initial material, working tools, measuring and testing tools, accessories) as well as the sequence of operations for the manufacture of these workpieces; also contained is an illustrative working drawing.

Thus, the trainees have the necessary information to begin their exercises.

If the quality of the produced workpieces should be considered insufficient, the trainee has to carry out comprehensive preliminary exercises. For this purpose any waste parts may be used. If the respective skill has been practised sufficiently, the envisaged workpiece can be produced.

The following hint should be taken into consideration:

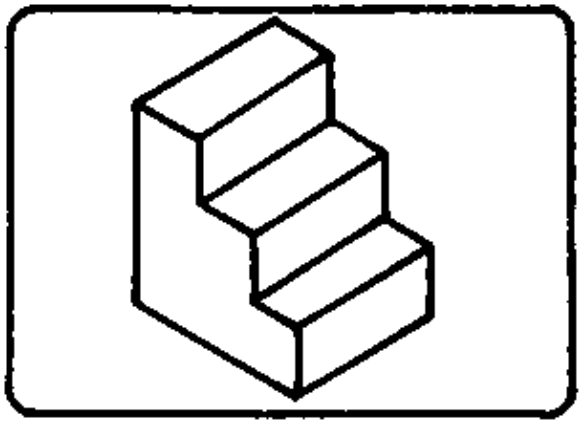
> The trainee has to do all the work involved alone – from the very beginning till completion.
>
> This is the only way to guarantee a just evaluation of the achievements.

Should the offered "Instruction Examples ..." not be used in the exercises, then it is also possible to select other parts for practising. In this case all the working techniques acquired earlier should be also practised when working these pieces.

4.1. Instruction Examples

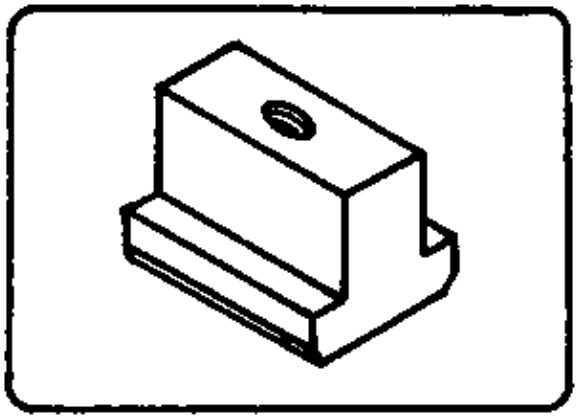
What follows is a brief description of the individual instruction examples in order to give a survey of the parts to be produced for practising the knowledge acquired:

Instruction Example 5.1.
Step Block



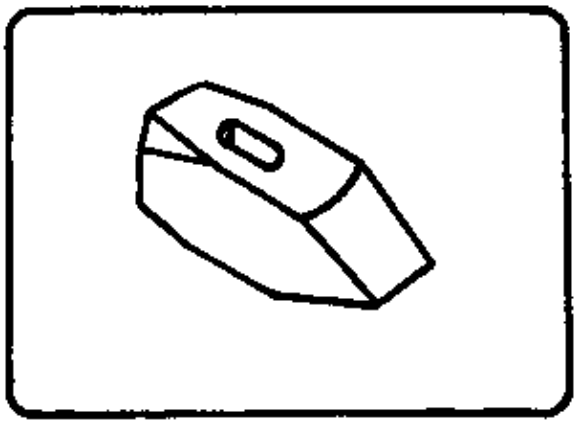
Filing of flat surfaces of square steel to finishing quality and of sawn out, stepped surfaces of small dimensions. Together with the parts produced as instruction examples 2.2., 5.2. and 5.5., it can be used as part of a set of clamping tools for an upright drilling machine.

Instruction Example 5.2.
Sliding Block



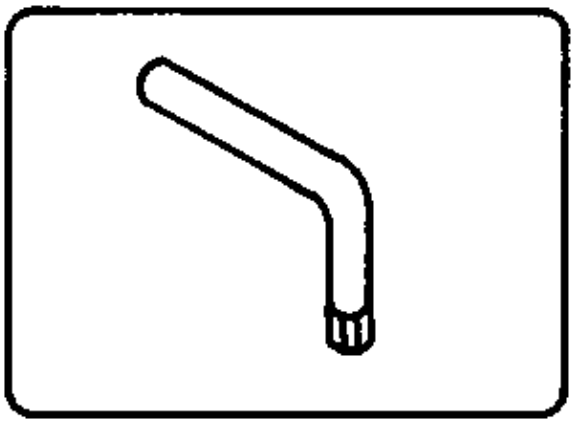
Filing of flat and stepped small–size surfaces of square steel to finishing quality and angularity. Additionally, the trainees practise filing of chamfers. Together with the components produced as instruction examples 2.2., 5.1. and 5.5. it will form another part of the set of clamping tools for an upright drilling machine.

Instruction Example 5.3.
Locksmith's Hammer



Filing of flat and inclined surfaces, radii, a break–through and chamfers on square steel. After being hardened, the locksmith's hammer can be fitted with a handle and be used in the workshop.

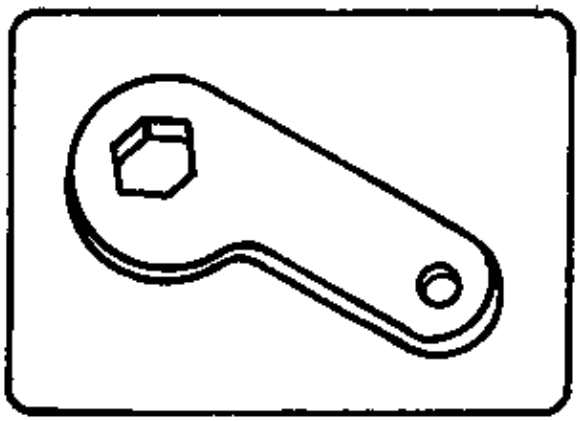
Instruction Example 5.4.
Hexagon Socket Wrench



This exercise concentrates on filing small−sized, stepped surfaces on round steel materials. Angularity and accuracy to size are essential. A new degree of difficulty is added by filing a chamfer on round material.

After hardening this workpiece it may be used for mounting hexagonal socket−head bolts in the workshop.

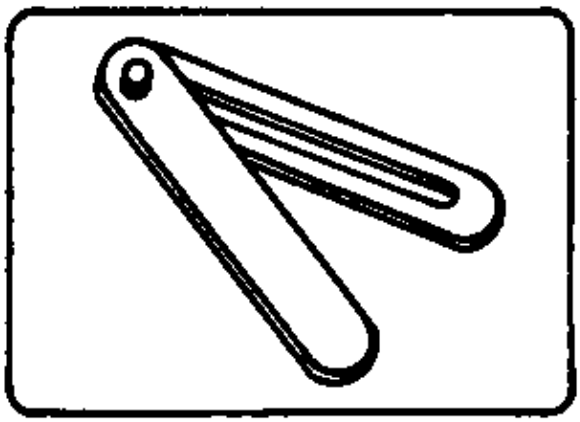
Instruction Example 5.5.
Box Wrench



This filing practise concentrates on flat and curved narrow steel plate surfaces. The trainee will also practise how to produce a true−to−size hexagonal break−through.

Being part of a set of clamping tools for an upright drilling machine the size of this part complies with the size of the components produced as instruction examples 2.2**.,** 5.1. and 5.2.

Instruction Example 5.6.
Bevel



Here, too, flat and curved surfaces of flat steel are filed to finishing quality. Extremely difficult tasks are

associated with a long break–through on a single component. This bevel can be used for transferring angle values in the workshop.

4.2. Criteria for practical training

It is recommended to determine some major points of observation and evaluation of the work to be performed.

The following criteria can serve as a guideline:

Flat surfaces and edges

– Is the trainee's posture correct?

– Does the trainee handle the file exactly horizontally or does the file "swing" over the surface?

– Does the trainee apply the oblique stroke technique to roughing?

– Does the trainee supply the cross stroke technique to achieve flat surfaces?

– Does the trainee apply longitudinal strokes to finishing filing?

– Does the trainee know how to check with the bevelled steel straight–edge or bevelled edge square?

Curved surfaces

– Does the trainee handle the file in the longitudinal direction of the round surface (with small–size round forms) and does he rock the file opposite to the radius?

– Does the trainee handle the file at right angles to the radius (with large–size round forms) and does he incline the file slightly?

– Does the trainee use a file with a smaller radius than the curvature for big internal radii?

Cut–outs and break–throughs

– Does the trainee employ the proper kind and size of file (in relation to cut–out and break–through)?

Chamfer

– Does the trainee employ the file at an angle of 45° with the file pointing upwards for large–size workpieces?

– Does the trainee use the saw sharpening vice when filing small–size components?

– Does the trainee handle the file laterally inclined and tilting towards the outside when filing round workpieces?

5. Captions and legends of the "Filing" transparencies series

Transparency no. 5.1.: Design and action of a file

(1) flat file

1 – file blade

2 – tang

3 – handle

(2) chip removal by the file teeth

4 – file tooth

Transparency no. 5.2.: Kinds of cuts

(1) single–cut file

(2) double–cut file

(3) rasp–cut file

Transparency no. 5.3.: Use of files

(1) square rubber file

(2) flat file

(3) square file

(4) triangular file

(5) round file

(6) half–round file

(7) knife–edge file

(8) barrette file

Transparency no. 5.4.: Filing of flat surfaces

(1) oblique–stroke filing

(2) cross–stroke filing

(3) longitudinal–stroke filing

Transparency no. 5.5.: Filing of curved surfaces

(1) filing of external radius – employing a flat file

(2) filing of Internal radius – employing a half–round file.

Filing – Course: Technique for Manual Working of Materials. Instruction Examples for Practical Vocational Training

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Filing – Course: Technique for Manual Working of Materials. Instruction Examples for Practical Vocational Training

Institut für berufliche Entwicklung e.V.
Berlin

Original title:
Lehrbeispiele für die berufspraktische Ausbildung
“Feilen”

Author. B. Zierenberg

First edition © IBE

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

Order No.: 90–33–3105/2

Introduction

The present material includes 6 selected practical examples by means of which the main methods of filing can be practised. For that purpose, flat, stepped, inclined and bent surfaces and edges are worked as well as chamfers and holes are filed.

All pieces of exercise may be used in the workshop after having been finished.

Locksmith’s hammer and bevel complete the trainee’s workplace equipment; step block, sliding block and box wrench are accessories for drilling machine fixtures, the hexagon socket wrench supplements the additional workshop outfit.

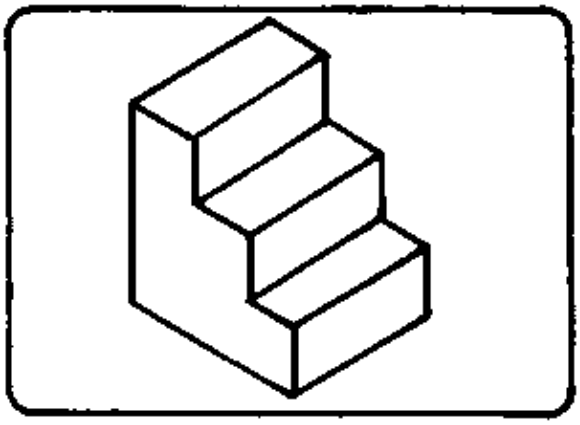
In order to facilitate the preparation and execution of work, required materials, hand tools, measuring and testing tools as well as accessories are given for each of the training examples. Furthermore, previous knowledge necessary to practise the individual exercises is specified. Pieces of exercise can be manufactured with the help of working drawings attached and respective sequences of operations.

Explanation on material designation:

Steel grading is as to the value of tensile strength given in the unit “Megapascal” (MPa).

Instruction example 5.1. – Step block

Practise filing of flat and stepped surfaces



Material

square steel	(420	MPa)
thickness:	40	mm
length:	48	mm

Hand tools

Steel scriber, scribing punch, hand hacksaw, locksmith's hammer, bastard and smooth files of 300 mm and 200 mm (flat and three–square)

Measuring and testing tools

Steel rule, vernier caliper, bevelled edge square

Accessories

Vice, surface plate, protective Jaws, saw sharpening vice

Required previous knowledge

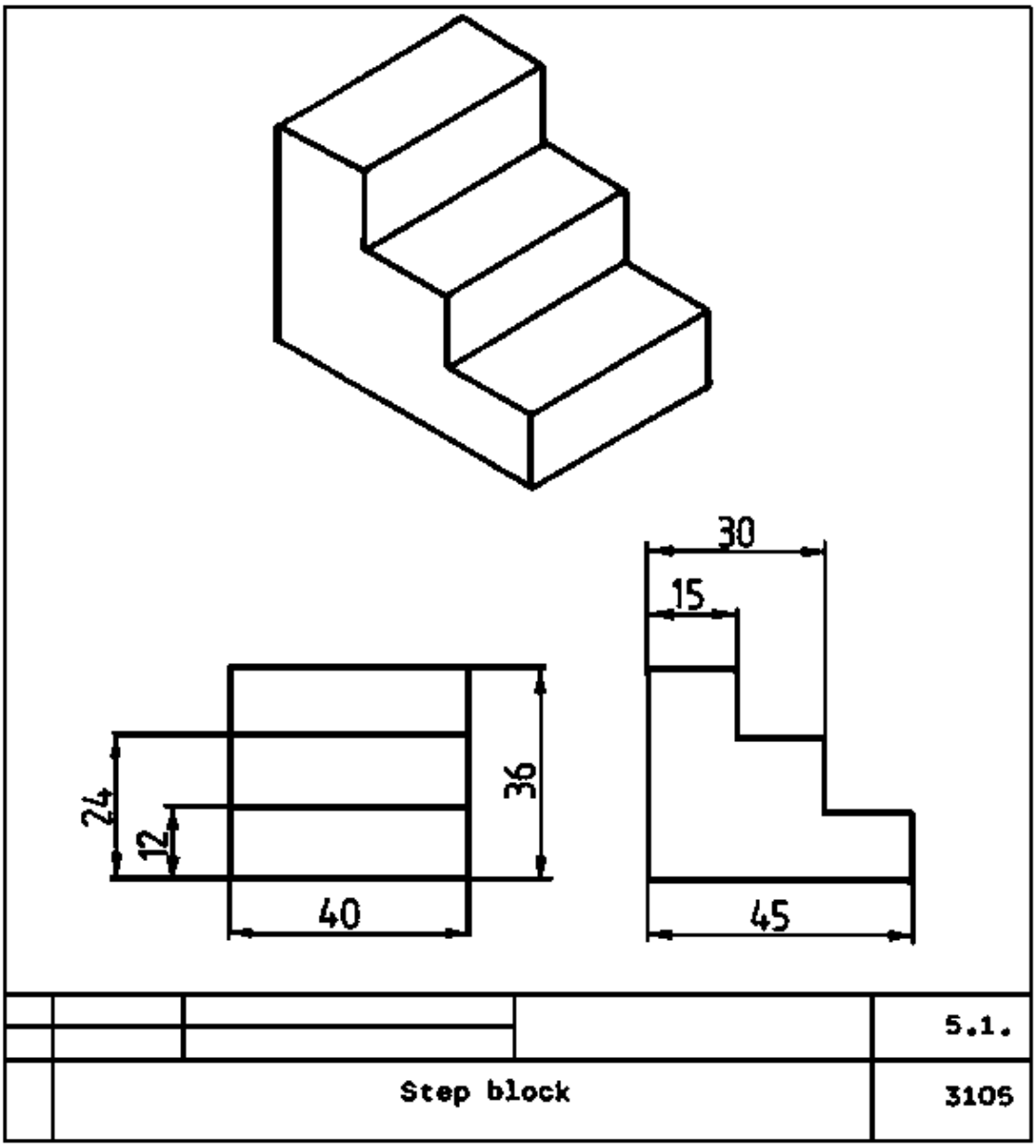
Reading of drawings, measuring, testing, scribing, prick–punching, sawing

	Sequence of operations	Comments
1.	Arrange workplace Prepare working material	– Check up completeness
2.	Check square steel length, file base flat as datum level – check	– Rough in oblique stroke – File flat in cross stroke – Smooth in longitudinal stroke
3.	File one face flat and square to base – check	– Check by means of bevelled edge square
4.	Scribe cover surface and second face starting from datum level, make control punches on the scribed line, subsequently saw	– Size allowance 0.5 to 1 mm!

5.	File sides flat and square to datum level – check	– surface – finishing quality! – Use protective jaws!
6.	Scribe steps starting from datum level, make control punches on scribed lines, subsequently saw	
7.	File horizontal surfaces (seen from base) flat and true–to–size – check	– Pay attention to control punches!
8.	File vertical surfaces flat and true–to–size – for that purpose, re–clamp work–piece – surfaces must be worked in horizontal position	– File inner edges by means of three–square files!
9.	Deburr all edges	
10.	Final control	– Surface finish, size, sqaureness

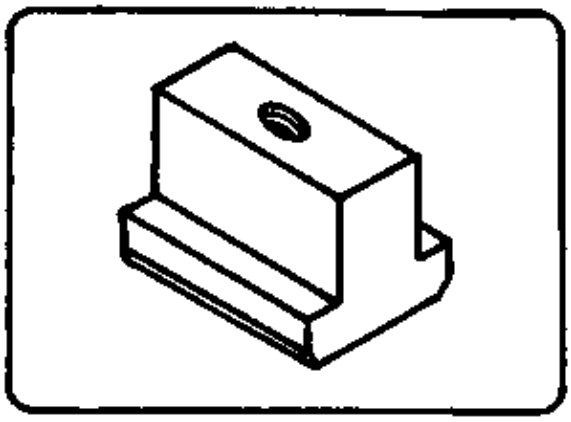
Remark

Together with the
Instruction example 2.2. (clamp),
Instruction example 5.2. (sliding block)
Instruction example 5.5. (box wrench) and
a screwed bolt M 16 with appropriate washer and nut M 16, this step block forms a complete set of clamping tools for an upright drilling machine.



Instruction example 5.2. – Sliding block

Practise filing of flat and stepped surfaces as well as chamfers paying attention to squareness and accuracy to size



Material

square steel	(600	MPa)
thickness:	36	mm
length:	32	mm

Hand tools

Steel scriber, scribing punch, hand hacksaw, locksmith's hammer, bastard and smooth files of 250 mm (flat and three–square)

Measuring and testing tools

Steel rule, vernier caliper, bevelled edge square

Accessories

Vice, surface plate, protective jaws

Required previous knowledge

Reading of drawings, measuring, testing, scribing, prick–punching, sawing

	Sequence of operations	Comments
1.	Arrange workplace Prepare working material	– Check up completeness
2.	Check up square steel length, file base flat as datum level – check	– Rough in oblique stroke – File flat in cross stroke – Smooth in longitudinal stroke
3.	File one face flat and square to base – check	
4.	Scribe cover surface and second face starting from datum levels, make control punches on scribed line – subsequently file	– Apply protective jaws – Surface Finishing quality!
5.	Scribe and punch steps starting from datum levels; subsequently saw and file – check	– Pay attention to squareness
6.	File chamfers	– Clamp workpiece in saw sharpening vice
7.	Deburr all edges	

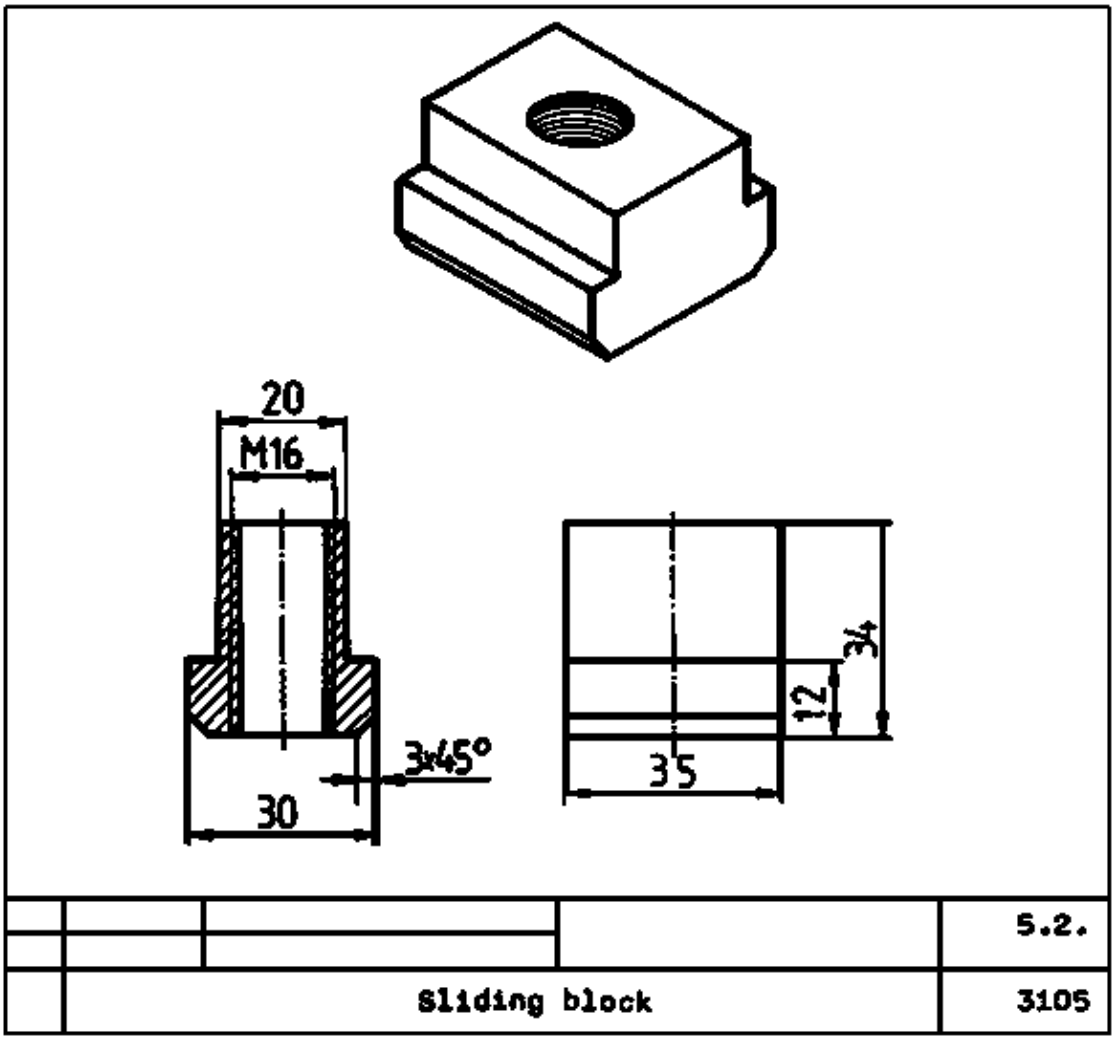
8.	Final control	– Surface finish, size, squareness

Finishing

Make tapped bore M 16 according to drawing.

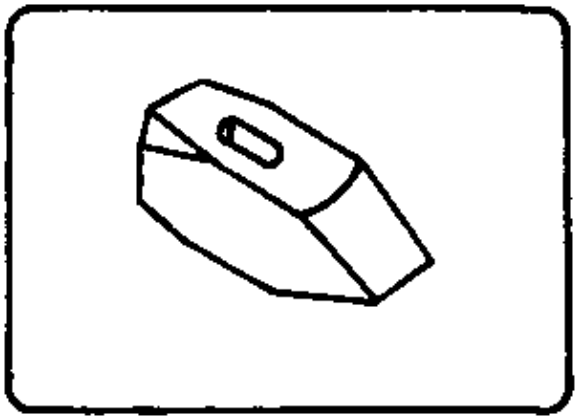
Remark

Together with the
instruction example 2.2. (clamp),
instruction example 5.1. (step block),
instruction example 5.5. (box wrench) and
a screwed bolt M 16 with appropriate washer and nut M 16, this sliding block forms a complete set of clamping tools for an upright drilling machine.



Instruction example 5.3. – Locksmith's hammer

Practise filing of flat and inclined surfaces, radii as well as holes and chamfers



Material

square material made of cold forming steel (carbon content 2 to 2.2%)

thickness: 24 mm

length: 108 mm

Hand tools

Hand hacksaw, steel scriber, scribing punch, hammer, drill of 10 mm dia., bastard and smooth files of 300 mm (flat), bastard file of 200 mm (round)

Measuring and testing tools

Steel rule, vernier caliper, bevel protractor, 3 mm radius gauge

Accessories

Vice, surface plate, protective Jaws, saw sharpening vice, lubricant and coolant (diluted soluble oil), machine vice

Required previous knowledge

Reading of drawings, measuring, testing, scribing, prick–punching, sawing, drilling

Sequence of operations	Comments
1. Arrange workplace Prepare working material	– Check up completeness
2. File sides flat	– Do not smooth yet!
3. Scribe and punch hammer peen; subsequently saw and file – check	
4. File top and base as well as face – check	
5. File chamfers and camber on hammer face as well as radius on hammer peen	– Use saw sharpening vice

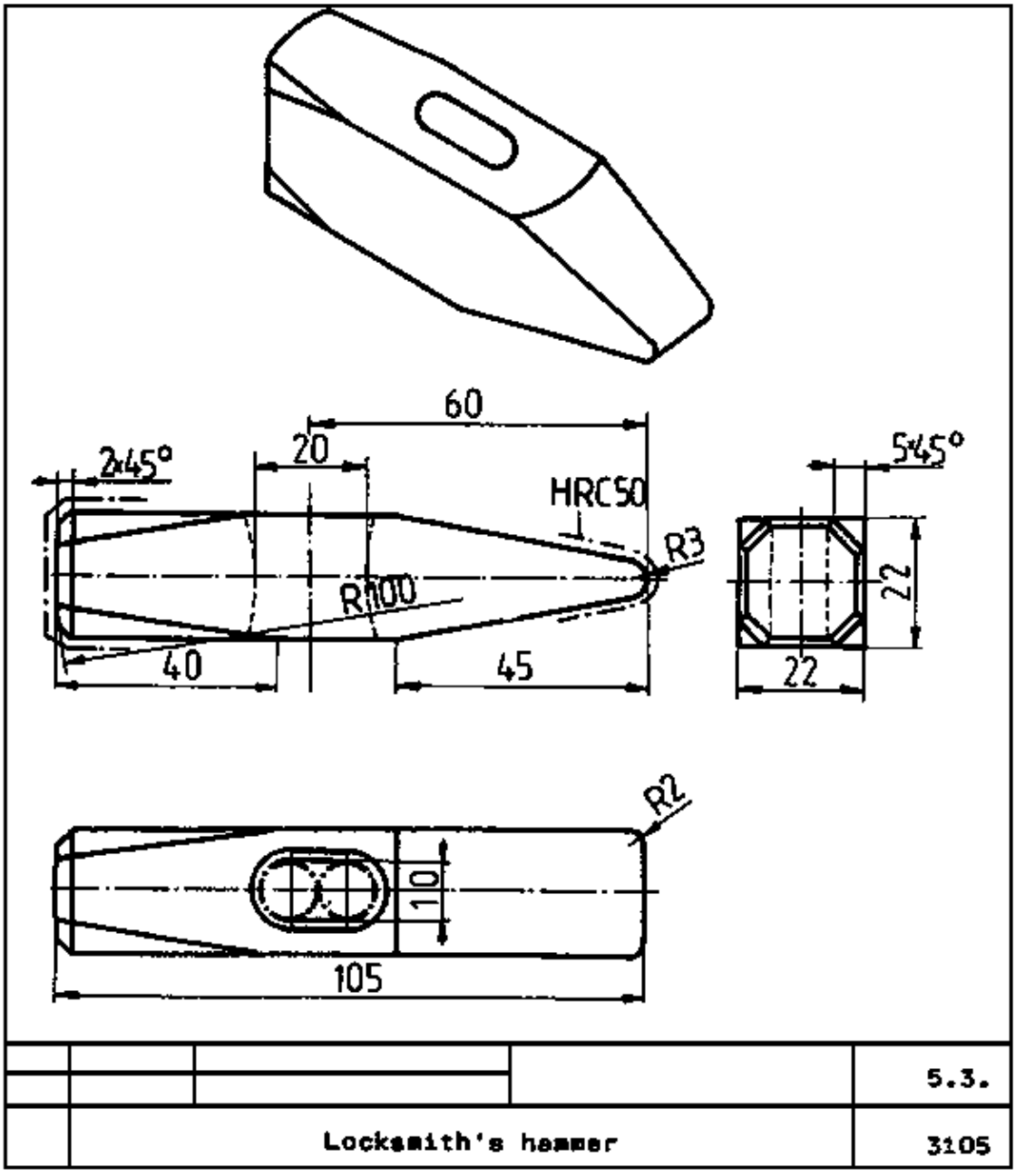
6. Drill hole, file hole with reciprocating movement – conical
   – Drill of 10 mm dia.
   – Drill under direction of instructor!

7. Smooth and deburr all surfaces

8. Final control
   – Surfaces,
   – Accuracy to size,
   – Flatness and angularity of surfaces

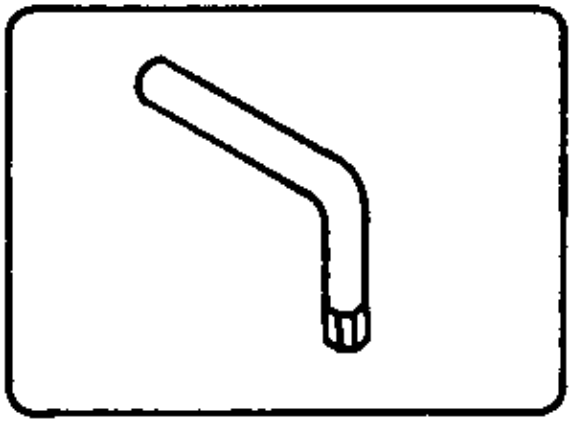
Finishing

Hardening of face and hammer peen to HRC 50, fit hammer handle, drive in key



Instruction example 5.4. – Hexagon socket wrench

Practise filing of small stepped surfaces In compliance with accuracy to size and angularity as well as of filing of a chamfer on round material



Material

round material made of cold forming steel (carbon content 2 to 2.2%*)*

diameter:	6	mm
length: approx.	120	mm

Hand tools

Hand hacksaw, steel scriber, warding file of 100 mm (flat)

Measuring and testing tools

Steel rule, vernier caliper, try square

Accessories

Vice, jaws for round material, Vees

Required previous knowledge

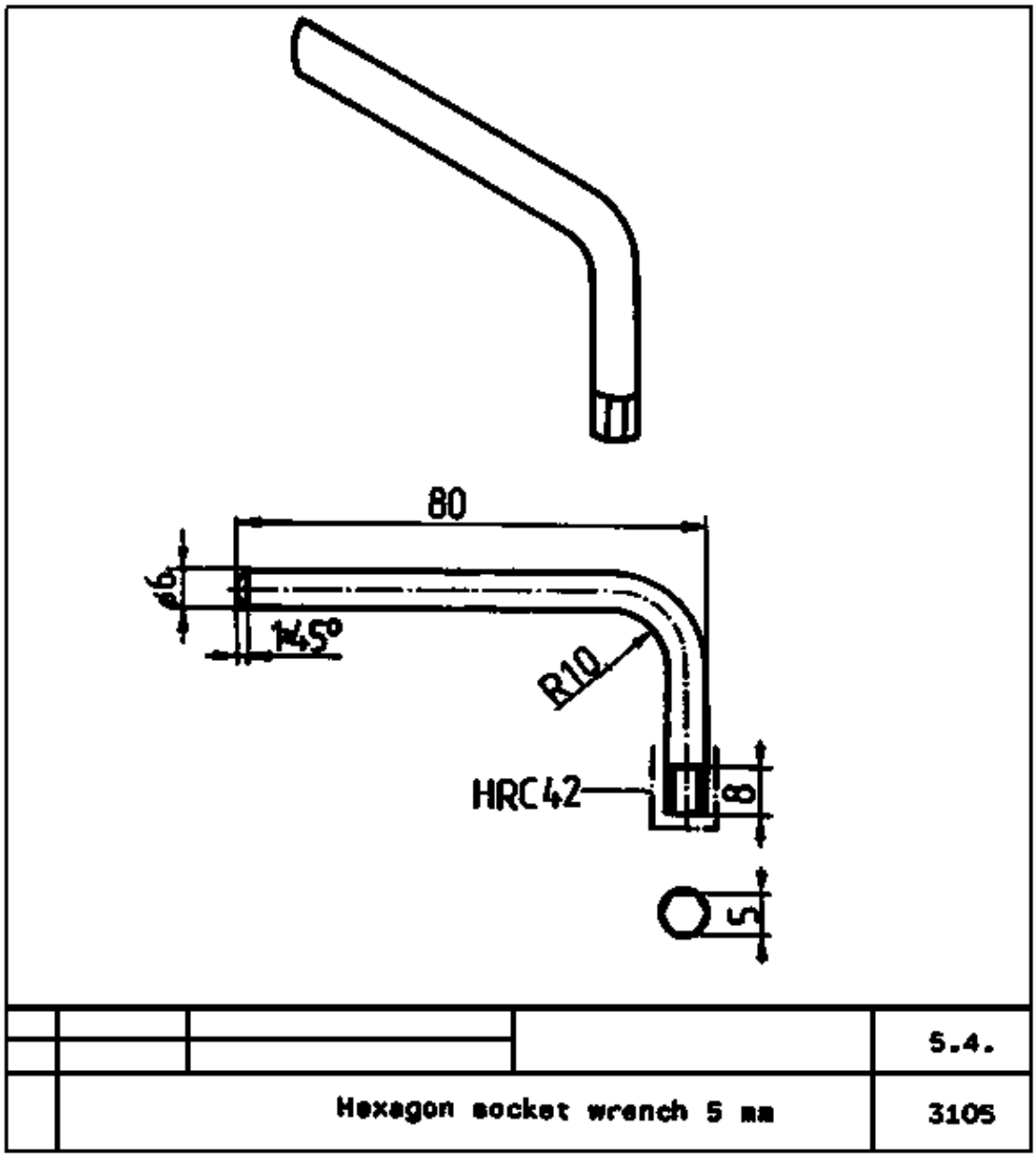
Reading of drawings, measuring, testing, scribing, sawing

	Sequence of operations	Comments
1.	Arrange workplace Prepare working material	– Check up completeness
2.	Clamp round materials into jaws, face–file one face and make a chamfer	– Swing file around the round material!
3.	Face–file the other face and scribe hexagon	
4.	Clamp round material horizontally into Vees and file hexagon step by step	– File opposite surfaces in parallel!

5. Final control – Accuracy to size
– Surfaces

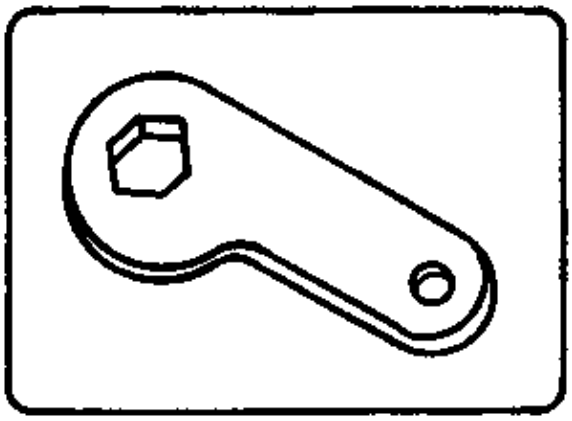
Finishing

Bend round material according to drawing; subsequently, get hexagon hardened to HRC 42.



Instruction example 5.5. – Box wrench 24 mm

Practise filing of flat and bent surfaces



Material

steel sheet made of cold forming steel (carbon content 2 to 2.2%*)*

thickness:	8	mm
width:	42	mm
length:	182	mm

Hand tools

Hand hacksaw, steel scriber, beam trammels, scribing punch, locksmith's hammer, drills of 6 and 22 mm dia., bastard and smooth files of 250 mm (flat and half round), warding file of 100 mm (flat)

Measuring and testing tools

Vernier caliper, radius gauge of 10 and 20 mm

Accessories

Vice, protective jaws, saw sharpening vice, lubricant and coolant (diluted soluble oil), machine vice

Required previous knowledge

Reading of drawings, measuring, testing, scribing, prick–punching, sawing, drilling

Sequence of operations	Comments
1. Arrange workplace Prepare working material	– Check up completeness
2. Scribe and punch steel sheet completely	– Start from datum lines!
3. Make the two bores	– Caution! Pay special attention to firm clamping of bore of 22 mm dia.
4. File hole of 24 mm	

5. Saw external outline, file to size and shape

6. Smooth all surfaces, chamfer all outer edges – Use saw sharpening vice!

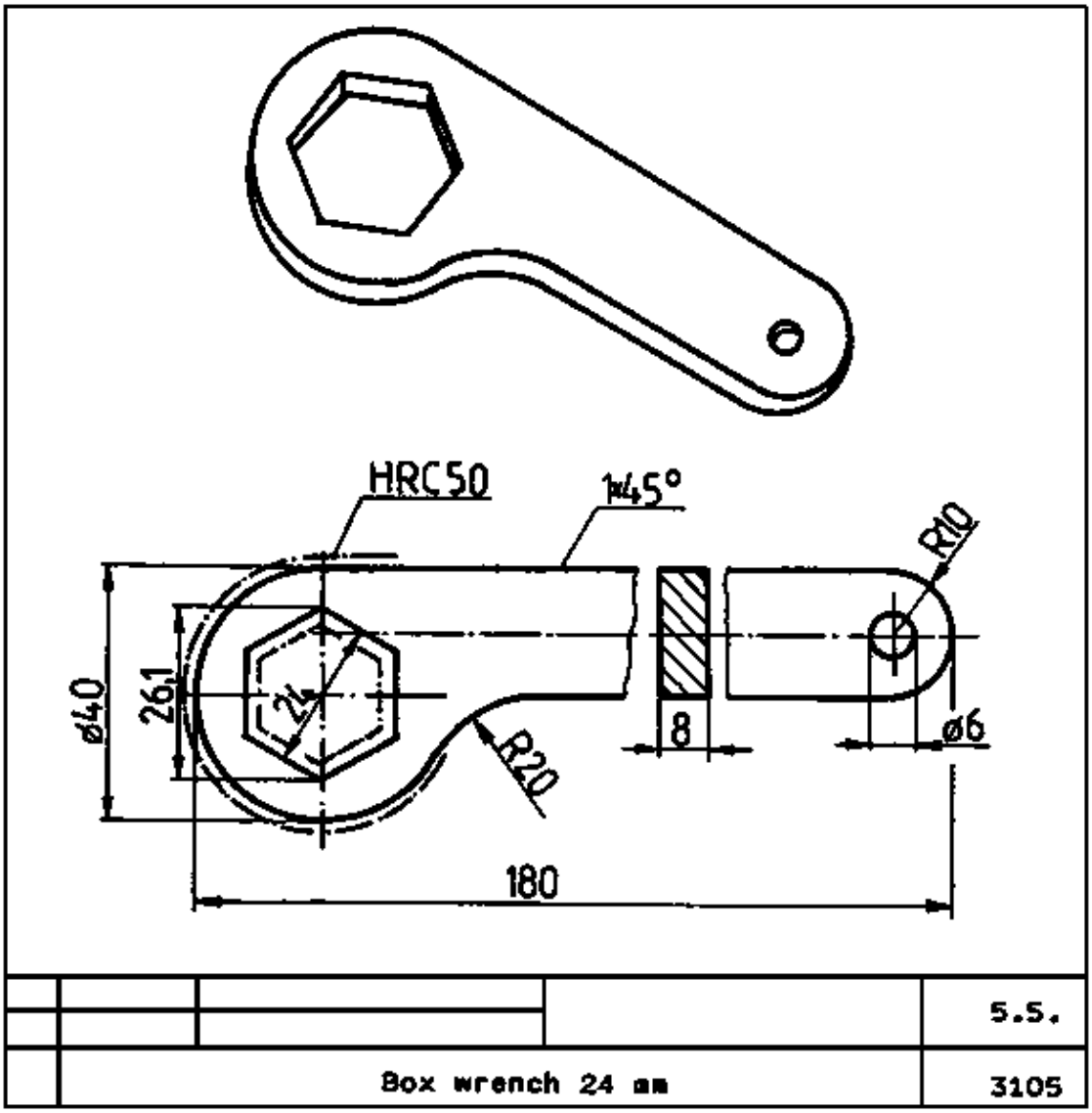
7. Final control – Accuracy to size, surfaces

Finishing

Hardening of box end to HRC 50

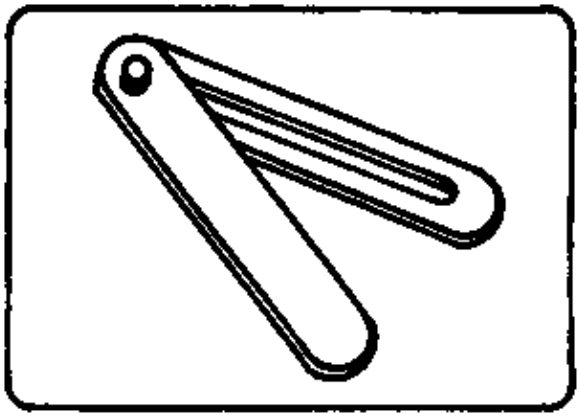
Remark

Together with the instruction example 2.2. (clamp), instruction example 5.1. (step block), instruction example 5.2. (sliding block) and a screwed bolt M 16 with appropriate washer and nut M 16, this box wrench forms a complete set of clamping tools for an upright drilling machine,



Instruction example 5.6. – Bevel

Practise filing of flat and bent surfaces as well as of a long hole according to size specified



Material

– 2x flat material made of high–strength steel (600 MPa)

thickness:	6	mm
width:	30	mm
length:	302	mm

– high straight–knurled screw M 6

– straight–knurled nut M 6

Hand tools

Hand hacksaw, steel scriber, scribing and centre punch, locksmith's hammer, cutting–off mortiser, drills of 11.8 and 12 mm, bastard and smooth files of 240 mm (flat)

Measuring and testing tools

Steel rule, vernier caliper, radius gauge 14 mm

Accessories

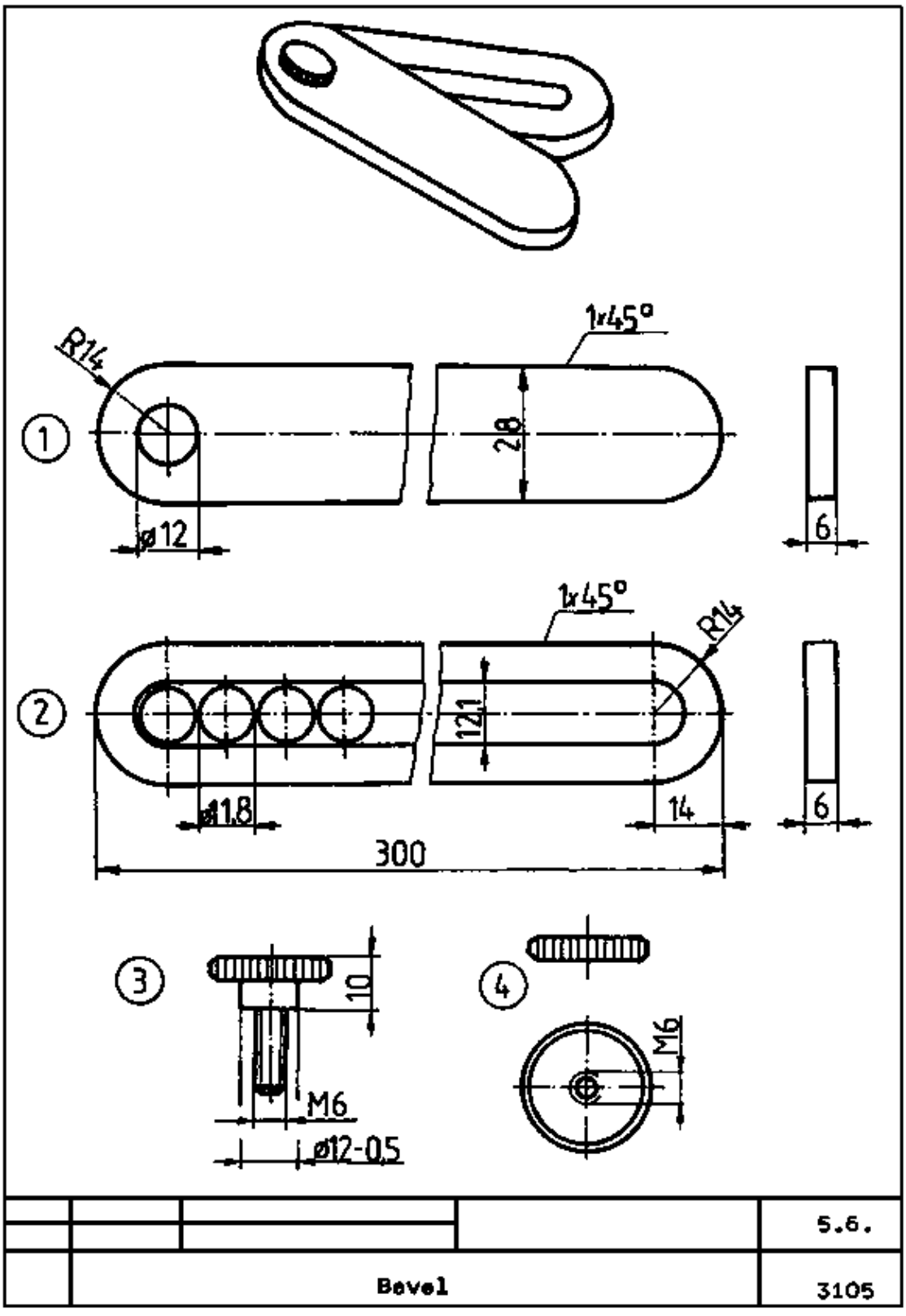
Vice, saw sharpening vice, surface plate, machine vice, lubricant and coolant (diluted soluble oil)

Required previous knowledge

Reading of drawings, measuring, testing, scribing, prick–punching, sawing, drilling, chiselling

	Sequence of operations	Comments
1.	Arrange workplace Prepare working material	– Check up completeness
2.	Produce a cent re line on both flat materials, scribe external outline starting from centre line, punch radii	
3.	Scribe and punch bores	– Prick–punch through–hole bores in a distance of 12 mm!

4.	Drill part (1) by drill of 12 mm dia., drill part (2) by drill of 11.8 mm dia.	– Secure workplaces against pulling up and turning round!
5.	Calk hole of part (2) by means of cutting–off mortiser and file to size 12.1 mm	– Constant edge line – no steps!
6.	File outer edges and surfaces of part (1) and part (2); chamfer all edges with 1 x 45°	– Surface; Finishing quality – Use saw sharpening vice
7.	Check up surfaces and edges for evenness and finishing quality	
8.	Mount parts (1) and (2) by parts (3) and (4)	
9.	Final control	– Accuracy to size, appearance, good movability of part (2)



				5.6.
	Bevel			3105

Filing – Course: Technique for Manual Working of Materials. Trainees' Handbook of Lessons

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Filing – Course: Technique for Manual Working of Materials. Trainees' Handbook of Lessons

Institut für berufliche Entwicklung e.V.
Berlin

Original title:
Arbeitsmaterial für den Lernenden
“Feilen”

Author: Frank Wenghöfer

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

Order No.: 90–35–3105/2

1. Purpose of filing

By filing chips are removed from straight or curved faces of pre–machined parts.

It serves to change the size, shape or surface finish of faces, to remove irregularities, to deburr, chamfer or round off edges, and to make parts fit.

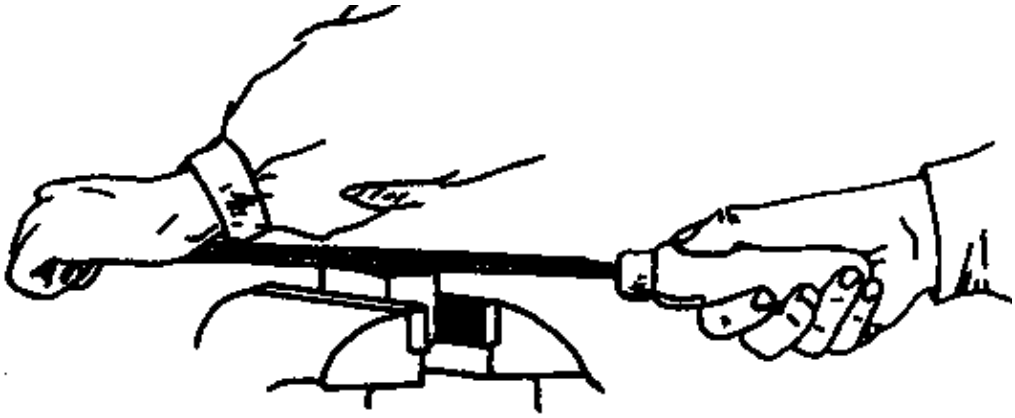


Figure 1 Files

Filing is hard and time–consuming manual work. It is useful only in single–piece production, repair work and partly in assembly work (fitting work and reworking).

2. Filing tools

Files are available in different shapes, sizes and types of cut. They consist of a blade of hardened tool steel and a wooden handle.

2.1. File shapes

Flat file:

> For use on straight and curved external faces and on side edges to provide them with chamfers and to deburr edges.

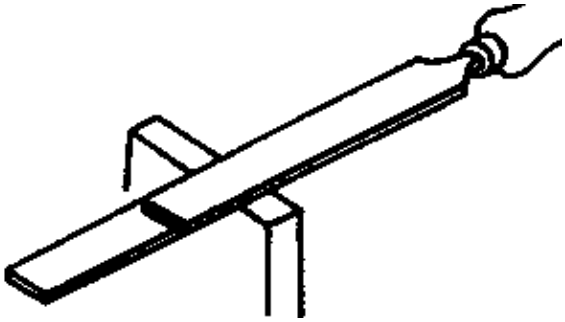


Figure 2 Flat file

Square file:

For use on square openings and narrow steps.

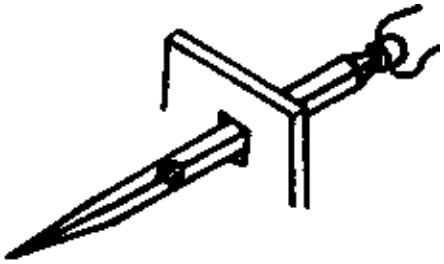


Figure 3 Square file

Triangular file:

For use on sharp–edged openings and steps as well as on small and short external faces.

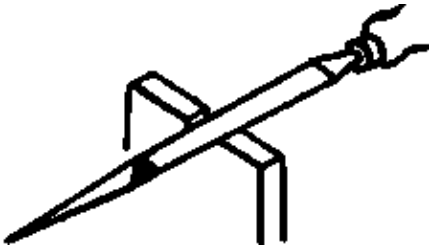


Figure 4 Triangular file

Round file:

For use on round openings and small inside radii.

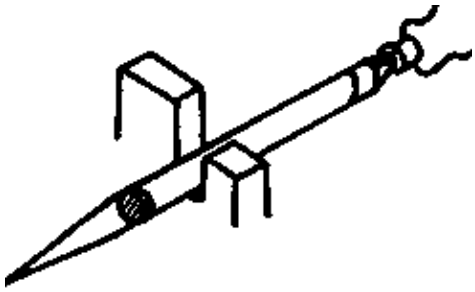


Figure 5 Round file

Halfround file:

For use on arched recesses and big inside radii.

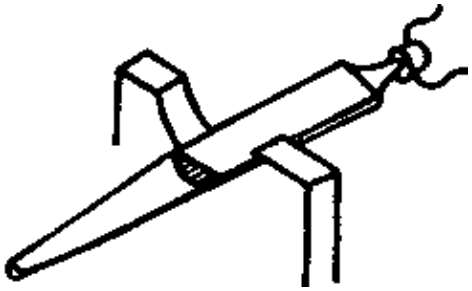


Figure 6 Halfround file

Crossing file:

For use on recesses and openings with very big radii.

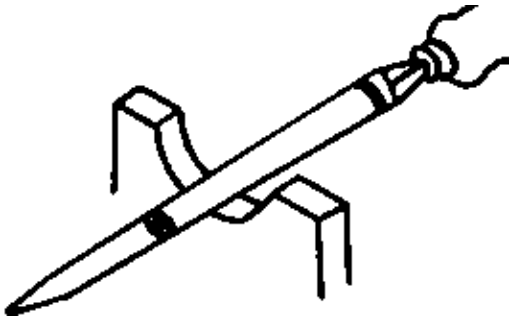


Figure 7 Crossing file

Barrette file:

For special use on dovetail guides.

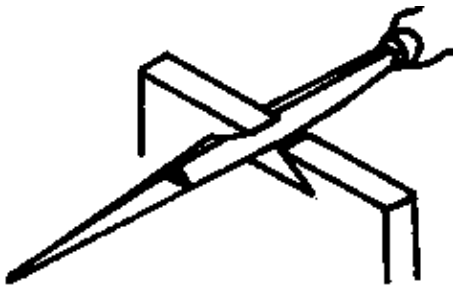


Figure 8 Barrette file

Knife file:

For use on narrow openings and for sharpening of saws.

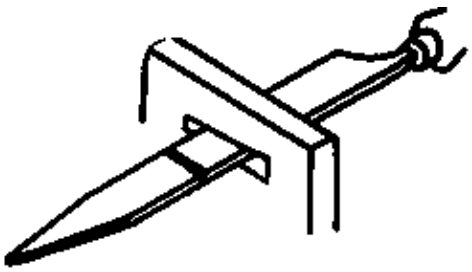


Figure 9 Knife file

2.2. File sizes

Big and heavy files (square rubber files and hand files) are used for large, straight, rough faces; medium–size files (ranging between 160 and 375 mm in length) may be used for any application.

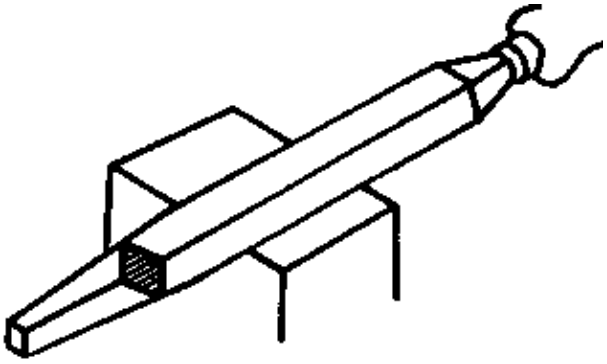


Figure 10 Filing of faces by a square rubber file

Small and smallest files (warding files and needle files of 100 am length) are used for special purposes, mostly for very small cuts and openings.

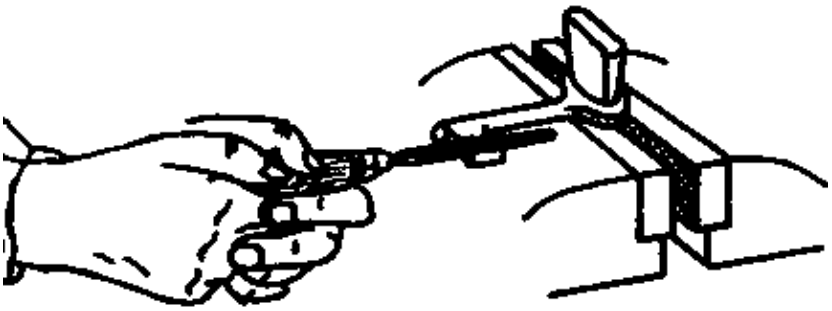


Figure 11 Filing of cuts by a warding file

Offset files (rifflers) are used for recesses and openings not easily accessible.

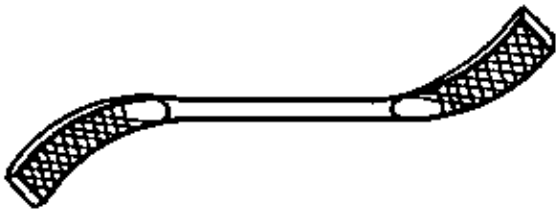


Figure 12 Riffler

2.3. Types of cut

Single–cut files (milled):

File blade with long cutting edges which may be interrupted by chip breakers.
For use on soft metals, such as aluminium, lead, zinc.

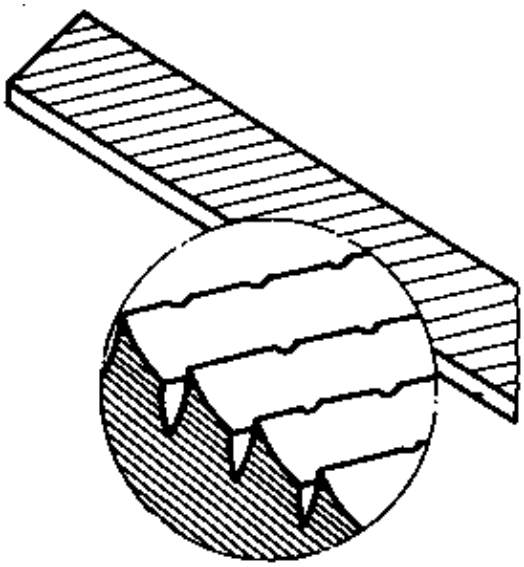


Figure 13 Single−cut file

Double−cut files (chiseled):

Files with crossed cutting edges forming the teeth of the file.
For use on general steel and cast iron.

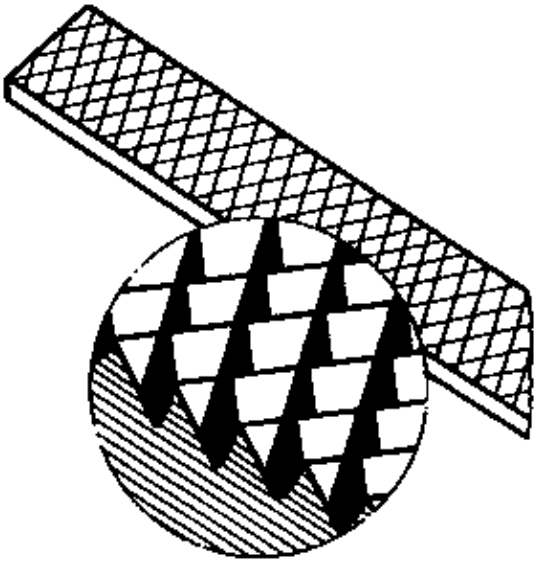


Figure 14 Double−cut file

Rasp−cut files:

Files with special cutting edges with ripping effect.
For use on soft metal with big working allowance and on non−metallic soft materials (wood).

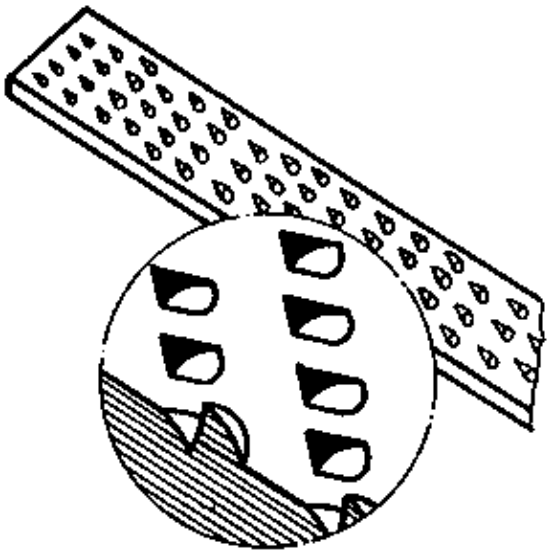
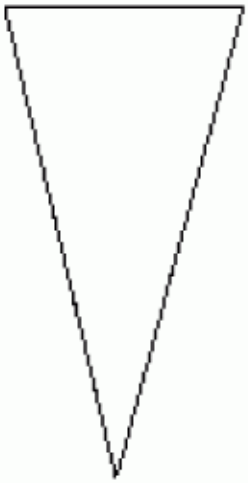


Figure 15 Rasp−cut file

Single−cut files and double−cut files are classified by the degree of coarseness of their teeth and can be marked by numbers of cut (grade of cut).

Designation Cut	no.	File surface	Use of file	Fineness of file
rough−cut file (roughing file)	0	rough (stroke of file tangible and visible)	for oversize of 0.5 mm and more	very coarse
bastard file (coarse file)	1			
second−cut file (coarse finishing file)	2	fine (file stroke no longer tangible but still visible)	for oversize of less than 0.1 mm	
smooth−cut (finishing file)	3			
dead−smooth file (fine finishing file)	4	very fine (file stroke neither tangible nor visible)	for fits and best surface finish	
super−smooth file (superfine finishing file)	5			very fine

Files are selected depending on:

- the shape of the face or edge to be filed,
- the hardness of the material to be filed,
- the size of the face to be filed,
- the amount of filing and the surface finish.

In which cases will filing be useful?

_____

Which shape of file is mainly used?

_____

Which type of cut is used for filing of general steels and cast iron?

_____

3. Auxiliary means for filing

Auxiliary means for filing are clamping devices which are to be selected according to the purpose of clamping the relevant cross section of the workpiece.

Requirements: The workpiece is to be clamped so that the file stroke is always horizontal. The workpiece is to be clamped as firmly and securely as to eliminate any springiness and displacement of the workpiece during filing!

In addition to the clamping devices also used for the working technique “manual sawing”, such as:

– vice
– vee clamps
– angle clamps
– protective jaws,

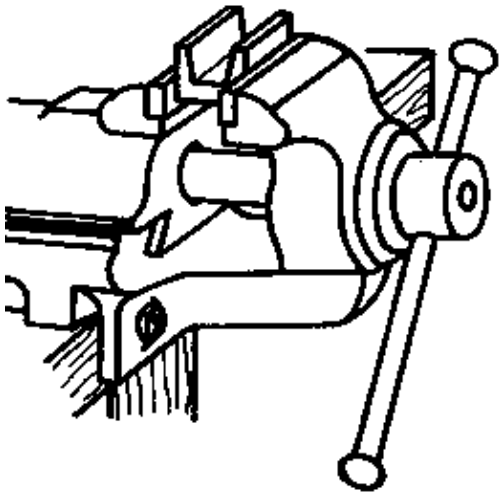


Figure 16 Vice

the following auxiliary means are in use:

Clamping jaws for round stock:

Specially formed vice attachments with halved holes permitting vertical clamping without squeezing of thin round stock.

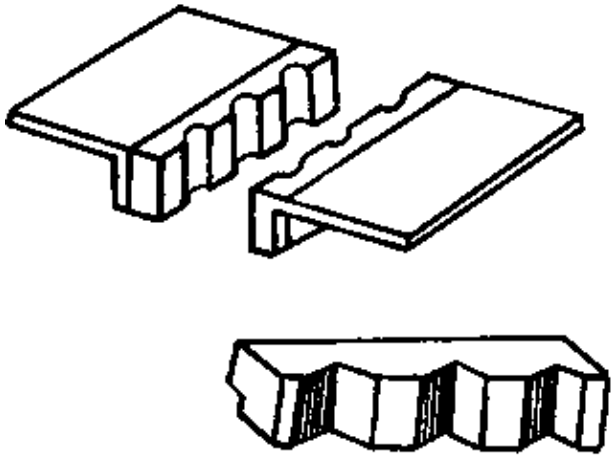


Figure 17 Clamping jaws for round stock

Clamping jaws for threaded bolts and thread clamps:

Specially formed vice attachments with halved holes permitting vertical clamping of threaded bolts. For small screws a thread clamp is used.

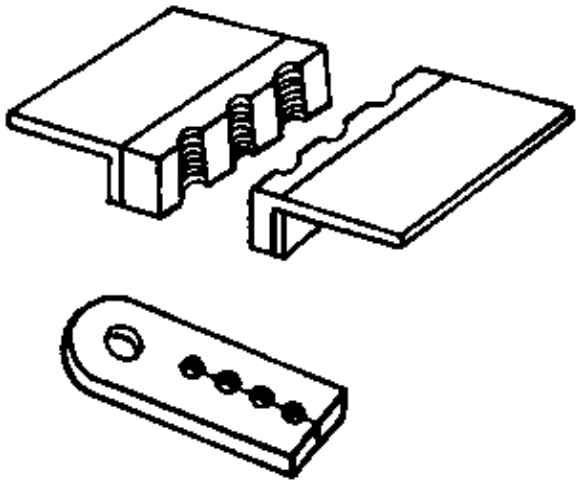


Figure 18 Clamping jaws for threaded bolts and thread clamps

Angle vice:

Clamping device for clamping of small, flat parts in a vice at an angle of 45 degrees. It is used for filing of bevels only.

Figure 19 Angle vice

Hand vice and pin vice:

Clamping device for clamping of small parts, mostly sheets, to be filed on any support.

Pin vices are also often used as universal clamping devices for other working techniques (drilling, counterboring, riveting).

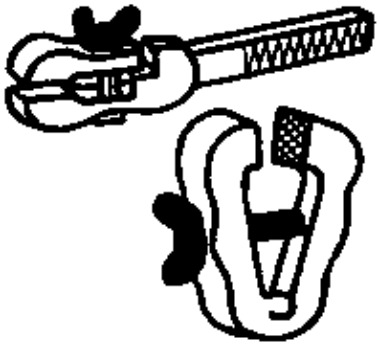


Figure 20 Hand vice and pin cice

Sheet metal clamp:

Angle attachment to extend the vice jaws serving for horizontal clamping of longer sheets. At the protruding end it is mounted with a small clamp or hand vice.

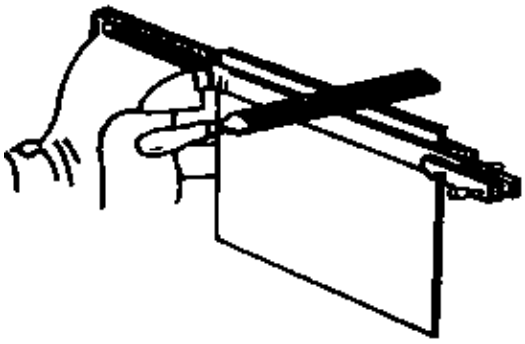


Figure 21 Sheet metal clamp

Note:

Profiles are to be clamped with suitable attachments which can be made from wood so as to suit the relevant form.

Figure 22 Wooden attachment for clamping of profiles

Which requirements must be met when clamping?

_____

_____

Which auxiliary means are suitable for clamping of workpieces?

_____

_____

4. Operation of filing

The file blade has many wedge–shaped teeth. It is pressed onto the workpiece and pushed forward at the same time so that the teeth are penetrating into the material removing chips.

Figure 23 Action of the milled file

Milled files have very sharp teeth with a small angle of wedge (47 degrees) and work with positive rake angle – the teeth have a forward inclination. This results in a cutting action which is suitable for soft material.

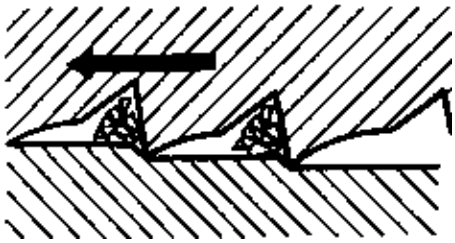


Figure 24 Action of the chiseled file

Chiseled files have teeth with big angle of wedge (70 degrees) and work with negative rake angle. This results in a shaving action which is suitable for hard material.

Note:

For fine finishing of faces the file may be slightly chalked. The chalk will deposit in the tooth gullet reducing the depth of penetration of the teeth.

Fine chips, which would otherwise destroy the smooth surface of the workpiece, settle in this chalk layer.

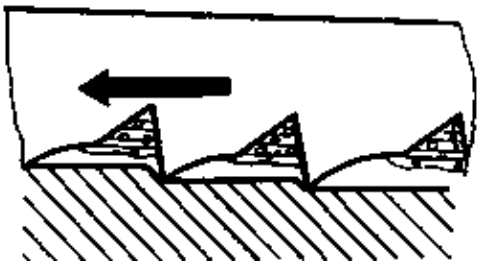


Figure 25 Chalked chiseled file

5. Standing position and guiding of the file

Before beginning to file make sure that the vice has the correct height and the workpiece is firmly clamped!

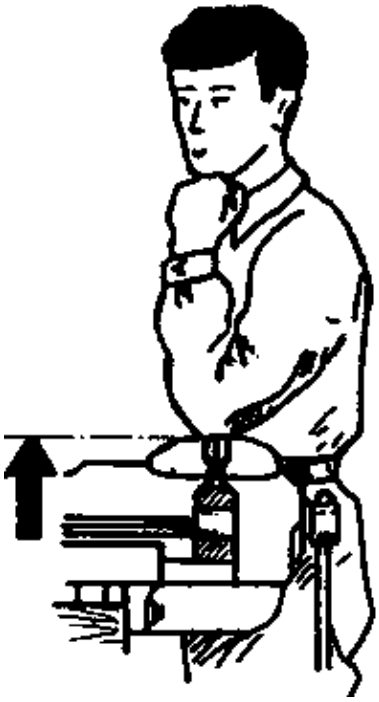


Figure 26 – Correct height of the vice

Procedure:

– The weight of the body is resting on one leg; the other leg is always straightened; both feet have to be firmly on the ground

– The file is moved with the arms only, not with the upper part of the body – the upper part of the body must not swing!

– The file is pressed onto the workpiece when pushing the file forward only; It is pulled back without pressure!

– The file is to be guided so that the movement is always horizontal!

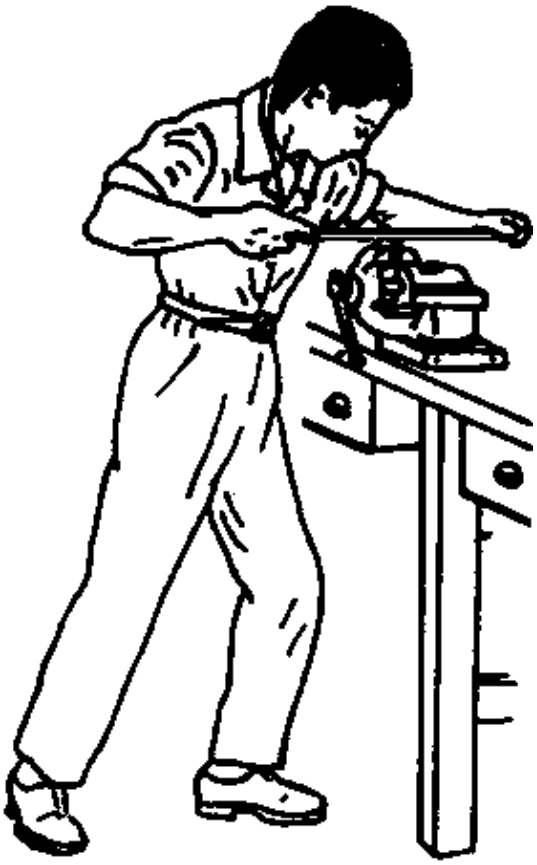


Figure 27 Correct standing position

Note:

Support the movement of the arms by analogous movement of the body when working with big files only!

Why are milled files suitable for soft material?

_____
_____

Why are chiseled files suitable for hard materials?

_____

Why must not the upper part of the body swing when filing but the file be moved by the arms only?

_____
_____
_____

6. Handling of the files

Big files:

One hand grips the file handle while the palm of the other hand (guiding hand) lies on the end of the file blade and holds and guides the file in the horizontal plane.

Figure 28 Handling of big files

Middle−size files:

One hand grips the file handle while thumb and fingers of the other hand (guiding hand) grip the end of the file blade guiding the file.

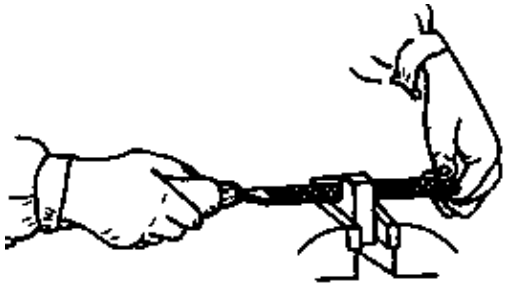


Figure 29 Handling of middle−size files

Small files:

One hand grips the file handle while the fingers of the other hand press onto the file blade so as to avoid deflection of the file blade
(Filing without guiding hand is also possible)

Figure 30 Handling of small files

6.1. Filing of straight faces

There are three types of filing strokes

Oblique stroke:

Suitable for removing big quantities of chips with rough surface

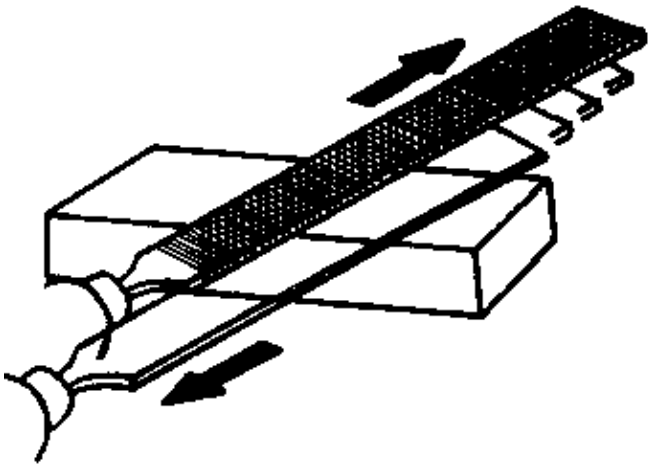


Figure 31 Oblique stroke filing

Crossing stroke:

The traces left by changing the working direction are noticeable on the surface as peaks and valleys!

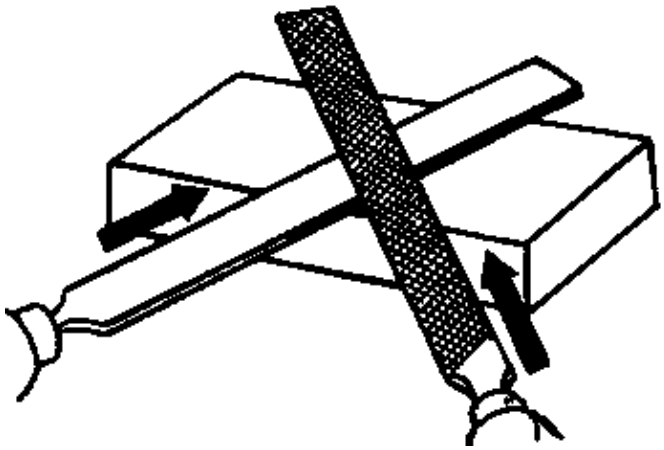


Figure 32 Cross–stroke filing

Longitudinal stroke:

Working traces in parallel with the longest edge of the work – light guidance of the file for smooth finish.

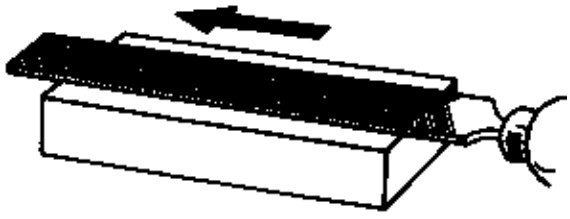


Figure 33 Longitudinal stroke filing

Testing of faces for flatness and angularity is preferably done by bevelled steel straightedge and bevelled edge square!

6.2. Filing of curved faces

Small outer radii are filed longitudinally in the direction of the radius.

The working movement is featured by a rocking feed movement opposite to the radius

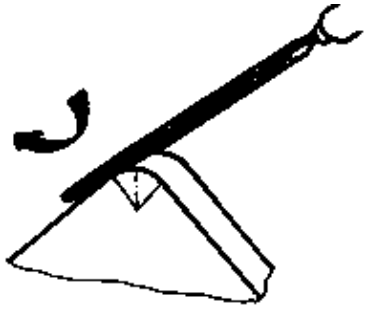


Figure 34 Filing of small outer radii

Filing on big outer radii is at right angles to the radius starting at one side and working to the other side with slightly oblique stroke.

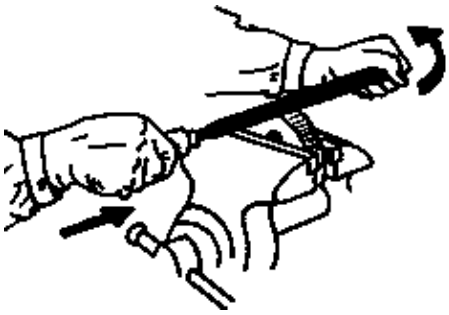


Figure 35 Filing of big outer radii

Filing on inside radii of any size is at right angles to the radius. The radius of the file (round file, half round file) must be smaller than the radius of the work.

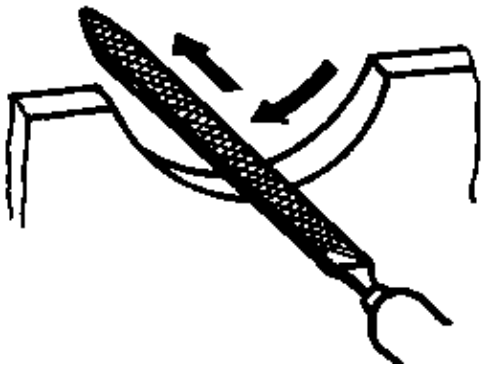


Figure 36 Filing of big inside radii

Testing of the radii for accuracy to shape is by radius gauges for outer and inner radii.

6.3. Filing of recesses and openings

The file is carefully selected depending on the size and shape of the recesses or openings It must be smaller than the recess or opening to be filed.

Testing for accuracy to size is by measuring instruments, for accuracy to shape by adequate counterparts.

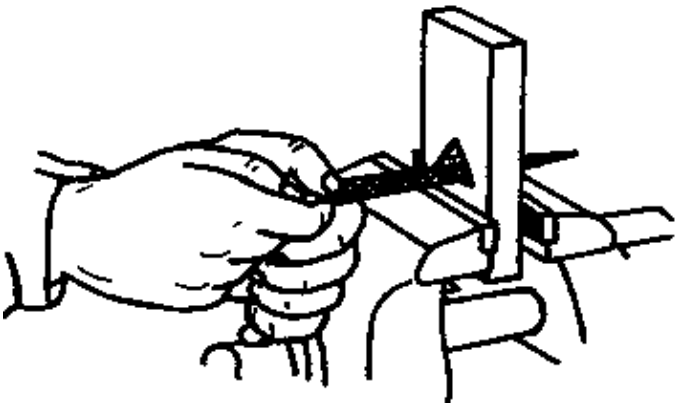


Figure 37 Filing of an opening

6.4. Filing of chamfers

On big workpieces filing of chamfers at an angle of 45 degrees is performed with vertically inclined file. Small workpieces may be clamped in an angle vice and are filed horizontally.

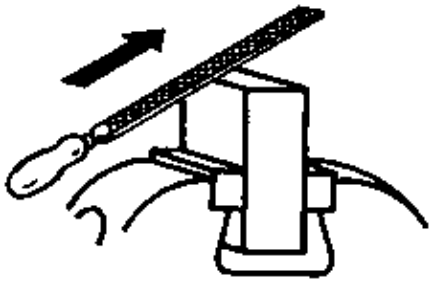


Figure 38 Filing of a chamfer on big workpieces

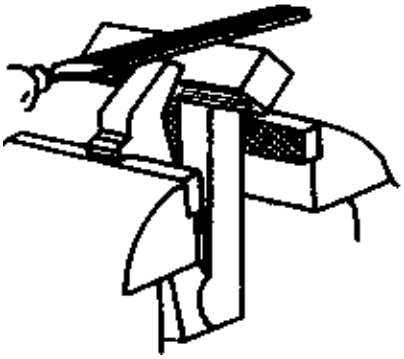


Figure 39 Filing of a chamfer on small workpieces by means of an angle vice

On round stock (bolts) filing of chamfers is performed with the file laterally inclined by 45 degrees, filing step by step around the round stock with the file whipped outwards

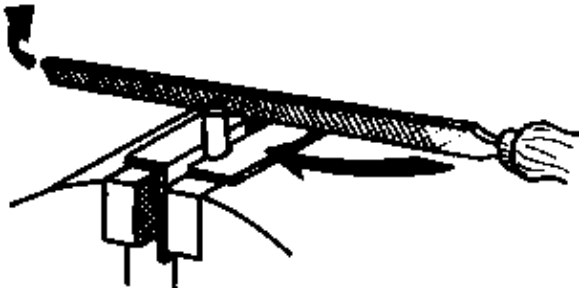


Figure 40 Filing of a chamfer on round stock

Testing of the chamfer is by Judgement by the eye, particularly with respect to evenness and surface finish.

Which kinds of stroke are to be subsequently used when filing straight faces?

_____

Why can evenness with good surface finish be achieved only by crossing–stroke filing?

_____
_____

What is typical of the working movement when filing small outside radii?

_____
_____

Which requirements are to be met when filing inside radii?

_____

What makes the difference between filing of big and small parts?

_____
_____

7. Labour safety recommendations

– Don’t wipe off chips with bare hands – danger of injury!

– Use files with crackless file handles only – otherwise danger of injury!

– Bore and enlarge new file handles according to the tang and then fix them by gentle hammer blows!

– Hardened parts roust not be filed!

– Don’t stack files one above the other – protect them from falling down!

– Clean files regularly with file brush and latten brass!

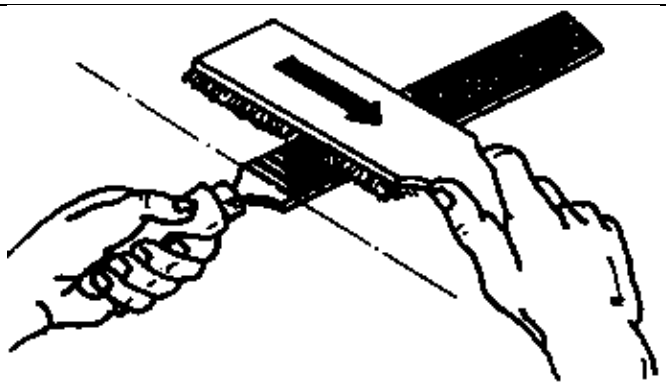


Figure 41 Cleaning of the file with the file brush

Fitter 1st Year – Transparencies

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Fitter 1st Year – Transparencies

Directorate General of Employment & Training, Ministry of Labour, Govt. of India.

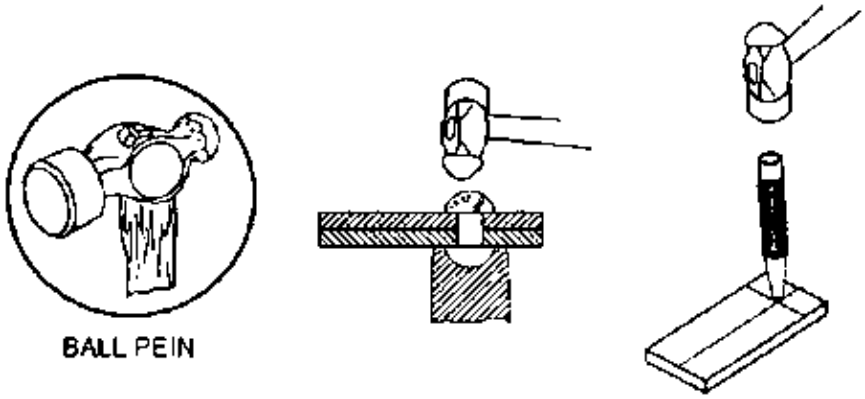
CENTRAL INSTRUCTIONAL MEDIA INSTITUTE, MADRAS
AN INDO-GERMAN PROJECT

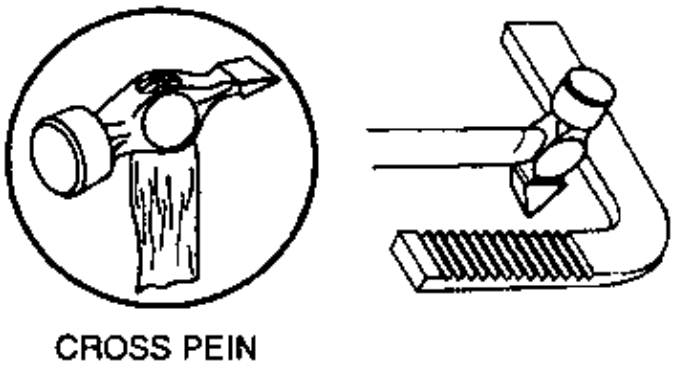
NOTE:

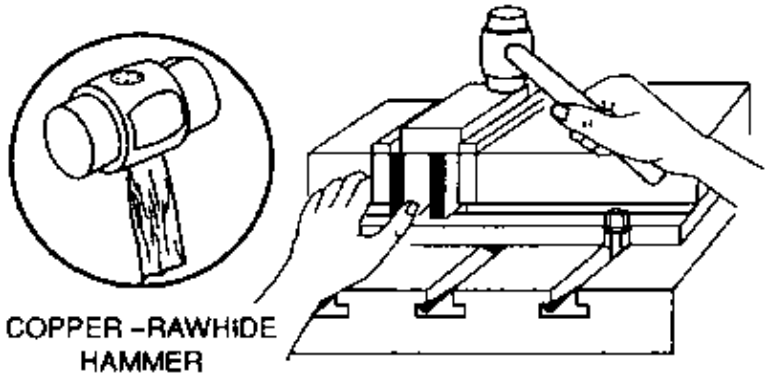
CIMI has developed a set of twenty five transparencies in order to assist the instructors in presenting their lessons. These transparencies cover only a part of the syllabus content but CIMI is working towards producing transparencies to cover all the major portion of the trade syllabus progressively.

In order to reduce the number of transparencies, these transparencies are slightly over loaded with informations. To overcome the adverse effects of such overloaded OHP transparencies, it is suggested that the instructors may use a thin board or paper and reveal part by part of the transparency that is required for explanation. You may find that in most transparencies, informations are incomplete. This is intentionally designed with a view to enhancing classroom interaction. For the assistance of the instructor a key is provided along with each transparency.

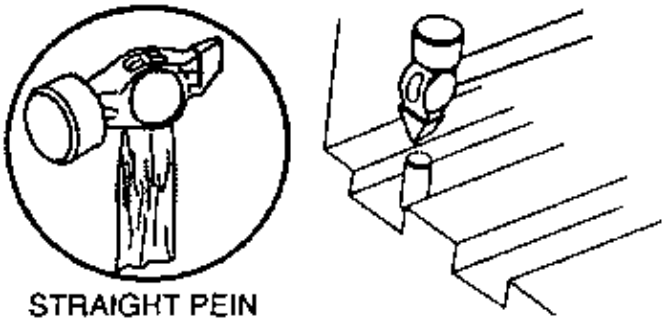
1. TR 01 01 01 01 93 – HAND HAMMERS – APPLICATIONS



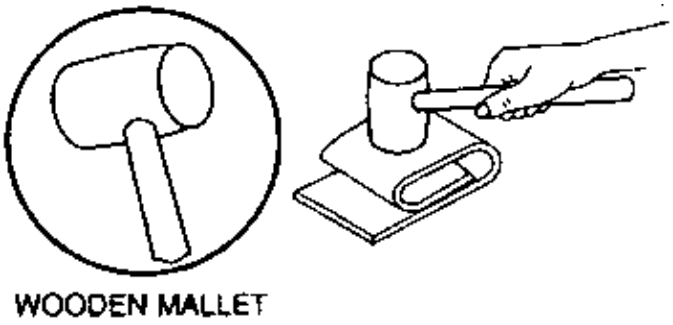




COPPER –RAWHIDE
HAMMER

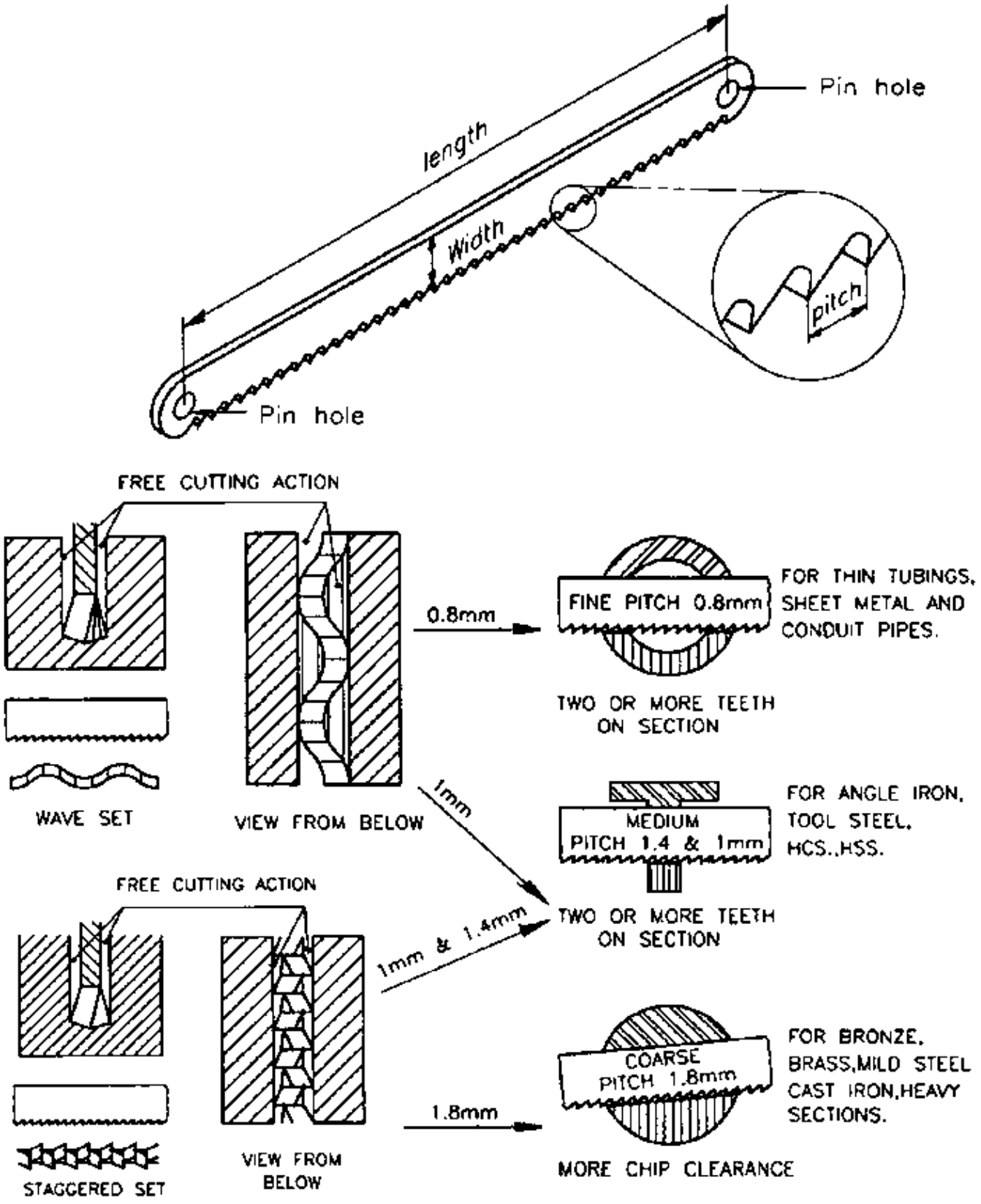


STRAIGHT PEIN



WOODEN MALLET

2. TR 01 01 01 02 93 – HACKSAW BLADE – SELECTION



3. TR 01 01 01 03 93 – CUT OF FILES

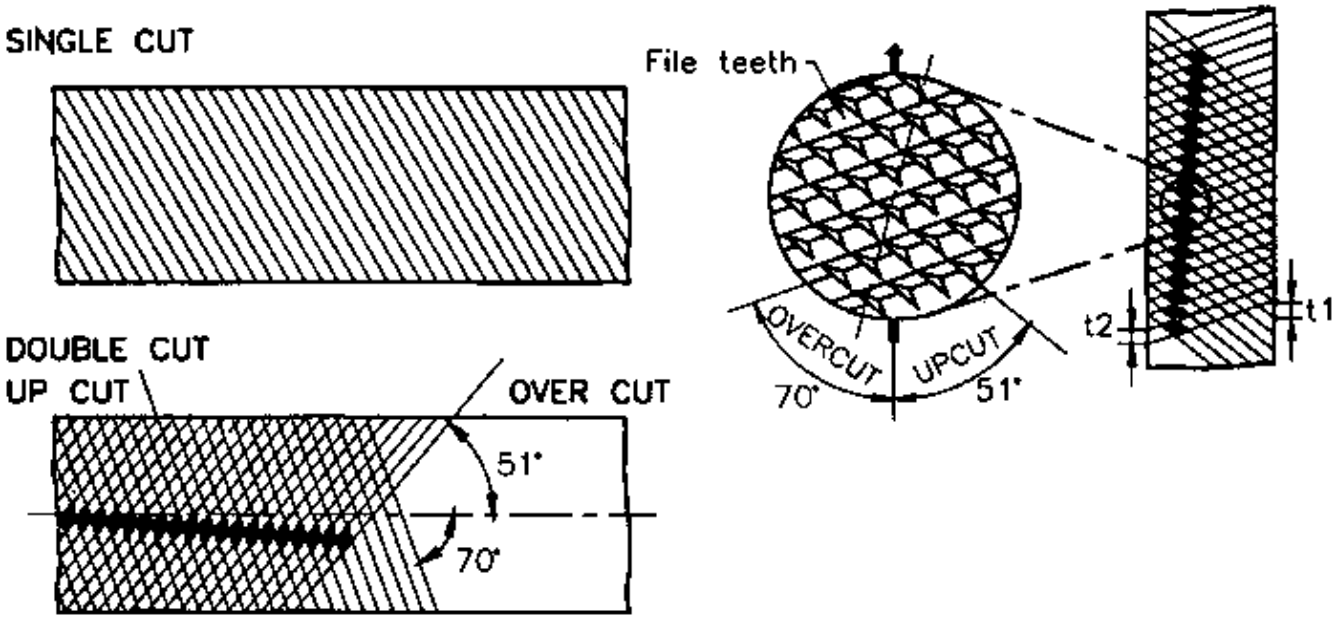
• SINGLE CUT FILES USED FOR FILING SOFT METALS

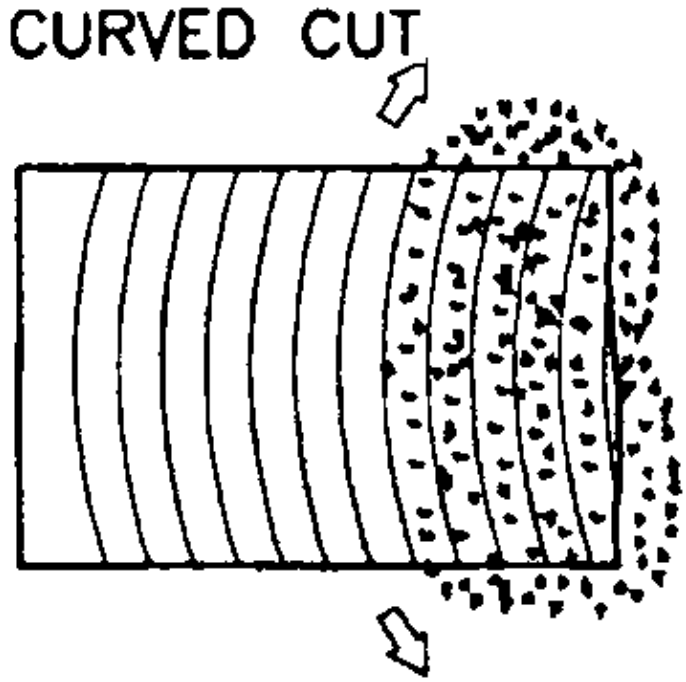
Eg. ALUMINIUM, BRASS, BRONZE ETC

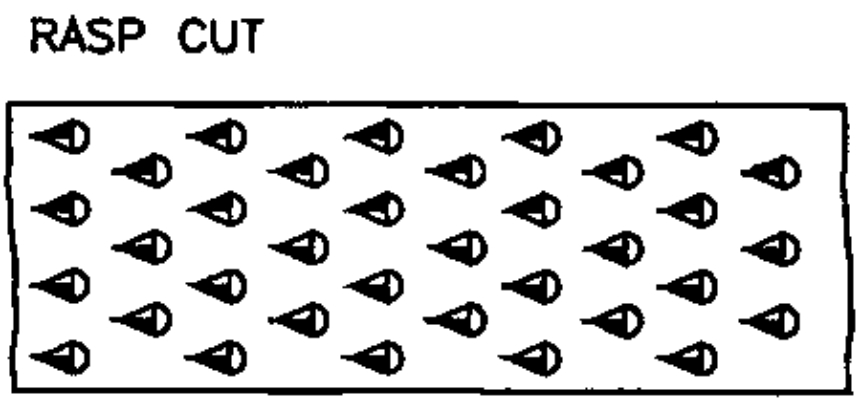
• DOUBLE CUT FILES USED FOR FILING HARD METALS

Eg. STEEL, CAST IRON ETC.

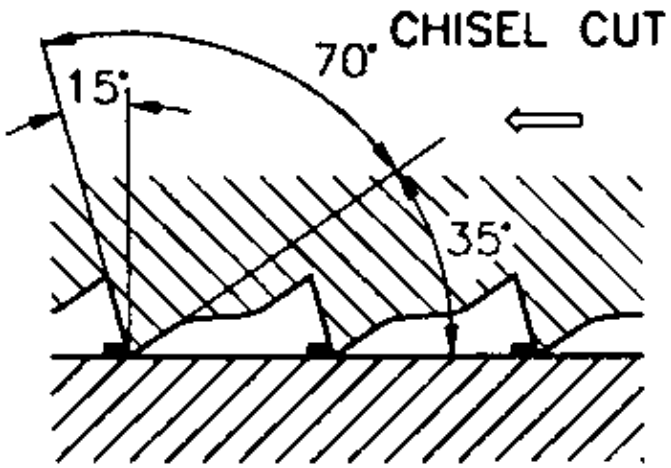
THESE FILES HAVE OVERCUT & UPCUT AT DIFFERENT ANGLES AND DIFFERENT SPACING OF TEETH. DUE TO THIS TEETH DO NOT FALL BEHIND ONE AFTER THE OTHER



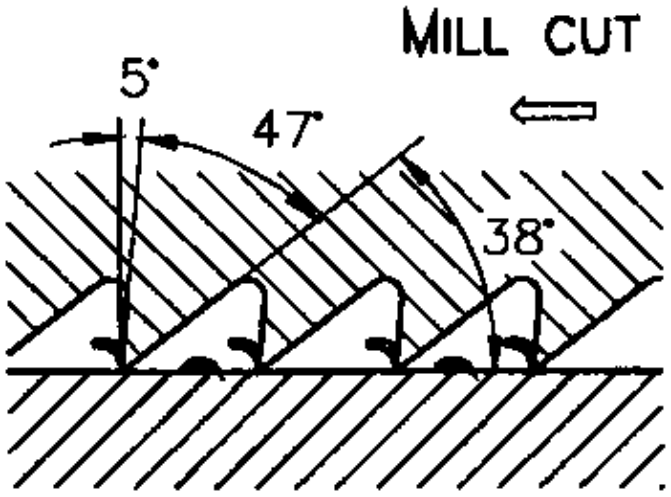




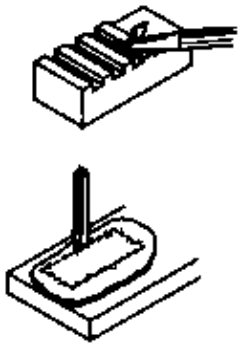
FOR HARD METALS NEGATIVE RAKE SCRAPING ACTION

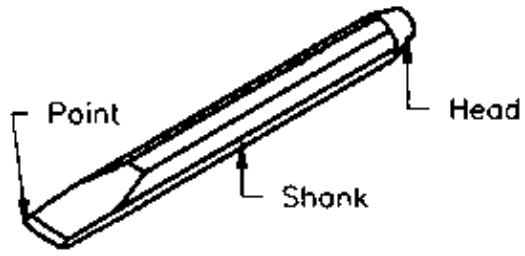


FOR SOFT METALS CUTTING ACTION

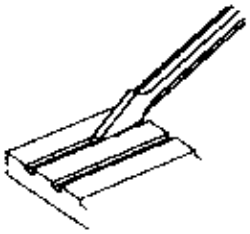


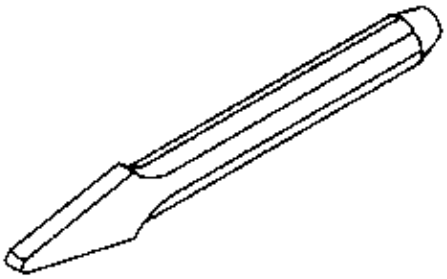
4. TR 01 01 01 04 93 – TYPES OF CHISELS AND APPLICATION



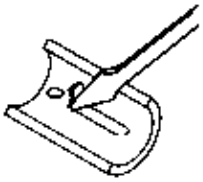


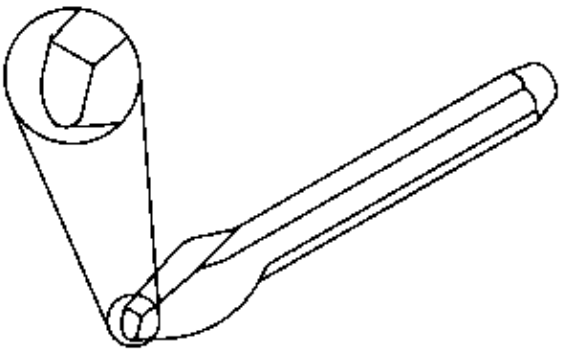
(a) Flat chisel



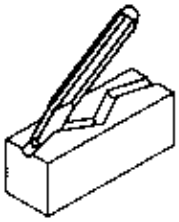


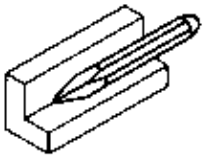
(b) Cross-Cut Chisel

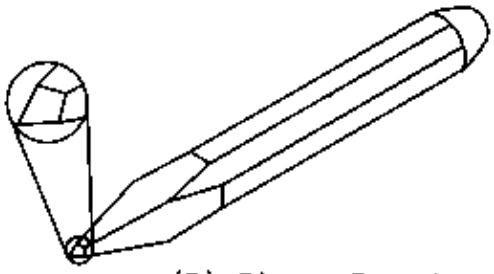




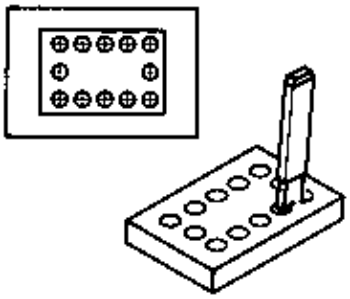
(c) Round-nose chisel

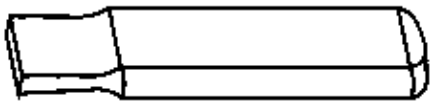






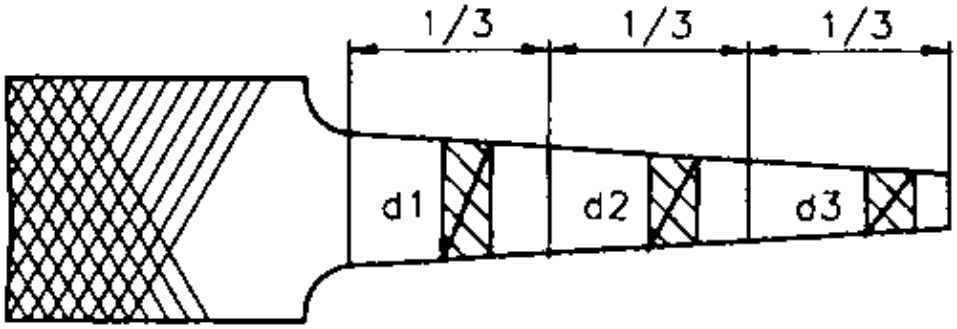
(D) DiamonD-point chisel

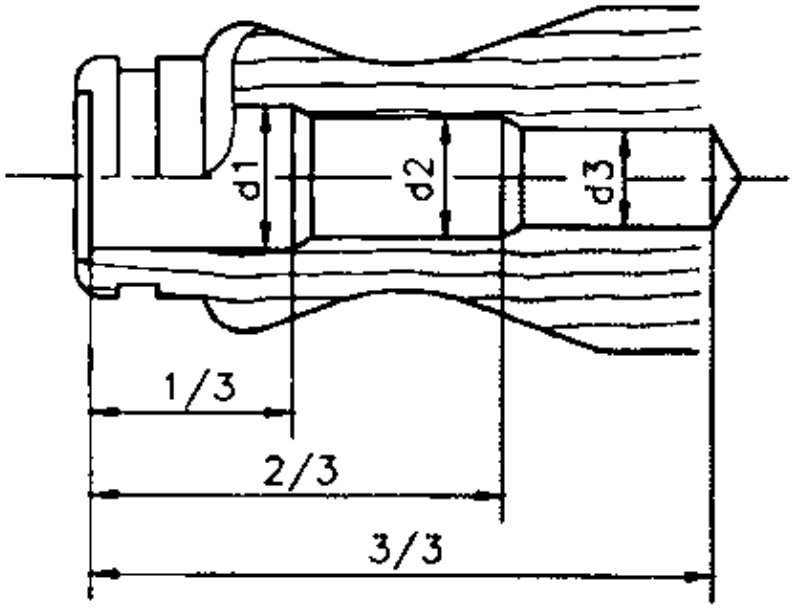


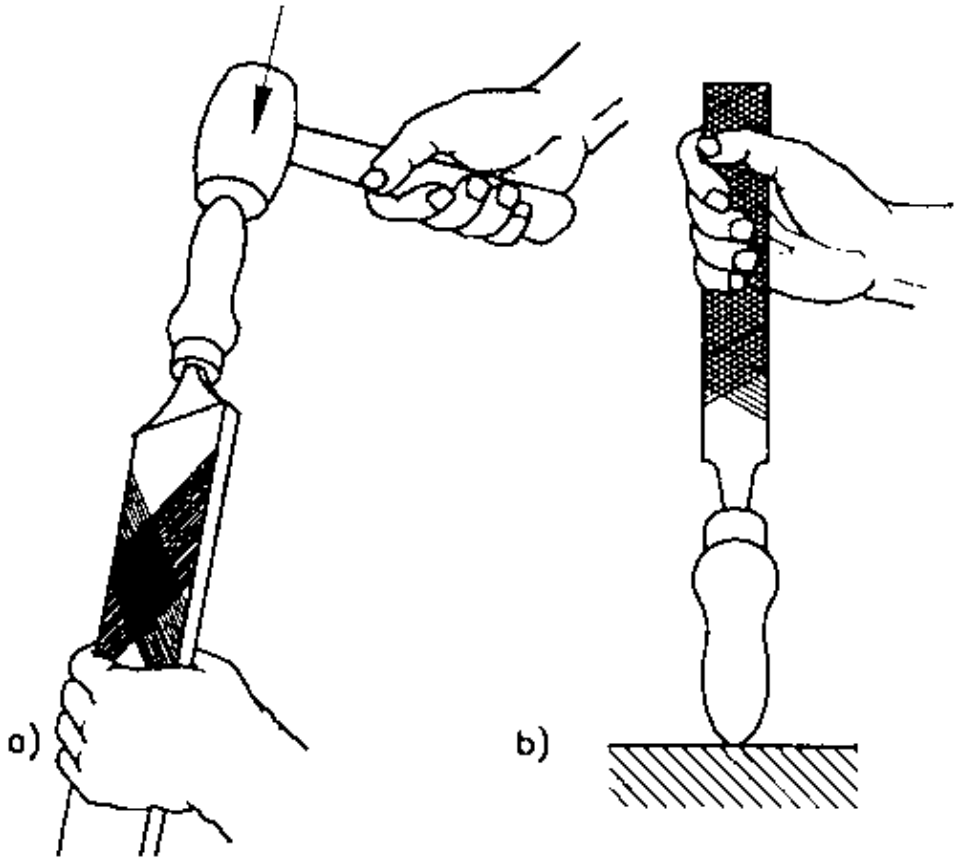


(e) Web chisel

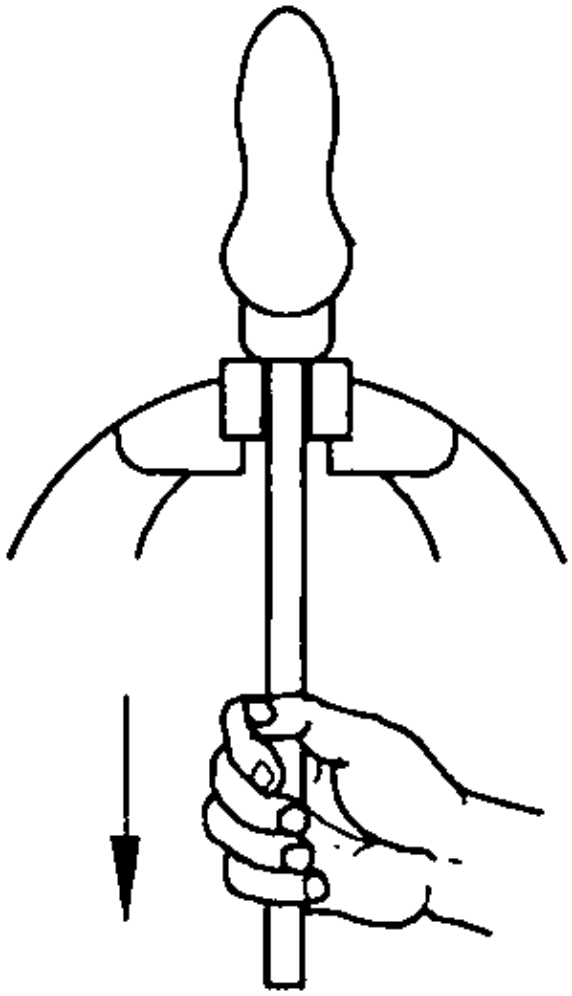
5. TR 01 01 01 05 93 – FIXING FILE HANDLES





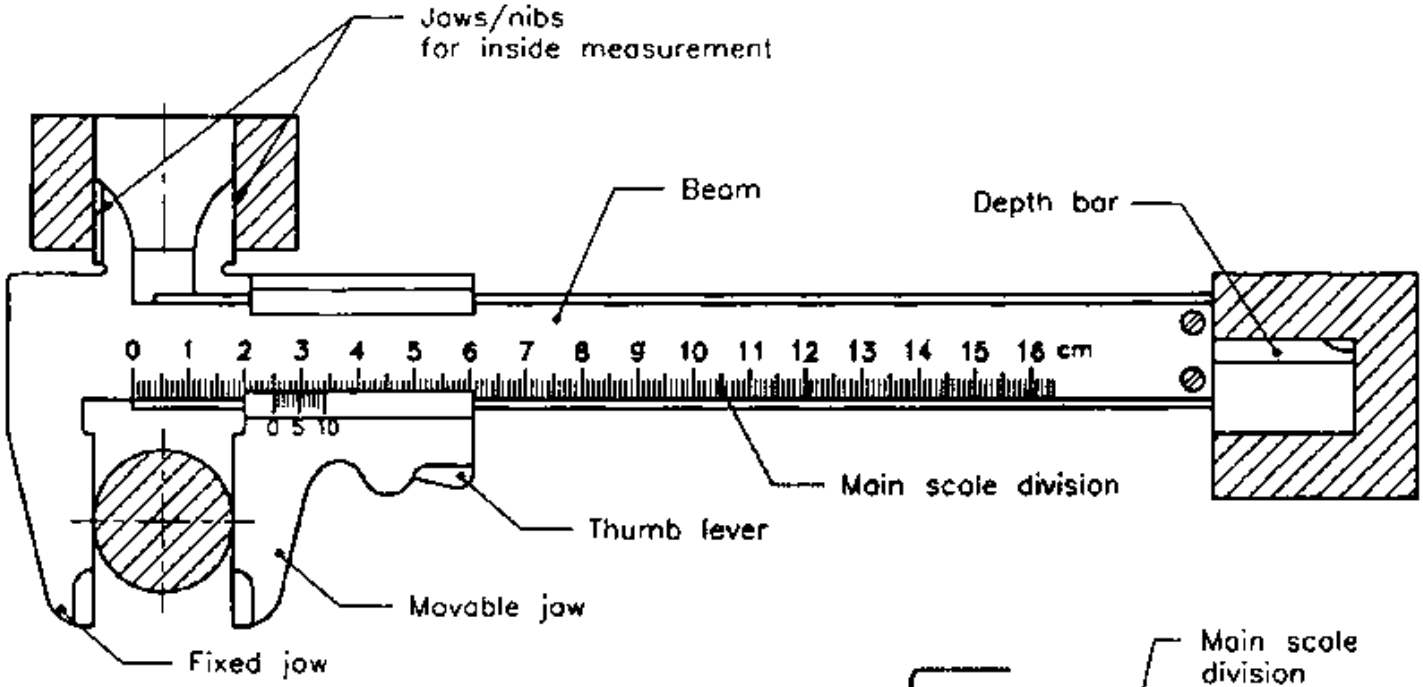


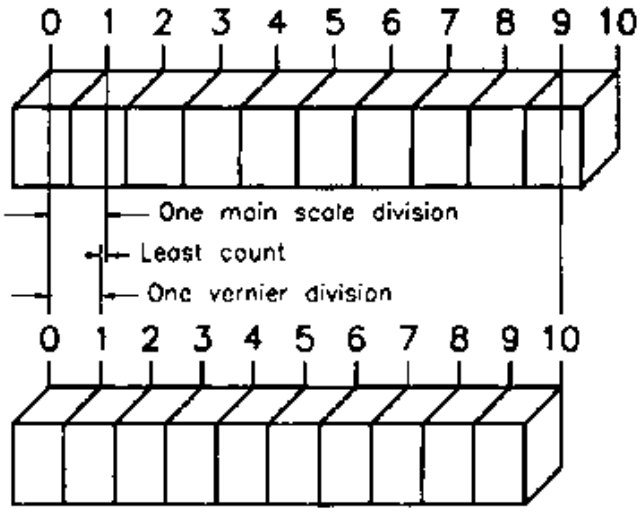
FIXING HANDLE

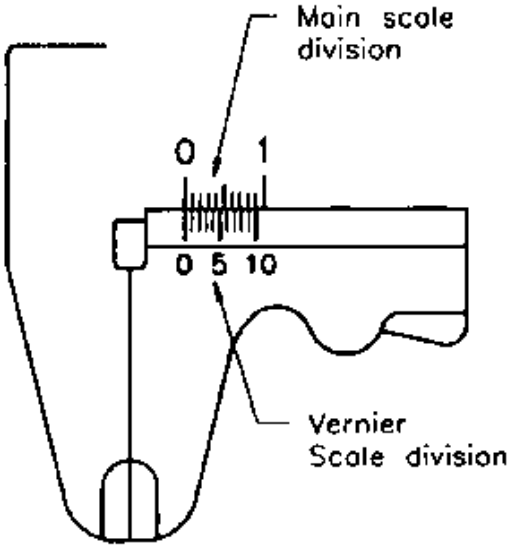


REMOVING HANDLE

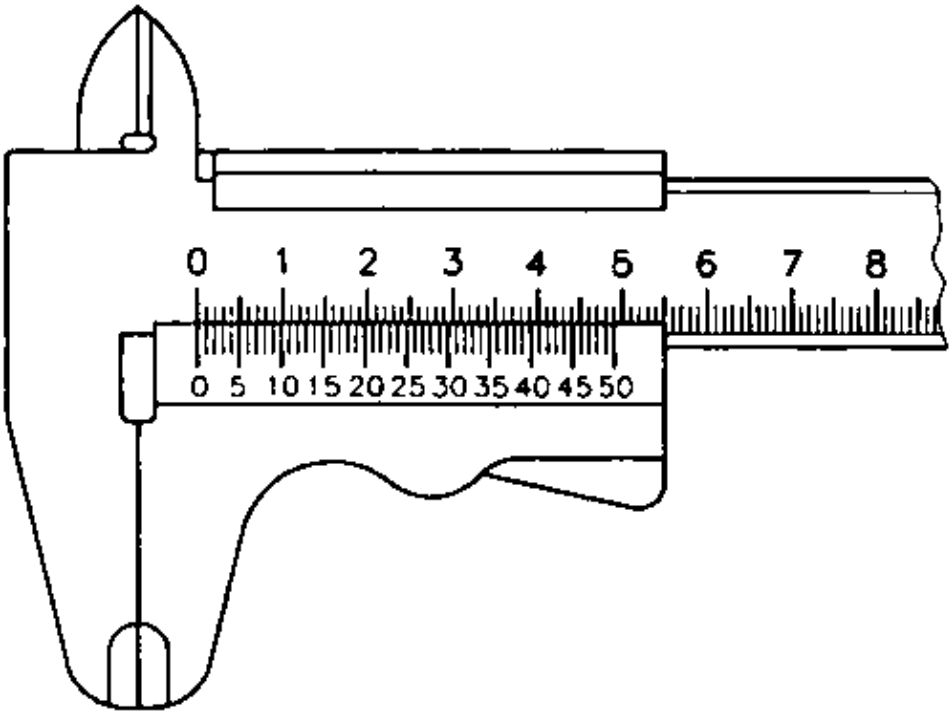
6. TR 01 02 01 01 93 – VERNIER CALIPER PARTS AND PRINCIPLE

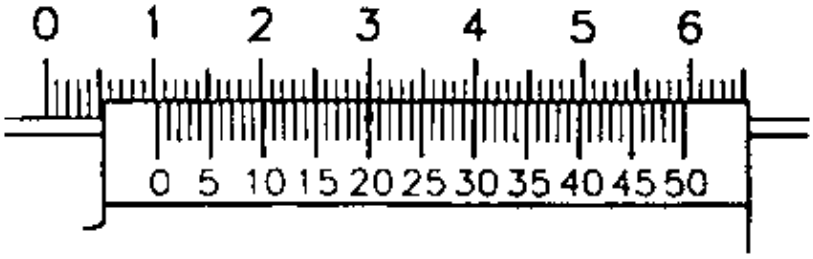






7. TR 01 02 01 02 93 – READING OF VERNIER CALIPER





49 Main scale divisions are divided into 50 vernier scale divisions

$$\text{Value of 1 VSD} = \frac{49}{50}\text{ mm}$$

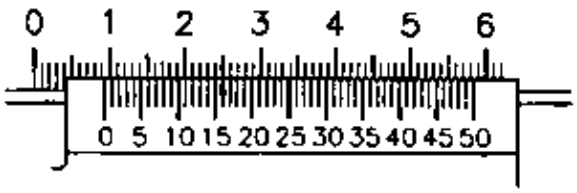
$$\text{Least count} = 1\text{MD} - 1\text{VSD}$$
$$= 1 - \frac{49}{50}$$
$$= \frac{1}{50} = 0.02\text{ mm}$$

Main scale reading = 10.00 mm

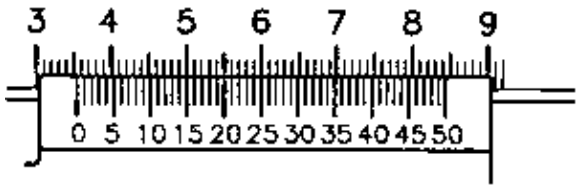
Value of coinciding vernier division = 00.40 mm

Reading = 10.40 mm

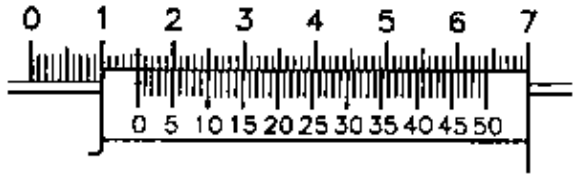
Assignments:–



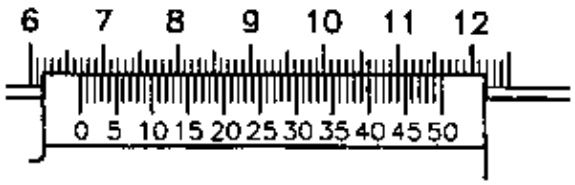
A Reading **9.32 mm**



B Reading **35.40 mm**

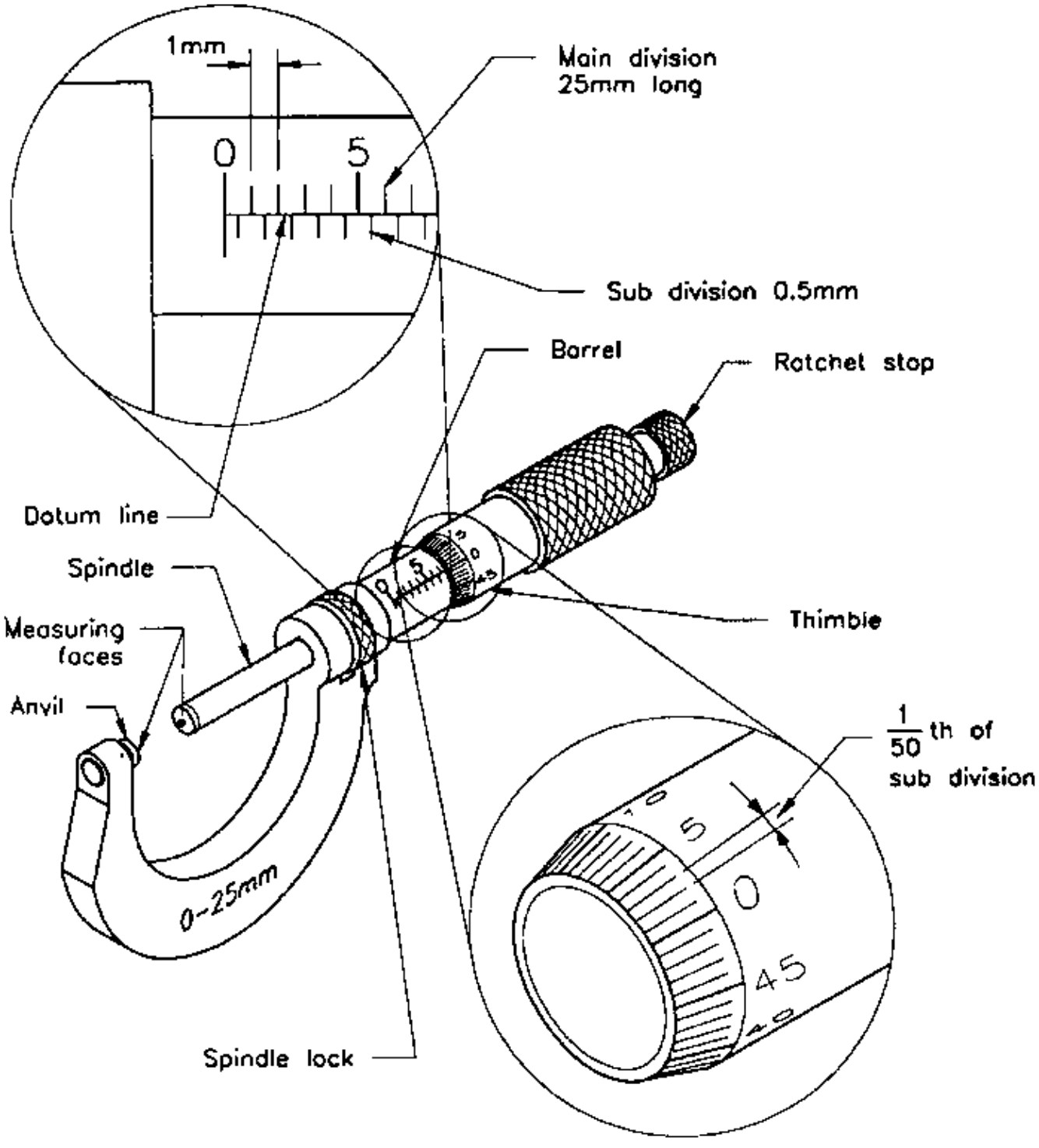


C Reading **15.00 mm**



D Reading **66.80 mm**

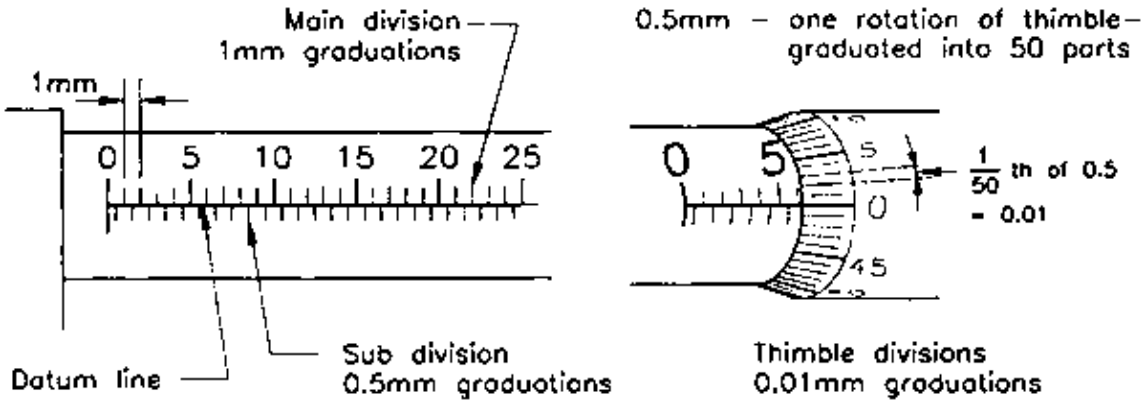
8. TR 01 02 02 01 93 – MICROMETER PARTS AND GRADUATIONS



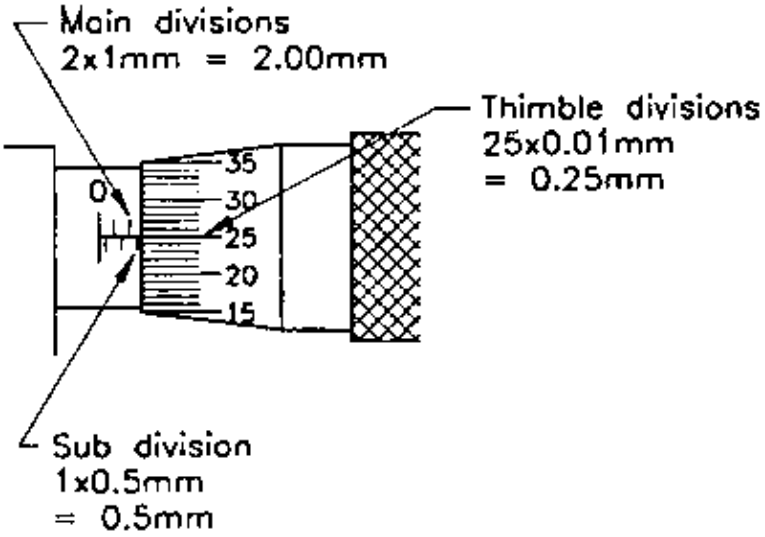
$$\text{Leastcount} = \frac{1}{50}\text{th of } 0.5 = 0.01\text{mm}$$

9. TR 01 02 02 02 93 – MICROMETER READING

Micrometer graduations

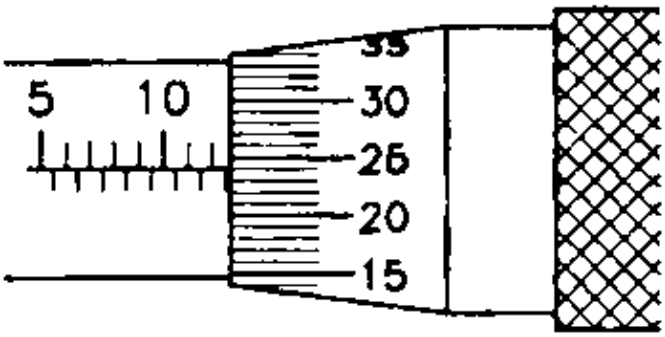


Micrometer reading



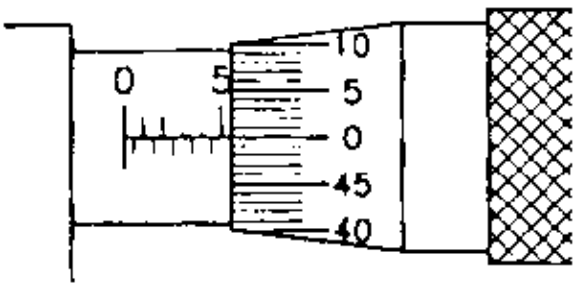
Main divisions = 2.00 mm
Sub division = 0.50 mm
Thimble divisions = 0.25 mm
Reading = 2.75 mm

Example

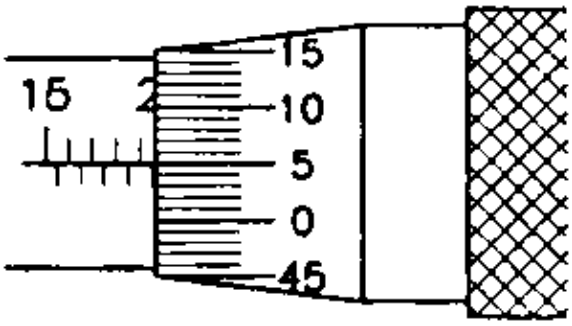


Main divisions = 12.00 mm
Sub division = 0.50 mm
Thimble divisions = 0.24 mm
Reading = 12.74 mm

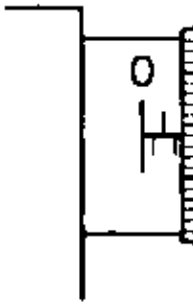
Assignments:–



A Reading **5.50 mm**

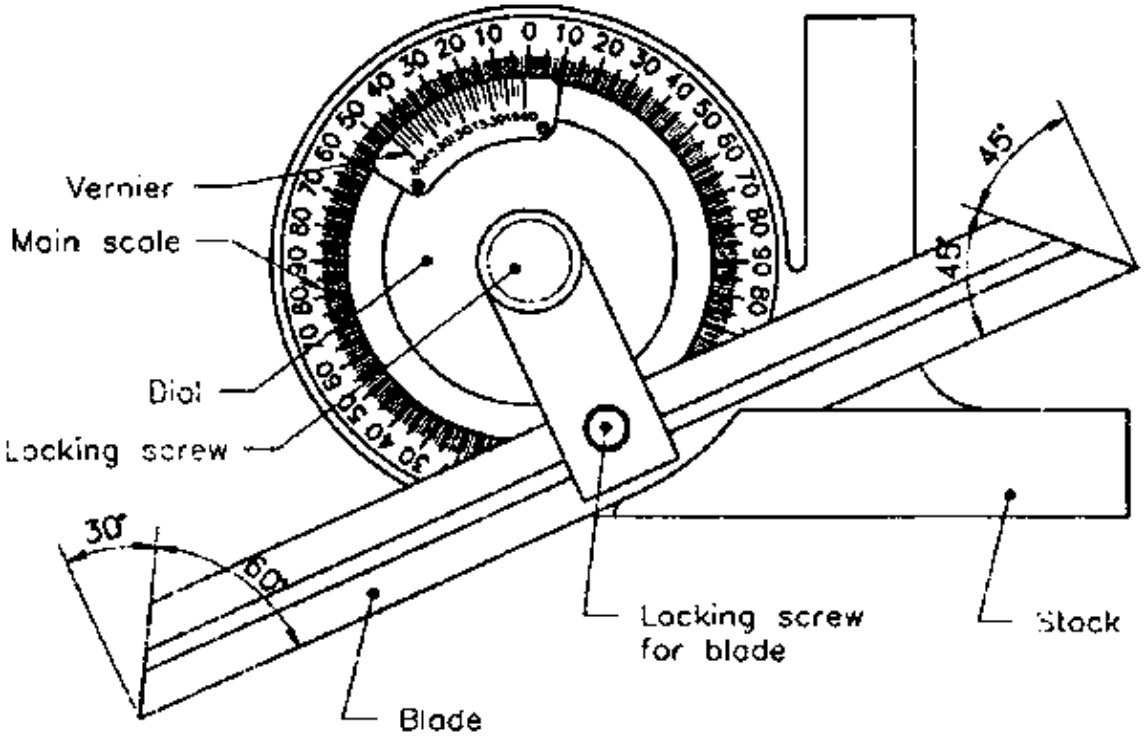


B Reading **19.55 mm**

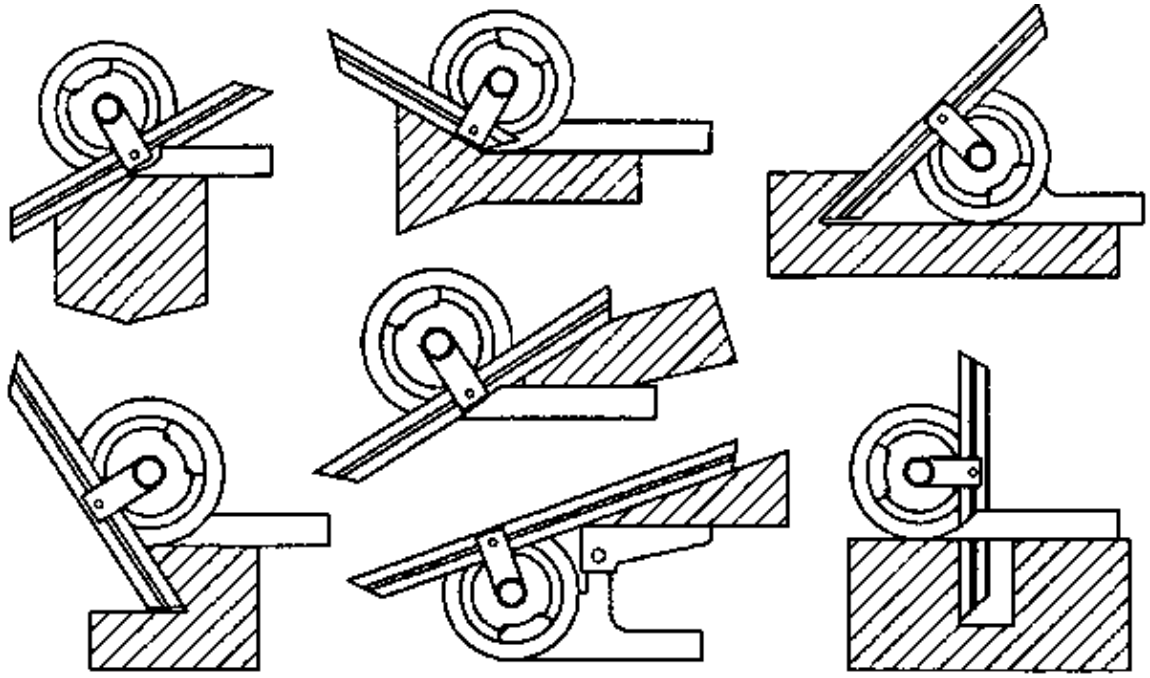


C

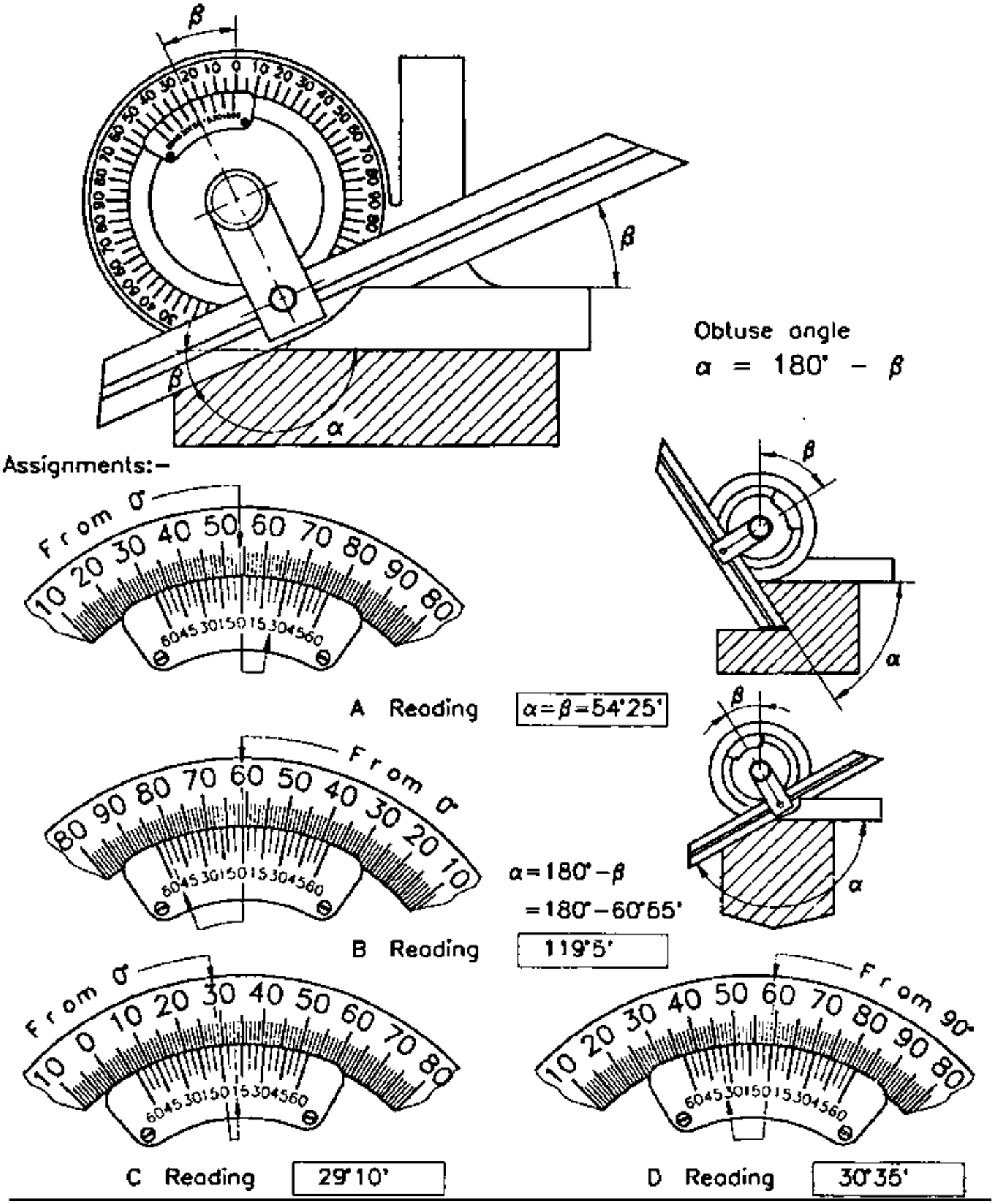
10. TR 01 02 03 01 93 – VERNIER BEVEL PROTRACTOR PARTS & APPLICATION



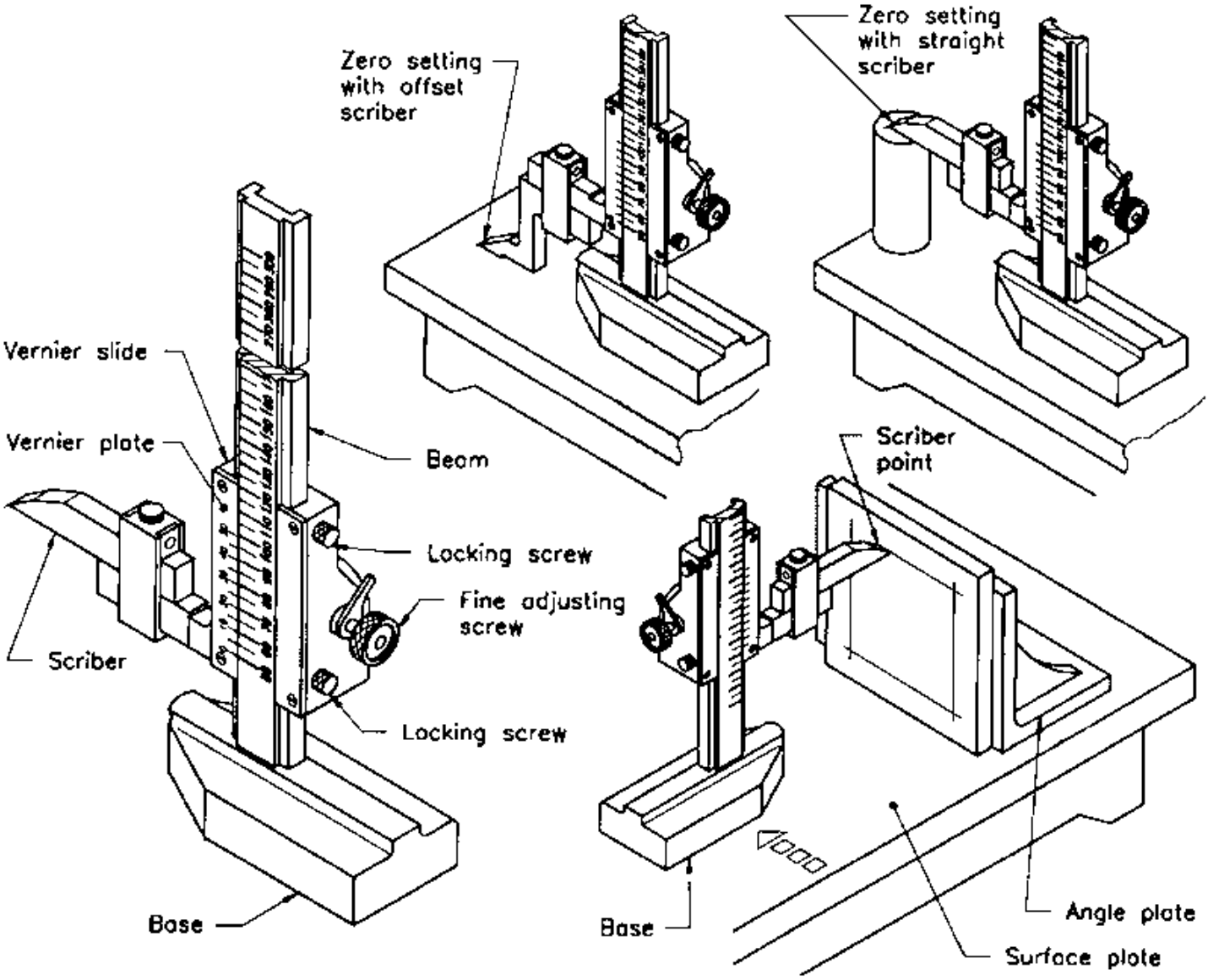
Applications:–



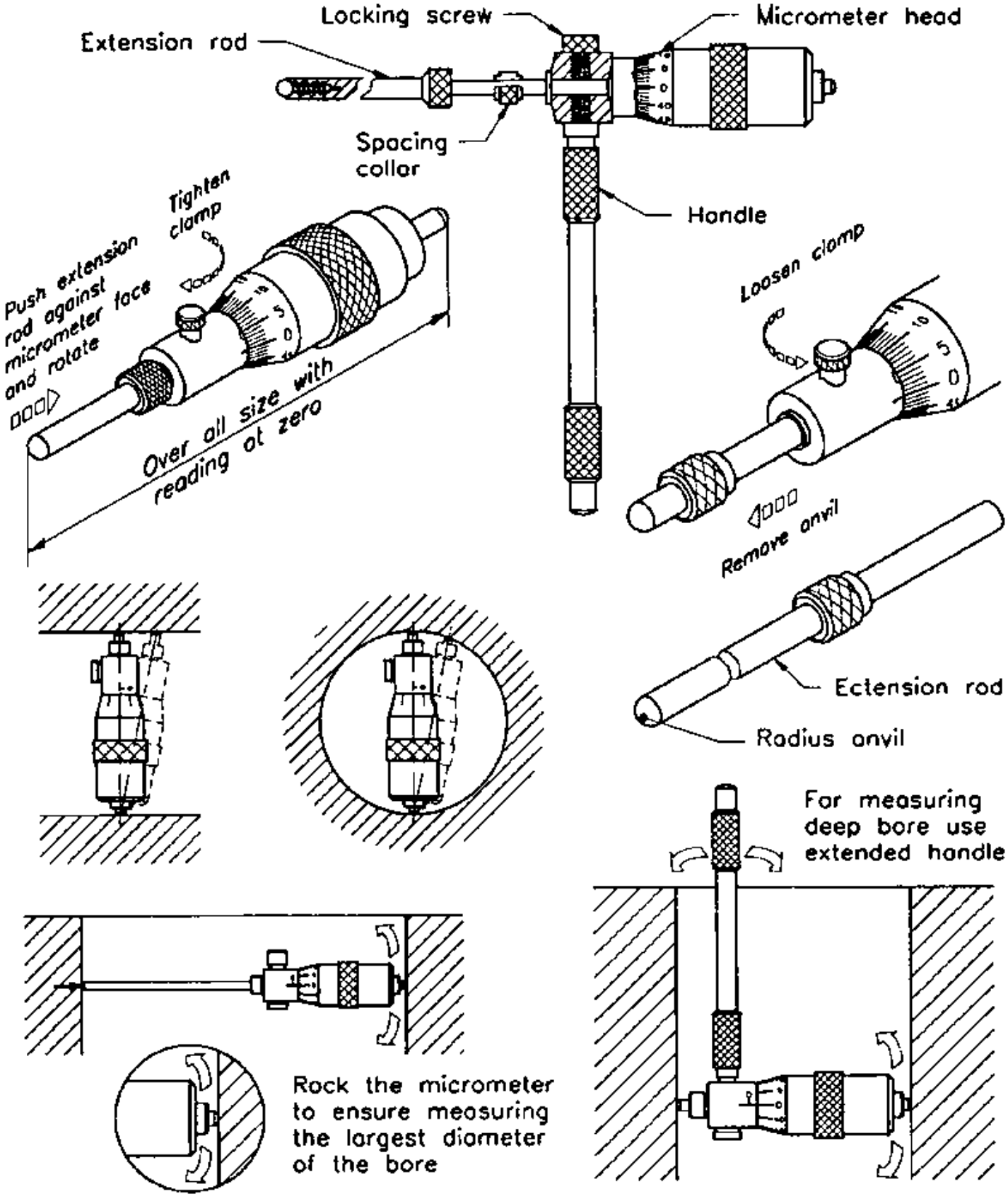
11. TR 01 02 03 02 93 – BEVEL PROTRACTOR READING



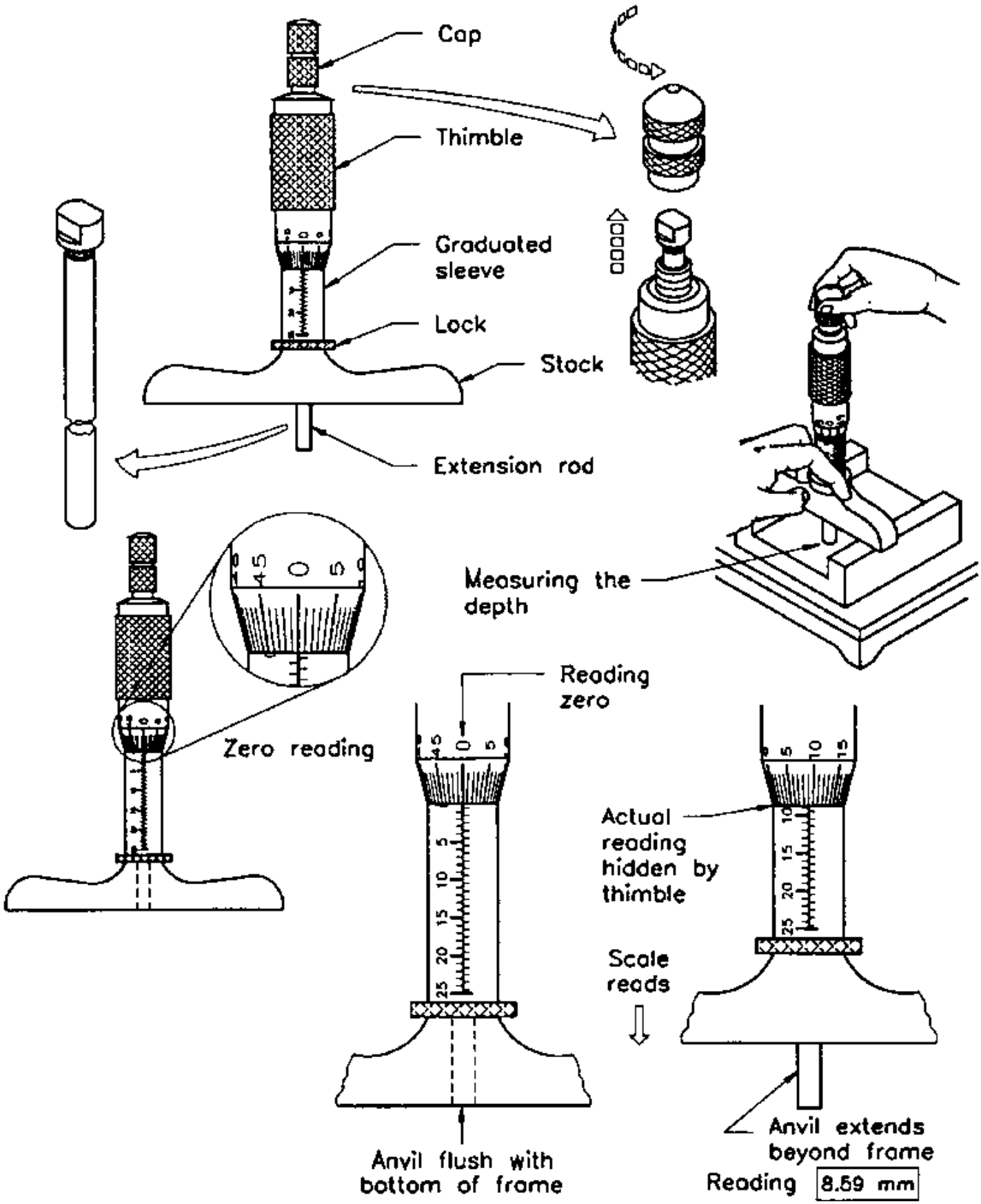
12. TR 01 02 04 01 93 – VERNIER HEIGHT GAUGE



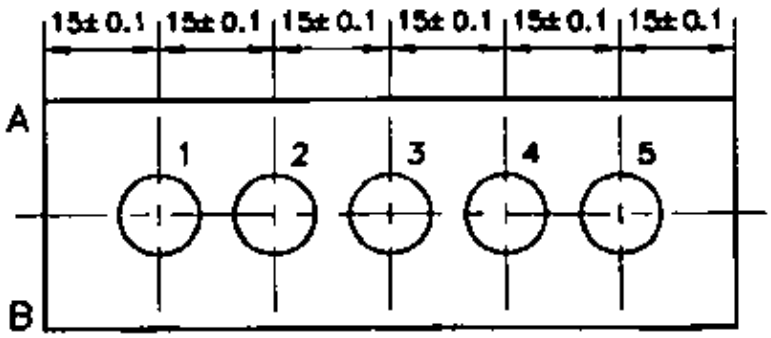
13. TR 01 02 05 01 93 – INSIDE MICROMETER



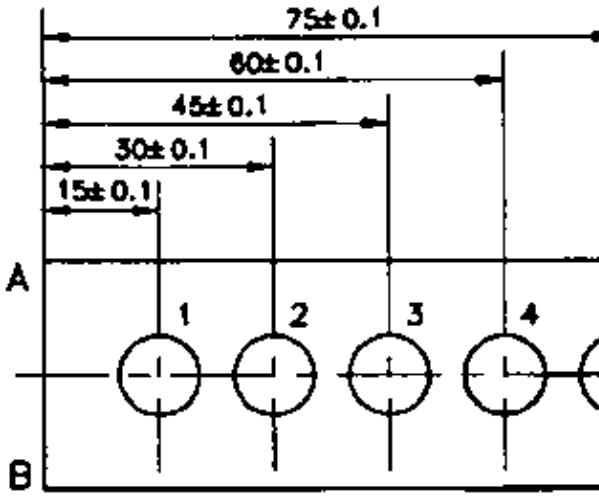
14. TR 01 02 06 01 93 – DEPTH MICROMETER



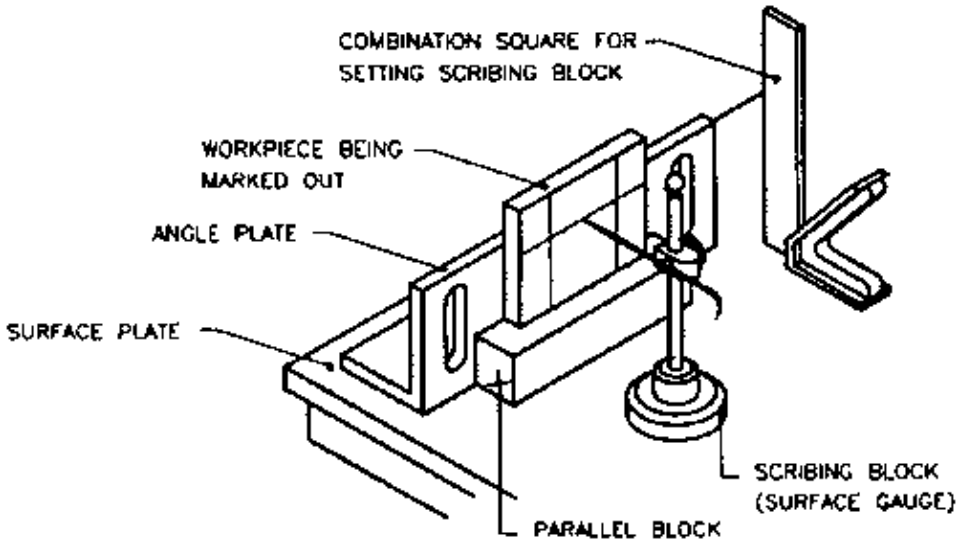
15. TR 01 02 09 01 93 – DATUM – CUMULATIVE ERROR IN MARKING



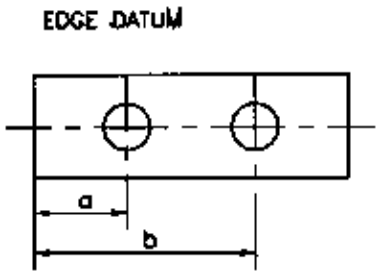
Dimensions marked progressively.
Cumulative error may built up



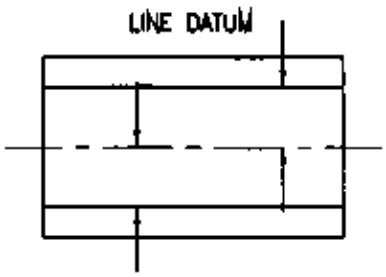
Each dimension is individually marked from on
possibility for cumulative error.



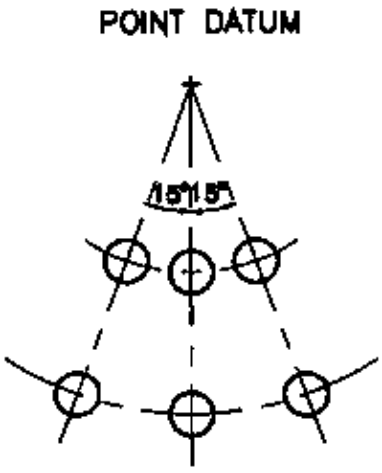
While marking datum is required
It can be a line or a reference surface



Reference for marking are the
edges of the component.

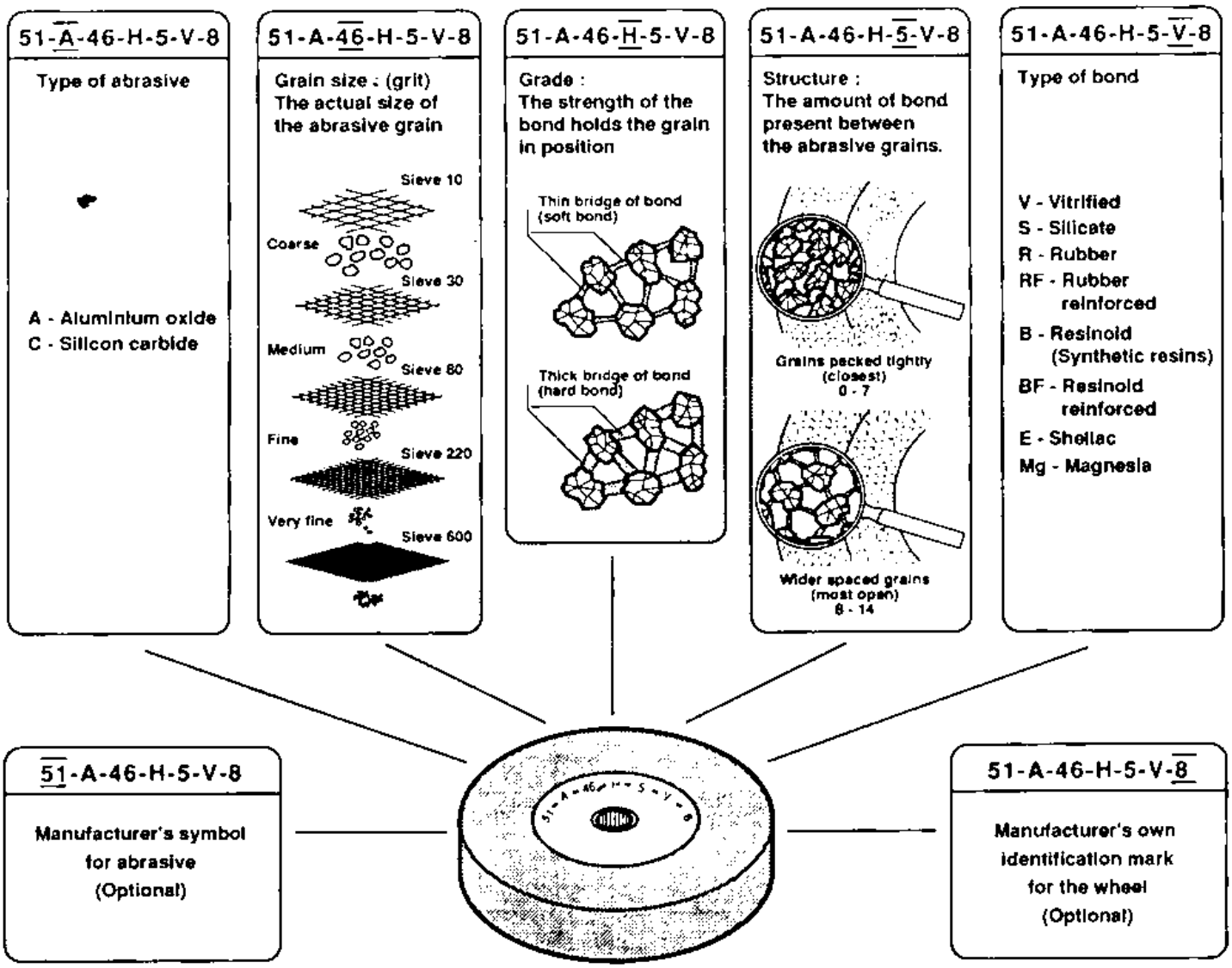


Dimensions ore marked with
centre line as reference.

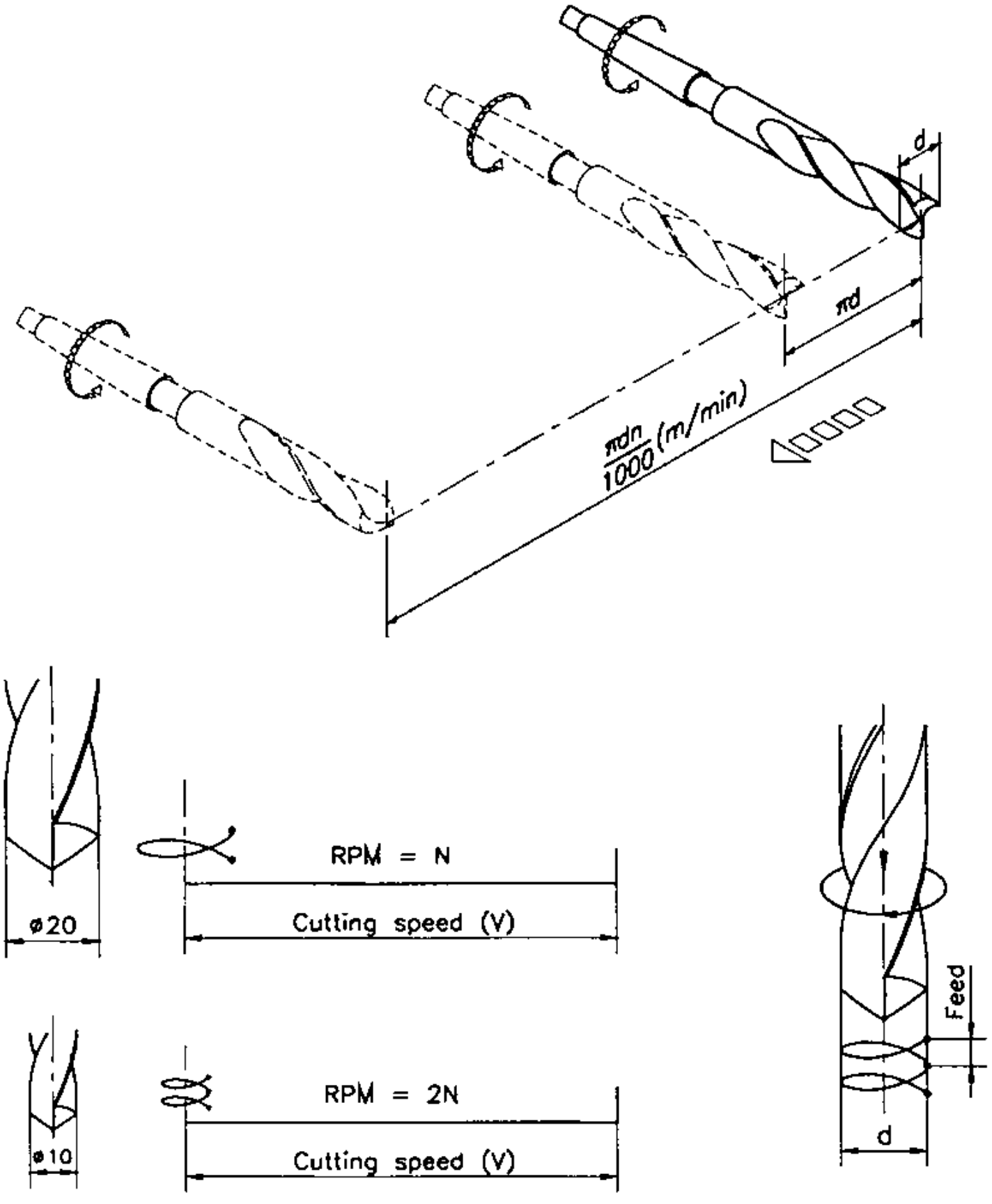


The reference for marking is a
point

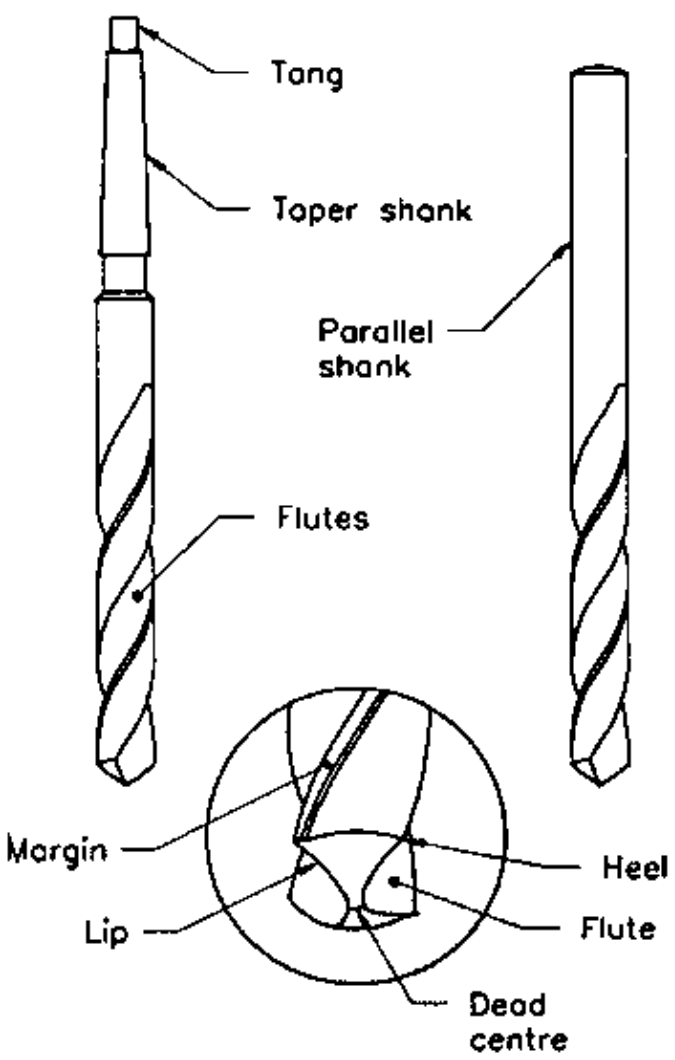
16. TR 01 04 01 01 93 – GRINDING WHEEL MARKING

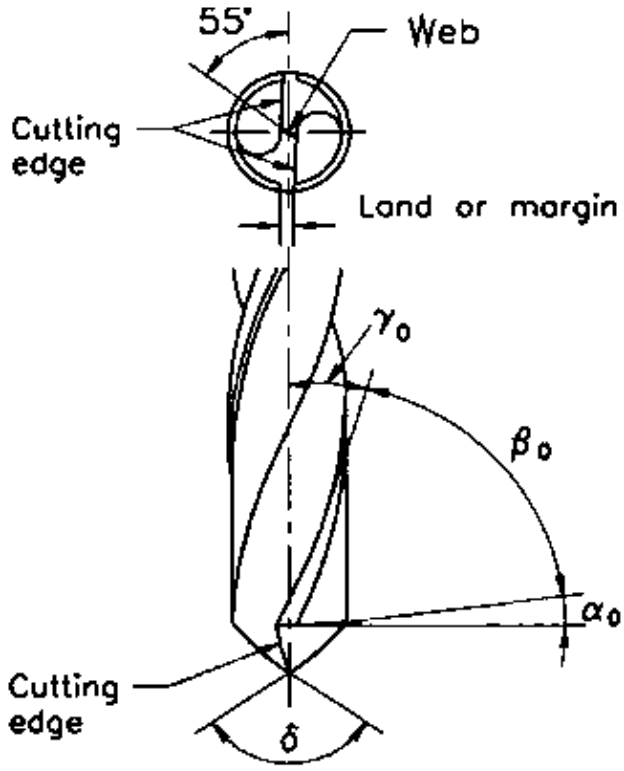


17. TR 01 05 01 01 93 – CUTTING SPEED, FEED AND R.P.M. OF DRILLS

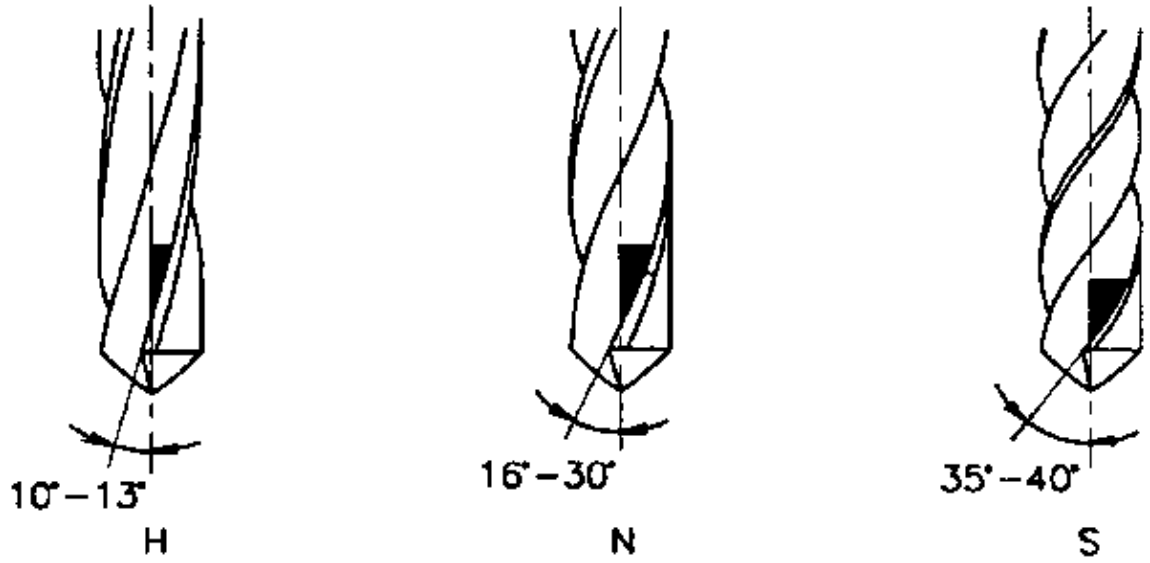


18. TR 01 05 02 01 93 – DRILL PARTS AND ANGLES



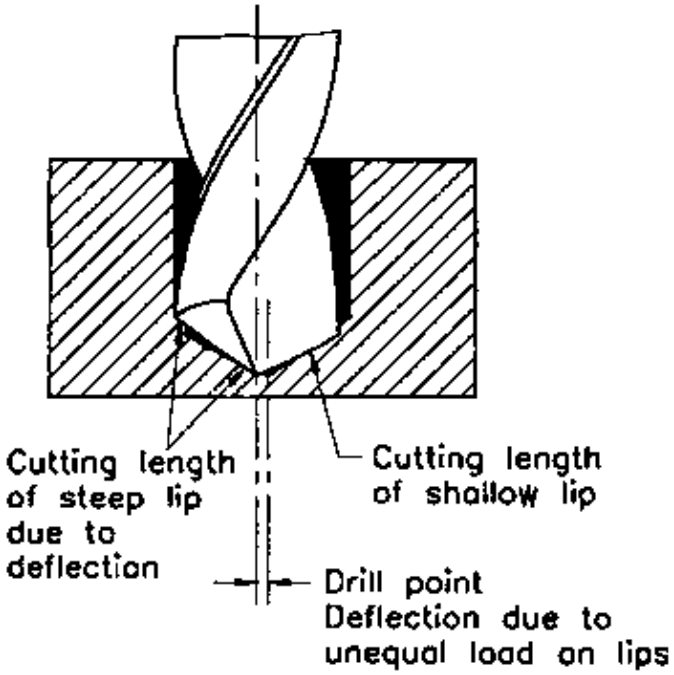


$?_0$ – Lip clearance angle
$?_0$ = Wedge angle
$?_0$ = Rake or helix angle
? = Point angle



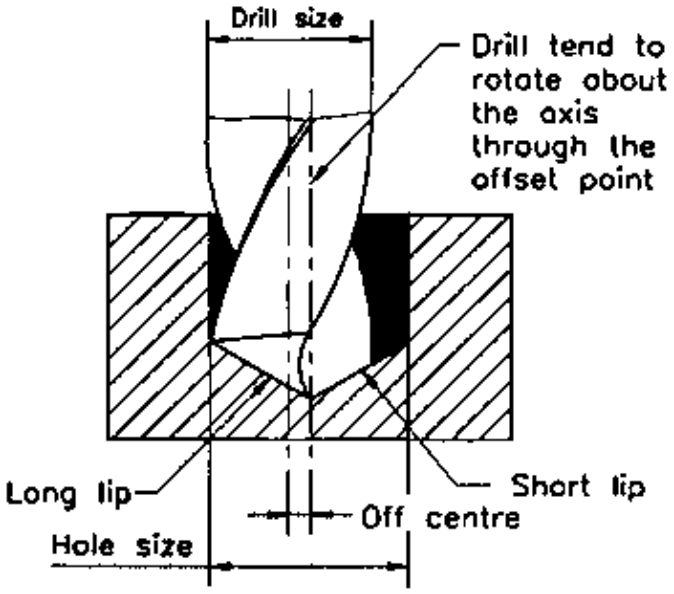
Type H – For hard and tenaceous materials.
Type N – For normal low carbon steels.
Type S – For soft and tough materials.

19. TR 01 05 02 02 93 – DRILL SHARPENING – DEFECTS THINNING OF WEB



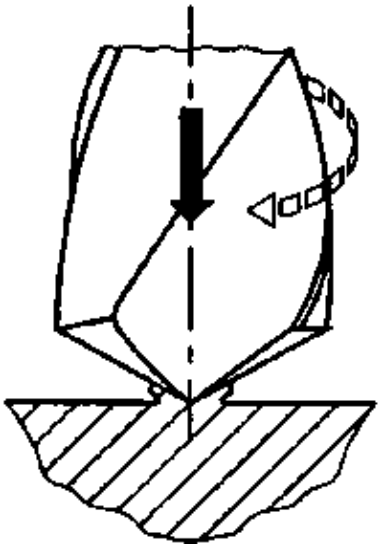
Cutting edges of unequal angles

- Only one lip does most cutting.
- Unequal load on tip.
- Drill point deflection
- Rapid wear on one cutting edge.
- Hole size larger.



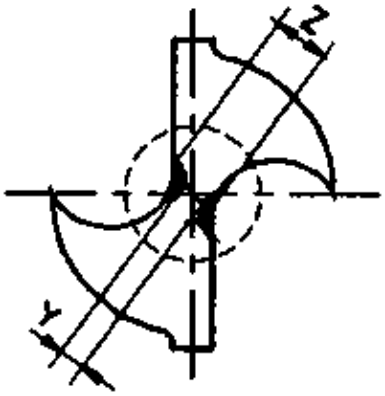
Cutting edges of unequal length but angles equal

- Eccentric running of drill point
- Hole size larger.
- Drill may break due to unequal load on lips.
- Drill life reduced.



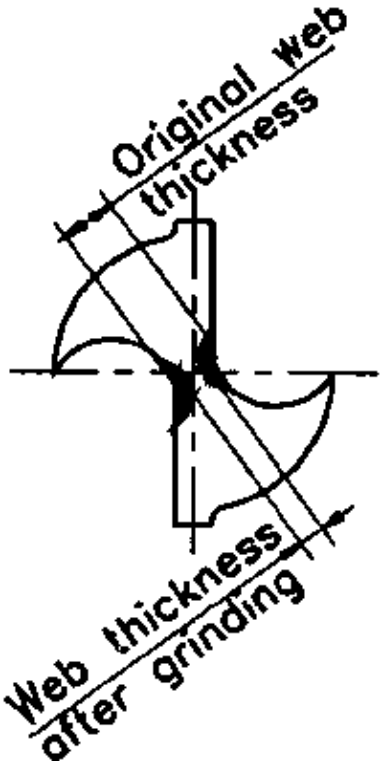
Thick web due to frequent grinding

• Drill cannot penetrate.
• Excessive pressure required for feeding.



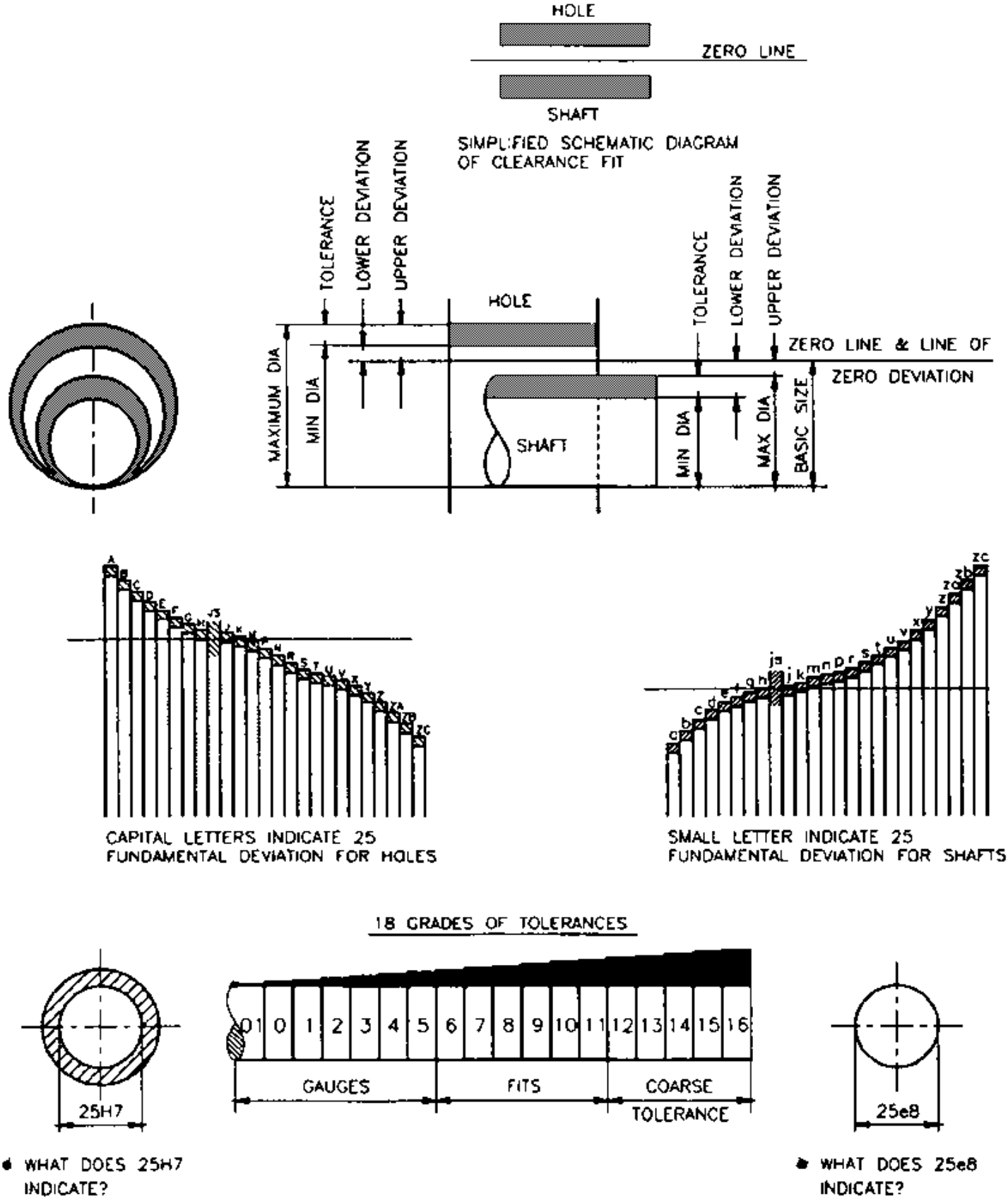
Web thinned by grinding

• Provides shorter chisel edge.

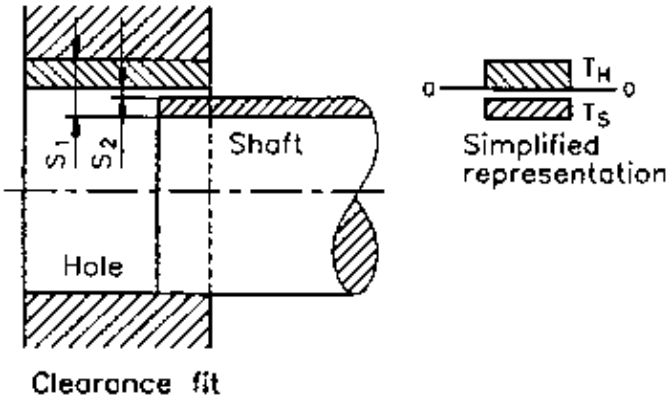


• How will this grinding affect the size of the hole drilled?

20. TR 01 06 01 01 93 – FUNDAMENTALS OF LIMITS AND FITS

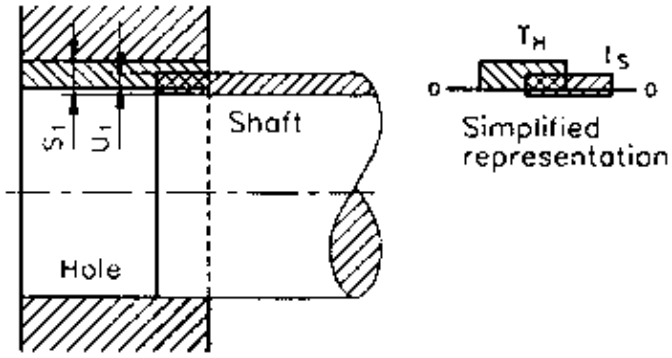


21. TR 01 06 01 02 93 – CLASSES OF FIT



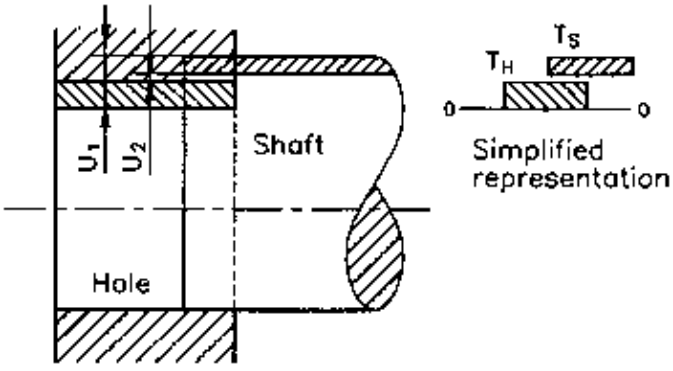
Clearance fit

S1 = Maximum clearance
S2 = Minimum clearance



Transition fit

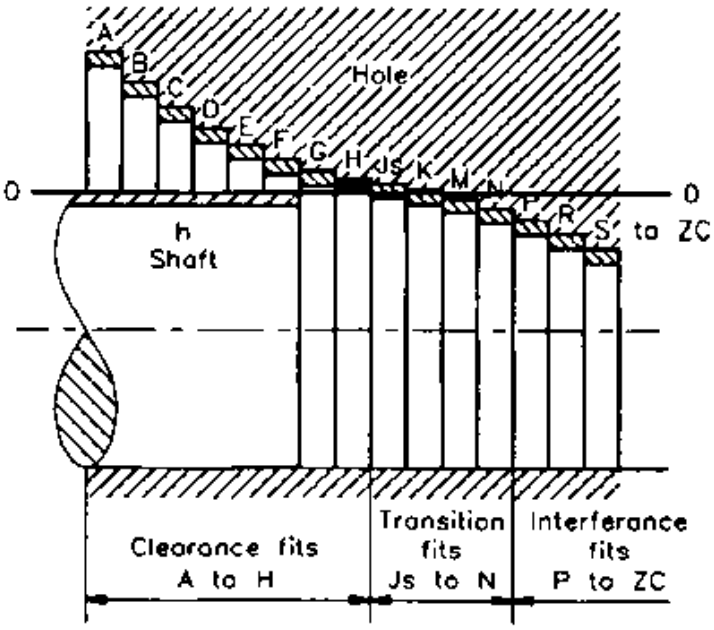
S1 = Maximum clearance
U1 = Maximum interferance



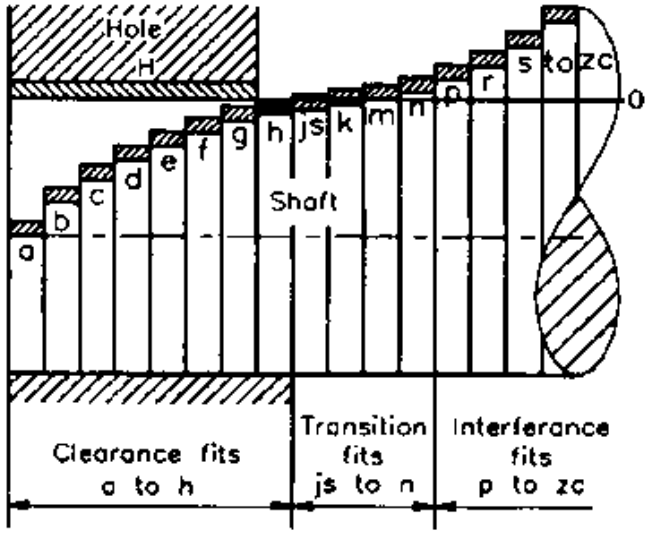
Interferance fit

U1 = Maximum interferance
U2 = Minimum interferance

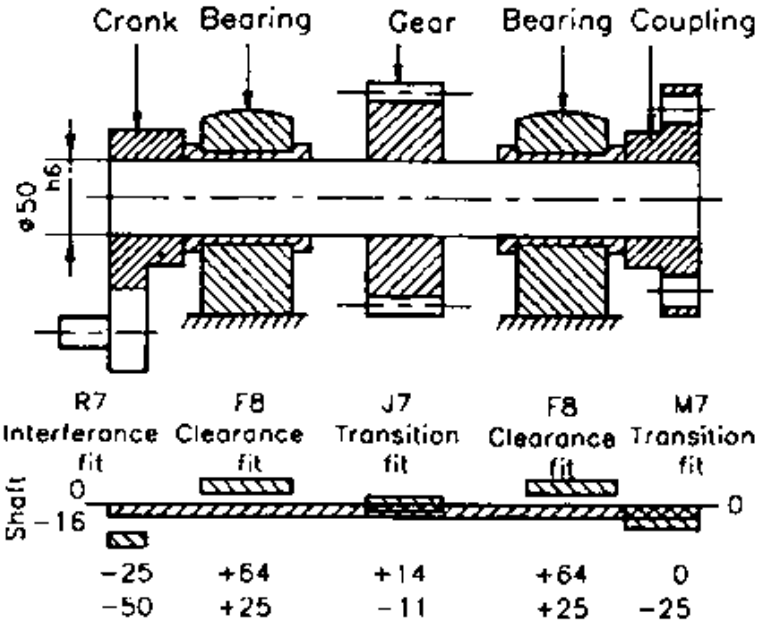
22. TR 01 06 01 03 93 – SHAFT BASIS AND HOLE BASIS SYSTEM OF LIMITS AND FITS



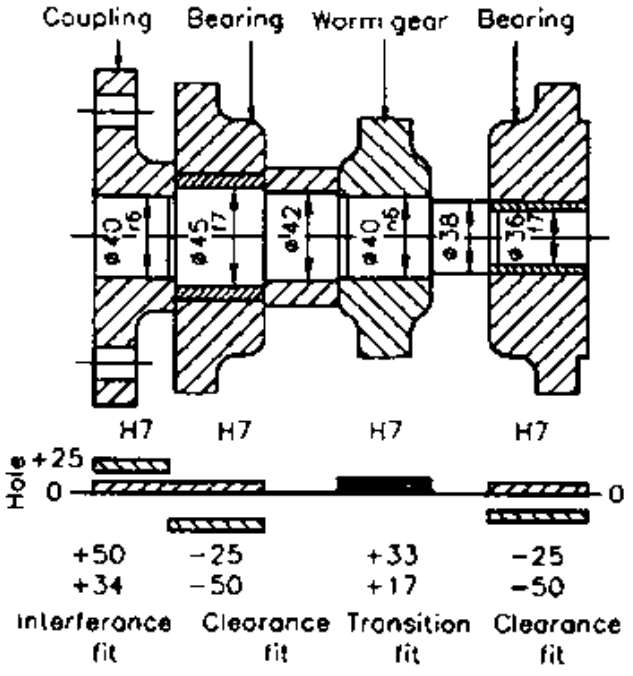
BASIC SHAFT SYSTEM
(SHAFT BASIS)



BASIC HOLE SYSTEM
(HOLE BASIS)

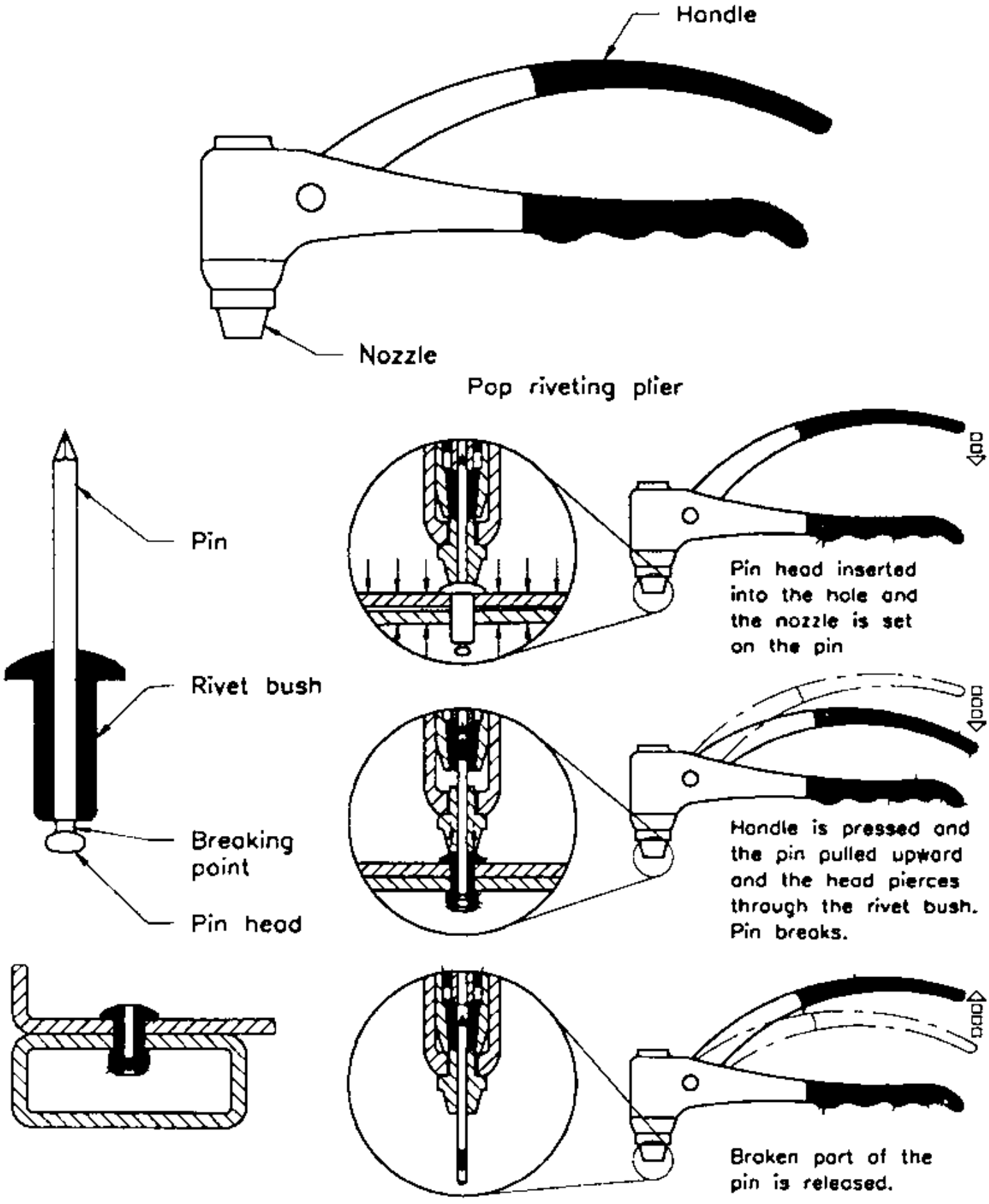


APPLICATION OF THE BASIC SHAFT SYSTEM

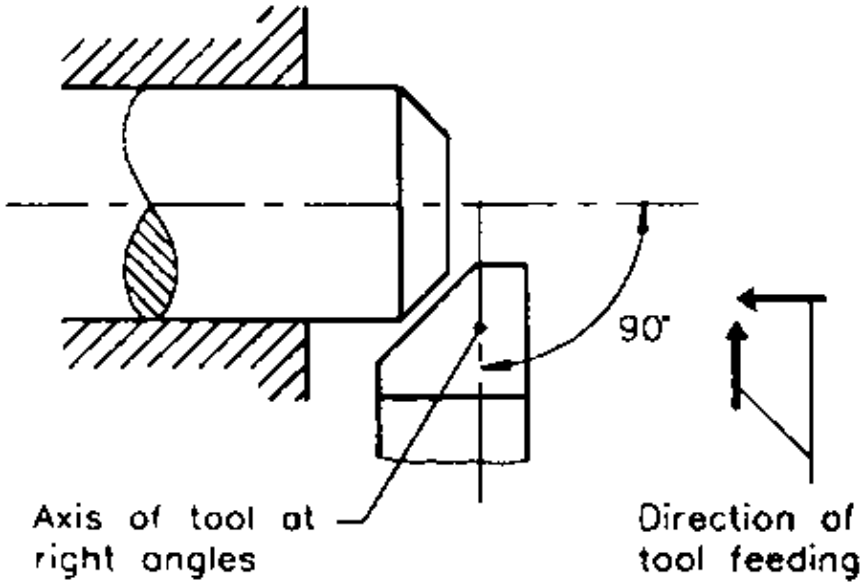


APPLICATION OF THE BASIC HOLE SYSTEM

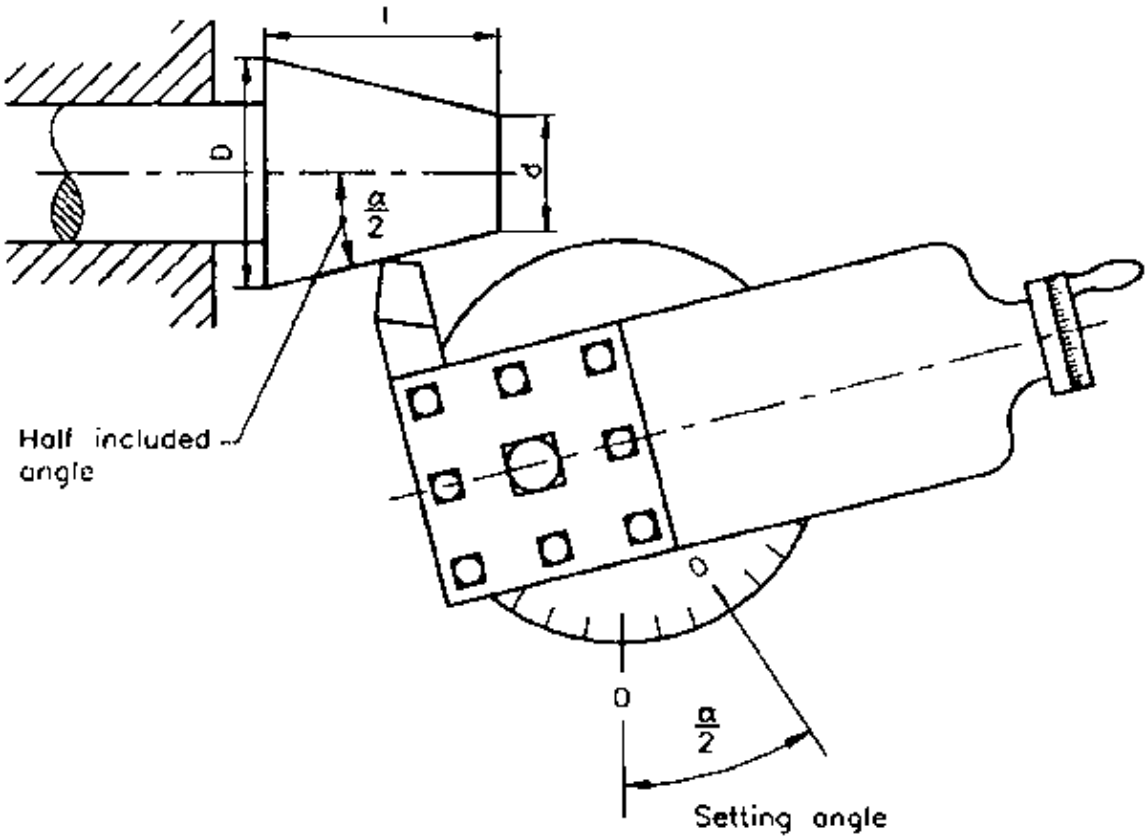
23. TR 01 11 03 01 93 – BLIND RIVETING WITH POP RIVETS



24. TR 01 15 03 01 93 – DIFFERENT METHODS OF TAPER TURNING (FORM TOOL AND COMPOUND REST)



FORM TOOL METHOD



COMPOUND SLIDE METHOD

$$\tan\frac{\alpha}{2}=\frac{D-d}{2\times l}$$

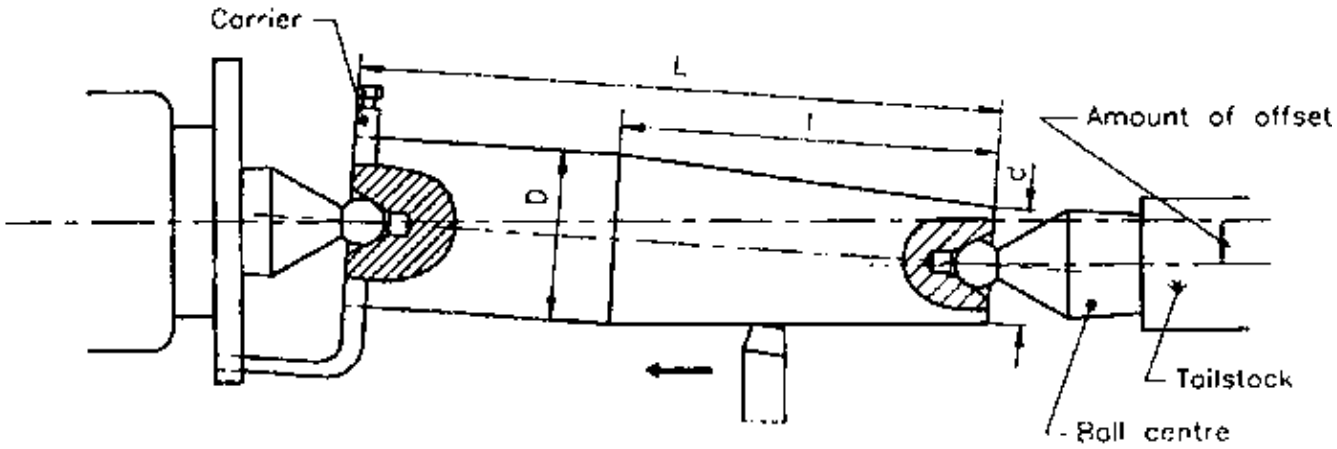
Where D = Big dia.

d = Small dia.

l = Length of taper

$\frac{\alpha}{2}$ = 1/2 included angle in degrees.

25. TR 01 15 03 02 93 – DIFFERENT METHODS OF TAPER TURNING (TAIL STOCK SET OVER AND TAPER TURNING ATTACHMENT)



TAIL STOCK OFFSET METHOD

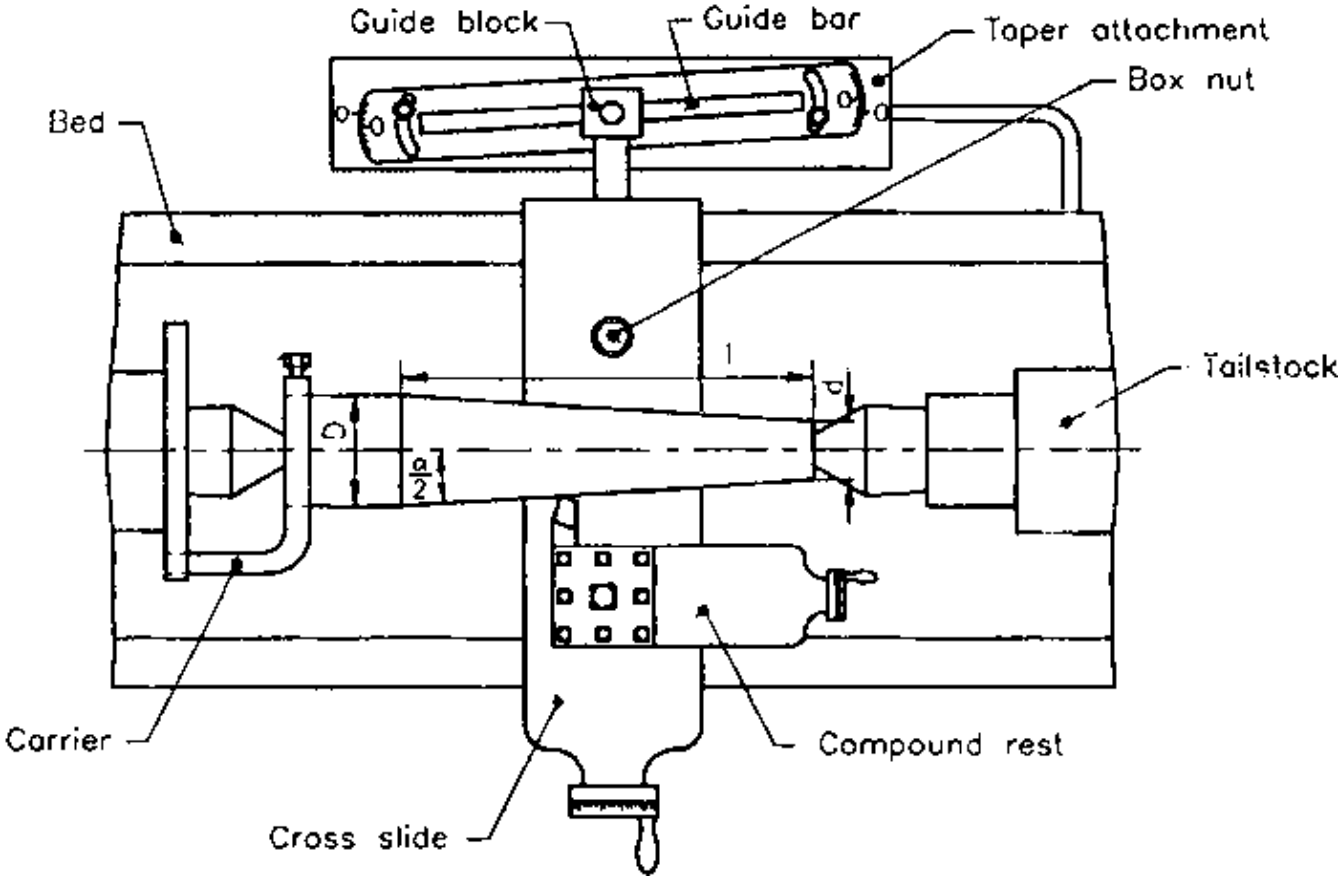
$$\text{Offset} = \frac{(D-d)\times L}{2\times l}$$

Where D = Big dia. of taper

d = Small dia. of taper

l = Length of taper

L = Total length of job



TAPER TURNING ATTACHMENT METHOD

$$\tan\frac{\alpha}{2} = \frac{D-d}{2\times l}$$

Where D = Big dia.

d = Small dia.

l = Length of taper

$\frac{\alpha}{2}$ = 1/2 included angle in degrees.

Back Cover

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P.O. Box 3142, 76, GST Road, Guindy, Madras – 600 032. Phone: 2345256, 2345257. Fax: 91–44–86627,
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Fitter 2nd Year – Transparencies

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Fitter 2nd Year – Transparencies

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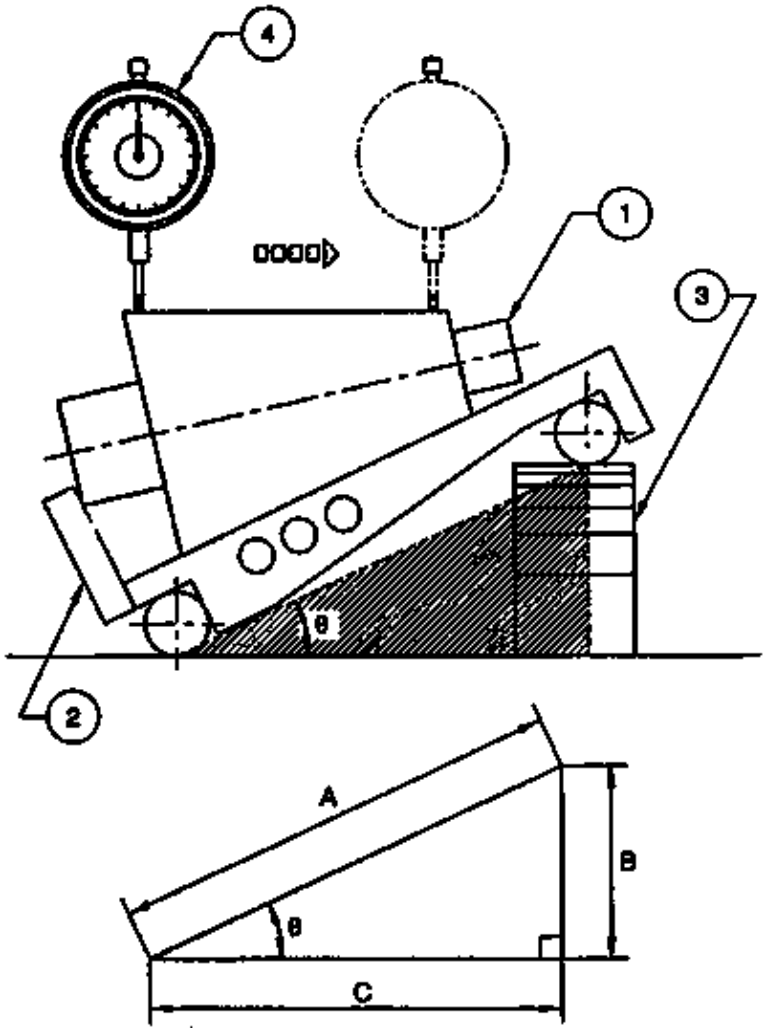
MEASUREMENT OF TAPER ANGLE USING SINEBAR – TR 01 02 10 01 95



To calculate the angle of taper formed on a round rod, the job (1) is placed on sine bar (2). One end of the sine bar (i.e. smaller dia. end on job) is lifted up and slip gauges (3) are placed in between sine bar roller and the surface plate. The top surface of the taper portion should be brought to perfect horizontal line by placing additional slip gauges, and testing with dial test indicator (4). A right angled triangle is formed, with the slip gauge height as opposite side (B) and the length of sine bar as hypotenuse (A). By applying the

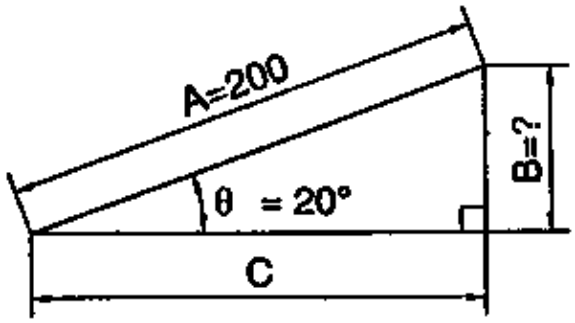
trigonometrical ratio formula,

$\sin e\theta = \frac{\text{Opposite side}}{\text{Hypotenuse}}$, we get sine ? value in degrees i.e. the included angle of the tapered job.

TAPER CALCULATION USING SINEBAR – TR 01 02 10 02 95

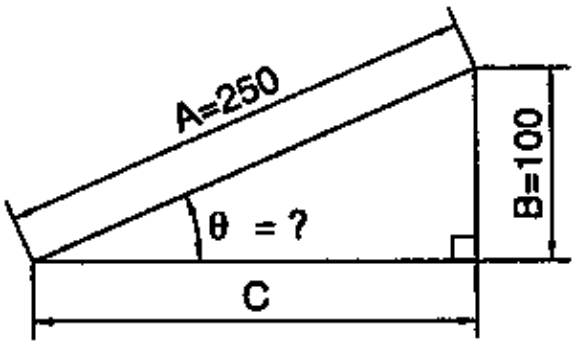
1. $\text{Sine}20^\circ = \frac{B}{A} = \frac{B}{200}$

Therefore B = 68.404.



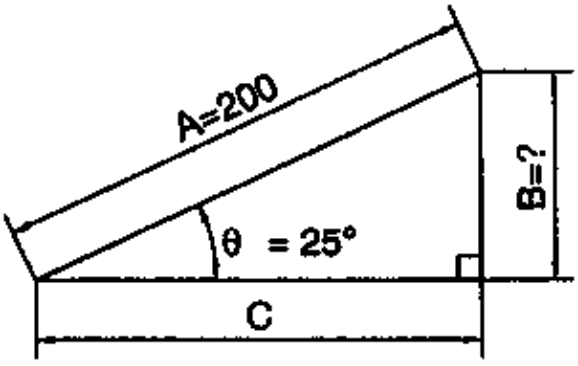
2. $\text{Sine}\theta = \frac{B}{A} = \frac{100}{250}$

Therefore ? = 23°34' 41"



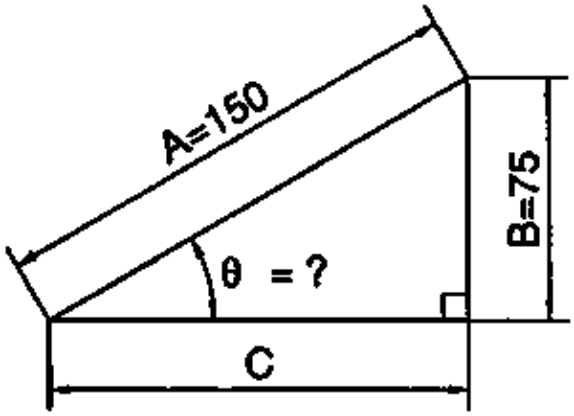
3. $\text{Sine}25^\circ = \frac{B}{A} = \frac{B}{200}$

Therefore B = 84.524



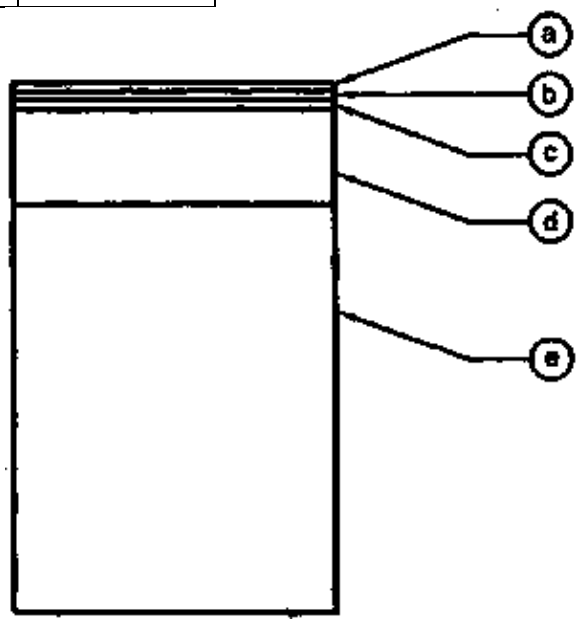
4. $\text{Sine}\,\theta = \frac{B}{A} = \frac{75}{150}$

Therefore ? = 30°



DETERMINING SLIP GAUGE SIZES – TR 01 02 10 03 95

Set of 112 pieces		
Range (mm)	**Steps (mm)**	**No. of pieces**
1.0005	–	1
1.001 to 1.009	0.001	9
1.01 to 1.49	0.01	49
0.5 to 24.5	0.5	49
25 to 100	25	4
Total pieces		**112**



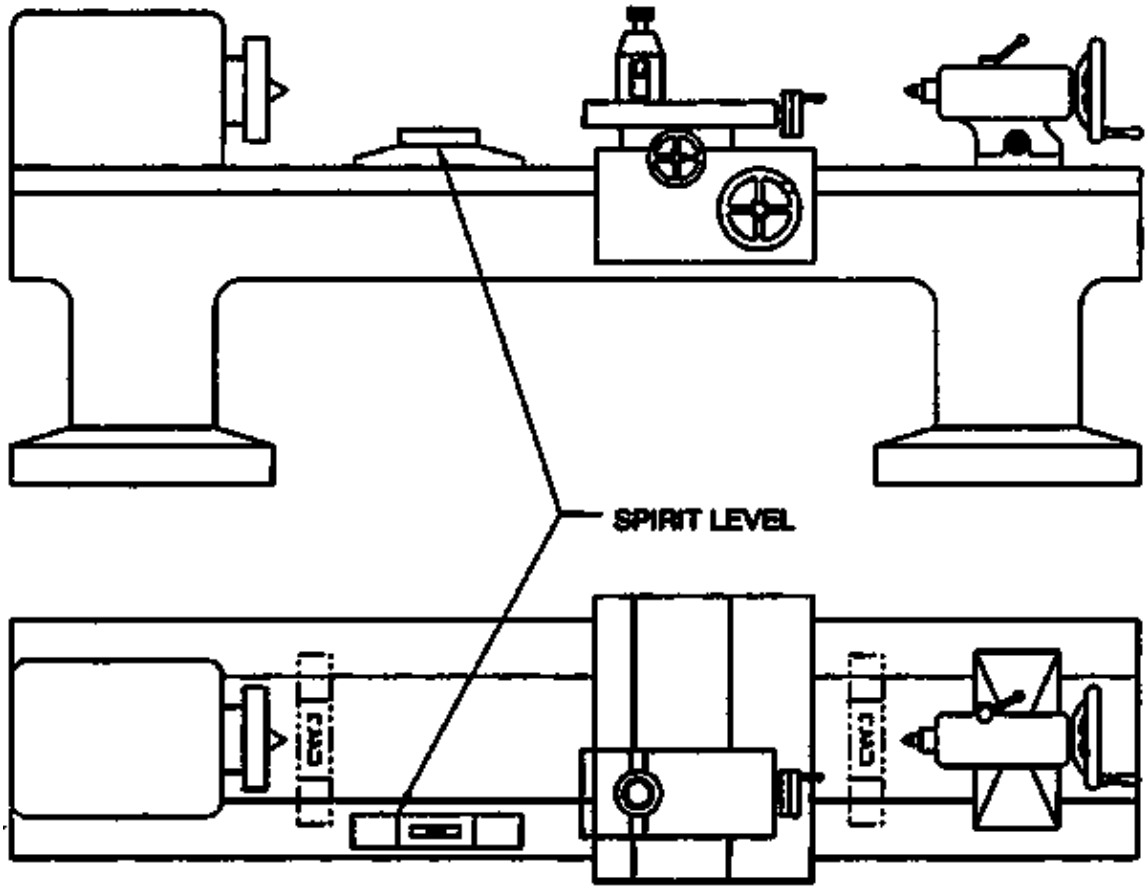
	Steps	**Slip size**	**Calculation**
1.	First write the required dimension.		64.7235

2. Select the slip gauge having the 4th decimal place.	**(a)** 1.0005	Subtract	1.0005 / 63.723
3. Select 1st series slip that has the same last figure.	**(b)** 1.003	Subtract	1.003 / 62.72
4. Select the 2nd series slip that has the same last figure and that will leave .0 or 0.5 as the last figure.	**(c)** 1.22	Subtract	1.22 / 61.50
5. Select a 3rd series slip that will leave the nearest 4th series slip (61.50–11.50)	**(d)** 11.50	Subtract	11.50 / 50.00
6. Select a slip that eliminates the final figure.	**(e)** 50.00	Subtract	50.00 / 0
	64.7235		

ASSIGNMENT
Determine the slip gauges for the following sizes

1.35.8475 mm
2. 108.648 mm

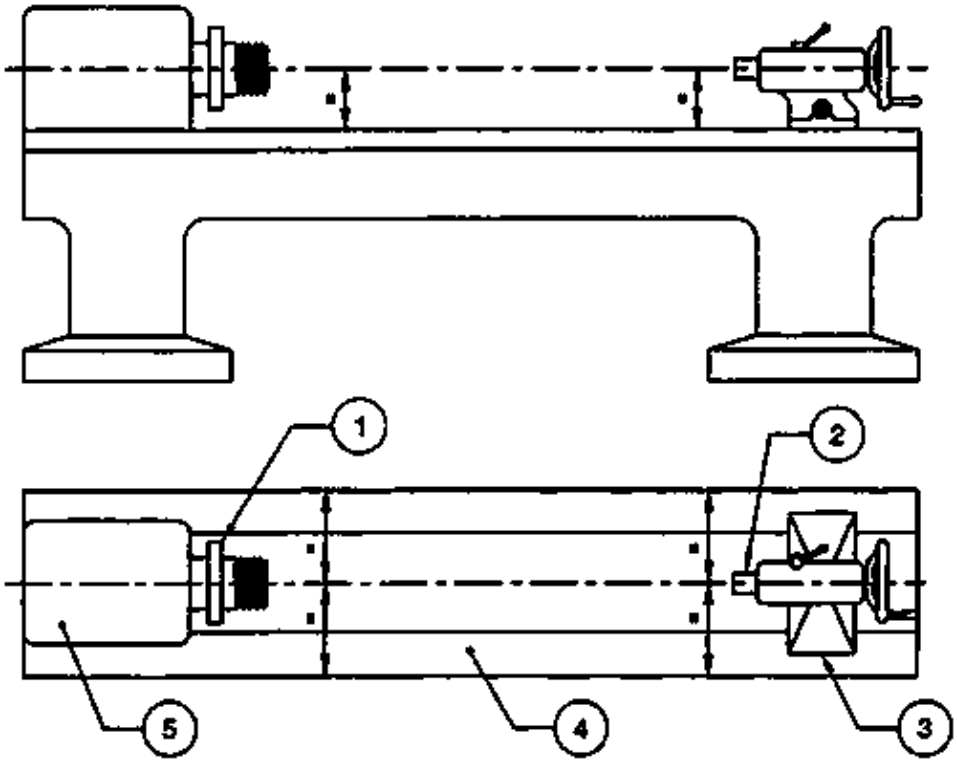
LEVELLING A LATHE – TR 01 07 01 01 95



Note:

A machine is leveled up to ensure that the basic structure of the machine is not twisted. The standard tests for alignment or accuracy should be carried out only after levelling the machine.

BASIC ALIGNMENTS OF A LATHE – TR 01 07 01 02 95



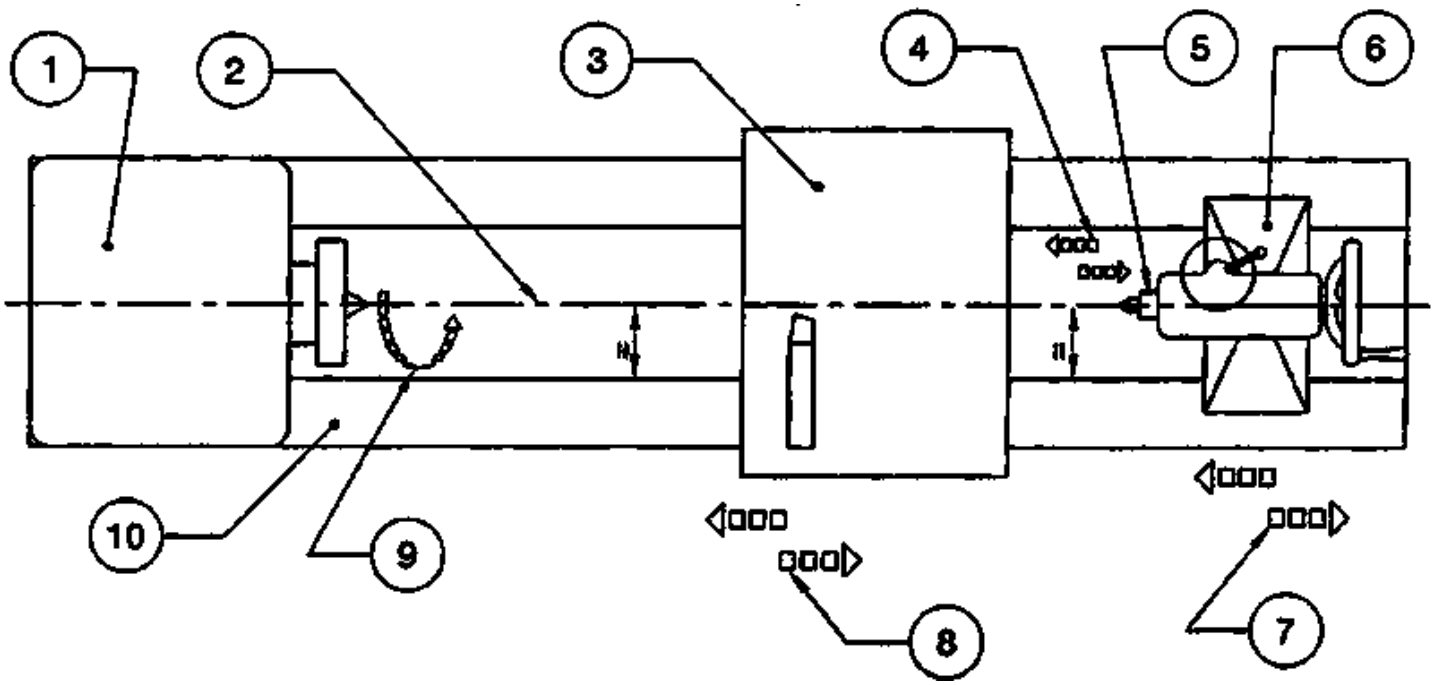
1. Spindle
2. Barrel
3. Tailstock
4. Bed
5. Head stock

Note:

• The figure shows the basic alignment of Head stock (5) tail stock (3) spindle (1) and bed (4) slide ways.

• The spindle and tailstock axis are parallel to the bed slide ways in both vertical and horizontal planes.

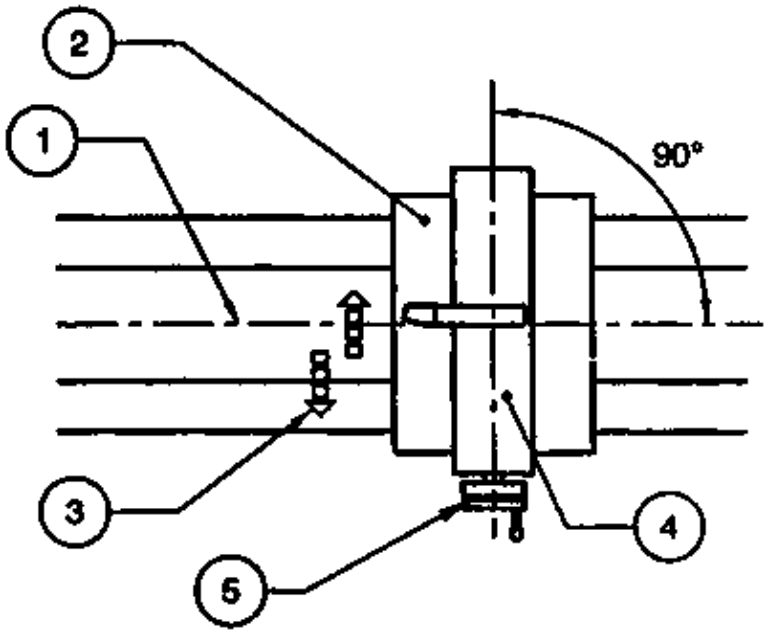
CENTRE LATHE BASIC GEOMETRY – (1) – TR 01 07 01 03 95



The carriage or saddle provides the basic movement to the cutting tool, parallel to the work axis and this produces true cylindrical surfaces.

1. Headstock
2. Axis of workpiece and spindle rotation
3. Carriage
4. Barrel movement within tailstock
5. Barrel
6. Tailstock
7. Movement of tailstock along bed parallel to spindle axis
8. Movement of carriage along bed parallel to axis of rotation of spindle
9. Spindle rotation
10. Bed slide ways

CENTRE LATHE BASIC GEOMETRY – (2) – TR 01 07 01 04 95



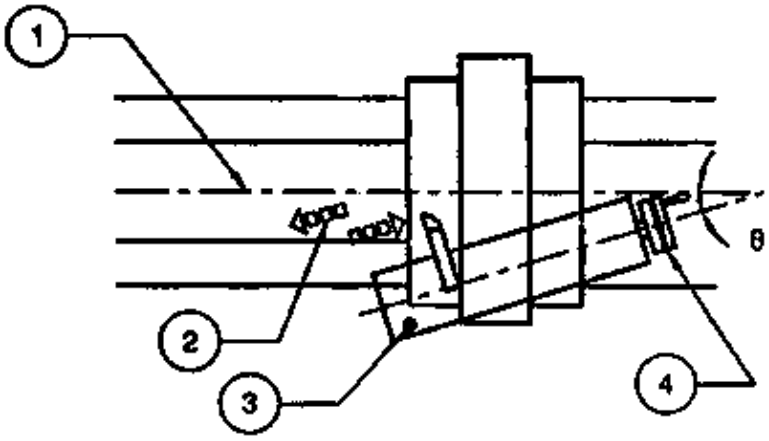
A

A. Cross slide movement

1. Spindle axis
2. Carriage
3. Movement of cross slide
4. Cross slide
5. Micrometer dial

Note:

The cross slide on top of the carriage is aligned at 90° to the spindle axis. Since the slide moves the tool in a path at 90° to the spindle axis it produces plane surfaces.



B

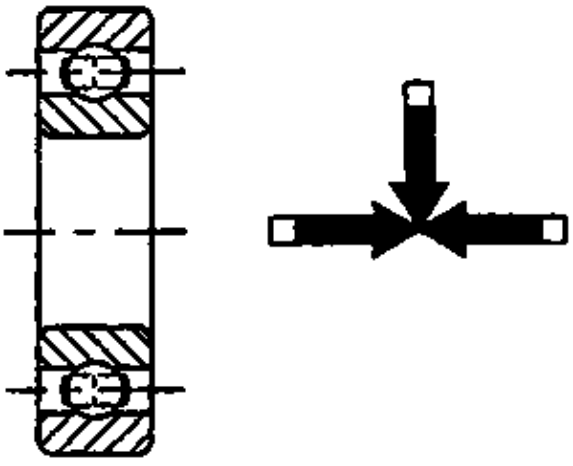
B Compound slide movement

1. Spindle axis
2. Movement of compound slide
3. Compound slide
4. Micrometer dial

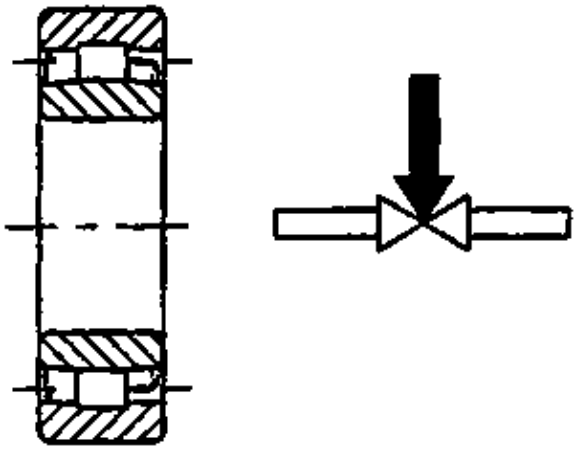
Note:

The compound slide is located on top of the cross slide and can be set accurately at an angle to the spindle axis. It moves the tool in a path at an angle to the spindle axis and is used to produce tapered conical components.

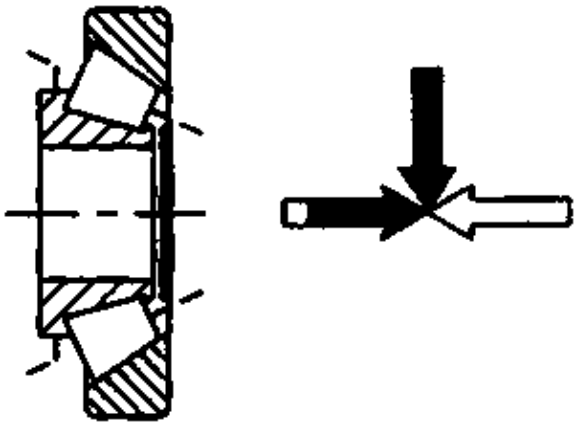
LOAD CONDITIONS FOR BEARINGS – TR 01 07 05 01 95



1 Deep groove ball bearing

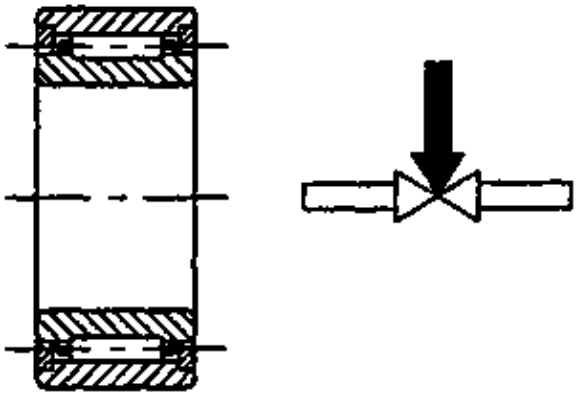


2 Roller bearing

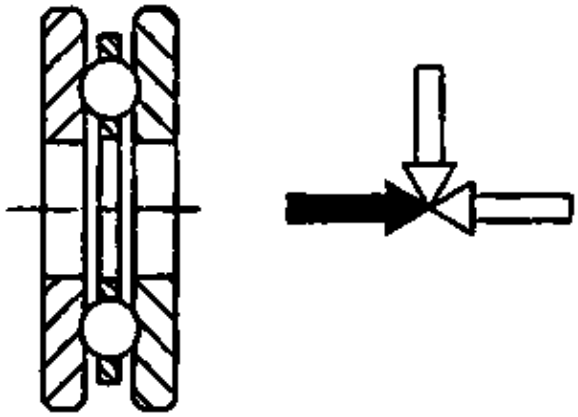


3 Taper roller bearing

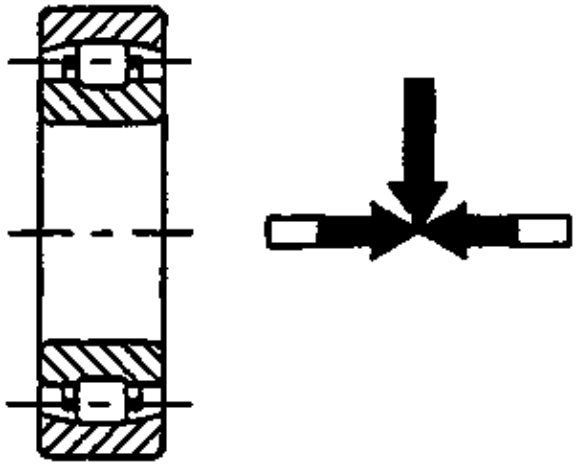
Needle bearing



4 Needle bearing

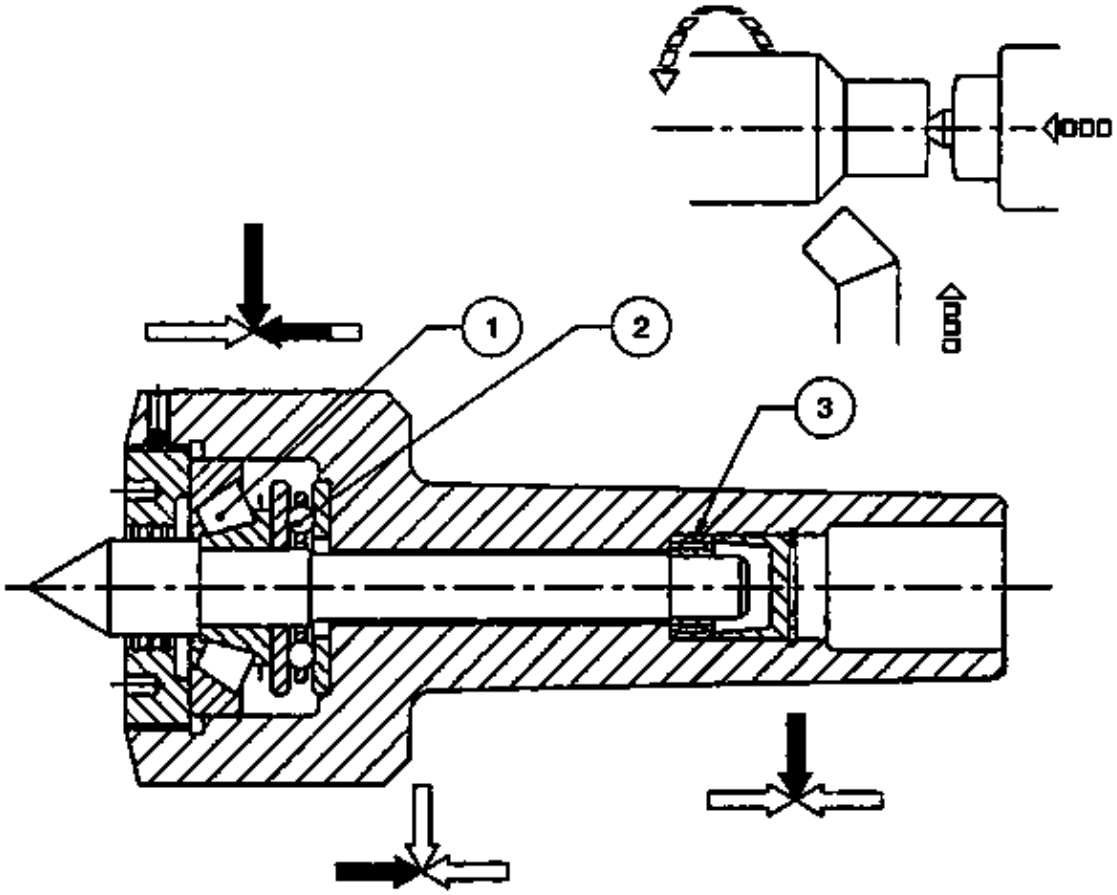


5 Thrust ball bearing



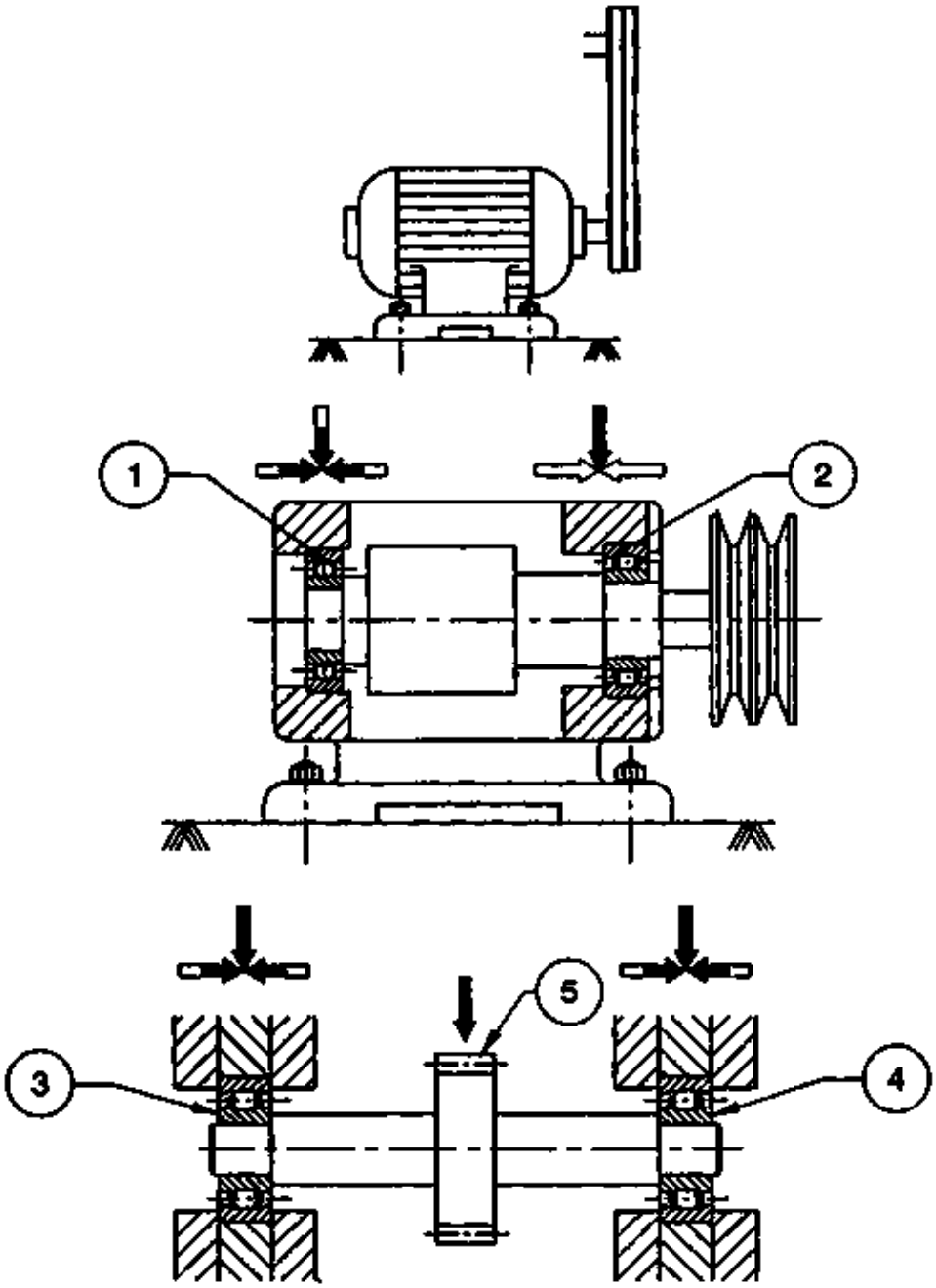
6 Self aligning roller bearing

APPLICATIONS OF BEARINGS – (A) – TR 01 07 05 02 95



1. Taper roller bearing
2. Thrust ball bearing
3. Needle bearing

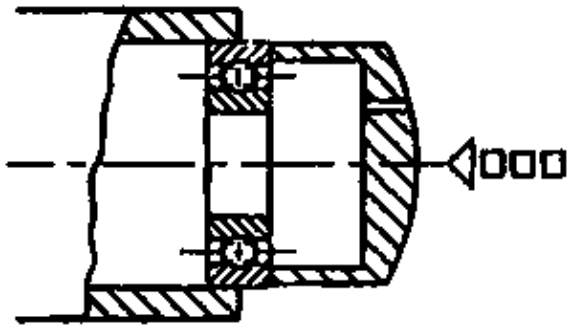
APPLICATIONS OF BEARINGS – (B) – TR 01 07 05 03 95



1 – Deep groove ball bearing
2 – Roller bearing
3 & 4 – Self aligning roller bearing
5 – Pulley

FITTING AND DISMANTLING OF BEARINGS – TR 01 07 05 04 95

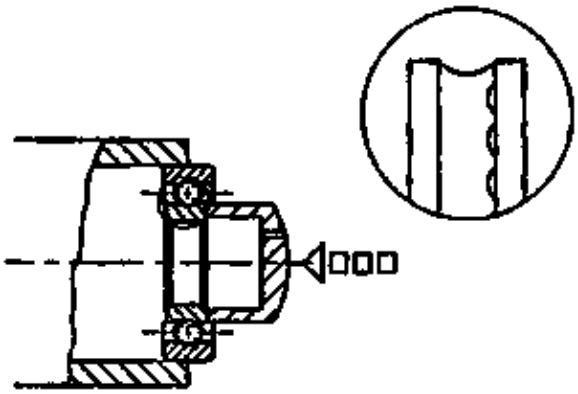
Note: A sleeve is used for mounting small bearings.



1

Correct Method

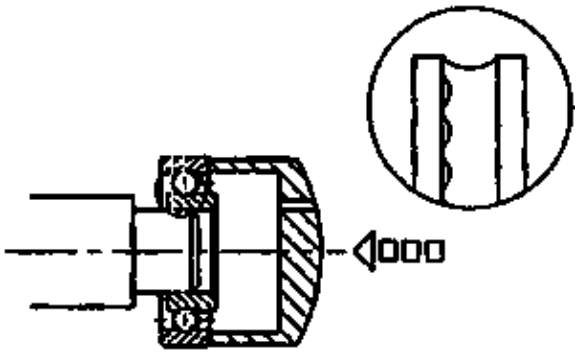
When assembling bearing in housing the force must act on the outer race.



2

Wrong Method

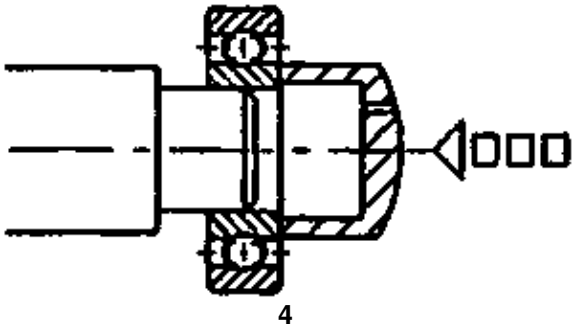
When the force acts on the inner race, the inner race will be damaged.



3

Wrong Method

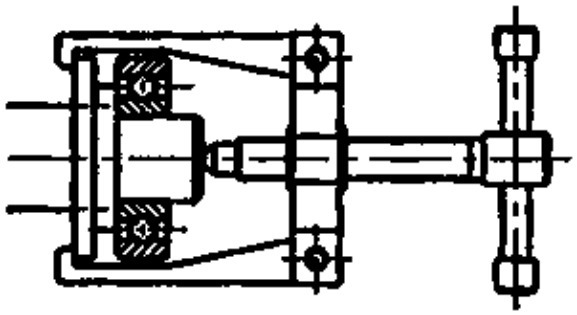
When the force acts on the outer race, the outer race will be damaged.



4

Correct Method

When assembling bearing on shaft the force must act on the inner race.



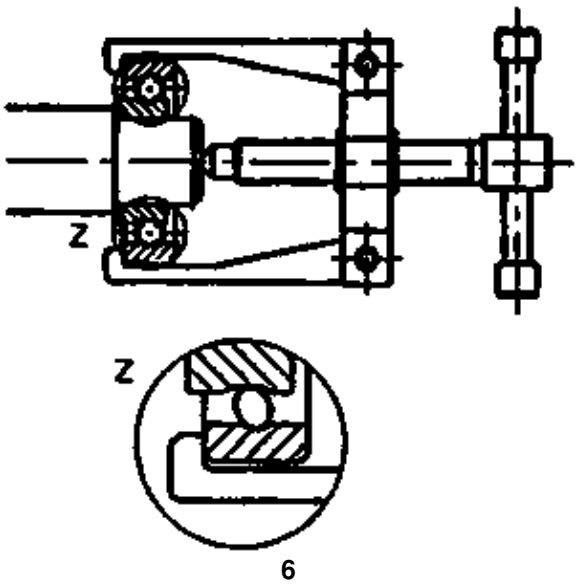
5

Disassembling by puller

When dismounting the force directly acts at the tightly fit ring.

Correct Method

The bearing is dismounted by a puller and a puller plate.

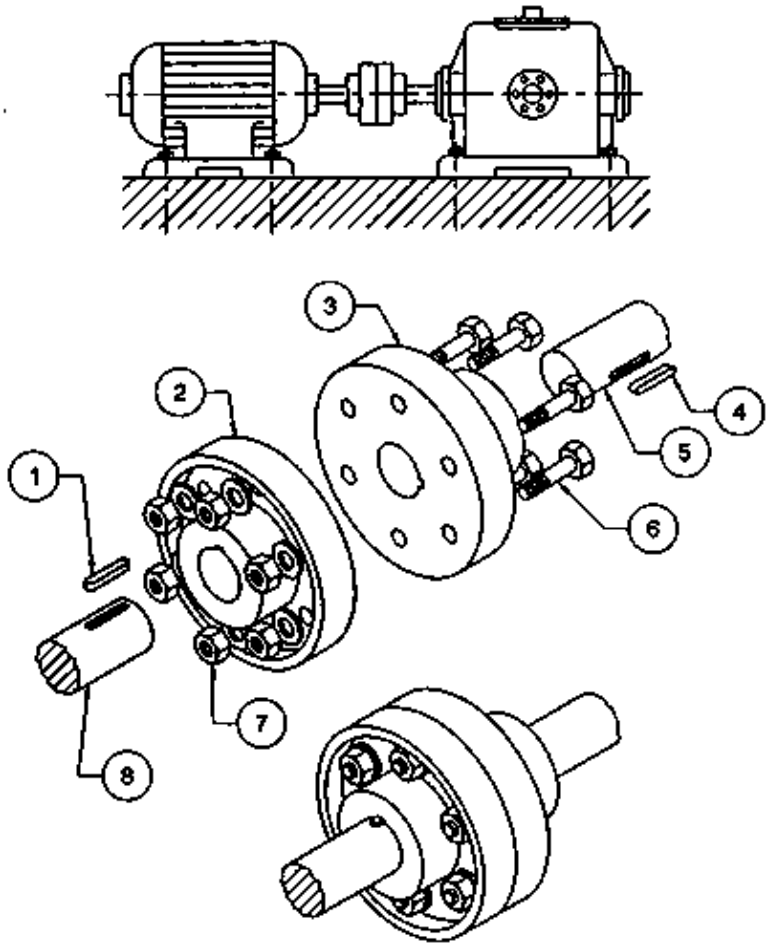


6

Wrong Method

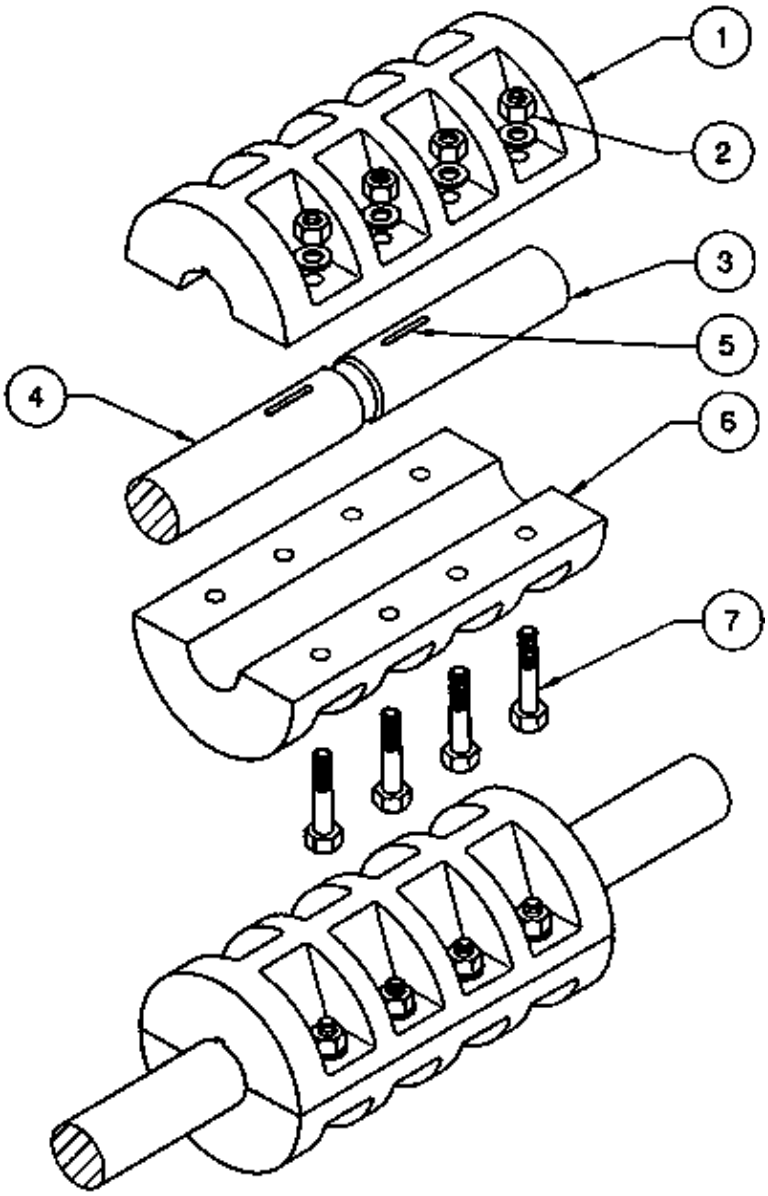
When dismounted without puller plate, the race way and rolling elements will be damaged.

COUPLING ASSEMBLY – TR 01 07 06 01 95



1 & 4 Keys
2 & 3 Coupling flanges
5 & 8 Shafts
6 Bolts
7 Nuts

CLAMP COUPLING – TR 01 07 06 02 95



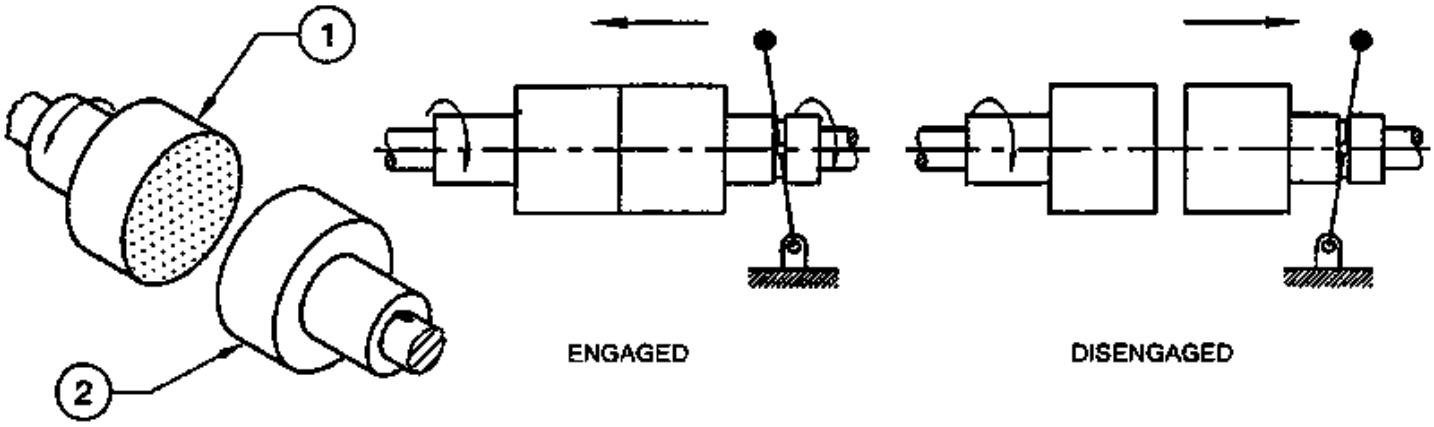
1 – Clamp top
2– Nut
3 & 4– Shafts
5 – Keyway
6 – Clamp bottom
7 – Bolts

Note:– Shafts 3 & 4 are keyed to the clamp top 1 while assembly.

APPLICATION OF CLUTCHES (FRICTION AND FORM FITTING) – TR 01 07 06 03 95

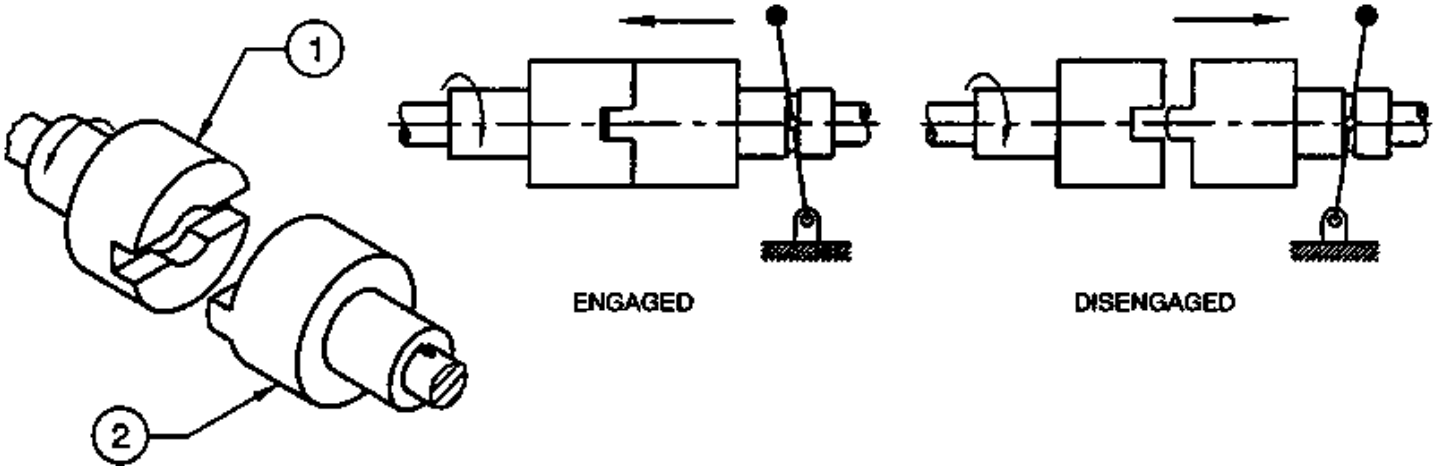
A. FRICTION CLUTCH

1. FIXED PART
2. MOVABLE PART

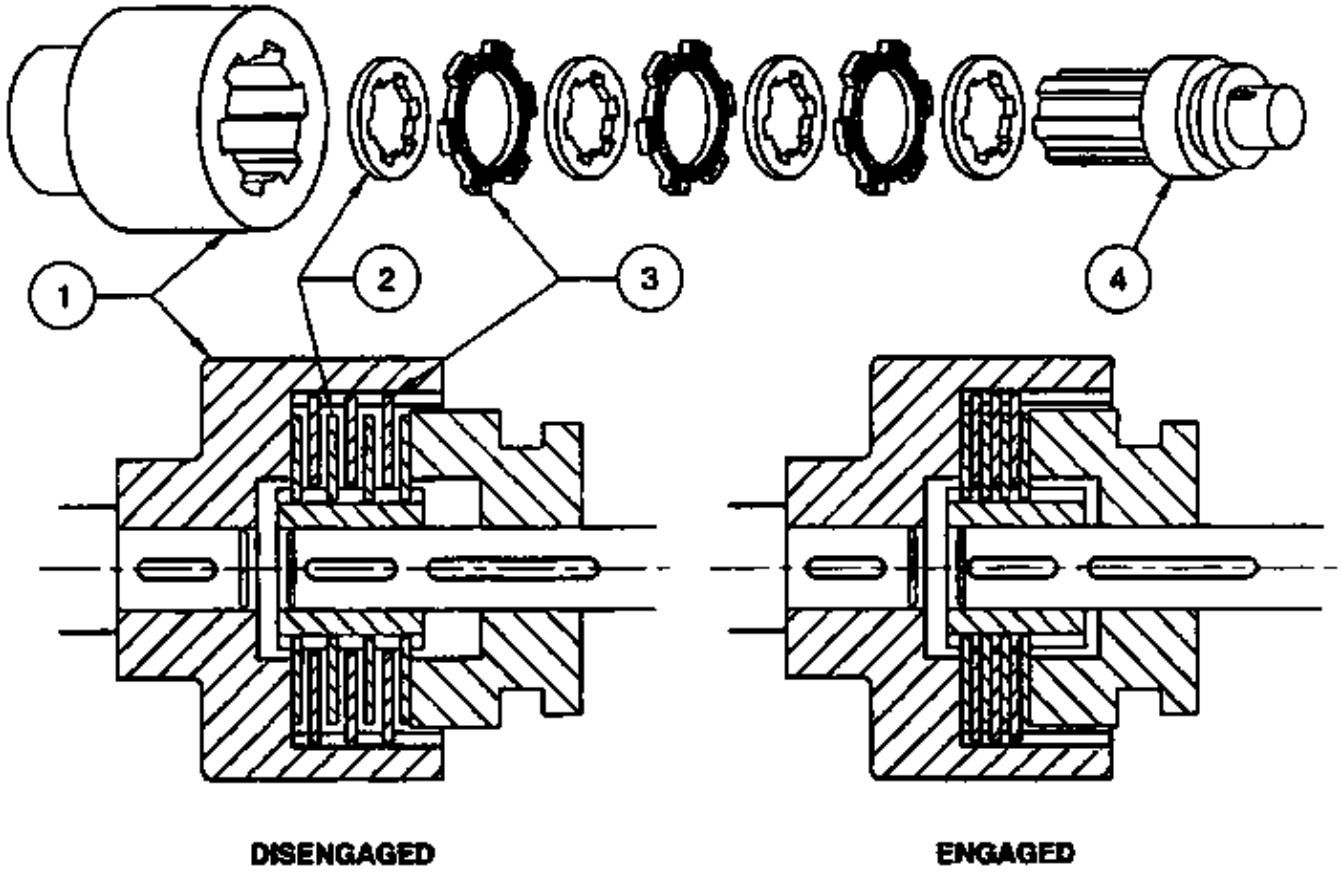


B. FORM FITTING CLUTCH

1. FIXED PART
2. MOVABLE PART



MULTIPLE DISK CLUTCH – TR 01 07 06 04 95



1. Housing
2. Pressure plates
3. Clutch disc
4. Spline shaft

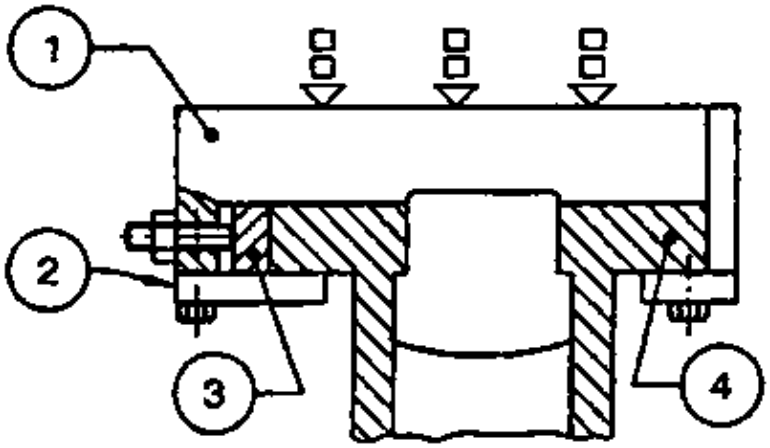
In the case of a single plate clutch, bigger fly wheels and clutch plates are used to transmit torque. But in the case of multiple plate clutch, the frictional area is increased by the use of more number of smaller clutch discs. The pressure plates (2) and clutch discs (3) are alternately arranged on the spline shaft (4). The plates and the shaft are then assembled in a housing (1) having splined hole.

The clutch discs and the pressure plates are pressed together in the housing when the clutch is engaged. When the clutch is disengaged the clutch discs and pressure plates are separated. The torque cannot be transmitted in this condition.

SLIDE WAYS AND WEAR ADJUSTMENT – TR 01 07 07 01 95

SLIDEWAYS ARE LINEAR BEARINGS WHICH SUPPORT AND GUIDE THE SLIDING MEMBERS OF A MACHINE TOOL

FLAT SLIDEWAYS

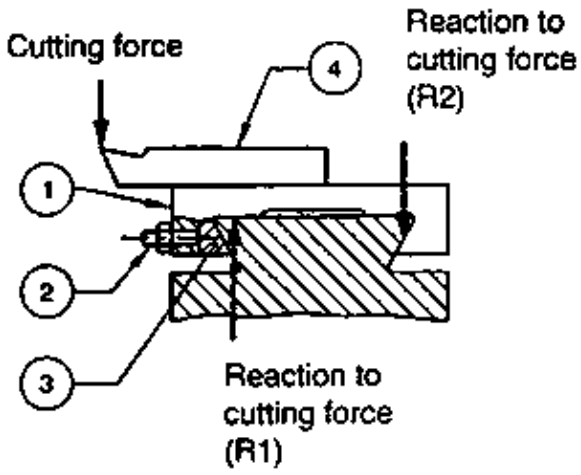


1. Sliding member
2. Keeper plate
3. Adjustable gib strip (Fixed to sliding member)
4. Flat slide ways (Fixed member)

Note:–

* This slide way is strong and gives accurate guidance when new
* Wear on the sides of the slides is taken up by the adjustable gib strip
* Keeper plates under the slides prevents tilting or lifting in case of excessive loading.

DOVETAIL SLIDEWAYS



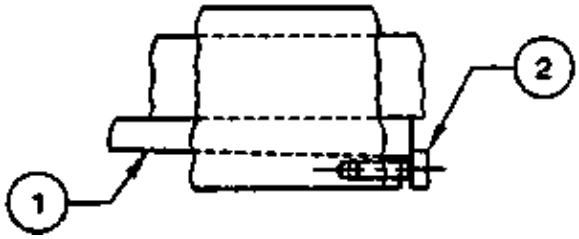
1. Sliding member
2. Adjusting screw
3. Adjustable gib strip
4. Tool

Note:–

This slide way is used
* When the applied forces form a couple which tries to rotate the sliding member
* Where the applied force lies outside the slide

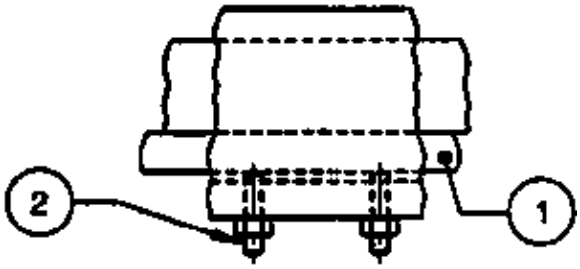
WEAR ADJUSTMENT BY GIB STRIP

TAPER GIB



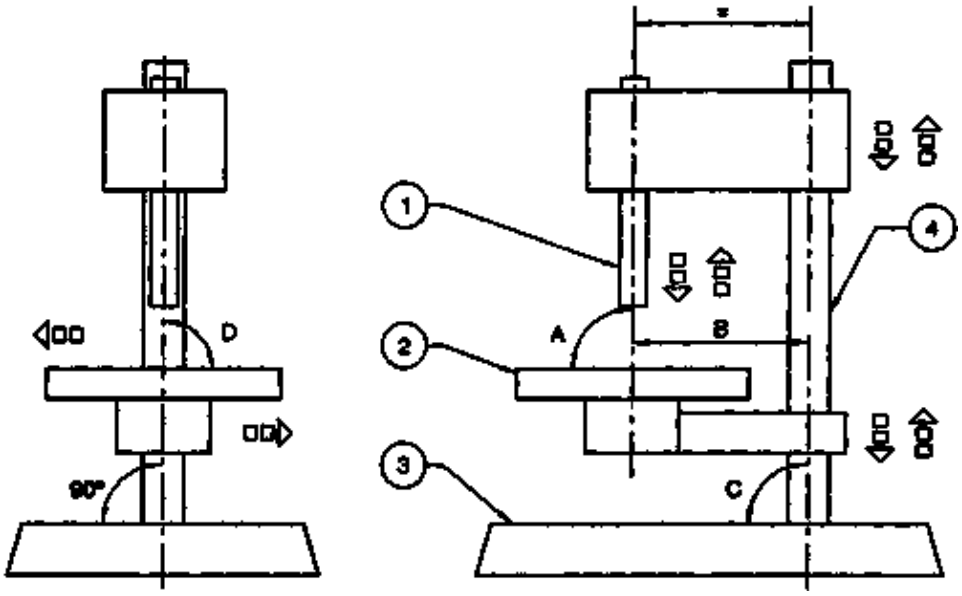
1. Taper Gib
2. Adjusting screw

PARALLEL GIB



1. Parallel Gib
2. Adjusting screw

DRILLING MACHINE – ALIGNMENT GEOMETRY – TR 01 07 08 01 95



1. Spindle
2. Table
3. Base
4. Column

• The geometry of the drilling machine is designed to maintain the alignments between the spindle axis and the workpiece (Angle A)

• Spindle (1) is mounted on precision bearings and housed in a sleeve that can move in the head of the drilling machine.

• Sleeve travels to or from the workpiece in a path parallel to the axis of the spindle.

• Spindle axis is perpendicular to the surface of the work table (2)/workpiece.

• The table is adjustable up and down a precision ground column (4) It can also be rotated around the column maintaining the perpendicularity of spindle (D).

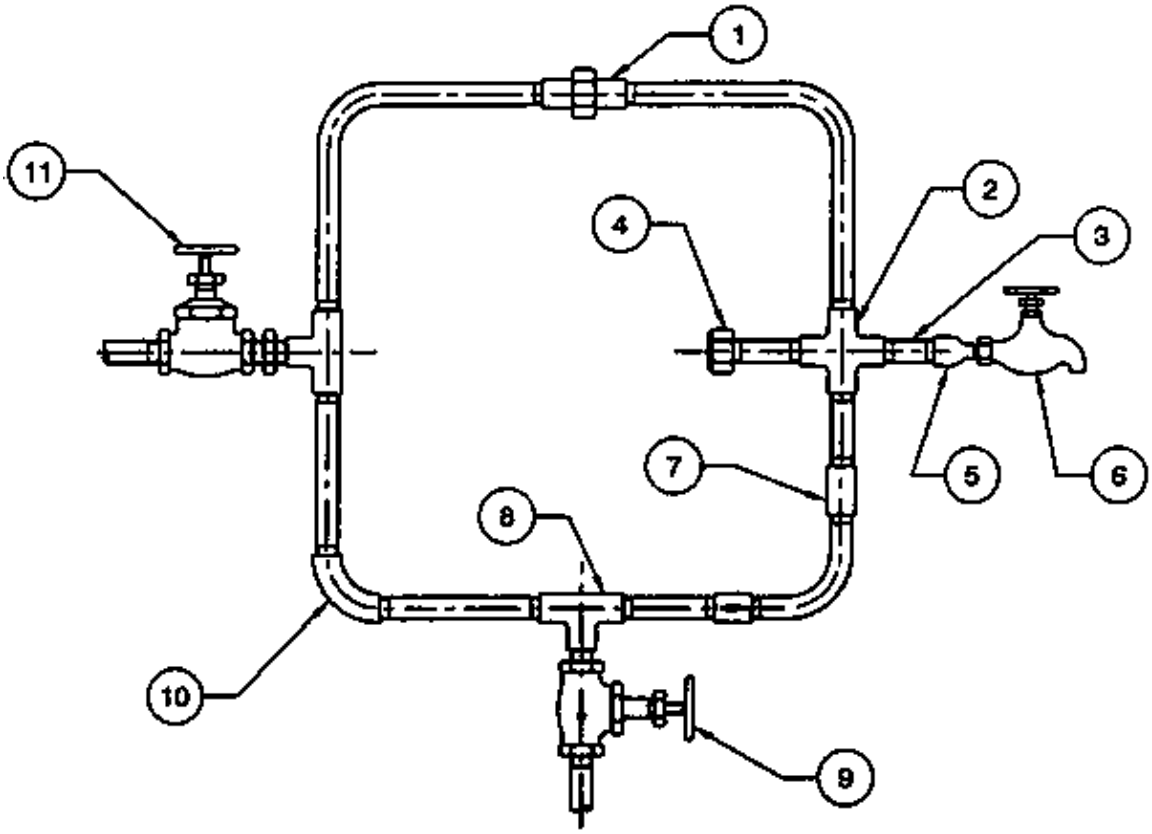
• The axis of the column and the axis of the spindle are parallel (B)

• The axis of the column is perpendicular (C) to the machine base (3)

• The spindle head can be moved up and down over column (4)

ANY INACCURACY IN THESE ALIGNMENTS WILL RESULT IN INACCURACIES IN DRILLING.

STANDARD PIPE FITTING ASSEMBLY – TR 01 08 02 01 95



1. Union – A device used to connect pipes
2. Cross – Allows flow in different directions
3. Barrel nipple – Tubular pipe fittings used to connect 2 or more pipes
4. Cap – Used for closing the end of a pipe or a fitting which has external thread
5. Reducer – Used to connect 2 pipes of different diameters
6. Bib cock – controls the outlet
7. Plain coupling – Used to connect 2 pipes of the same diameter
8. Tee – Helps the pipeline to branch off at 90°
9. Globe valve – Used for controlling the flow of water, steam etc in the main line
10. Elbow – Provides deviation of 90° & 45° in pipe system
11. Gate valve – Provides an unobstructed waterway when fully opened.

GLOBE VALVE – PARTS AND FUNCTION – TR 01 08 04 01 95

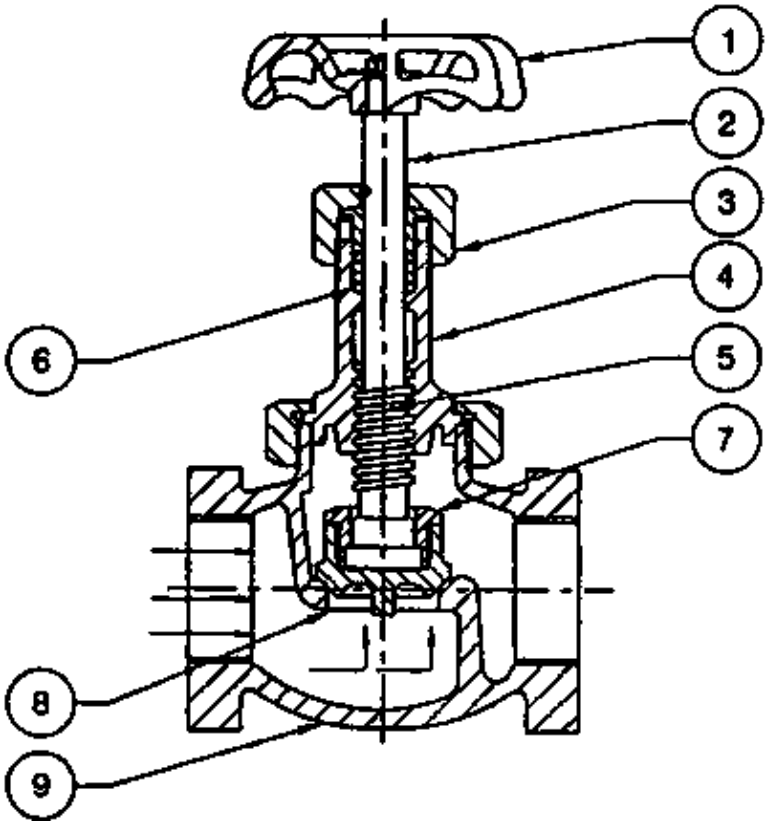


Fig a

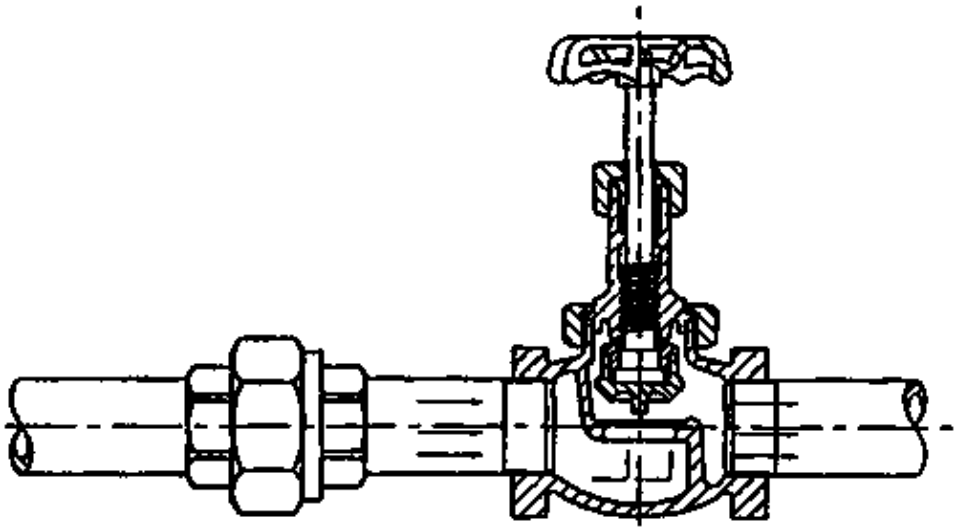


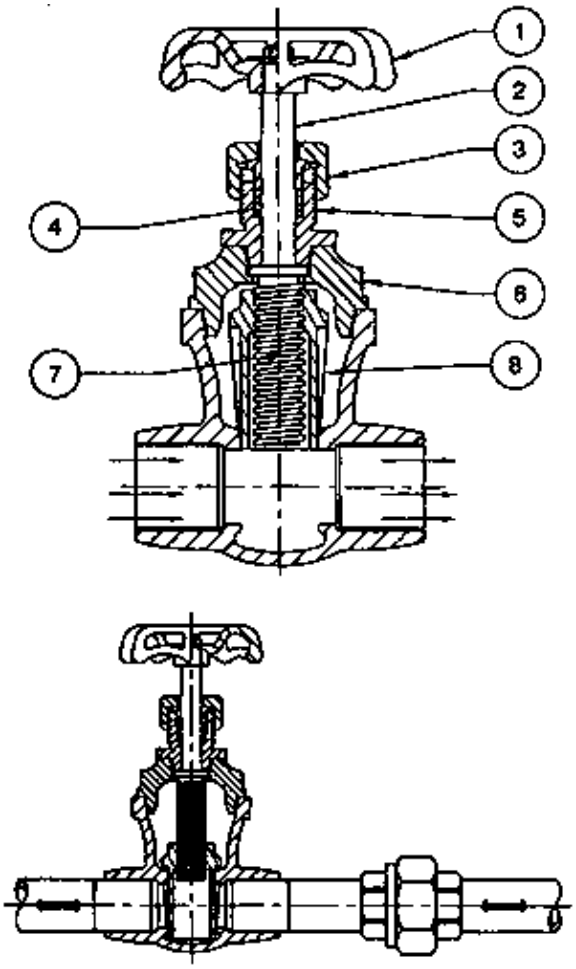
Fig b

1. Hand wheel
2. Spindle
3. Gland nut
4. Bonnet
5. Threaded portion of spindle
6. Gland packing
7. Disc holder with rubber washer
8. Valve seat
9. Body

Note:–

Figure (a) Valve in closed position
Figure (b) Valve in open position – Flow in one direction only

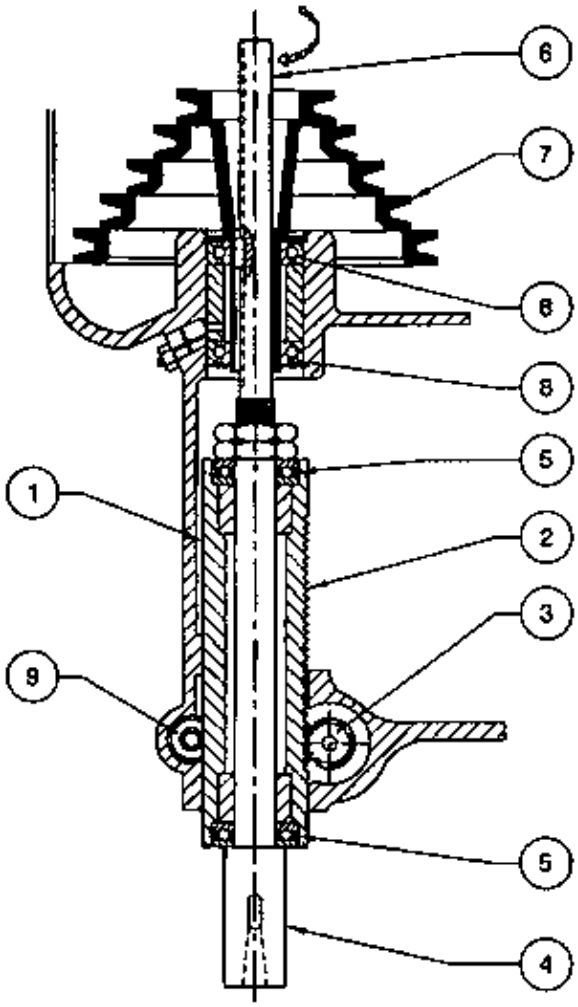
GATE VALVE – PARTS AND FUNCTION – TR 01 08 04 02 95



1. Hand wheel
2. Shaft (spindle)
3. Gland nut
4. Gland packing
5. Stuffing box
6. Bonnet
7. Threaded portion of spindle
8. Seat and disk gate

Note: Flow in both direction

DRILLING MACHINE SPINDLE ASSEMBLY – TR 01 08 09 01 95



1. Sleeve
2. Rack
3. Pinion
4. Spindle
5. Thrust bearings
6. Spindle extension
7. Pulley
8. Journal bearings
9. Sleeve lock

Drill sleeve **(1)** has a rack **(2)** on one side. **(2)** meshes with pinion **(3)** which can be moved by a hand lever. By moving this lever, **(1)** can be moved up and down along with the spindle **(4)**.

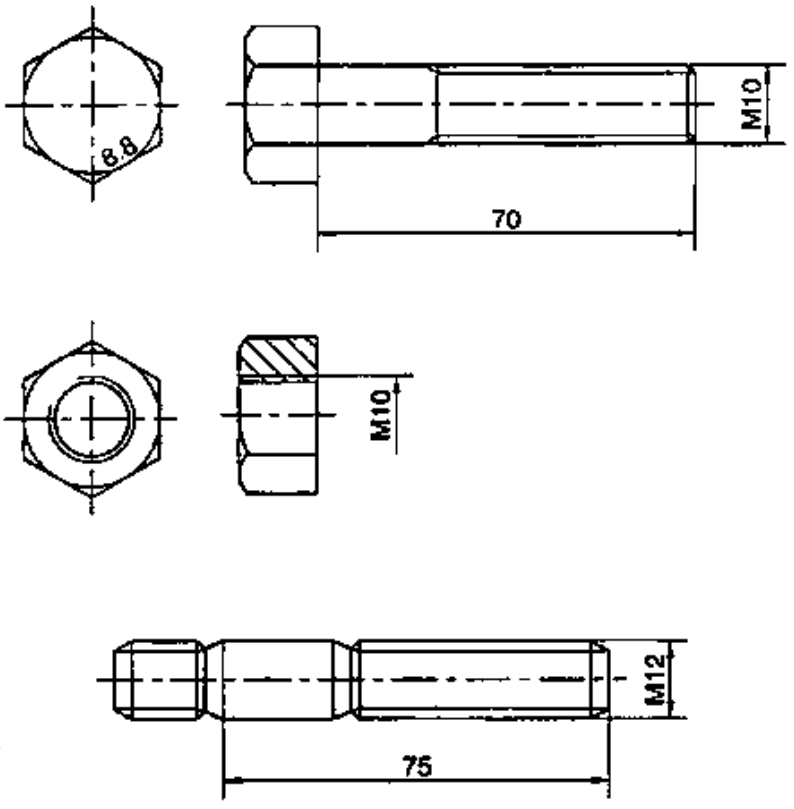
(4) is supported with in the sleeve by Journal bearings **(5)**.

Spindle extension shaft **(6)** is splined and it passes through the matching splined hole in the pulley **(7)** driven by a motor.

(7) is supported by journal bearings **(8)**. This enables **(4)** to rotate freely at any position when it is moved up or down during drilling operation.

In some type of drilling machines sleeve lock **(9)** is provided to lock the sleeve when not in use.

SPECIFICATION OF MACHINE SCREW – NUT AND STUD – TR 01 11 02 01 95



M 10 x 70 **BOLT (Hex-Screw)**
- Length 70mm
- Major diameter 10mm
- Metric thread

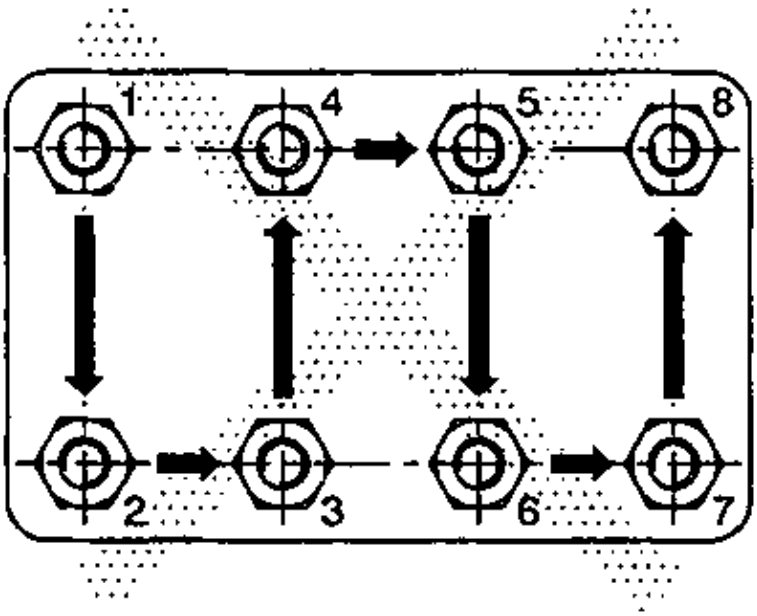
8.8 **PROPERTY CLASS**
- Yield point ratio 8 x 8 x 10N/mm²
- Tensile strength 8 x 100 N/mm²

M 10 **HEXAGON NUT**
- Major dia 10mm
- Metric thread

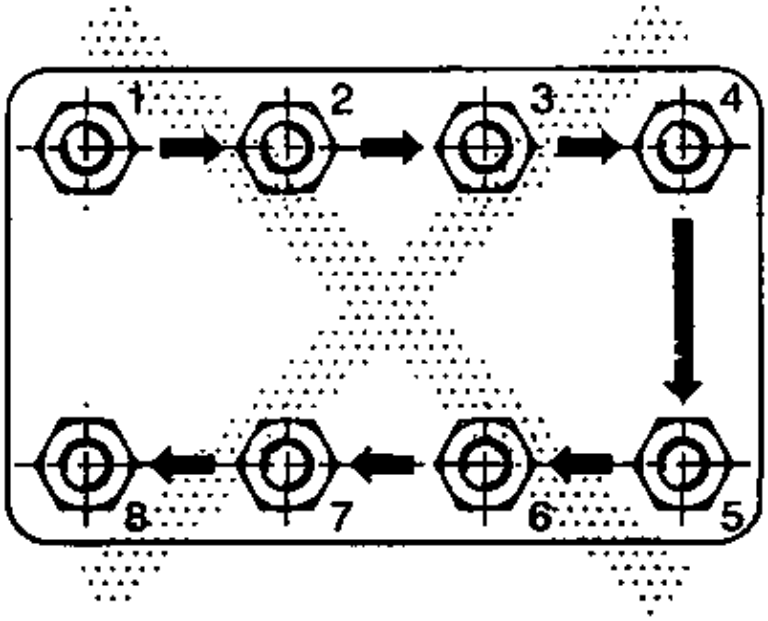
M 12 x 75 **STUD**
- Length 75mm
- Major diameter 12
- Metric thread

Note:– The specifications M10 × 1.25 × 70 indicates a fine thread the pitch is 1.25 mm.

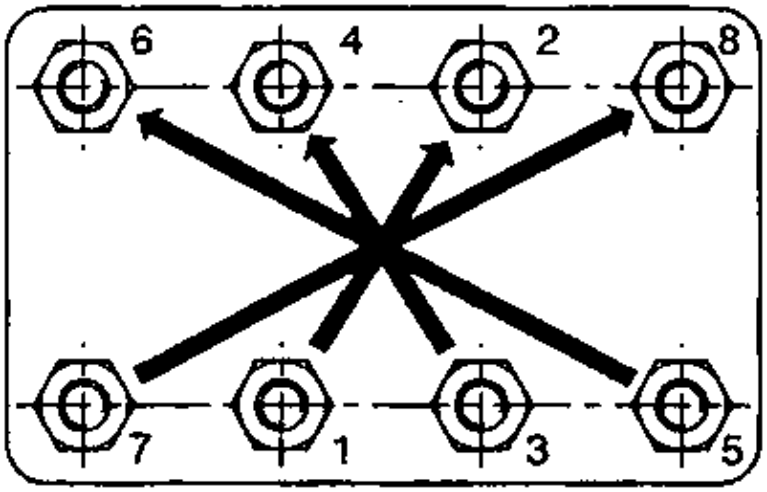
SEQUENCE FOR TIGHTENING NUTS IN ASSEMBLIES – TR 01 21 01 01 95



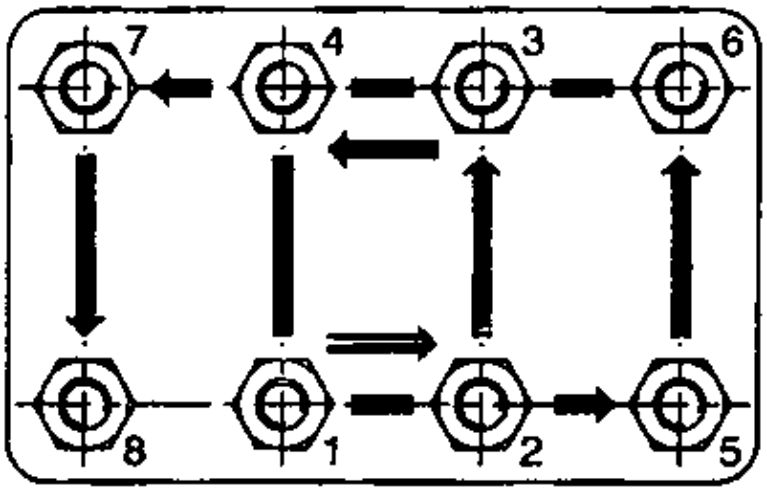
1.



2.



3.



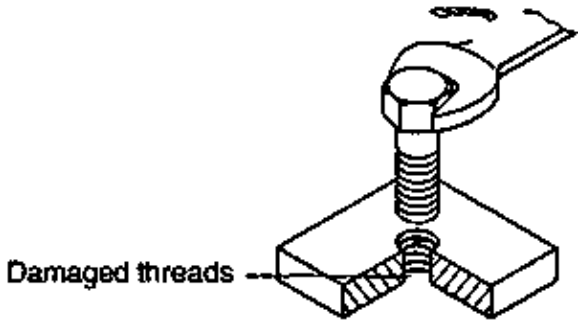
4.

1. Across one after another row
2. Longitudinal order
3. Over cross
4. Circular

Steps:

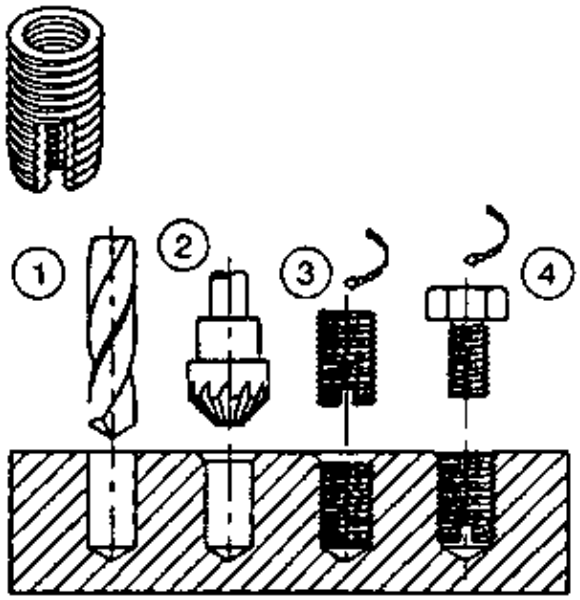
1. Tighten all nuts moderately by in one of the ways shown above
2. Tighten all nuts till full torque is achieved

REPAIRING DAMAGED INTERNAL THREADS – TR 01 21 02 01 95



REASON

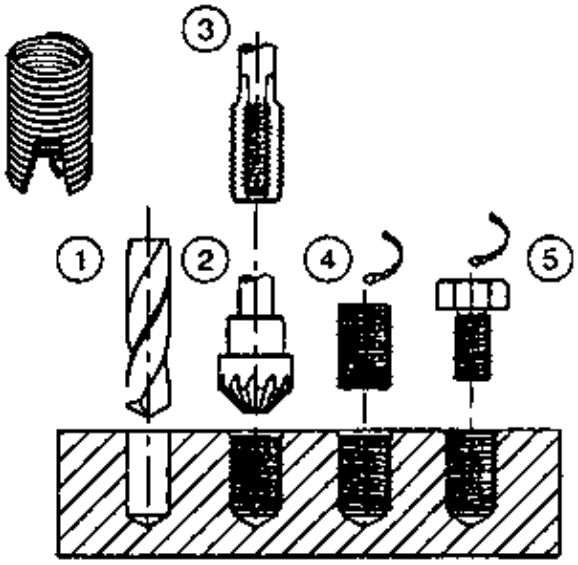
Happens especially when the material of the workpiece is soft (e.g. aluminium)



SCREW BUSH

1. Drilling to tap drill size
2. Countersinking
3. Fitting screw bush
4. Assembly

A screw bush acts like a self–cutting screw

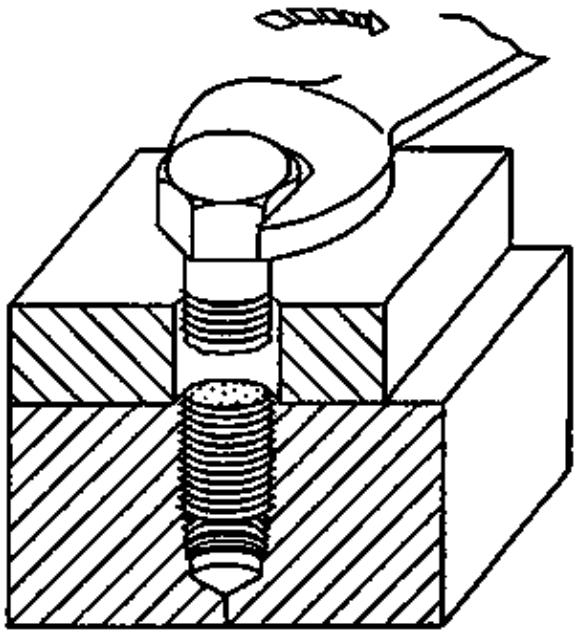


HELICOIL

1. Drilling to tap drill size
2. Countersinking
3. Tapping
4. Fitting helicoil
5. Assembly

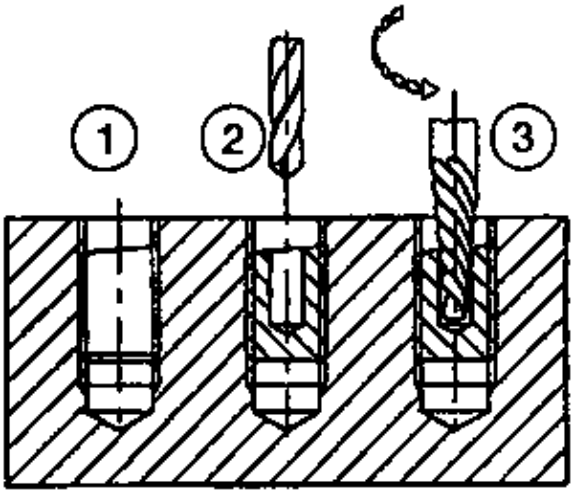
For a helicoil a thread must be tapped.

EXTRACTING BROKEN BOLTS FROM HOLES – TR 01 21 03 01 95



REASON

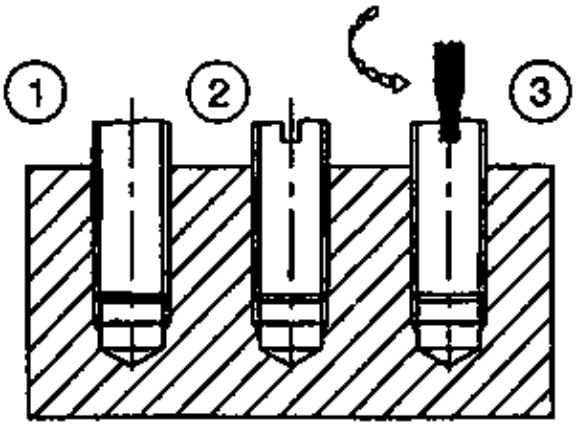
Excessive torque



A. EXTRACTOR

A. EXTRACTOR

1. Broken stud
2. Hole drilled on stud
3. Use of extractor



B. SLOTTING

B. SLOTTING

1. Broken stud
2. Slot cut on stud
3. Turn anticlockwise with screw driver

Note:– to be turned anticlockwise direction for loosening.

Fundamentals of Fitting – Course: Techniques of Fitting and Assembling Component Parts to Produce Simple Units. Methodical Guide for Instructors

Table of Contents

Fundamentals of Fitting – Course: Techniques of Fitting and Assembling Component Parts to Produce Simple Units. Methodical Guide for Instructors

Institut für berufliche Entwicklung e.V.
Berlin

Original title:
Methodische Anleitung für den Lehrenden “Grundlagen des Passens”

Author: Frank Wenghöfer

First edition **© IBE**

Institut für berufliche Entwicklung e.V.
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13187 Berlin

Order No.: 90–32–3131/2

1. Objectives and Subject Matters of the Practical Vocational Training in the Techniques of “Fitting”

On completion of the training the trainees are supposed to have a good command of the manual techniques of fitting component parts, in order to produce simple units.

To achieve this, the following is required:

Objectives of training

– The trainees have knowledge of the purpose, types and use of the fitting of component parts and sub–assemblies (units).

– They know the various methods used for manual fitting works in preparation of assemblings.

– They are able to produce the correct type of fit according to the use and function of the component parts and sub–assemblies.

– The trainees are able to properly select the tools and auxiliaries and to suitably apply them by strictly observing the health protection, labour safety and fire protection rules.

To meet these objectives, the instructor or teacher should emphasize the following points of content:

Subject matters of training

Knowledge

– purpose, types and methods of manual fitting works
– types and fields of application of the tools, testing instruments and auxiliaries
– selected basic terms of the ISA System of Fits, representation and designation of fits
– principal technological sequences of fitting works on plane and curved surfaces
– hints on labour safety

Skills

– selection and handling of the tools, testing instruments and auxiliaries for manual fitting works

– selection and implementation of the appropriate technique according to the demands made on the work–pieces:

- narrow, plane surfaces by filing
- broad, plane surfaces by filing and scraping
- curved surfaces by scraping
- bores by reaming
- quality control and function test.

2. Organizational Preparation

All instructions, demonstrations and exercises should be prepared thoroughly and meticulously.

This requires the following measures:

2.1. Planning of the Practical Vocational Training in the Techniques of "Fitting"

Draw up a time schedule and set an approximate number of hours in which you expect to complete the instruction on the various techniques of fitting. Plan an appropriate number of hours for the theory instruction on each subject, the practical demonstration, the instruction in preparation of a particular job, especially the exercises, the proper execution of the exercises, for recapitulations and controls.

When elaborating your time schedule, remember the level of know–how of your trainees, the conditions of trainees, the jobs which your trainees will take on in future and the degree of difficulty of the respective training stage.

The emphasis at each stage of training is always on the impairment of high craftsmanship and teaching of mechanical skills with the help of practice–related exercises which should be given the biggest chunk of time your schedule–

2.2. Preparation of the Labour Safety Instructions

A short labour safety instruction should precede every practical exercise, where the main points of the safe handling of all tools, auxiliaries, etc. are explained to avoid injuries. The directions which are binding on the safe handling of drills, countersinks and reamers should be repeated as they apply to the techniques of fitting. The following focal points should be repeated several times:

– Make sure that all tools are clean, sharp and undamaged.

– Make sure that the workpiece is clamped securely and safely. Never apply excessive force. This may damage the workpieces.

– Put all measuring and testing means aside at their proper place. Use pads, supports, etc. where provided, to protect them against impact, shock and corrosion.

– It is regarded as good workmanship to keep one's workplace tidy and always to put down individual components together with their matching parts.

Have a notebook or file at hand where you keep minutes of these instructions. All trainees shall certify with their signature that they were instructed accordingly.

2.3. Preparing the Teaching Aids

– The "Trainees' Handbook of Lessons – Fundamentals of Fitting" has to be given to each trainee.

– Surveys can be prepared in form of blackboard drawings prior to the beginning of the instructions.

– Component parts, assemblies and models of guides can be made available as demonstration aids.

2.4. Preparing the Working Materials

– Each trainee has to be given the “Instruction Examples for the Practical Vocational Training – Fundamentals of Fitting” as theoretical basis for the exercises to be done.

– The starting material necessary for the exercises has to be prepared with the help of the material contained in the “Instruction Examples...” and made available in a sufficient number.

– The workshop has to be checked for complete equipment with tools, measuring and testing means and auxiliaries according to the planned exercises.

– Recommended basic equipment:

- hand hacksaws, files of various forms, scrapers, hand reamers with and without angular momentum
- steel scriber, pencil, centre punch, hammer, aluminium hammer
- limit gauges for external and internal dimensions
- form gauges and feeler gauges, centre squares
- steel tape, vernier caliper, external, internal and depth micrometers, protractor
- marking devices
- marking colour, chalk, cutting oil, tap wrench, machine grease
- vice with protective jaws, special clamping devices

– A bench or upright drilling machine with pertinent clamping devices is required for the necessary preparatory works (boring and countersinking),

– Prior to the beginning of the exercises, the serviceability of this machine has to be controlled with regard to the aspects of labour safety.

3. Recommendations for the Practical Vocational Training in the Techniques of “Fitting”

The following paragraphs make suggestions for the theory instructions, demonstrations of the techniques of fitting, as well as for checking and assessing the trainees’ knewly acquired know–how.

3.1. Introductory Instruction

The trainees should be instructed on the basics of the subjects. For this, use a room where they can sit down and take notes. The trainees should be asked to enter the answers to the questions in the “Trainees’ Handbook...”. The trainees are supposed to have a good command of the techniques of filing, scraping and reaming before they are instructed in the techniques of fitting. The essentials of these techniques should be repeated occasionally. The contents of the “Trainees’ Handbook...” follow the system of the introductory demonstrations and instructions. The focal points in that “Handbook” can be discussed in the order given there.

Purpose, types and methods of manual fitting works

To start with, explain to the trainees the necessity of fitting works in preparation of mounting sub–assemblies.

It is advisable, to show examples of interference and clearance fits by means of visual aids available and to explain the use of these types of fits.

Since the methods applied in manual fitting works differ strongly in individual and series production these differences have to be illustrated by examples.

In doing so the manufacturing condition of “exchangeability” of series−manufactured component parts has to be especially pointed out.

Tools, testing means and auxiliaries

Introduce the tools, testing means and auxiliaries, as well as the fields of their application. The trainees will have some knowledge from their instructions on the manual techniques of material working. Discuss these points again with your trainees. Ask them questions to find out what they remember.

The following instruments are to be recapitulated:

- files, scrapers, hand reamers
- matching pieces, testing instruments, measuring instruments
- marking devices
- special clamping devices, vice with protective jaws.

Selected basic terms of the ISA System of Fits

The worldwide use of the ISA System of Fits, particularly in countries which have adopted the metric system of units makes it necessary to enable the trainees to work with ISA−standardized sub−assemblies. With the help of the respective section in the “Trainees’ Handbook...” basic terms can be explained which have to be known for reading an engineering drawing with fit specifications.

Only selected terms from this extensive field are to be mentioned:

- nominal size and actual size
- dimensional limits, dimensional variations and fit sizes
- tolerance and tolerance zone.

Accordingly, .the representations of fits in engineering drawings have to be shown, and “fit specifications with dimensional variations” and “fit specifications with ISA symbols” have to be presented.

> Imparting of this knowledge should be aimed at recognizing fit specifications in engineering drawings and deducing their fabrication with corresponding tools and testing means.

For the practical work it is not necessary to calculate the dimensional limits by means of ISA tables. However, the trainees should be shown such a way of determining a dimensional limit by the example of a “fit size symbol”.

This focal point has to be concluded with the explanation of the advantages of the ISA System of Fits. It should be especially emphasized how simply precision bores can be worked manually using ISA−standardized hand reamers and testing instruments the dimensions of which have been coordinated accordingly.

Fitting works on plane and curved surfaces

The various techniques are to be explained proceeding from the description of the working surfaces of component parts and sub−assemblies.

The “Trainees’ Handbook...” contains pertinent examples:

Fitting works on narrow plane surfaces are described by the example of a mitre angle gauge, the working of broad plane surfaces is explained by examples of a square−box wrench and a lock screw. Precondition for this is the good command of the techniques of “filing” and “scraping of plane surfaces”.

When explaining these works the different test methods are to be dealt with.

It is important to show the trainees the limits of the light gap test method and to explain to them the drag mark and the touching−up method as supplementary and more exact test methods.

Recommendation:

Here, the instructions can be finished and followed by exercises in the working of plane surfaces (1st and 2nd Instruction Examples).

Subsequently, the instructions have to be continued be the following focal point:

Fitting works on curved surfaces are also described by means of examples.

The fitting in by scraping of a slide bearing and the reaming of a gear bore for the reception of a shaft are explained. The latter example requires the recapitulation of the knowledge of the point “ISA System of Fits” and an explanation of the practical application. It is recommended to determine a fit size as example to designate tools and testing means with concrete specifications.

Hints on labour safety

The main points of safe filing, scraping and reaming should be discussed once more. These main points can be taken from the “Trainees’ Handbook of Lessons”.

3.2. Exercises

The necessary hints on labour safety have to be given, on principle, before the beginning of the exercises.

Afterwards, the workshop and the available technical equipment are to be shown to the trainees and their operation is to be demonstrated. It is recommended that the instructor begins each exercise with a demonstration in connection with instructions related to the given instructional example. The trainees are to be motivated to perform the exercise in good quality. Expected difficulties have to be pointed out.

The exercises can be done either as a compact whole according to the recommendations mentioned in Section 3 or in two exercise stages.

By means of the “Instruction Examples for the Practical Vocational Training – Fundamentals of Fitting” four exercises can be performed by using different techniques of fitting.

The “Instruction Examples for the Practical Vocational Training – Fundamentals of Fitting” contain a list of the material (starting material, tools, measuring and testing means and auxiliaries), the sequence of operations for doing the exercises and a comprehensible workshop drawing. This provides the trainees with the information necessary to perform the exercises purposefully.

If the course of the exercises shows that the quality of the practising workpiece is insufficient, more extensive exercises will have to be done. In this case, any waste products should be used. After the trainees have sufficiently proved their skills with these products, the envisaged Instruction Example can be manufactured.

> It is necessary that the instructor previously produced the practising workpiece by himself so that he knows all the problems of the manufacturing process.

Thus it is possible to name clear main points for evaluating the performances – problematic points of the practising workpiece can be pointed out. During the task−related instructions the sequences of operation and workshop drawings should lie on the tables so that the trainees can take down notes into their handbooks.

The individual Instruction Examples are shortly described in the following to give a survey of the practising workpiece to which the previously imparted knowledge should be applied:

Instruction Examples

Instruction Example 31.1. Mitre Angle Gauge

A testing means is made of a 2−mm−thick steel sheet by filing an angle sector of 135°. The fit lest is performed with the light gap test method by means of an available angle gauge or a protractor.

(Figure 1)

Instruction Example 31.2. Square Bolt for a Three–jaw Chuck Wrench

A square with a wrench opening of 12 mm is filed to a round stock with a diameter of 16 mm. The accuracy of the fit is tested with a square bush of corresponding size of a three–jaw chuck. The drag mark method is used as test method.

(Figure 2)

Instruction Example 31.3. Lock for Three–jaw Chuck Wrench

The pre–fabricated square bolt is now being equipped with a head and a lock. The fitting work is performed by reaming with ISA–standardized hand reamers. The required pin joints are to have clearance and interference fits. Limit gauges are used to test the fit.

(Figure 3)

Instruction Example 31.4. Pulley and Shaft to be Fitted together

An available pulley is joined with a pre–fabricated shaft. The bore of the shaft has to be adjusted according to the desired fit size – the subsequent mechanical treatment is performed by reaming. The feather key is to be inserted into the shaft keyway, if necessary it has to be pre–worked by filing true to size.

(Figure 4)

All trainees can do the exercises simultaneously, provided that the material prerequisites are guaranteed (availability of a sufficient number of devices).

In this case, the trainees can individually carry out the exercises – each trainee should be given as much time as he needs.

If there are not enough working tools available, the trainees will have to be split up in groups. It is favourable to divide them into groups according to the use of the various tools, measuring and testing means.

If the suggested Instruction Examples are not used for the exercise, it will also be possible to select other practising workpieces. The instructor should take care that all techniques previously discussed can also be practised with these pieces.

Major points as to practical work

It is advisable for the instructor to select certain aspects which he will give his particular attention when supervising and evaluating the trainees' exercises. Here are a few suggestions:

– Do the trainees carefully prepare the workplaces?
– Do they select the proper tools (size, form) for the fitting works?
– Do the trainees recognize the fit sizes from the engineering drawing?
– Do the trainees adhere to the correct sequence of the fitting works?
– Do the trainees correctly apply the test methods?
– Do the trainees meet the quality requirements?
– Are the trainees able to correctly assess the quality of their work?
– Do the trainees observe the labour safety rules?

The main points of evaluation have to be made known to the trainees prior to the beginning of the exercise!

3.3. Examples for Recapitulation and Control

This section contains tasks for consolidating and testing the acquired knowledge and skills; the answers to each task are also given:

1. What is the purpose of fitting?
(To assemble component parts, according to their function, to sub−assemblies.)

2. Which types of fits are mainly distinguished?
(Interference and clearance fits, cylindrical and flat fits.)

3. Which methods can be applied in fitting works?
(Individual or single−piece production and series production.)

4. Which manufacturing condition is good for an efficient economic assembling?
(The elements belonging together according to their function have to be exchangeable.)

5. Which tools are used for manual fitting works?
(Files, scrapers, hand reamers.)

6. Why has the internationally valid ISA System of Fits been adopted?
(To render possible the international exchange of ready−to−assemble component parts and sub−assemblies.)

7. Which specifications have to be recognizable in an engineering drawing?
(The permissible dimensional variations have to be given in form of numbers or symbols.)

8. How is the specification of an ISA fit size marked?
(Nominal size specification, tolerance zone and quality number.)

9. Which practical importance does the application of the ISA System of Fits have for testing?
(Standardized gauges make possible a lime−saving testing of the quality of the fit without determining the actual size.)

10. Which recommendation has to be paid attention to during the testing?
(Testing means and workpiece must have the same reference temperature.)

11. What does “shift−fitting” mean?
(A symmetrical element has to fit into the matching piece also in case of a rotation of 90° or 180°.)

4. Teaching Aids

For a better understanding by the trainees it is recommended to make available demonstration objects.

These can be component parts and smaller sub−assemblies of machines, but also self−made models of flat tracks, dovetail guides and cylindrical guides. It is also favourable to use prepared practising workpieces in the instructions (on the basis of the “Instruction Examples...”) to demonstrate good and bad fitting work.

If the trainees are to be familiarized more profoundly with the ISA System of Fits, it is recommended to prepare blackboard drawings or transparencies for overhead projection with extracts from ISA tables and representations of fits.

Likewise, such teaching aids can also be derived from national standards.

Grinding of Simple Tools – Course: Technique for Manual Working of Materials. Instruction Examples for Practical Vocational Training

Table of Contents

Grinding of Simple Tools – Course: Technique for Manual Working of Materials. Instruction Examples for Practical Vocational Training

Institut für berufliche Entwicklung e.V.
Berlin

Original title:

Lehrbeispiele für die berufspraktische Ausbildung
"Schärfen einfacher Werkzeuge"

Author: B. Zierenberg

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Parkstraße 23
13187 Berlin

Order No.: 90–33–3112/2

Introduction

The present documentation comprise 5 selected instruction examples with additional versions by means of which the grinding of tools can be exercised.

The exercises should be carried out, on principle, on worn–out original tools, but possibilities for substituting such tools are mentioned as well if original tools are not available.

To facilitate the preparation and execution of the work, the materials, working tools, measuring and testing tools as well as accessories required for each instruction example are given. Moreover, the previous knowledge is mentioned which is necessary for the individual exercises.

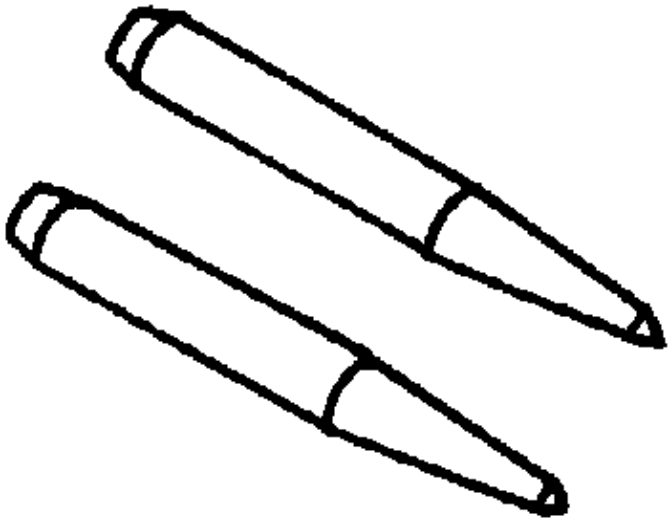
On the basis of the working drawings enclosed and the appertaining sequences of operations the exercise pieces can be manufactured or worked.

Explanations to the working drawings:

> The hardness of the tools is given to the hardness test with the Rockwell symbol "HRC" in connection with the unit of Rockwell. Marking of the characteristic pattern of the ground surface is shown on the working drawing in a circular detail representation.

Instruction example 12.1. Centre punch and scribing punch

Exercising of sharpening of punches



Material

– Worn punches or
– Round material of silver steel:

(carbon content 1.1. to 1.25 %)

Diameter: 10 mm

Length: 122 mm

Working Tools

Hand hacksaw

Measuring and testing tools

Vernier caliper, grinding gage or protractor

Accessories

Coolant (water)

Required previous knowledge

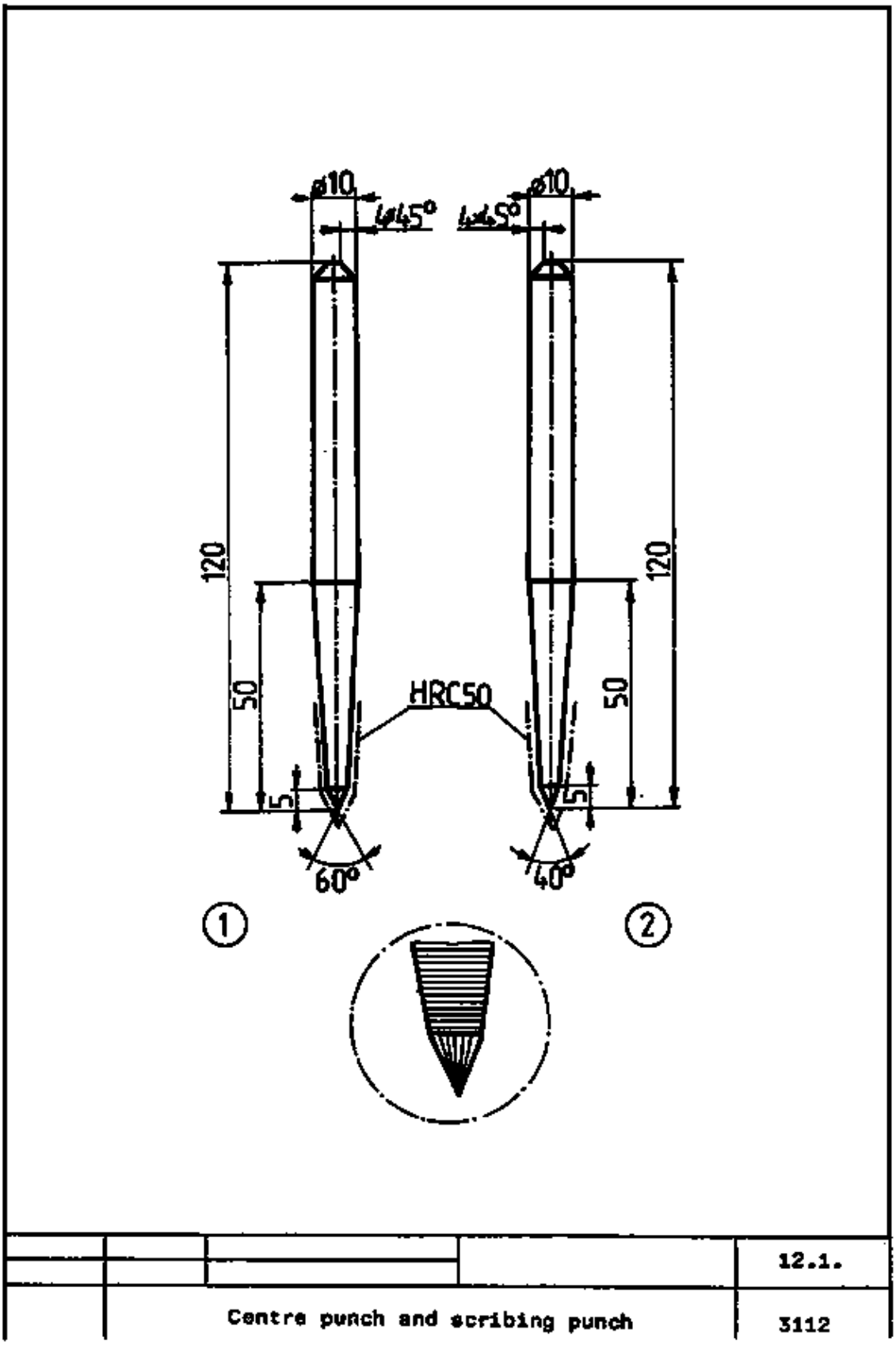
Reading of the drawings, measuring, testing, scribing, prick–punching, (sawing – when producing the punches)

Sequence of operations	**Comments**
1. Arrange workplace prepare working material	– Check for completeness
2. Sawing of the round material to length	– only if a original tool is not available!
3. Face grinding of one face	– Press workpiece in vertical direction against the wheel, turn it slowly around its axis
4. Grinding of a 4 mm chamver on	– Press workpiece against the wheel with a setting angle of 45°, in

this face – horizontal or vertical position	doing so, turn is speedily and uniformly around its axis
5. Grinding of a 50 mm long taper, proceeding from the other face–horizontal position	– The right hand guides the workpiece, the left forefinger lies between the workpiece and the grinding support – press workpiece in horizontal direction against the wheel, turn is speedily as well as push it forward and back
6. Grinding of the point – vertical position! (1) – Centre punch 60° (2) – Scribing punch 40°	– Press against the wheel only slightly with quick turning of it around its axis –risk of drawing the temper!
7. Final check	– Angle, accuracy to sice grinding pattern (as per drawing)

Completion:

Have the point hardened to HRC 50



Centre punch and scribing punch

Instruction example 12.2. Steel scriber

Exercising of the sharpening of steel scribers

Material

– Worn steel scriber or

– Round material of silver steel:

(carbon content 1.1 to 1.25 %)

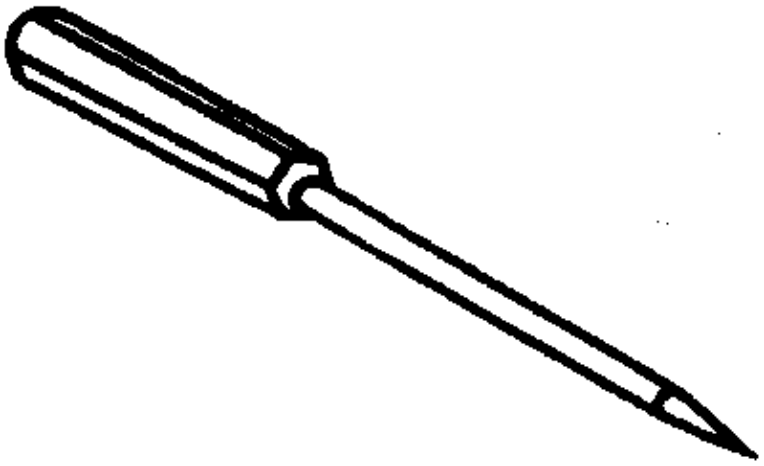
Diameter: 4 mm

Length: 150 mm

– Hexagonals of standard steel (380 MPa)

width across flats: 10 mm

Length: 78 mm



Working Tools

Hand hacksaw, drill 3.3 mm dia.; tap and threading die M4

Measuring and testing tools

Vernier caliper

Accessories

Coolant (water), cutting oil, tap wrench

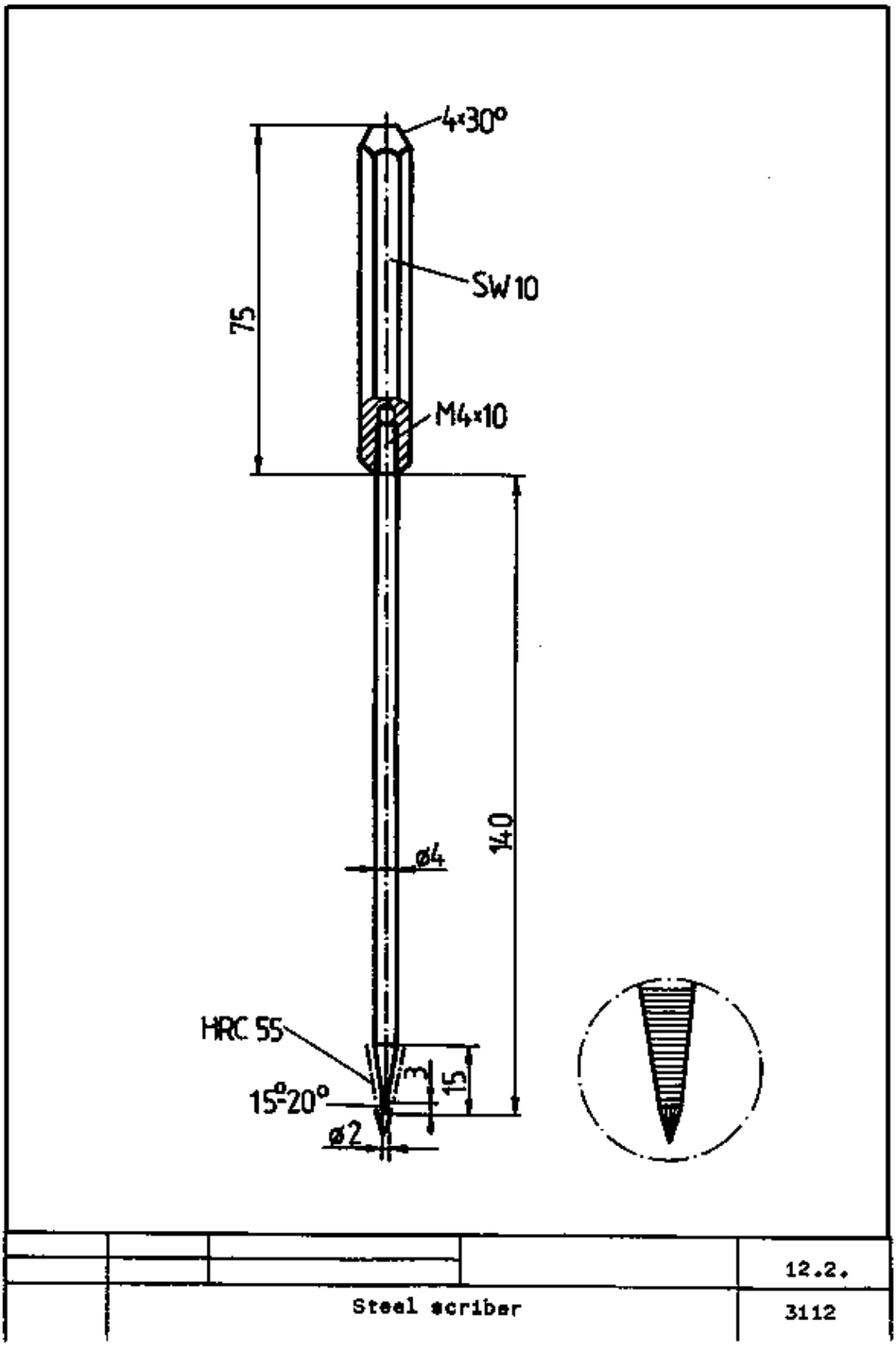
Required previous knowledge

Reading of the drawings, measuring, testing, scribing, prick–punching, (sawing, drilling, countersinking/counterboring, threading – when manufacturing the steel scriber)

Sequence of operations	**Comments**
1. Arrange workplace prepare working material	– Check for completeness
2. Manufacturing of the individual components as per drawing	– Only if original tools are not available

3. Grinding of a chamfer of 4 mm at both sides of the handle – horizontal or vertical position!	– Press the workpiece against the wheel with a setting angle of 30°
4. Screwing of the scriber with the handle	– Firm joint!
5. Grinding of a 15 mm long taper on the scriber – horizontal position!	– Attention I Forefinger lies between the grinding support and the distance between the grinding support and the wheel, 2 mm max.!
6. Grinding of the point – vertical position!	– Turn quickly –cool much! Risk of drawing the temper
7. Final check	– Accuracy to size grinding pattern (as to drawing)

Completion: Have the point hardened to HRC 55



Steel scriber

Instruction example 12.3. Screw driver

Exercising of grinding of screw drivers

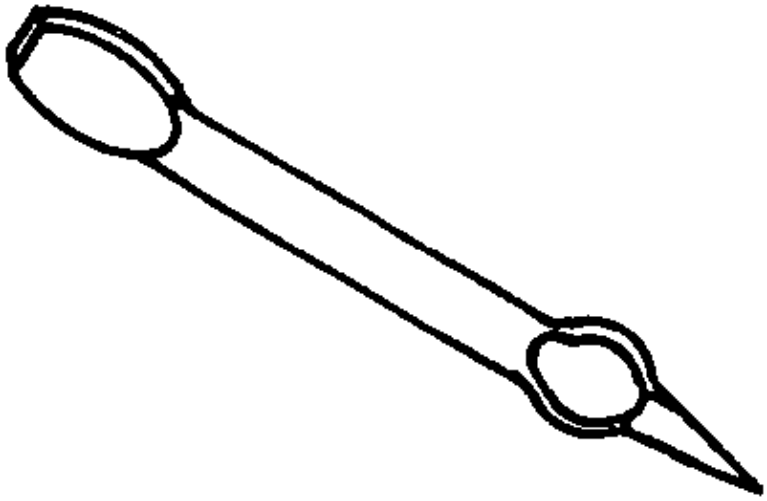
Material

– Worn screw drivers

or

– Round material of tool steel

(carbon content: 1 to 1.1 %)
Diameter: 5 mm



Working Tools

Hand hacksaw, engineer's hammer

Measuring and testing tools

Vernier caliper

Accessories

Surface plate, coolant (water)

Required previous knowledge

Reading of the drawings, measuring, testing, hammering

Sequence of operations	**Comments**
1. Arrange workplace prepare working material	– Check for completeness
2. Sawing of the round material to length	– Only if original tools are not available
3. Hammering of the screw driver blade (both sides) with the hammer face	– See to uniformity of the width! Hammer no edges into the surface!

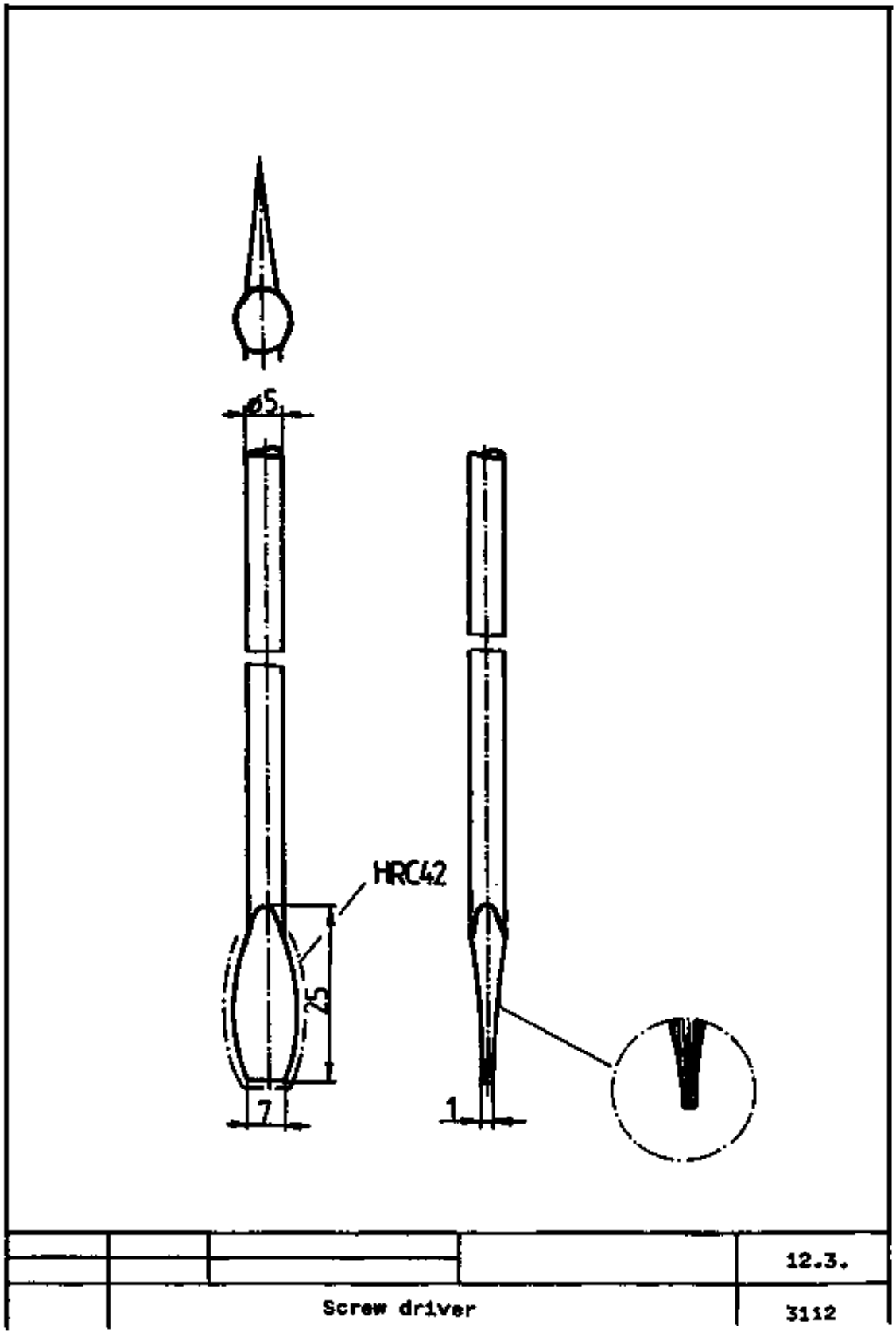
4. Grinding of the screw driver blade in vertical position by placing it flat against the wheel and slightly pushing up and down	– Place the screw driver blade far above against the grinding wheel! – Cool!
5. Checking of the concaving and of the accuracy to size	
6. Grinding of the tang in horizontal position	– Turn quickly!
7. Final check	– Accuracy to size, grinding pattern (as to drawing)

<u>Completion:</u>

Hardening of the blade to HRC 42

Hammering of the enlargement of the handle below the tang

Fixing of a wooden handle



Screw driver

Instruction example 12.4. Flat chisel and cape chisel

Exercising of sharpening of chisels

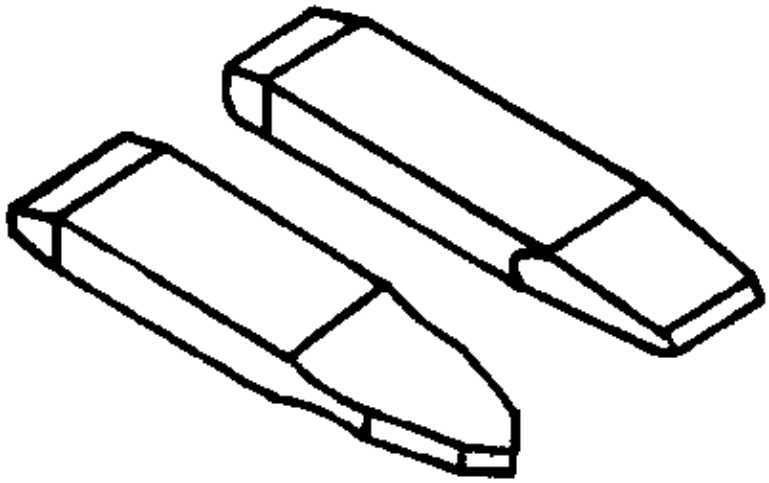
Material

– Worn flat or cape chisels

or

– Flat material of tool steel (carbon content: 1 to 1.1 %)

Thickness:	12 mm
Width:	20 mm
Length:	162 mm



Working Tools

Hand hacksaw, steel scriber, whetstone

Measuring and testing tools

Steel rule, vernier caliper, grinding gage or protractor

Accessories

Vice, coolant (water)

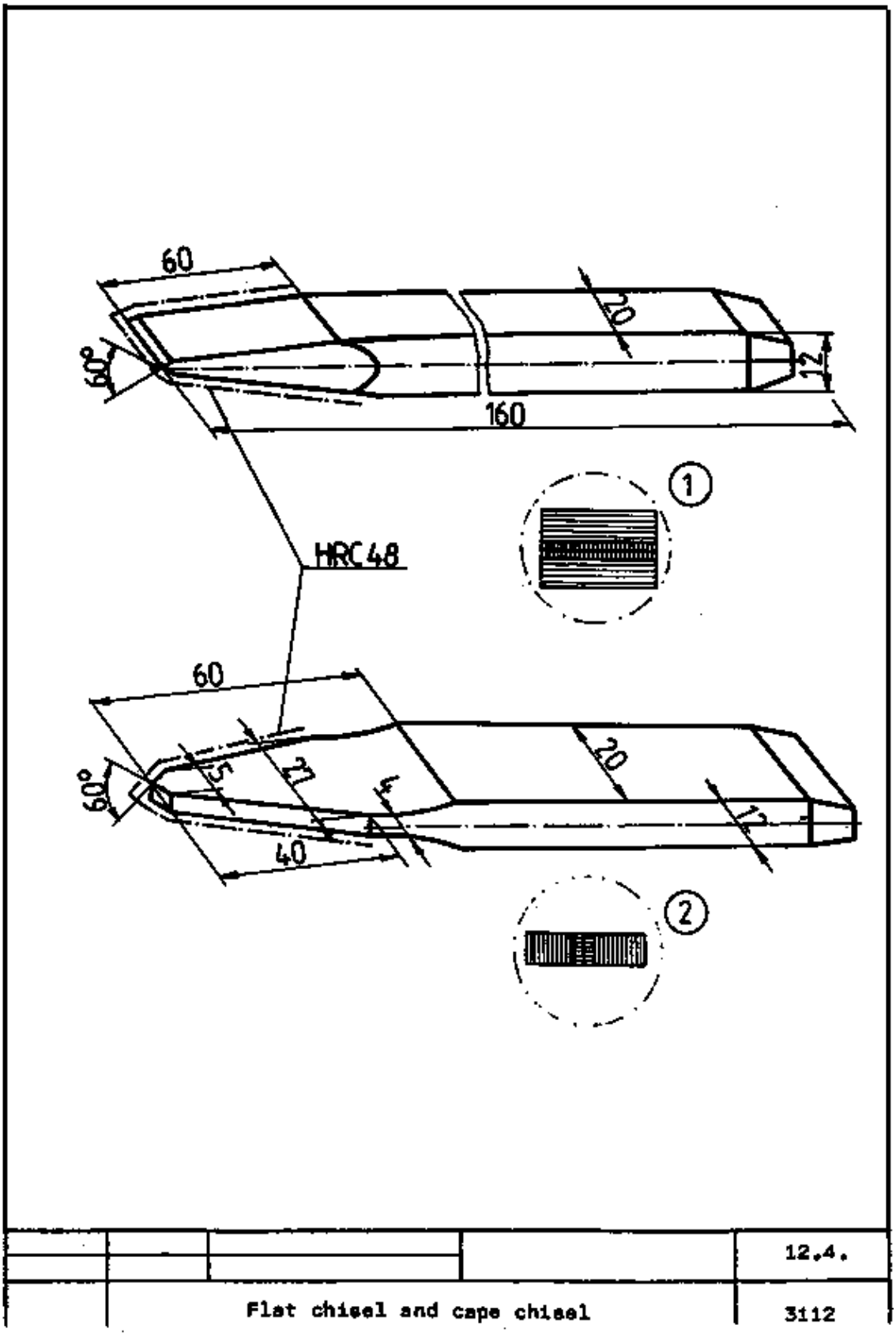
Required previous knowledge

Reading of the drawings, measuring, testing, sawing, chiselling

Sequence of operations	**Comments**
1. Arrange workplace prepare working material	– Check for completeness
2. Sawing of the flat material to length	– Only if original tools are not available
3. Place the flat chisel (1) with its wide side horizontally against the wheel and uniformly move to and fro until the taper has reached a length of 60 mm	– Uniformly grind the taper by permanently changing the sides! – Cool constantly!

4. Grinding of the blades in vertical position by uniform pressure against as well as to–and fro movements	– Forefinger lies between the chisel and the grinding support!
5. Checking of the surface of the taper as well as of the quality of the blades	– Surfaces to be smooth, blades to be sharp as well as parallel and angular to the outer edges
6. Place the cape chisel (2) with its flanks horizontally against the wheel and grind (move to and fro)	– Permanently change the sides and cool!
7. Place the blades in vertical position against the wheel and grind alternately by a short pressure against	– Attention! Risk of drawing the temper – cool!
8. Checking of the surfaces as well as of the quality of the blades	– Same as for flat chisel
9. Clean whetting of the blades with the whetstone (removing of the burr)	– Pull along the side of the blade
10. Final check	– Accuracy to size, appearance, grinding pattern (as per drawing)

Completion: Have the blades hardened to HRC 48



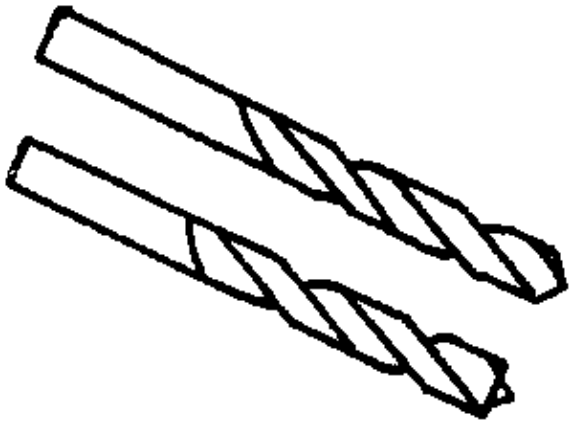
Flat chisel and cape chisel

Instruction example 12.5. Drill with standard drill point as well as flat drill point and centre point

Exercising of sharpening of drills in the most used types of drill point grinding

Material

worn−out drills
diameter: 4 to 12 mm



Working Tools

Measuring and testing tools

Grinding gage or protractor

Accessories

Coolant (water)

Required previous knowledge

Reading of the drawings, measuring, testing, drilling

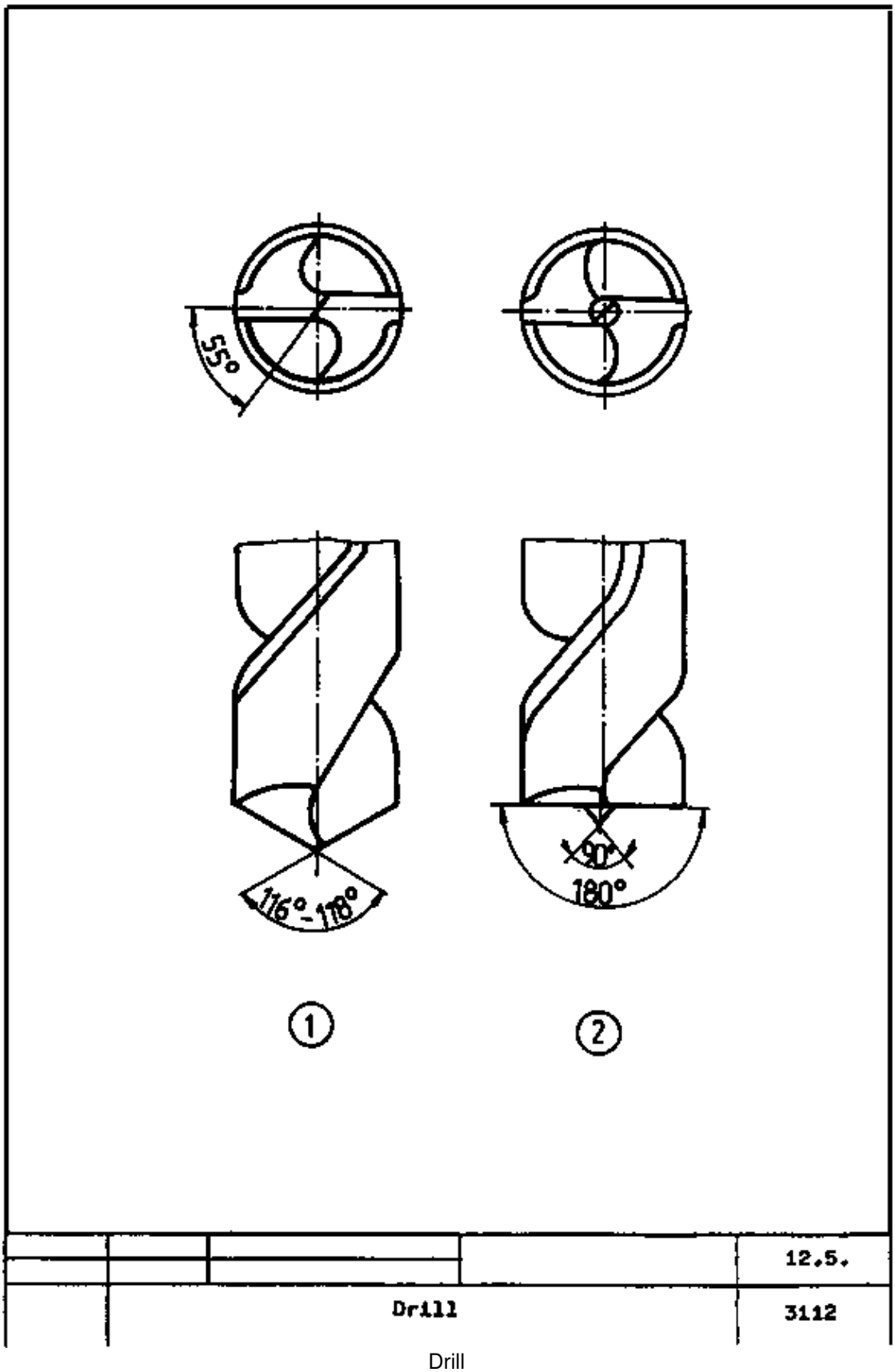
Sequence of operations	**Comments**
1. Arrange workplace prepare working material	– Check for completeness
2. Lay the drill with the standard drill point (1) between thumb and forefinger (left hand) and advance the drill with the right hand towards the grinding wheel so that the main cutting edge lies horizontally and the drill itself exactly horizontally. The setting angle is about 56° from the left−hand side	
3. Press the drill slightly against the wheel and push it towards above and at the same time slightly to the right−hand side –at the top take it off	– Grind both cutting edges uniformly (alternately) – and cool!
4. Check for grinding faults as well as for adherence to the angles given	
5. Take the drill with the flat drill point and centre point (2) as described above and press it with the main cutting edge exactly vertically against the horizontally lying grinding wheel, in doing so, the centre point must project at the right−hand grinding wheel edge!	

6. Push the drill with a slight pressure in vertical direction towards above, at the top take it off

– Cool!
Grind uniformly at both sides!

7. The centre point is sharpened by lateral grinding at the right–hand grinding wheel edge

8. Checking for grinding faults



				12.5.
		Drill		3112

Drill

Grinding of Simple Tools – Course: Technique for Manual Working of Materials. Methodical Guide for Instructors

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Grinding of Simple Tools – Course: Technique for Manual Working of Materials. Methodical Guide for Instructors

Institut für berufliche Entwicklung e.V.
Berlin

Original title:
Methodische Anleitung für den Lehrenden
"Schärfen einfacher Werkzeuge"

Author: Frank Wenghöfer

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13187 Berlin

Order No.: 90–32–3112/2

1. Objectives and contents of practical vocational training in the working technique of "Grinding of Simple Tools"

By concluding their training, the trainees shall have a good command of the working technique of "Grinding of Simple Tools".

Therefore, the following objectives have to be achieved:

Objectives

- Knowledge of purpose and application of the off–hand sharpening technique.

- Proper command of the working techniques and capability of off–hand sharpening of the most common tools.

- Capability of making decisions on the quality of their work independently.

The following contents have to be imparted to the trainees:

Contents:

- Purpose of sharpening
- Machines and tools for sharpening
- Action of grinding and whetting
- Applications of off–hand sharpening
- Hints for mounting and dressing of grinding wheels

2. Organizational preparations

In order to guarantee a trouble–free development of the instructions, exercises and practical work it is necessary to prepare this training properly.

This includes the following measures:

2.1. Preparations for instructions on labour safety

Prior to the exercises a brief instruction on the proper use of tools and equipment has to be given. This comprises hints for accident–free work too.

The following main subjects have to be imparted to the trainees:

– Only one trainee must work at a grinding machine at a time.
– A safety distance of at least 1 m around the grinding machine is to be observed.
– A trainee at the grinding machine must never be distracted, pushed or teased.
– The conditions of safety at the grinding machine have to be permanently checked:

• maximum distance of grinding support 1 – 2 mm
• distance of spark killer 5 mm (maximum)

– Grinding machines without attached eyeshields must be operated with the safety goggles on,
– Never grind the tools without the guidance of the left hand.
– Grinding wheels must be stressed frontally only – no lateral stress is allowed.
– You must never wear gloves or use pieces of cloth when holding the tools during sharpening.

Familiarity with these hints has to be confirmed by the trainees signatures in a control book.

2.2. Provision of teaching aids

The "Trainees' Handbook of Lessons – Grinding of Simple Tools" has to be handed out to the trainees in sufficient numbers. When using the transparencies series of "Grinding of Simple Tools" check whether they are complete (transparencies nos. 12.1. – 12.3.) and whether the overhead projector is functional. (Check whether the operating conditions are appropriate on the spot and make sure of the proper mains supply.)

Surveys etc. which are to be written on the blackboard have to be completed prior to the instruction.

All the grinding wheels and tools to be sharpened mentioned in section 3 should be kept ready for illustration purposes.

2.3. Provision of working tools and materials

Sufficient copies of the "Instruction examples for practical vocational training – Grinding of Simple tools" roust be handed out to the trainees to provide them with the theoretical foundations for the exercises to be carried out.

Based on the materials listed in the "Instruction examples ..." the initial materials necessary for the exercises have to be prepared and laid out in sufficient numbers.

For simple repair work or the production of tools the workbenches of the trainees have to be provided with firmly installed vices. The instructor has to check whether the workbenches are fully equipped with tools and accessories – based on the planned exercises – if other repair work or the production of new tools is planned in addition to sharpening.

Recommended basic equipment:

– vernier caliper, protractor, grinding gauge
– steel scriber
– hand hacksaw, locksmith's hammer
– whetstone.

Based on the number of trainees a sufficient number of grinding machines (bench–type and pedestal grinding machines) is to be provided.

For the purpose of off−hand sharpening of tools made of tool steel, flat wheels made of corundum must be available.

Tools with carbide cutting edges require flat wheels made of silicon carbide.

2.4. Time schedule

Time planing is recommended for the following training stages

- introduction to the working technique in the form of instructions
- necessary demonstrations
- job−related instructions for carrying out the exercises
- carrying out the exercises
- recapitulations and tests.

The necessary time share depends on the respective training conditions. The biggest time share is to be allocated to the exercises.

3. Recommendations for practical vocational training in the working technique of "Grinding of Simple Tools"

The following paragraphs comprise proposals on conducting trainee instruction, demonstration of the working techniques and on the form of exercises and tests.

The following course of events is recommended:

- Introductory instruction accompanied by demonstrations based on the "Trainees' Handbook of Lessons".

- Exercises in sharpening based on the "Instruction examples 12.1. – 12.5." and subsequent evaluation.

- Final test of theory knowledge based on the "Examples for recapitulation and tests".

Practical skills should be checked immediately after handing over the completed workplace. Theory knowledge can be checked constantly. However, it is recommended to have a final test written after the exercises.

3.1. Introductory instruction

If possible, this instruction should be conducted in a classroom. Make sure that the trainees put down necessary supplements and answers to questions in the "Trainees' Handbook of Lessons".

The subjects of instruction can follow the main points contained in the "Trainees' Handbook of Lessons".

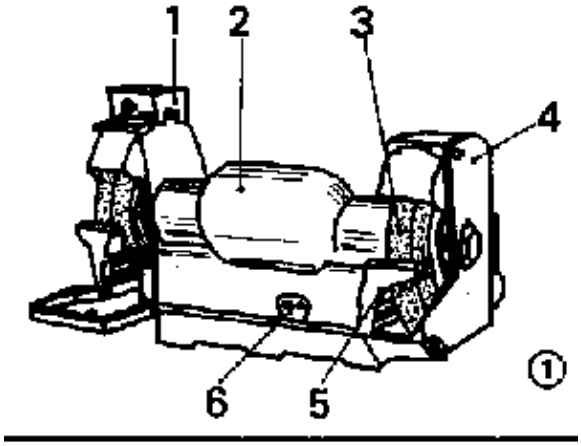
Purpose of sharpening

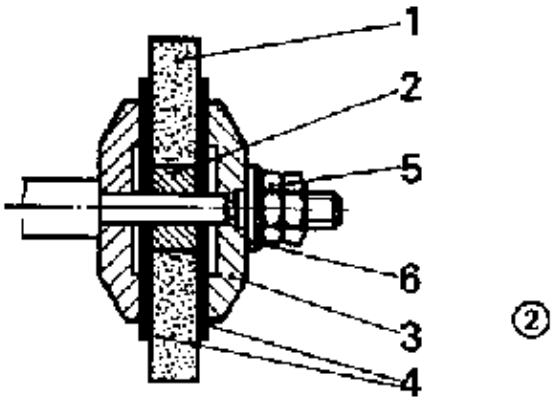
The instructor shows dull tools (chisels, drills) and workpieces which were treated with these tools in order to explain the purpose of sharpening the tools to the trainees. The instructor has to point out that the use of dull or damaged tools can result in great losses. The trainees have to understand that the technique of off−hand sharpening is high−quality manual work. They will learn that nearly all the common tools in a locksmith's shop are maintained this way.

Machines and tools for sharpening

Based on the hints contained in the operating manuals and folders the instructor makes the trainees familiar with the bench−type and pedestal grinding machines in the workshop. The basic design of a bench−type grinding machine can be also seen on transparency no. 12.1. The grinding wheels used as tools for sharpening are the subject of the subsequent instruction in the different forms and structural composition of

such wheels.



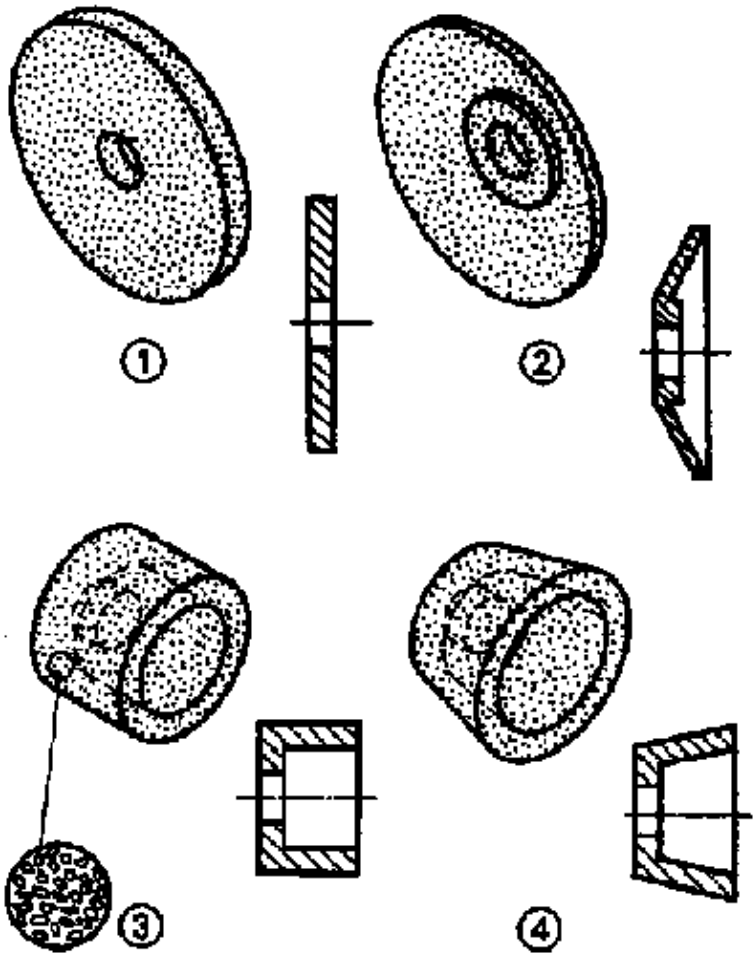


Transparency 12.1

The following forms should be illustrated:

- flat grinding wheels
- dish wheels
- cup wheels.

If these grinding wheels are not available as originals, transparency no. 12.3. or the figures contained in the "Trainees* Handbook of Lessons" can be employed as teaching aids. It is also recommended to demonstrate coarse, medium and fine–grained grinding wheels and their respective fields of application. The trainees should be shown the silicon carbide and corundum wheels used for off–hand sharpening. They must learn to select the proper wheels by eyesight.

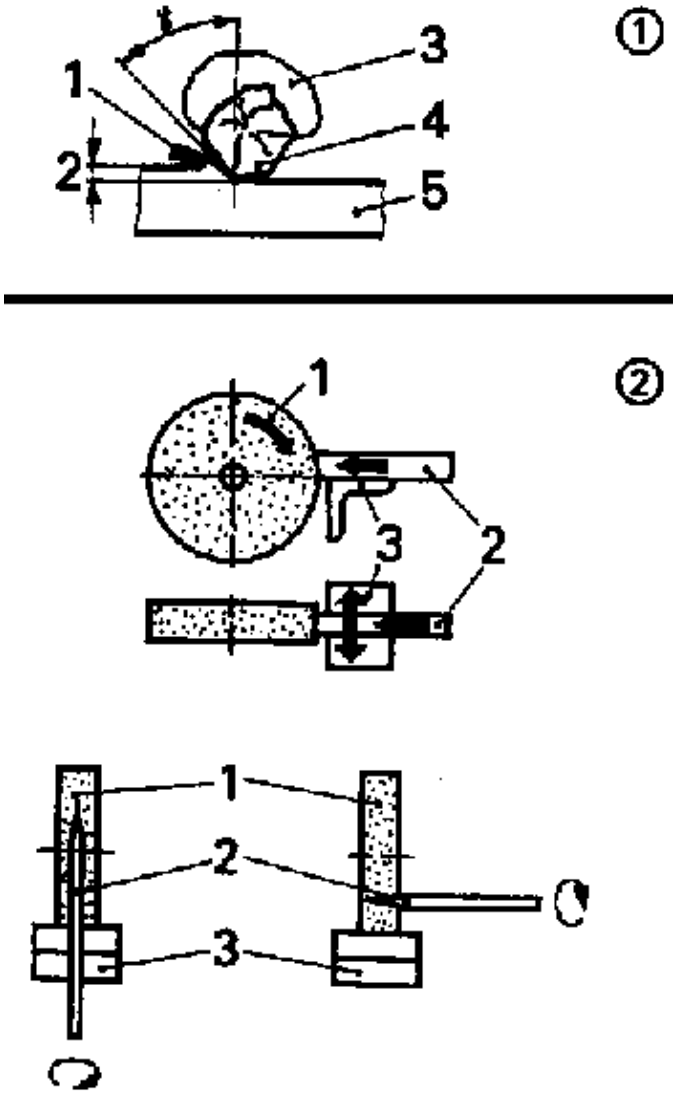


Transparency 12.3

Action of grinding and whetting

The action of grinding can be seen during the grinding process.

Transparency no. 12.2. can support the necessary explanations. As some burrs will occur at the cutting edge during the grinding process, the trainees are given a detailed description of the whetting process. It is recommended to demonstrate the position of the cutting edge on the whetstone and the kinds of movement involved in whetting. The instructor should never forget to underline the importance of this process and to stress that tool life greatly depends on an exact whetting process. (The tool life of a properly whetted chisel can be four times as long as that of a chisel which has not been whetted),



Transparency 12.2

Applications of off–hand sharpening

Based on the detailed descriptions contained in the "Trainees' Handbook of Lessons", the instructor can describe the sharpening technique for the following tools:

- centre punch and scriber
- flat chisel
- drill with standard drill point

This description can be supported by using the sequences of operations given in the "Instruction examples for practical vocational training". As the different positions of the hand are the main point in these processes, the trainees must be demonstrated how to hold the tools. The instructor can do so by simply showing a grinding wheel and the hand positions associated with grinding. This must be supplemented by repeated demonstrations at a grinding machine later.

Hints for mounting and dressing of grinding wheels

The instruction in mounting the grinding wheels should follow the order contained in the "Trainees' Handbook of Lessons". When describing the individual activities the instructor has to mention all the associated safety regulations. These activities must be carried out in a workshop under the supervision of the instructor only. Supervision is also necessary for dressing of grinding wheels with a hand dresser.

3.2. Exercises

If it has not been possible to include the demonstrations in the instructions by now, this should be done right

now prior to the beginning of the exercises.

These demonstrations must be so designed that not more than two trainees watch them at a time. These trainees have to repeat this action immediately afterwards under the supervision of the instructor. It will be necessary for the instructor to repeat these demonstrations frequently, for the proper sharpening technique can be only acquired by detailed observation and immediate duplication.

Subsequently, the trainees can begin with their first exercises based on the "Instruction examples for practical vocational training".

However, it will be necessary to prepare every individual exercise by a "job–related instruction". This comprises the demonstration of a finished workpiece in order to underline the purpose and objectives of this exercise,

> The instructor must have completed such a workpiece himself in order to understand all the problems involved in the production of the workpiece.

Thus, the instructor can clearly indicate the main points of evaluation and assessment of the achievements as well **as** crucial manufacturing areas. During these instructions the sequences of operations and the working drawings of the "Instruction examples" should be placed on the desks so that the trainees can make notes therein..

The trainees can carry out all the exercises simultaneously in the given order, provided that the number of tools etc. will allow this. If this is not the case, the trainees have to be grouped into teams – based on the tasks and the number of tools, machines etc. available.

If there are only a few grinding machines available, the exercises in sharpening should be done in parallel with exercises in other working techniques. Preferably, the techniques of "drilling, countersinking and counterboring" as well as "manual reaming" and "manual thread cutting" should be practised. During these exercises waiting times might occur at the drilling machines, and these times could be usefully **bridged** by exercises in sharpening.

The supervision of the instructor has to concentrate on some crucial points:

Since it is difficult to learn the proper positioning of the hands, as can be seen from repeatedly occurring handling errors, the instructor has to keep a close eye on the trainees. The instructor can reduce the trainees' anxieties caused by the rotating grinding wheels through calm and steady demonstrations and permanent supervision.

The trainees are requested to have their tools checked frequently. The instructor can recognise errors in the position of hands from the characteristic grinding pattern. If a trainee does not learn the proper handling techniques – even after prolonged exercises – the instructor has to guide the trainee's hands for a while. The exercise is characterised by a constant alternation of demonstration and duplication.

Exercises at the grinding machine should not exceed 2 hours, because the attention of the trainees will slacken off very fast. In addition, you have to keep in mind that bench–type and pedestal grinding machines are not designed for continuous operation – danger of overheating. This is the reason why the sharpening process should be interrupted by other working techniques. Thus, the "Instruction examples..." concentrate on the production of simple tools and the subsequent sharpening operation.

3.3. Examples for recapitulation and tests

This section comprise questions which are to consolidate and test the previously acquired knowledge and skills. Each question is provided with the respective answer. Questions which are also contained in the "Trainees' Handbook of Lessons" are marked with the letter "A".

1. What is the purpose of sharpening?

> (Cutting edges of tools have to be prepared for cutting in manufacturing processes by grinding and whetting or dull edges are re–ground for further use.)

2. What is the advantage of off−hand sharpening?

"A" (You can do it at any grinding machine immediately without any time−consuming preparations.)

3. Which tools can be treated by off−hand sharpening?

(Steel scribers, scribers of beam trammels and scribing blocks; centre punches, chisels and drills of all kinds, screwdrivers and scrapers.)

4. Which−is the main wheel form used in off−hand sharpening?

"A" (Flat wheel.)

5. When do we use cup wheels for sharpening?

"A" (In case we have to create flat surfaces without any hollow grinding.)

6. What are the components of a grinding wheel?

(Abrasive and bonding agent.)

7. What kinds of wheels are used for off−hand sharpening?

(Corundum wheel and silicon carbide wheel.)

8. What kind of wheel is used for sharpening tools made of tool steel?

"A" (Soft to medium−hard corundum wheel with medium grain size.)

9. What is the action of grinding?

"A" (Irregularly shaped abrasive grains will shave fine segmental chips from the workpiece.)

10. What do we understand by "self−sharpening* of the grinding wheel?

"A" (Dull abrasive grains will get loose by the pressure of the workpiece and they will give way to the sharp abrasive grains which lie behind them.)

11. What is the purpose of whetting?

"A" (The occurring sharpening burr has to be removed from the tool cutting edge in order to increase the tool life.)"

12. How do we whet a cutting edge?

(Both sides of the edge are to be angularly rubbed on the whetstone until the burrs are removed.)

13. What is typical of the technique of sharpening punches and scribers?

"A" (Sharpening of the tapered end in a horizontal position, sharpening of the points in a vertical position.)

14. What is typical of the technique of sharpening chisels?

"A" (Vertical sharpening of the cutting edge in a slightly upward position and with simultaneous to–and fro–movements.)

15. What is the working movement for sharpening drills?

"A" (The main cutting edge of the drill is brought into a horizontal position and then the drill is pressed upwards and to the right simultaneously.)

16. Which angles are to be maintained when grinding drills with standard drill point?

– angle of point 118°
– complementary angle of the drill edge angle 55°
– clearance angle 4–6

17. What grinding faults can we detect by eyesight?

– unequally long main cutting edges
– main cutting edges with unequal angles
– hollow–ground main cutting edges

18. What do we understand by 'drill–pointing'?

"A" (This is the lateral resharpening of the drill edge in a vertical position.)

19. Why is it necessary to dress grinding wheels?

(To guarantee true running and surface finish of the grinding wheel.)

4. Application of the working technique of "Grinding of Simple Tools"

The exercises can follow the order given in the "Instruction examples for practical vocational training – Grinding of Simple Tools" for 5 (or, resp. 8) examples.

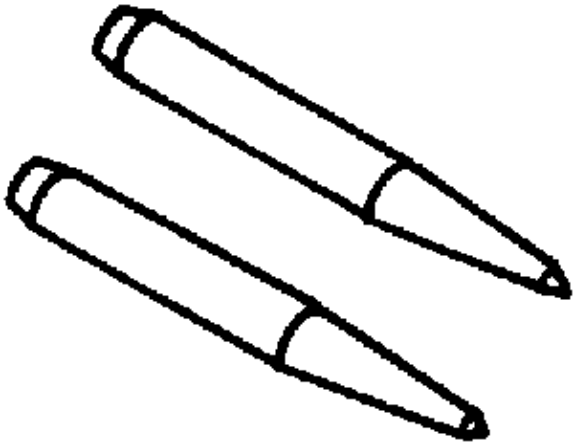
These "Instruction examples..." contain a list of materials (initial materials, hand tools, measuring and testing tools, accessories) as well as the sequence of operations for working or manufacturing the workpiece.

Thus, the trainees avail of all the necessary information to begin their exercise–related work.

4.1. Instruction examples

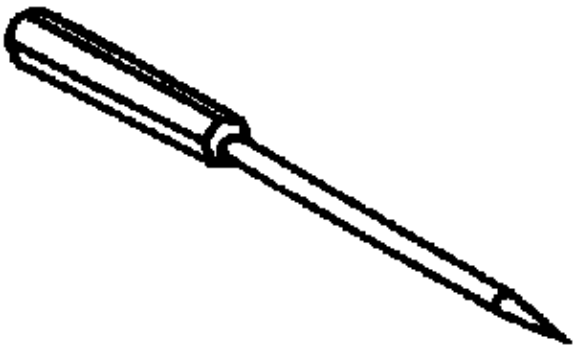
What follows is a brief description of the individual instruction examples in order to give a survey of those workpieces on which the previously acquired knowledge can be practised.

Instruction example 12.1.
Centre punch and scribing punch



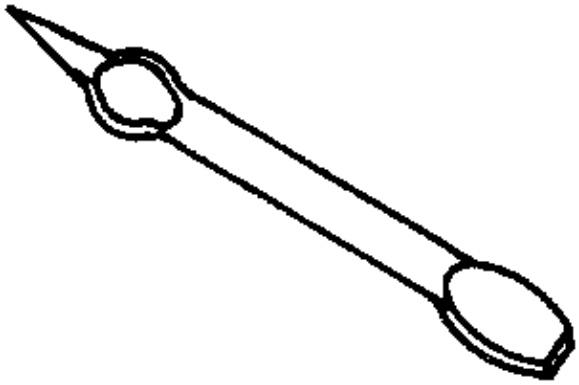
This exercise serve to practise the simple sharpening technique of worn punches as well as the production of these two kinds of punches.

Instruction example 12.2.
Steel scriber



Similar to the practice involved in sharpening the punches, the trainees practise how to sharpen or to manufacture steel scribers professionally.

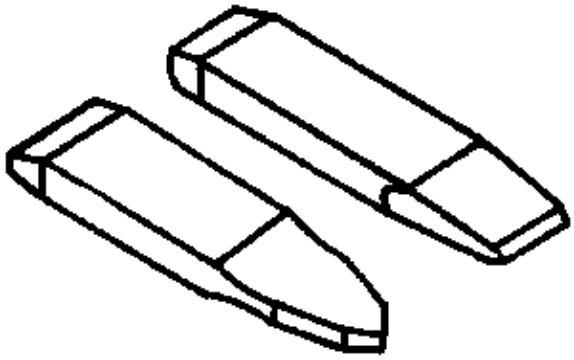
Instruction example 12.3.
Screw driver



The trainees practise the proper grinding of screw drivers.

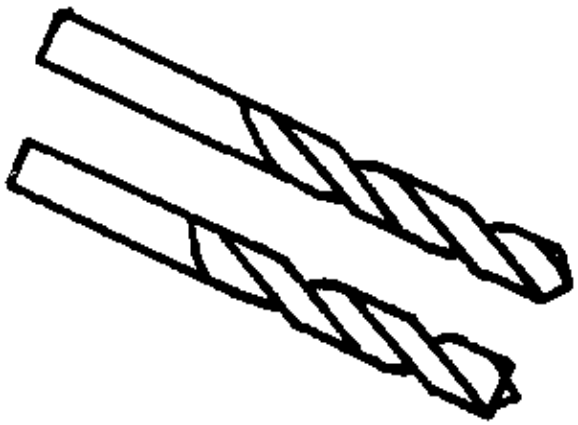
The instructor underlines the importance of a slightly hollow–ground blade.

Instruction example 12.4.
Flat chisel and cape chisel



Based on the special requirements of parallelism and angularity of the cutting edges, the working technique of sharpening chisels is the main subject of this exercise.

Instruction 12.5.
Drills with standard drill point as well as flat drill point and centre point



This exercise serves to practise grinding of the two main types of drill points of drills for steel. The instructor gives special hints for avoiding typical grinding errors.

4.2. Criteria for practical training

It is recommended to determine some crucial points of evaluation and supervision. The following criteria can serve as a guideline

- Does the trainee employ the appropriate grinding wheel?
- Did he check the distances at the grinding machine?

– Punch and scriber:

• Does the trainee grind the tapered end with a horizontal position of the hand?
• Does the trainee grind the tapered end with a vertical position of the hand?
• Does the trainee cool the tool regularly?
• Does the trainee stick to the given dimensions?

– Flat chisel, cape chisel and scraper

• Does the trainee grind the cutting edge through regular to– and fro–movements?

• Does he cool the tool sufficiently?

• Does he comply with requirements for angularity and parallelism of the cutting edges with the outer edges?

– Drills

• Does the trainee apply the main cutting edge of the drill in a horizontal position and with a setting angle from the left of about 58 degrees?

• Does the trainee prese the drill upwards and to the right simultaneously?

• Did the trainee avoid typical grinding faults?

5. Caption and legends of the "Grinding of Simple Tools" transparencies series

Transparency no. 12.1. <u>Construction of a grinding machine</u>

(1) grinding machine

1 dripping vessel

2 drive motor

3 grinding wheels

4 protective hoods

5 support table

6 switch

(2) clamping mechanism of the grinding wheel

1 wheel

2 lead bushing

3 bored flange

4 cardboard disks

5 hexagonal nuts

6 washers

Transparency no. 12.2.

Principles of the grinding process

(1) action of grinding

1 chip

2 cutting thickness

3 bonding agent

4 abrasive grain

5 workpiece rake angle

(2) Kinds of movement associated with grinding

1 grinding wheel

2 workpiece

3 support

Transparency no. 12.3.

Kinds of grinding wheels

(1) flat wheel

(2) dish wheel

(3) cup wheel, straight

(4) cup wheel, tapered

Grinding of Simple Tools – Course: Technique for Manual Working of Materials. Trainees' Handbook of Lessons

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Grinding of Simple Tools – Course: Technique for Manual Working of Materials. Trainees' Handbook of Lessons

Institut für berufliche Entwicklung e.V.
Berlin

Original title:
Arbeitsmaterial für den Lernenden
"Schärfen einfacher Werkzeuge"

Author: Frank Wenghöfer

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Order No.: 90–35–3112/2

1. Purpose of grinding

Sharpening is grinding and whetting of tools after their manufacture in order to prepare the cutting edges for use, i.e. mainly in metal cutting processes.

Furthermore, dull, worn out tools are made serviceable again by this technique. There are two different techniques:

Off–hand sharpening and sharpening by means of fixtures or special grinding machines.

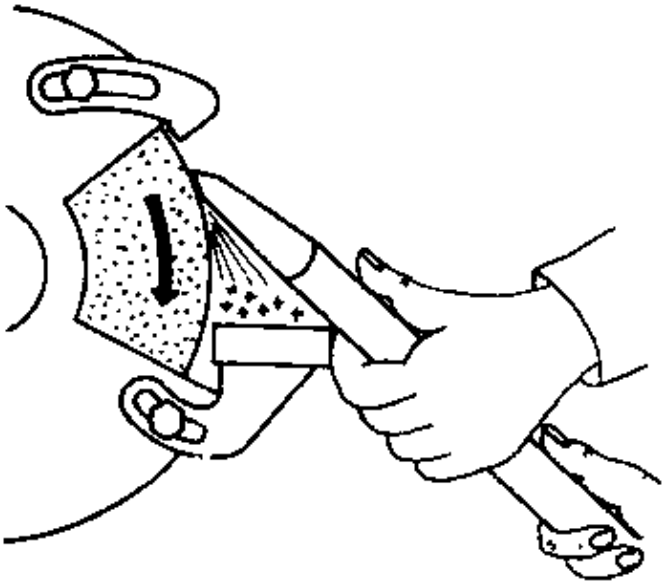

Figure 1 – Off–hand sharpening

Off–hand sharpening can be done any time and without much preparations on any grinding machine as soon as a tool that was used has become dull. Therefore, this technique should be perfectly mastered. Permanent exercise and practise is required so that the technique is not unlearned. By off–hand sharpening, the following tools can be sharpened:

> Steel scribers and scribers of beam trammels and scribing blocks; punches, chisels and drills of all kinds; screw drivers and scrapers.

What is the advantage of off–hand sharpening?

_____

_____

2. Machines for grinding

In the fields of production and maintenance, bench and pedestal type grinding machines are used which are equipped with two grinding wheels, mostly of a different grain size.

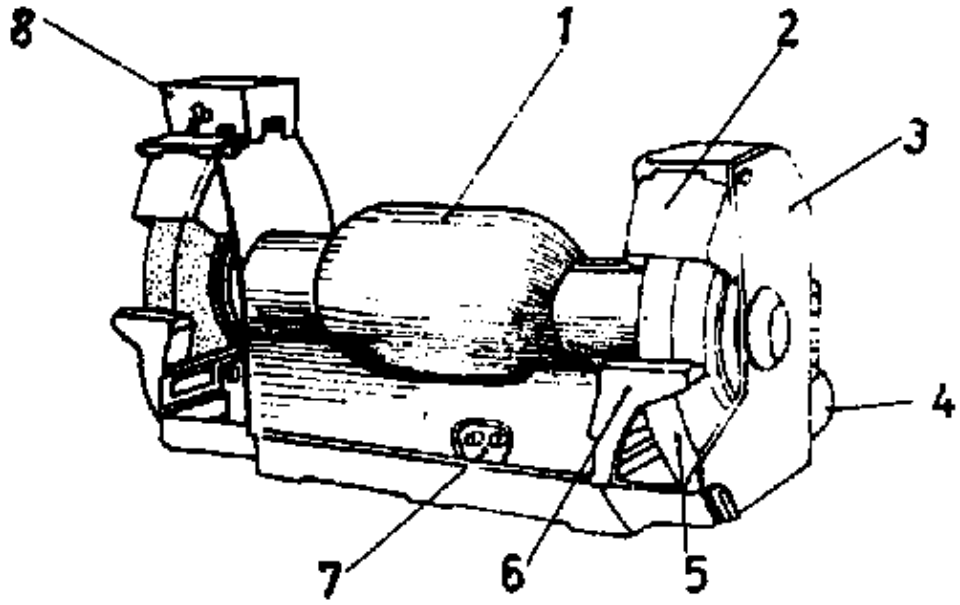

Figure 2 – Bench–type grinding machine

1 – Motor in motor casing
2 – Spark killer
3 – Covering hood of the grinding wheel
4 – Pipe connection for exhauster
5 – Grinding wheel
6 – Grinding support
7 – Switch
8 – Water tank for wet grinding

3. Tools for grinding

These are grinding wheels. They are manufactured in different forms and structural compositions.

3.1. Forms

Straight grinding wheels:

Most used grinding wheel for all kinds of tools; it is used in various widths. Since the grinding operation takes place only at the circumference of the wheel, the result is always hollow grinding.

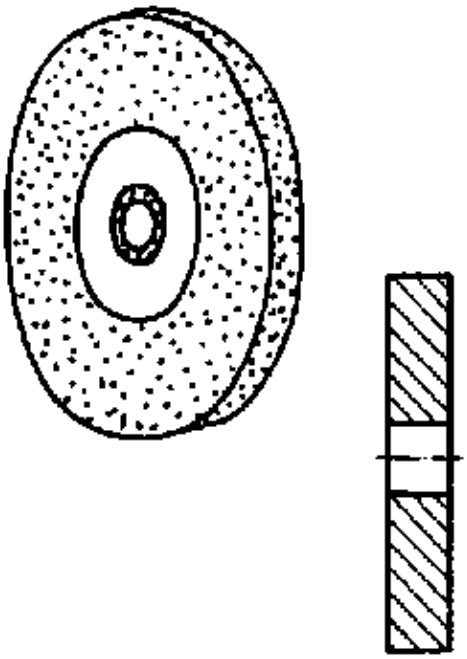

Figure 3 – Straight grinding wheel

Dish wheels:

Special grinding wheel for the pointing of drills.

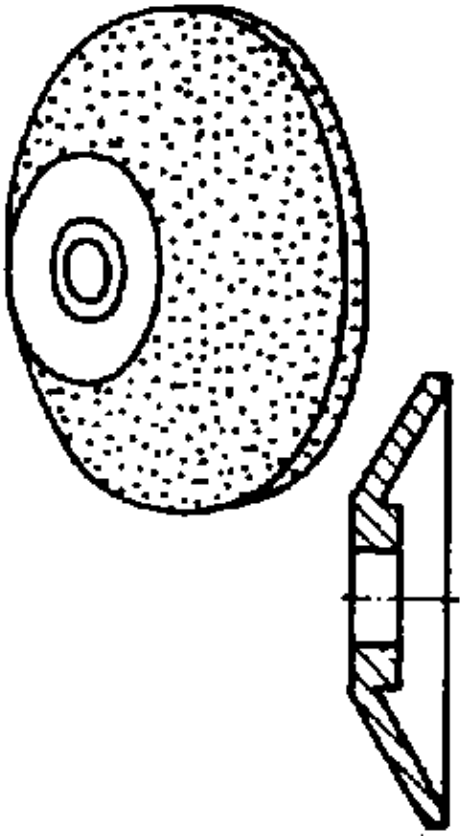

Figure 4 – Dish wheel

Cup wheels:

Grinding wheels with flaring or straight (cylindrical) outer face, which – due to their flat end faces – are especially suited for grinding surfaces that must not be hollow–ground, such as lathe tools and planing tools.

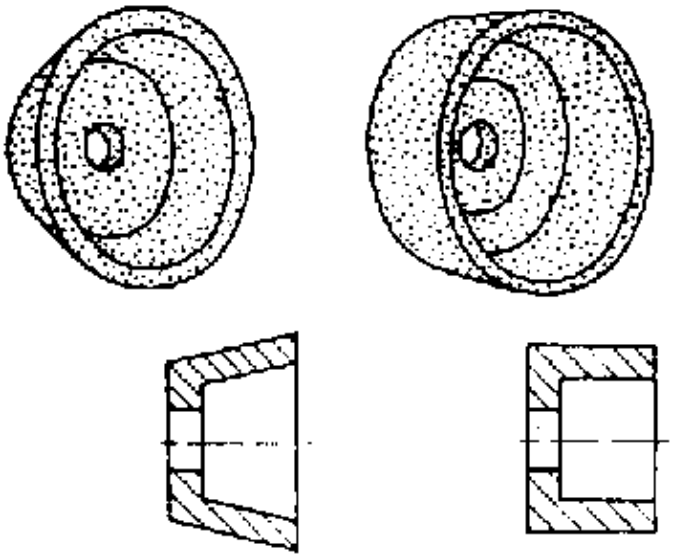

Figure 5 – Cup wheels

3.2. Structural compositions

Grinding wheels consist of abrasives (natural or synthetic) and binding agents.

Abrasives are produced in grain sizes ranging from very coarse to dust–fine and showing different void spaces between the grains – from very wide to very narrow – in the structure of the grinding wheel.

Binding agents may consist of elastic or inelastic materials, which – by the stability of their coherence with the grains of the abrasive – determine the hardness of the grinding wheel.

Note

– If the abrasive grain shall remain for a long time, because a soft material is to be ground and. therefore, the edges of the abrasive grains are worn out only little, a hard binding agent is used, i.e. a hard wheel.

– Shall a hard material be ground, a soft binding agent is to be used, so that the rapidly dulling abrasive grains can tear loose quickly to make room for the following sharp grains: soft grinding wheel.

Since with off–hand grinding the pressure exerted on the wheel differes greatly and the abrasive grains tear loose more quickly, mostly hard grinding wheels are used.

3.3. Selection of the grinding wheels for off–hand sharpening

Corundum wheels:

Soft to medium hard with medium grain size for tool steel and high–speed steel.

Silicon carbide wheels:

Hard with medium to fine grain size for tools with carbide cutting edges.

What kind of wheels are mainly used for off–hand sharpening?

_____

In which cases cup wheels are used?

_____

_____

Which kind of wheel is used for sharpening tools made of tool steel?

_____

4. Operation of grinding

When the workpiece is pressed against the grinding wheel which is rotating at a high speed (approximately 2800 rotations per minute), the abrasive grains by their irregular and sharp cutting edges scrape smallest chips from the workpiece.

After the abrasive grains have become dull they tear loose from the structure of the wheel making room for the next following sharp abrasive grains that continue the cutting operation.

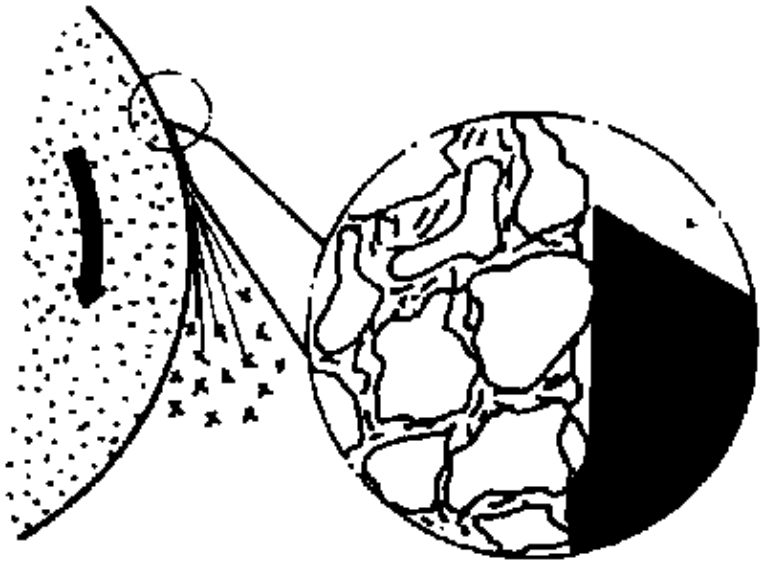

Figure 6 – Effect of the abrasive grains

Thus the grinding wheel sharpens itself.

After sharpening a cutting edge of a tool, a burr is to be noted at the edge. This must be removed by whetting before the tool is used.

5. Operation of whetting

The flanks of the cutting edges of the tool are rubbed on a fine–grained whetstone moistened with water or oil. The flanks must be treated with the on both sides.

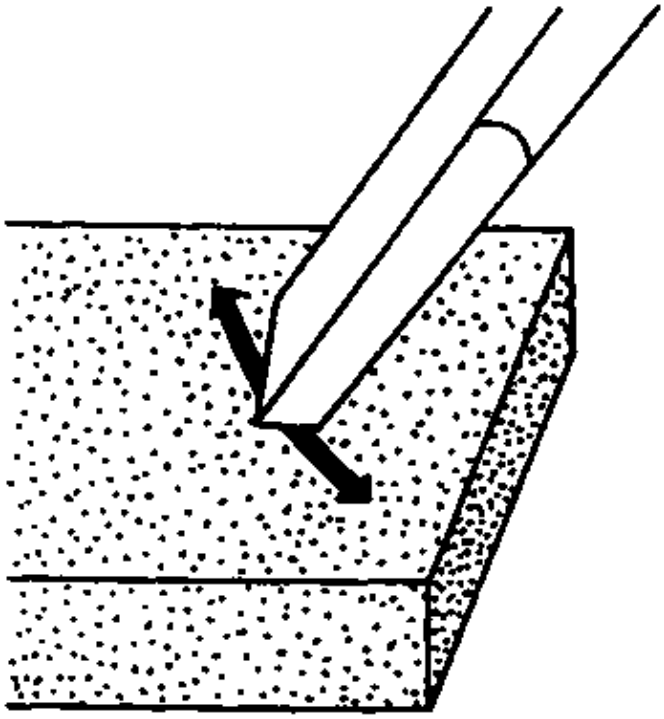

Figure 7 – Whetting of a shear tool

By repeated changing of the side, the burr is bent several times because it always evades to the side opposite to the flank which is being ground.

The movement is made in an oblique direction towards the edge till the burr is removed.

If the burr is not removed, it breaks off when the tool is used tearing gaps in the cutting edge and making the tool dull and useless soon.'

Whetting increases the service life of the cutting edge.

What characterizes the grinding operation?

_____
_____

What is understood by "self–sharpening" of the grinding wheel?

_____
_____

What is the purpose of whetting?

_____
_____

6. Examples for off–hand sharpening with straight wheels

6.1. Punch and scriber

The operations are similar with sharpening of punches and scribers.

The left hand guides the tool at the grinding wheel, the right hand moves the tool.

Operation:

Grinding of the taper:

The left forefinger lies between grinding support and tool, the thumb is on the tool.

The right hand presses the tool against the wheel in horizontal position at the same time revolving it quickly around its own axis.

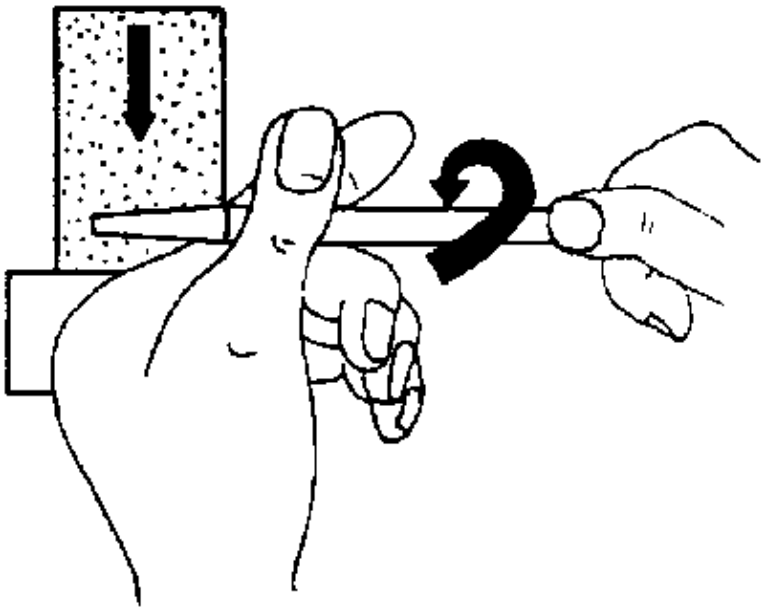

Figure 8 – Position of the hands when grinding the taper of a scriber

Cool at short intervals!

With punches, a forward and backward movement is carried out simultaneously.

Grinding of the point:

The left forefinger lies between grinding support and tool, the thumb is on the tool.

The right hand vertically presses it against the wheel in a steeply upward direction revolving it quickly around its own axis.

Grind and cool at short intervals in order to prevent annealing.

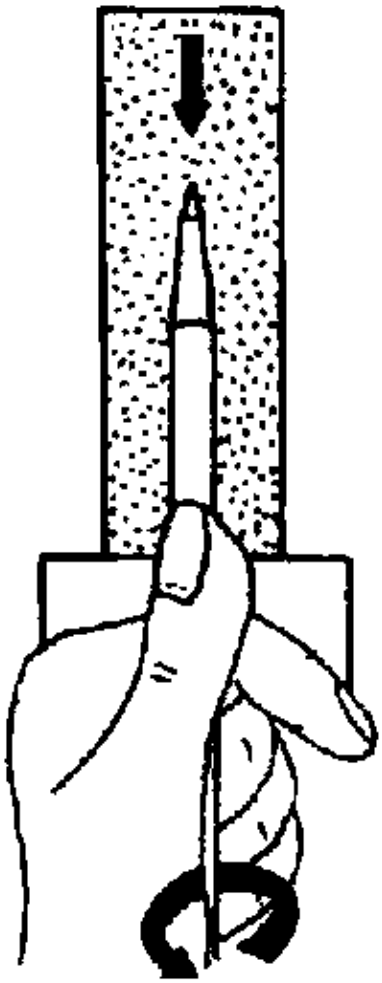

Figure 9 – Position of the hands when grinding the tip (point) of a scriber

Checking

The dimensions are checked by a vernier caliper, the angle by a gauge.

The surface must show a fine finish, the point must be situated right in the centre – on the axis of the tool.

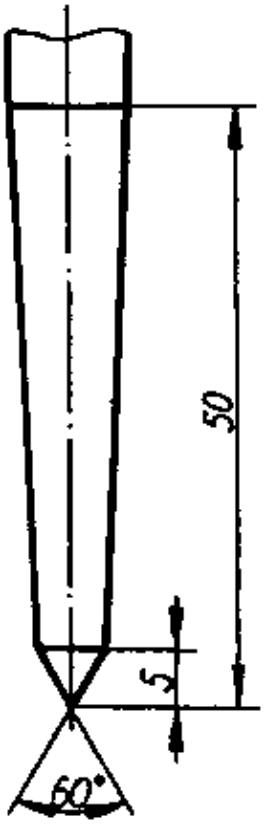

Figure 10 – Dimensions of the centre punch

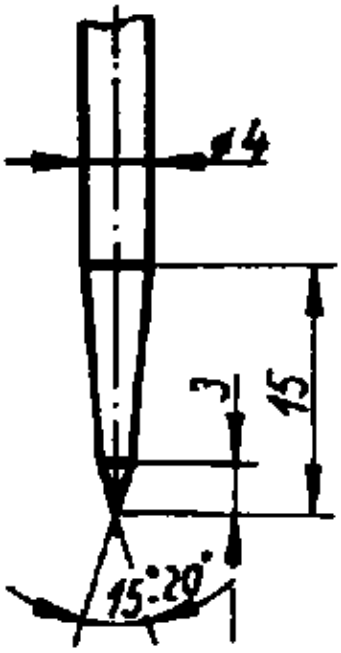

Figure 11 – Dimensions of the scriber

6.2. Flat chisel

Grinding the cutting edge:

The left hand holds the chisel so that the forefinger lies close to the grinding support and under the chisel. The right hand vertically presses the chisel against the wheel in a position directed slightly upwards steadily moving it to and fro.

Then, the chisel is sharpened from the other side. Cool at short intervals.

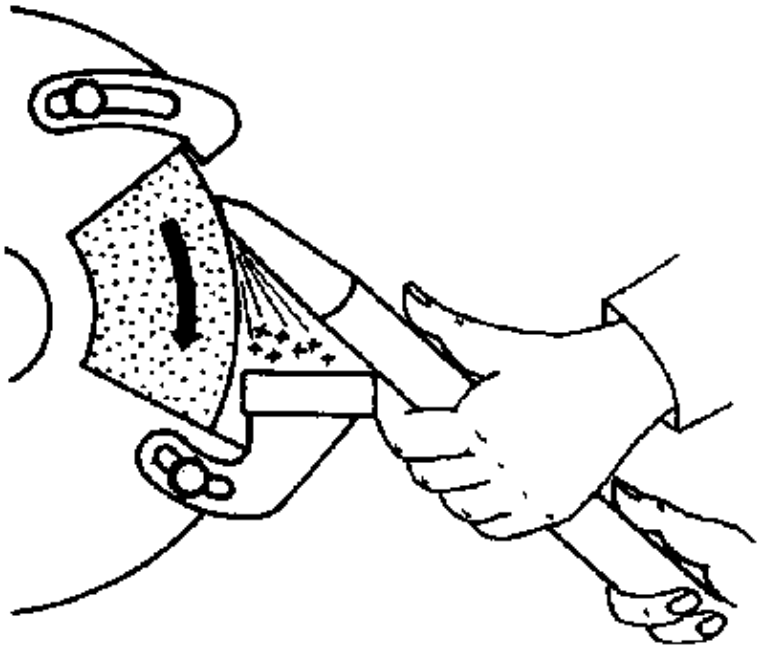

Figure 12 – Sharpening of a flat chisel

Checking:

The angle of the cutting edge is checked by the grinding gauge (60°), the surface and parallelism of the cutting edge is judged by the eye. The cutting edge must be situated in the middle on the axis and be parallel to the outside edges.

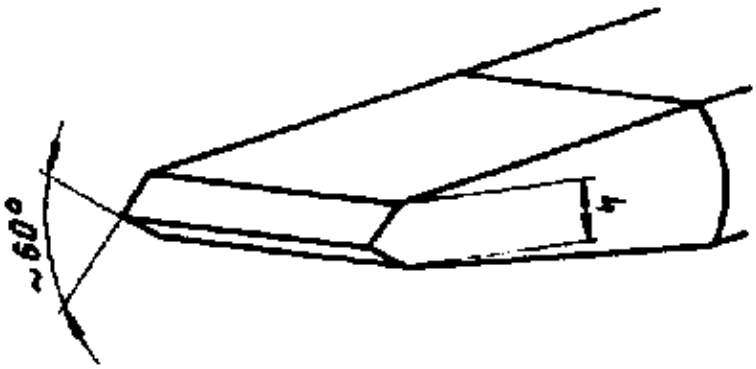

Figure 13 – Dimensions of the flat chisel

Whetting:

The cutting edge is rubbed over the whetstone diagonally and in an inclined way till the burr is removed.

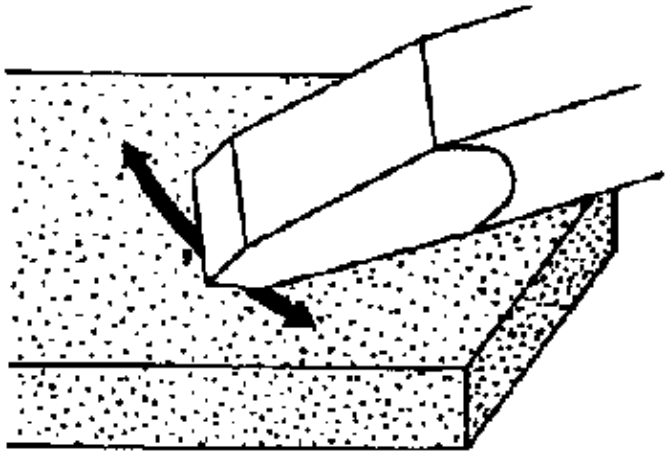

Figure 14 – Whetting of a flat chisel

Sharpening of other types of chisels as well as of scrapers is done in a similar way.

6.3. Drills with standard drill point

Grinding of the principal cutting edges:

> The drill is held between the left forefinger and thumb and guided in such a way that the left principal cutting edge comes in a horizontal position in front of the grinding wheel, the drill itself lies horizontally at an angle of incidence of approximately 58° from the left.

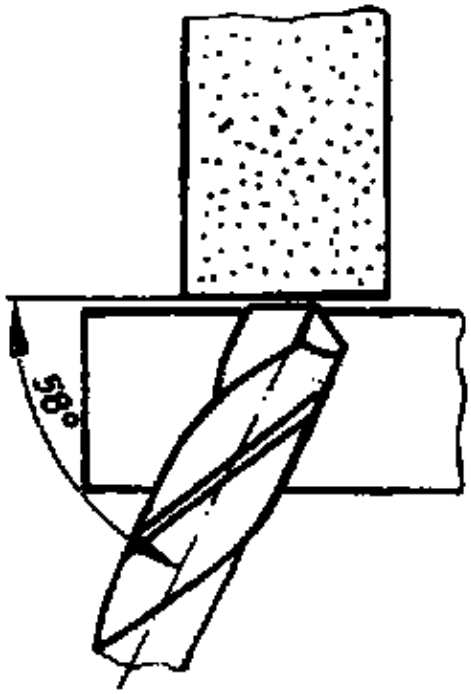

Figure 15 – Position of the drill

With slight pressure the drill is led by the right hand upwards from the wheel and, at the same time, slightly pushed to the right – it is lifted above.

This operation is repeated with the other principal cutting edge

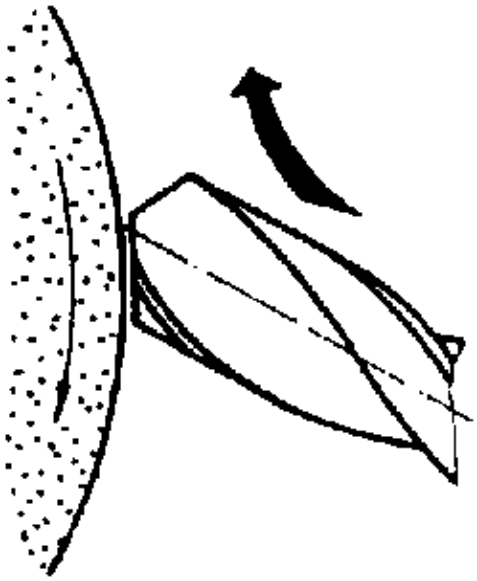

Figure 16 – Upward movement of the drill

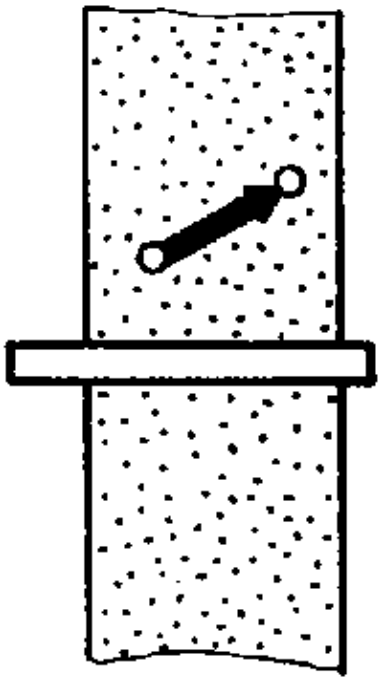

Figure 17 – Movement of the drill to the right

Checking:

After every grinding operation the angle has to be checked by the grinding gauge, the evenness and cleanliness of the surface ground is judged by the eye.

Recommended values:

– Point angle between the principal edges by gauge (118º standard drill point)
– Chisel edge must be exactly in the middle and have an angle of 55°
– Flanks shall taper off at 4 – 6° behind the principal cutting edges

Grinding faults:

– Point angle, angle of clearance, complementary angle of the chisel edge angle too large or too small
– Principal cutting edges (1) different in length (drill out of centre – bore hole too big)

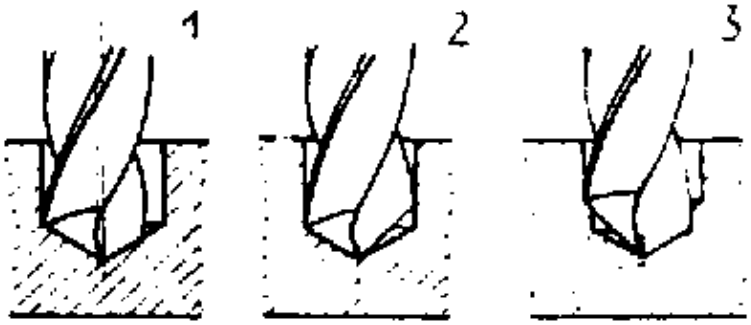

Figure 18 – Consequences of grinding faults (explanations 1,2,3 in the text)

– Principal cutting edges at unequal (2) angles (shoulder in the bore hole)
– Principal cutting edges different in length and unequal angles of the principal cutting edges (3)
– Incompletely ground principal cutting edges (drill does not cut)

Pointing of the chisel edge:

With drills of a diameter of more than 10 mm the chisel edge is vertically ground at the right edge of the grinding wheel or at the dish wheel in order to reduce the squeezing negative

effect of the chisel edge.

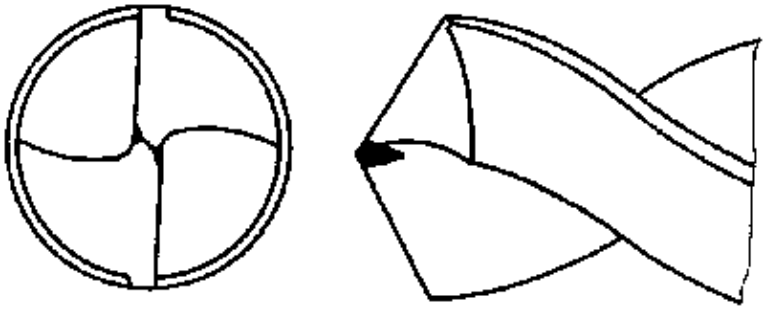

Figure 19 – Pointed drill

What characterizes the technique of punch and scriber sharpening?

_____
_____

What characterizes the technique of chisel sharpening?

_____
_____

How is the operation (movement) with the sharpening of drills to be carried out?

_____
_____

What is understood by 'pointing of the drill'?

_____
_____

7. Hints for mounting and dressing of grinding wheels

With mounting the grinding wheel, observe the following order:

– Sound out the grinding wheel if it has a ceramic bond (clear, slowly dying away sound – faultless wheel);

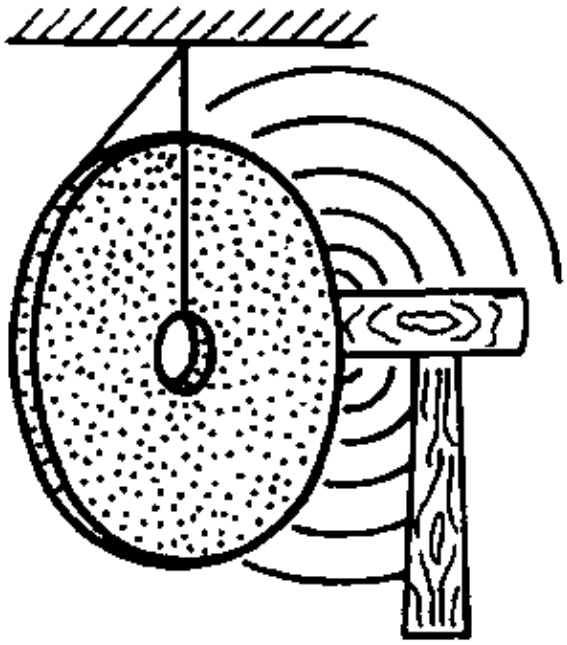

Figure 20 – Sounding out the grinding wheel

– If the bore hole is too big, put a lead bushing (2) into the wheel (1);
– Clamp the wheel (1) between two flanges of the same size (3);

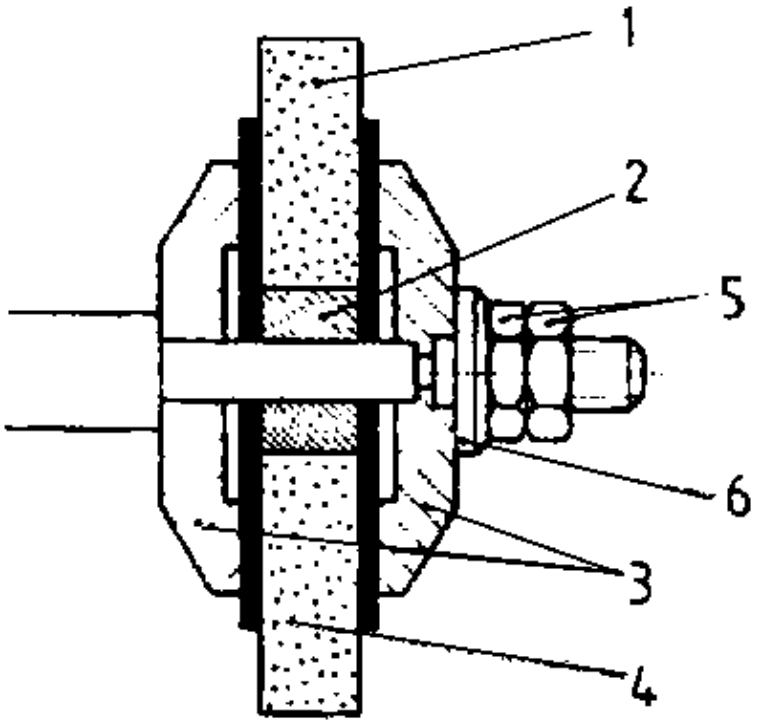

Figure 21 – Clamping device of the grinding wheel

– Put soft, elastic washers of rubber or cardboard (4) between the wheel and the flanges;
– Fasten the wheel by a bolt washer (6) and a lock nut (5) on the shaft.

Pay attention that the right end of the shaft has a right–hand thread, the left end of the shaft a left–hand thread. Then. the spark killer has to be adjusted so that the maximum distance between the spark killer and the grinding wheel is approximately 5 mm. The grinding support must not be more than 1 – 2 mm away from the grinding wheel, because otherwise there is the risk of thin tools being drawn in.

Since the size of the grinding wheel is reduced by abrasion during the grinding process, the distances must be permanently put right.

After the grinding wheel is mounted it roust be dressed in order to guarantee that it runs true. Dressing becomes also necessary when the grinding wheel is uneven or sticky. Only cutting or grinding dressers are used:

– Manual dresser
– Dressing stick

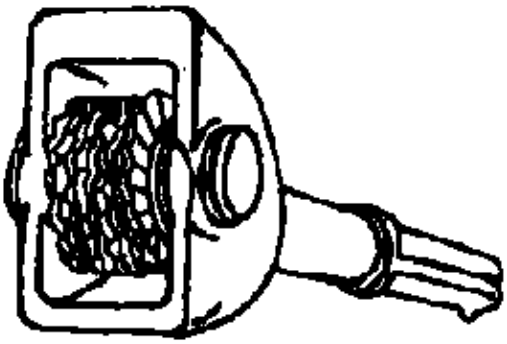

Figure 22 – Manual dresser

Dressing diamonds are applied with the help of dressing devices, if very great demands are made on the grinding wheel as to the precision of dimensions and form as well as surface quality.

Operation:

With running grinding wheel the manual dresser or dressing stick is pressed firmly against the grinding wheel and slowly moved to and fro.

Attention:

Put on safety goggles and respirator – very strong formation of dust – very detrimental to health I

8. Labour safety recommendations

– Only one person is working at the grinding machine – safety. distance laterally and backwards 1 metre.

– When working at grinding machines which are not equipped with a protective device for the eyes, put on safety goggles.

– Distance of the grinding support (1–2 mm) and distance of the spark killer (5 mm) have to be checked constantly.

– Do never grind any tool without guiding it by the left hand.

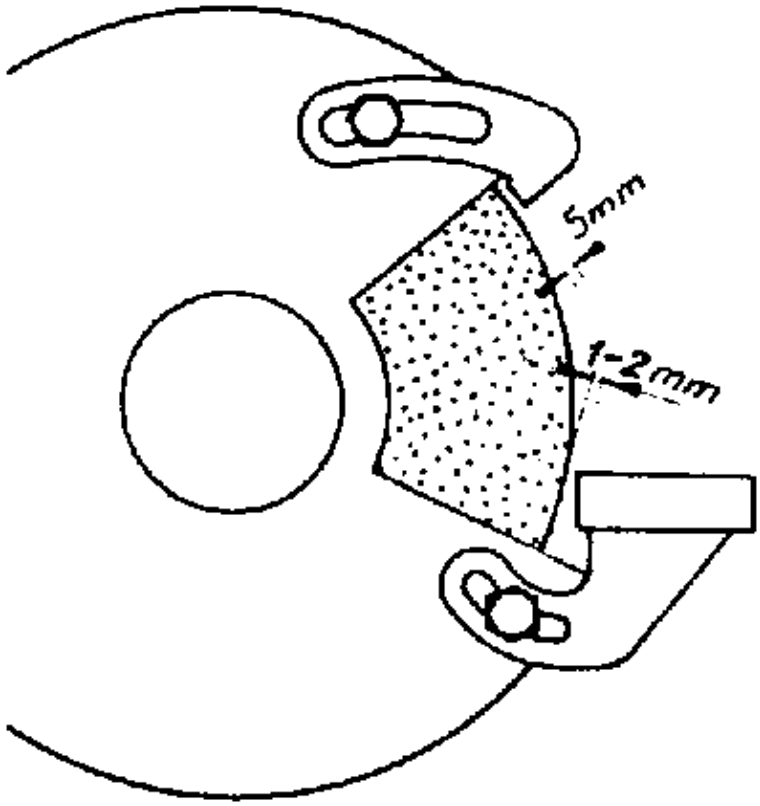

Figure 23 – Distances of grinding support and spark killer according to the requirements of labour safety

– Use grinding wheel only frontally – not laterally.

– Do never grip any tool with a piece of cloth or when you are wearing gloves.

Hammering and Marking – Course: Technique for Manual Working of Materials. Methodical Guide for Instructors

Table of Contents

Hammering and Marking – Course: Technique for Manual Working of Materials. Methodical Guide for Instructors

Institut für berufliche Entwicklung e.V.
Berlin

Original title:
Methodische Anleitung für den Lehrenden
“Hämmern und Kennzeichnen”

Author Frank Wenghöfer

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13187 Berlin

Order No.: 90–32–3103/2

1. Objectives and contents of practical vocational training in the working techniques of “Hammering and Marking”

By concluding their training the trainees shall have a good command of the working techniques of “Hammering and Marking”. Therefore, the following objectives are to be achieved:

Objectives

- Knowledge of the purpose and ranges of application of the hammering and marking techniques.
- Mastery of the various working techniques of hammering and marking.
- Capability of selecting the proper tools and accessories and of their proper use.
- Capability of evaluating the quality of their work.

The following contents have to be imparted to the trainees:

Contents

- Purpose of hammering and marking
- Tools and accessories
- Effect and working techniques of hammering
- Working techniques of marking.

2. Organizational preparation

To guarantee a trouble–free development of instruction, exercises and practical work it is necessary to prepare this training appropriately.

The following steps have to be taken:

2.1. Preparation of instructions on labour safety

Prior to the exercises, a brief instruction in the proper use of working tools and in guaranteeing an accident–free work has to be given.

The main emphasis is to be laid on:

Use of flawless hammers with well–fixed handles only.
Selection of the proper (hard and inflexible) support for hammering.
Use of burr–free punches.
Precautions for preventing fire damage in case of annealing the steel sheets.

Familiarity with these hints is to be confirmed by the trainees' signatures in a control book.

2.2. Provision of teaching aids

For demonstration purposes during instruction, a vice and appropriate hammering supports have to be installed at the place.

The "Trainees' Handbook of Lessons – Hammering and Marking" has to be handed out to the trainees.

When using the transparencies series of "Hammering and Marking", check whether it is complete (transparencies 3.1. – 3.4.) and whether the overhead projector is functional. (Check the operating conditions at the place of use and make sure of the proper mains supply!)

Surveys which are to be written on the blackboard have to be completed prior to instruction.

All the tools and accessories mentioned in section 3 (for hammering and marking operations) should be kept ready for illustration purposes.

2.3. Provision of working tools and materials

The "Instruction Examples for Practical Vocational Training – Hammering and Marking" must be handed out to the trainees in sufficient copies to provide them with the theoretical foundations for the exercises to be performed.

The initial materials necessary for the exercises are to be prepared and laid out in sufficient numbers according to the specifications of the "Instruction Examples...".

Each trainee is to be provided with a workbench that is equipped with a flat hammering support and a firmly installed vice (check whether it has the appropriate working height).

It must be checked that all workbenches are fully equipped with tools and accessories specified for the planned exercises.

Recommended basic equipment:

– steel rule, vernier caliper, protractor

– steel scriber, centre punch, dividers

– hand hacksaw or hand–lever shear

– bastard and smooth files 200 mm (flat)

– locksmith's hammer (engineers' hammer) chasing hammer, curving hammer, wooden hammer

– sledge, bordering tool, marking punch (numbers and letters)

– surface plate or anvil, clamping devices.

2.4. Time schedule

Time planning is recommended for the following training stages:

– introduction to the working techniques by way of instruction
– necessary demonstrations
– job–related instructions for carrying out the exercises

– carrying out the exercises
– recapitulation and tests.

The necessary time share depends on the respective training conditions. Most of the time is to be allocated to the exercises.

3. Recommendations for practical training in the working techniques of "Hammering and Marking"

The following paragraphs comprise proposals on conducting trainee instruction, carrying out demonstrations of working techniques as well as exercises and tests. We recommend two course variants:

Variant No. 1.

This variant should be chosen for trainees with generally good achievements and receptiveness.

1.1. Introductory instruction to the whole subject, accompanied by demonstrations specified in the "Trainees' Handbook of Lessons"

1.2. Exercises in hammering and marking as well as subsequent evaluation as specified in the "Instruction Examples 3.1. –3.7."

1.3. Test of theory knowledge based on the contents of "Examples for Recapitulation and Tests".

Variant No. 2.

This variant should be chosen for trainees with little previous knowledge or poor achievements.

2.1. Introductory instruction for the subjects of "Lengthening (elongating) and curving", accompanied by demonstrations specified in the "Trainees' Handbook of Lessons".

2.2. Exercises in lengthening and curving as specified in the "Instruction Examples 3.1. – 3.4." and subsequent evaluation.

2.3. Supplementary instruction in the subject of "Chasing and flanging (bordering)" as specified in the "Trainees' Handbook of Lessons".

2.4. Exercises in chasing and flanging as well as evaluation, as specified in the "Instruction Example 3.5.".

2.5. Supplementary instruction in the subject of "Marking" as specified in the "Trainees' Handbook of Lessons".

2.6. Exercises in marking, with subsequent evaluation as specified in the "Instruction Examples 3.6. and 3.7.".

2.7. Final test of theory knowledge as specified in the "Examples for Recapitulation and Tests".

The evaluation of practical skills should be done immediately after handing over the finished workpiece to the instructor. Knowledge of theory can be permanently checked, but it is advisable to have a final test paper (item 1.3. or. resp., 2.7.) after concluding the exercise.

3.1. Introductory instruction

If possible, this instruction should be given in a classroom. Make sure that the trainees put down necessary, supplementary hints or answers to questions in their "Trainees' Handbook of Lessons".

Instruction may be conducted on the basis of the main points contained in the “Trainees’ Handbook of Lessons”.

The main subjects of “purpose of hammering and marking” as well as “tools and accessories for hammering” should be accompanied by an intensive employment of all those teaching aids available.

Purpose of hammering and marking

To demonstrate the purpose of these working techniques, it is advisable to show such workpieces which had been formed, straightened or, resp,, marked by figures and letters. The instructor has to point out that this is mainly used in single–piece production. A summary can be given by using the “Trainees’ Handbook of Lessons” as a guideline.

Tools and accessories

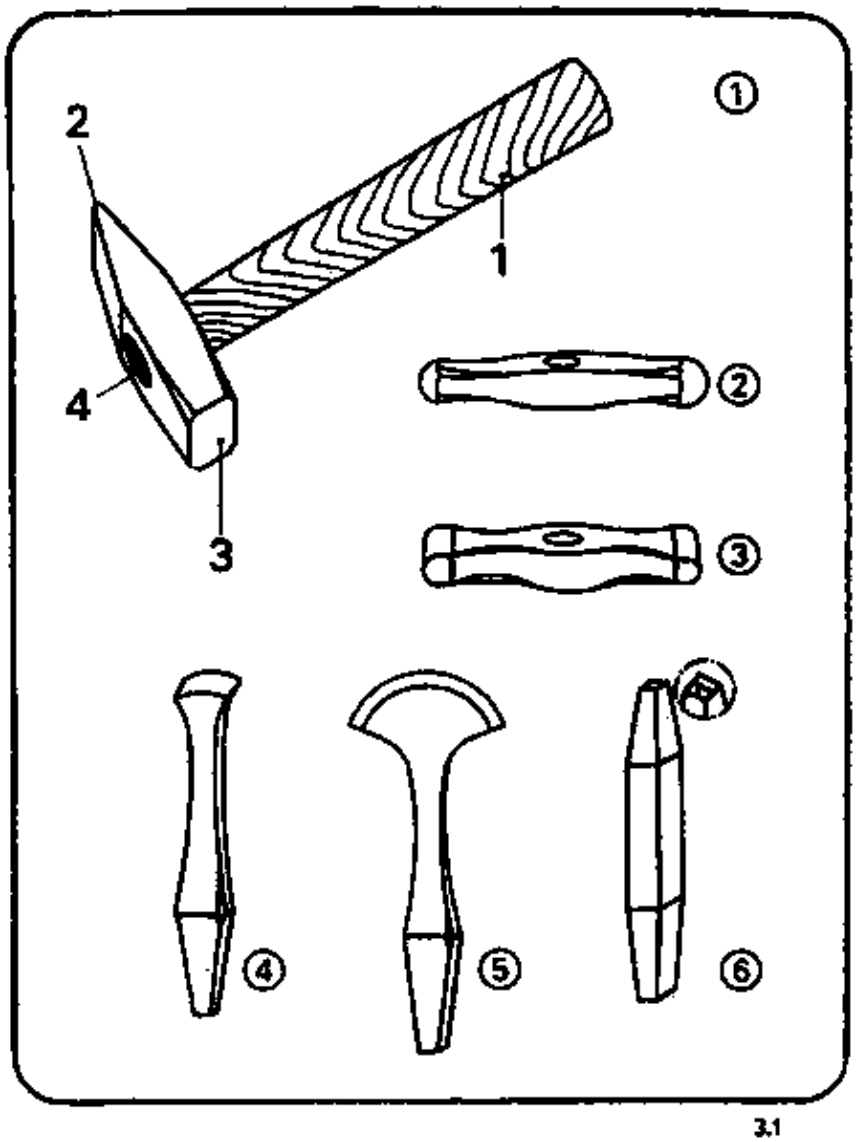
Transparency No. 3.1. can supplement the demonstration of original tools and accessories.

When describing the individual tools and accessories, their intended purpose has to be pointed out.

The following tools have to be shown and introduced:

– locksmith’s hammers
(hand hammer, riveting hammer, bench hammer)

– hammers for sheet metal working
(chasing, curving, finishing and planishing (or smoothing) hammers as well as wooden, rubber and aluminium hammers).



3.1

Following this instruction, the trainees should be in a position to describe the intended purpose of these hammers and to use their correct designations (using size and shape of hammers as distinctive marks).

This is followed by remarks on hammering supports:

– surface plate
– blacksmith's anvil
–special supports for sheet metal working (anvil tool, sledge, blacksmiths' hardy and bordering tool).

The intended purpose of using these supports is to be made quite clear.

The following marking tools should be included in the demonstrations:

– sets of letters (in an alphabetical order)
– sets of numbers
– punches with special numbers or words.

If not all of these tools and accessories are available as originals, the illustrations contained in the "Trainees' Handbook of Lessons" may be employed.

Effect of Hammering

The effects of hammering should be demonstrated by some examples A narrow strip of sheet metal should be worked with the face of a hammer and with the pane of a hammer. Thus, the trainees will learn that the

processes of lengthening and upsetting will be influenced by the form of the hitting area of the tool as well as by the form of the hammering support.

The trainee has to learn the technique of hardening the material by cold working, i.e. by many blows of the hammer. Annealing and the various types of cooling down depending on the kind of material should be mentioned in these instructions. The trainees should be shown how to position the hammer when performing the blows. It is recommended that each trainee does some blows with a hammer, so that mistakes can be corrected immediately.

Following this, the trainees should answer the questions contained in the "Trainees' Handbook of Lessons" in writing.

Working techniques of hammering

The various working techniques should be taught in the following order:

Lengthening

The trainees can be shown the hammering technique of using the face or pane of a hammer once again.

The trainees will understand that blows with the pane will lengthen the material, whereas the face will lengthen and widen the material.

Transparency No. 3.2. can illustrate this process.

Curving

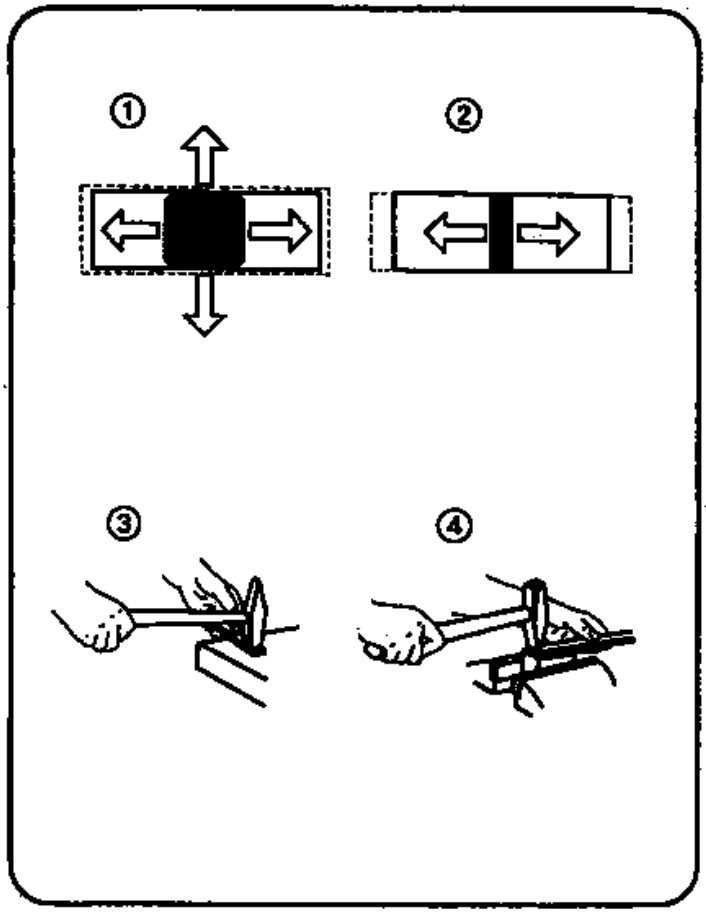
The trainees have to be shown the use of the pane of a locksmith's hammer or the faces of a curving hammer.

When demonstrating this working technique, emphasis is to be laid on evenly distributed hammer blows – the strip of sheet metal must show an arch–like curvature.

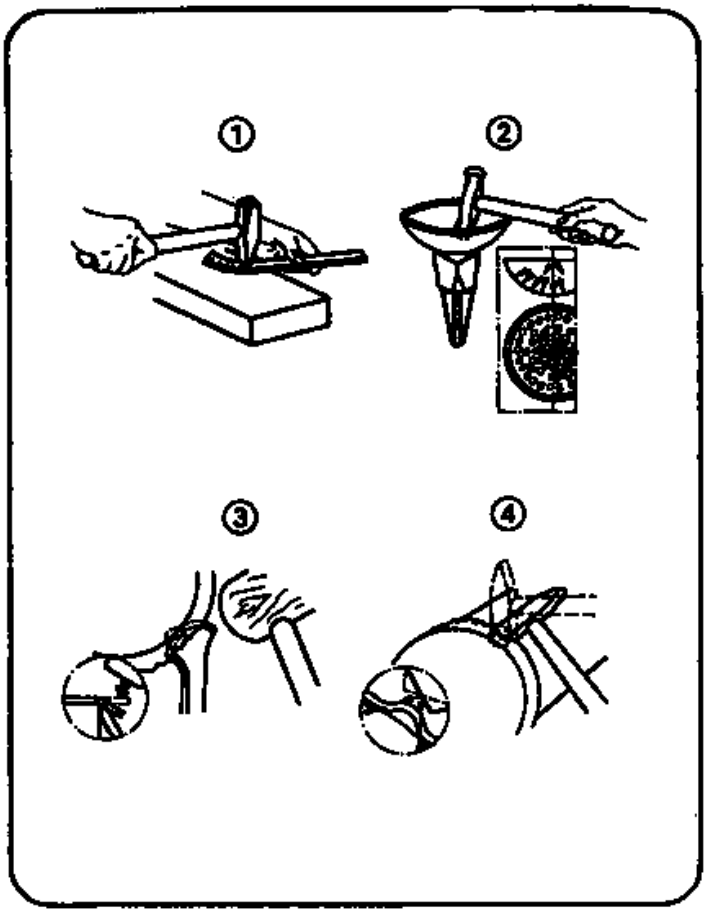
Transparency No. 3.3. will help to make this and the following working techniques clear.

Chasing

Two possible variants have to be demonstrated.



3.2



3.3

Variant No. 1

When using the face of a chasing hammer on a flat support, the instructor has to show that the hammer blows begin at the centre of the workpiece and then follow a spiral–like pattern to the outside of the workpiece.

Variant No. 2

When chasing with a rounded wooden hammer or chasing hammer on a hollow support, the instructor has to show that the hammer blows begin at the outside and advance to the centre in a spiral–like pattern.

This is followed by referring to the process of hardening by cold working again. The trainees have to learn that cracks will occur in the sheet metal, if this fact is neglected. Later on the trainees are shown the appropriate forms of annealing and cooling down in a workshop.

Flanging

The various techniques of outside and inside flanging can be explained in combination with the figures in the "Trainees' Handbook of Lessons".

It should be emphasised that this working technique is divided into two stages: rough–flanging and finish–flanging.

The use of various types of hammers (locksmith's hammer, bevelled wooden hammer, chasing hammer, curving hammer) has to be mentioned at the appropriate place.

Working technique of marking

When imparting the knowledge of placing and blowing the marking punch to the trainees, they have to be informed on the necessary preparation by appropriately scribed lines.

The interdependence of height of letters and space between the lines should be demonstrated briefly. This demonstration can refer to the following table and its recommended values:

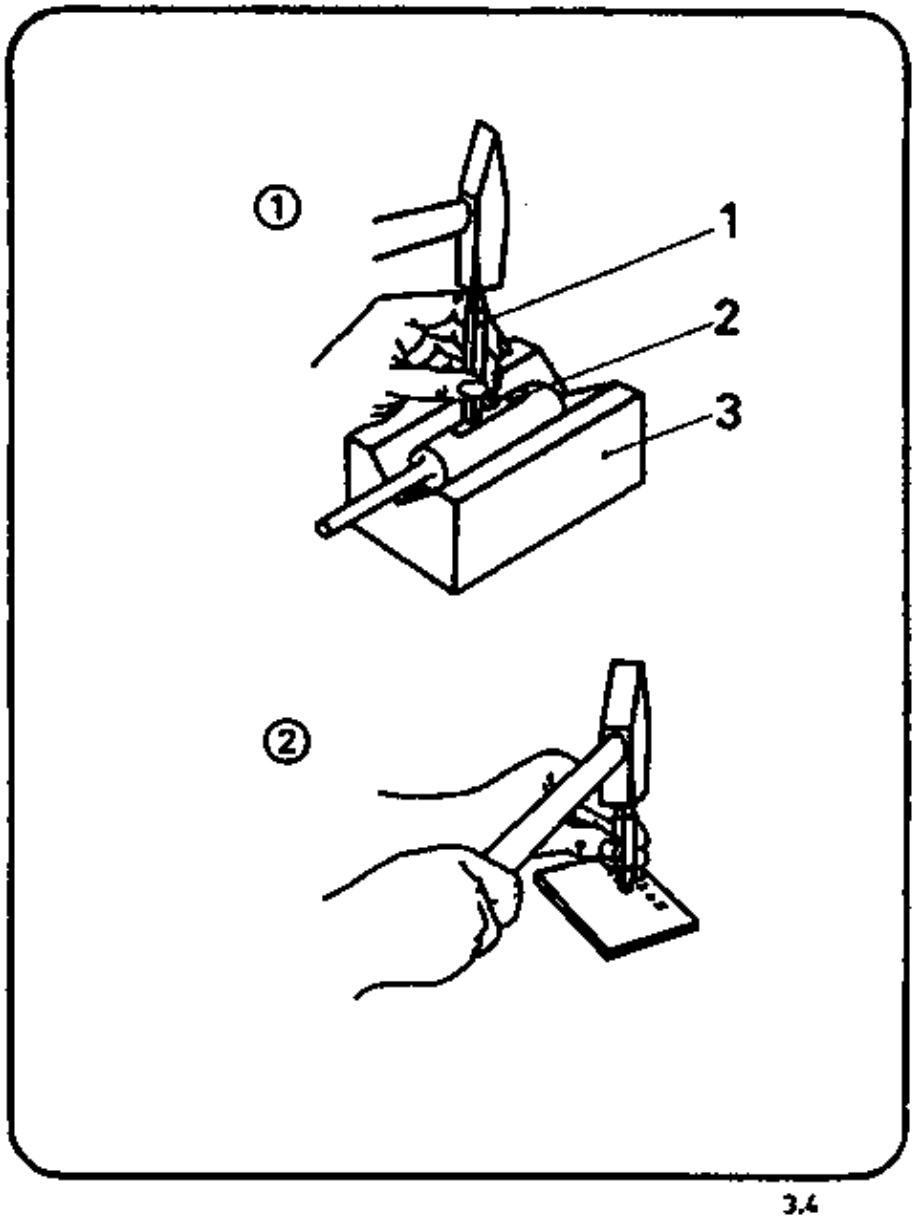
space between the lines	height of figures or letters
3	2.5
5	4
8	6
10	8
12	10

A small piece of sheet metal may serve to demonstrate the working technique of scribing using a marking gauge. The following hints should be included in the instruction on marking punches:

- The head of the punch must be burr–free.
- The engraving of a figure or letter must be perfect.
- The marking punch must not be crooked.

The trainees have to learn that marking operations require a high degree of concentration. This makes it necessary for the order of figures and letters during the marking operation to be permanently monitored.

Transparency No. 3.4. can be used to further illustrate this fact.



3.2. Exercises

If it was not possible to include demonstrations in the instruction, this must be done prior to the start of the exercises. If the trainees avail of only little practical skills, they should perform preliminary exercises on any small–size workpieces:

- minor exercises in lengthening sheet metal strips
- curving of a simple arch
- marking a combination of figures.

However, it is also possible to begin with the first exercise specified in the "Instruction Examples for Practical Training", at once.

However, it will be necessary, to prepare each exercise by a brief "job–related instruction", in which the trainees are shown a finished workpiece in order to make the purpose and intention of the exercises quite clear.

> The instructor must have finished such a workpiece by himself, so that he knows the problems involved in producing such a workpiece.

This makes it possible to identify the main points in evaluating the trainees' work and to inform them about difficult areas on the workpiece. During this special instruction, the sequences of operations and working drawings should be on the desks so that the trainees can make notes therein. All the trainees can carry out

the exercises simultaneously, if the appropriate number of working tools is available. If this is not possible, the trainees will be divided into groups according to the various categories of work and number of the tools available.

Trainees who cannot start with hammering and marking operations should perform some other activities in the workshop: selection and preparation of initial materials, checking and minor repair work on working tools under the supervision of the instructor. It is also possible to carry out exercises which consolidate the skills and knowledge of previously learned working techniques.

3.3. Examples for recapitulation and tests

This section comprises questions which should help to consolidate and test the acquired knowledge and skills. Each question is provided with the respective answer. Questions which are also contained in the "Trainees' Handbook of Lessons" are marked with the letter "A".

1. What is the purpose of hammering?
(Working of sheet and sectional metal by carefully directed blows of a hammer for forming, straightening, strengthening or hardening the workpieces.)

2. What is the purpose of marking?
(Punching of figures and letters into the surfaces of workpieces in order to distinguish them from each other or to indicate the order of assembling or to mark necessary manufacturing data in a long–lasting manner.)

3. How do the design types of locksmith's hammer and hammers for sheet metal working differ?
"A" (Locksmith's hammers differ from one another by their weight and size, but their heads show a uniform shape. Hammers for sheet metal working have, apart from differing weights, a differing form of faces and they have no panes.)

4. What are the required properties of hammering supports?
"A" (Rigid, inflexible, possibly hardened – smooth surface.)

5. Which hammering supports are meeting the general requirements of hammering?
"A" (Surface plate, blacksmith's anvil.)

6. Which hammering supports meet the special requirements of sheet metal working?
(Anvil tool, sledge, blacksmiths' hardy and bordering tool.)

7. What types of marking punches are generally used?
"A" (Letter punches and figure punches.)

8. What is the typical effect of hammering?
"A" (The impact of the hitting hammer head upsets the material which has to give way laterally. The hammering support prevents a displacement into the direction of the blow.)

9. What property must materials have that shall be hammered?
"A" (They must be ductile.)

10. What is the effect of many hammer blows on a single spot of a workpiece?
"A" (The material consolidates and gets hard and brittle.)

11. How can this effect be reduced or eliminated?
"A" (Annealing or cooling down.)

12. Which difference do we have to consider in working steel sheets and in working copper sheets with this technique?
(Steel sheets have to be cooled down slowly, copper sheets have to be cooled down fast.)

13. What makes the difference in lengthening and curving of a metal strip?
"A" (Lengthening will elongate the metal strip in a straight line or widen it at the same time; curving wilt lengthen the metal strip unilaterally and bend it arch–like on the plane.)

14. How must the blows be directed when lengthening and curving?
“A” (Short, successive blows from front to rear or from rear to front.)

15. Which variants of blows are possible in chasing sheet metal?

(Variant 1: The blows of the hammer will be performed spirally on a flat hammering support – beginning inside and ending outside.

Variant 2: The blows of the hammer will be performed spirally on a hollow hammering support – beginning outside and ending inside.)

16. What are the working steps of flanging borders of sheet metal?
“A” (Rough–flanging – bending down of the border of the metal sheet
finish–flanging – bulging–in of the wrinkles and smoothing of the border.)

17. Which hammering supports should be used when flanging lids or covering caps of containers?
(The container to be covered should serve as a hammering support.)

18. How must we scribe the lines necessary for marking combinations of figures or letters?
(With pencil or brass scriber – the spacing must slightly exceed the height of the figures or letters.)

19. What must be done first, if the marking has to be performed on rough or curved surfaces?
(The sections of the surfaces to be marked have to be smoothed or levelled first.)

4. Application of the working techniques of “Hammering and Marking”

The sequence of exercises can focus on one topic each according to the variant mentioned in section 3 or it may be divided into several stages.

The “Instruction Examples for Practical Vocational Training –Hammering and Marking” provide 7 exercises whose degree of difficulty increases gradually.

These “Instruction Examples...” comprise a list of required materials (initial material, hand tools, measuring and testing tools, accessories), as well as the sequence of operations for producing the workpiece. An illustrative working drawing is also contained in these “Instruction Examples...”.

Thus, the trainees avail of the required information to do their exercises in an objective–related way.

If the progress of work during the exercises shows that the achieved quality standards of the workpieces is not sufficient, the trainees must carry out comprehensive preliminary exercises. In this case it is possible to use any appropriate waste components. If the skill has been practised sufficiently, the workpiece mentioned in the “Instruction Examples...” can be manufactured. Please, take the following hint into consideration:

> From the very beginning (i. e. cutting to size) until finishing the workpiece, the trainee has to do all the associated work by himself. This is the only way to guarantee a just evaluation of his achievement.

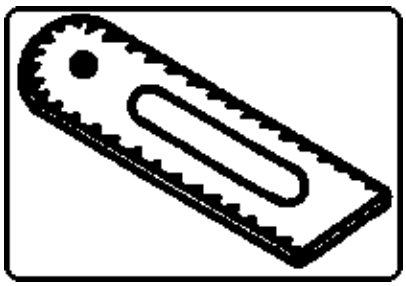
If the “Instruction Examples...” offered in this material should not be used for exercise purposes, it will be possible to work on other workpieces. However, you have to see to it that all the previous working techniques will be practised with that exercise.

4.1. Instruction Examples

To give a survey of the workpieces on which the previous knowledge shall be practised, the individual instruction examples are described in brief here:

Instruction Example 3.1.
Nameplate

A narrow strip of sheet steel is lengthened with the pane of a hammer so that it becomes 10 mm longer.

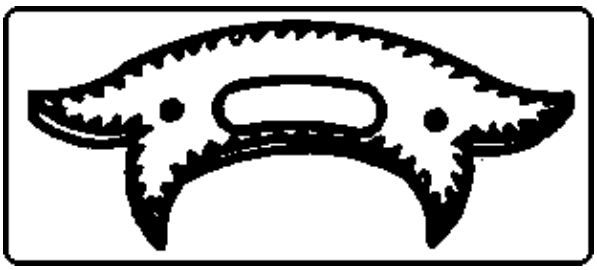


The section of the surface is smoothed with a hammer and sledge and then the trainee's name is marked on it.

This plate may be fixed to the finished workpieces so that it is easier to identify them.

Instruction Example 3.2.
Number Plate for Locker

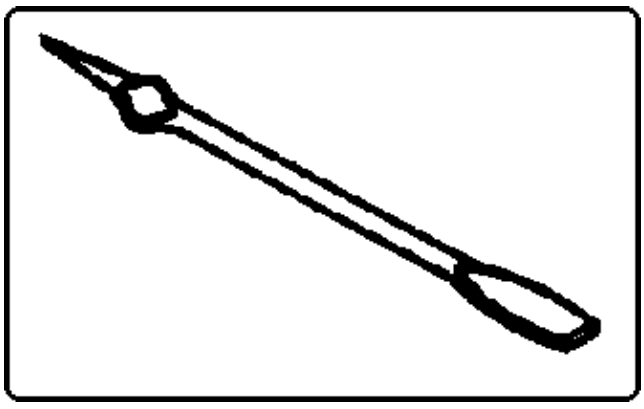
A narrow strip of sheet steel is curved with the pane of a hammer according to specified dimensions.



After smoothing a section of the surface and marking it with a figure it can be used as a numberplate for tool cabinets and wardrobes.

Instruction Example 3.3.
Screw driver

The face of a hammer is used to flatten round bar steel so that a screw driver blade and a handle extension will be produced. This workpiece can be finished by filing or grinding it according to Instruction Example 12.3.



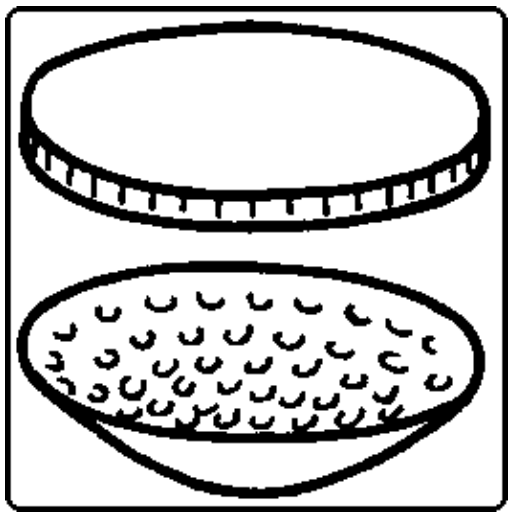
Instruction Example 3.4.
Copper Bit of a Soldering Iron

Round bar copper material is flattened with the face of the hammer and then work–hardened.

After its completion this workpiece can be used in the workshop.

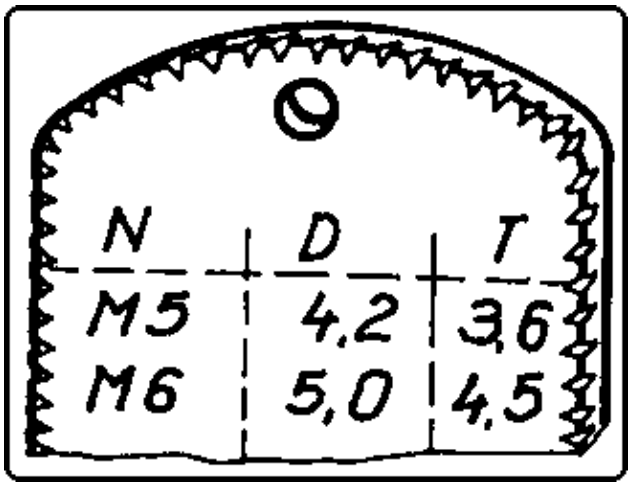
Instruction Example 3.5.
Bowl with Cover

Placed upon a hollow hammering support (steel tube), thin copper sheets are chased to form a bowl; a second sheet will be flanged so that it forms a cover matching the bowl.



Instruction Example 3.6.
Table to Determine Tapping Drill
Holes and Bore Depths

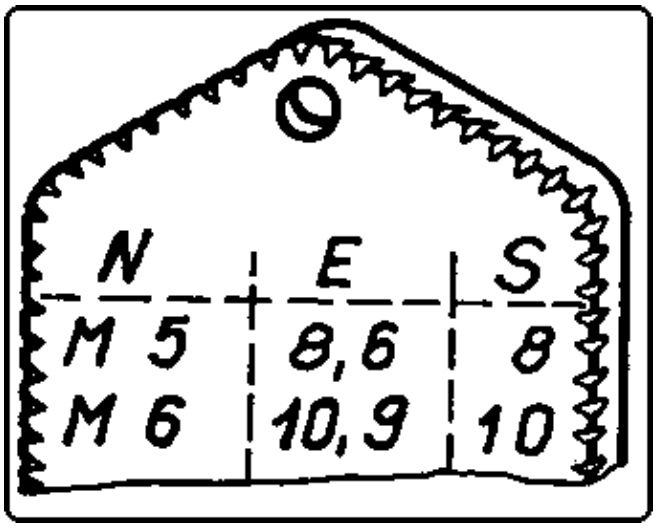
A table is punch–marked into a small–size steel sheet. When applying the working technique of “Thread Cutting” it will serve as a means to determine the required values.



Such a table is very handy and can be added to the personal tools of the trainee.

Instruction Example 3.7.
Table to Determine Widths across
Flats and Widths across Corners of
Hexagon–Head Screws and Nuts

A table will be punch–marked into a small–size steel sheet. In the assembly of screwed connections these values are required. They serve to select the proper open–ended spanners for the hexagon–head screws and nuts. This table is handy and can be added to the personal tools of the trainee.



4.2. Criteria for Practical Training

It is recommended to determine some major points of observation and evaluation when the work is being carried out. The following criteria may serve as a guideline:

Lengthening

Is the sequence of blows of the hammer uniform and narrowly spaced from one side to the other or does the trainee strike here and there at random?

Does the metal sheet stay straight during lengthening or does it curve?

Curving

Is the curvature of the sheet even or are there waves?

Chasing

Do the blows of the hammer comply with the respective variant (according to the hammering support)?

Does the trainee take cold–hardening into consideration and are there the proper intervals for cooling down the sheet?

Are there any cracks resulting from chasing?

Is it an even curvature or are there any buckles?

Flanging

Does the trainee observe the two working stages of rough–flanging and finish–flanging?

Does the trainee employ the appropriate types of hammers?

Is it an even flanging or are there any waves and irregularities?

Marking

Are the lines scribed with proper spacings?

Is the position of figures or letters even and upright?

Is there an even depth of punching?

Can the figures or letters be clearly identified or are there any double punchings?

5. Captions and legends of the "Hammering and Marking" transparency series

Transparency No. 3.1. Selected Tools for Hammering and Marking

(1) Locksmith's hammer

1 wooden handle
2 pane
3 face
4 wedge

(2) chasing hammer
(3) curving hammer
(4) bordering tool (flanging tool)
(5) blacksmiths' hardy
(6) marking punch

Transparency No. 3.2. Flattening (widening) and Lengthening
with Locksmith's Hammers

(1) Effect of hammer face
(2) effect of hammer pane
(3) flattening and lengthening with hammer face
(4) lengthening with hammer pane

Transparency No. 3.3. Curving, Chasing, Flanging

(1) curving with pane of locksmith's hammer
(2) chasing of a bowl with chasing hammer
(3) flanging of metal sheet border with blacksmiths' hardy and wooden hammer
(4) bulging–in of wrinkles with locksmith's hammer

Transparency No. 3.4. Marking with marking punches

(1) marking on curved surfaces

1 marking punch
2 filed area
3 vee support

(2) marking of combinations of figures –at right angles to the line of sight.

Hammering and Marking – Course: Technique for Manual Working of Materials. Instruction Examples for Practical Vocational Training

Table of Contents

Hammering and Marking – Course: Technique for Manual Working of Materials. Instruction Examples for Practical Vocational Training

Institut für berufliche Entwicklung e.V.
Berlin

Original title:
Lehrbeispiele für die berufspraktische Ausbildung
“Hämmern und Kennzeichnen”

Author: B. Zierenberg

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

Order No.: 90–33–3103/2

Introduction

The present material contains 7 selected instruction examples which are intended to help practising and consolidating knowledge and skills acquired in the working techniques “hammering and marking” with increasing level of difficulties in the working techniques of lengthening, widening, curving, chasing, flanging and marking.

In order to facilitate the preparation and execution of the work, the necessary materials, measuring and testing tools, hand tools, and accessories are stated for each training example.

Moreover, knowledge, required in addition to knowledge of hammering and marking is mentioned.

The sequence of operations given for each instruction example includes the necessary steps for the production of the workpiece.

For each instruction example a working drawing is attached showing the required shapes and dimensions of the workpiece.

The workpieces produced may be used by the trainees for personal purposes or in the workshop or production shop: the nameplate may be used by the trainee for identification of its personal tools or training pieces, the tables as an aid to determine values needed for the preparation of screwed joints, while the locker number plate, the soldering iron bit, the screw driver and the bowl may be used in the workshop.

Explanation to the specification of material:

The steel is specified according to the value of its tensile strength in the unit “Megapascal” (MPa).

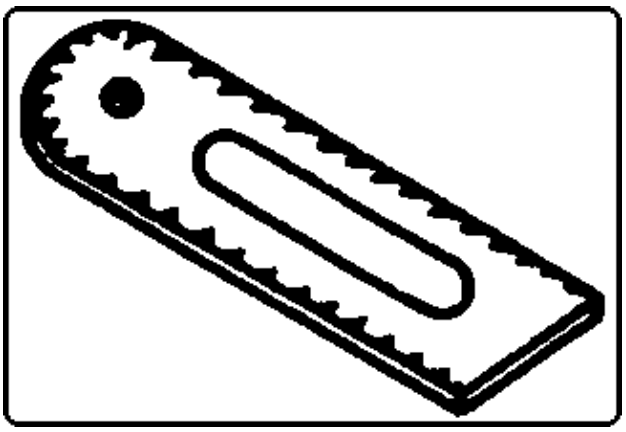
Instruction example 3.1. Nameplate

To practise lengthening of sheet steel by hammer blows with the hammer pane, flattening of a surface section by a sledge and simple marking.

<u>Material</u>

General–purpose constructional steel sheet strip (340 MPa)
Thickness: 2 mm
Width: 15 mm

Length: 80 mm



Hand tools

Hand hacksaw or lever shear, engineers' hammer (500 g) scriber, centre punch, 4 mm dia. drill, bastard file 200 mm (flat), sledge, marking punch (letters).

Measuring and testing tools

Steel measuring tool

Accessories

Surface plate, vice, flat nose plier or pin vice

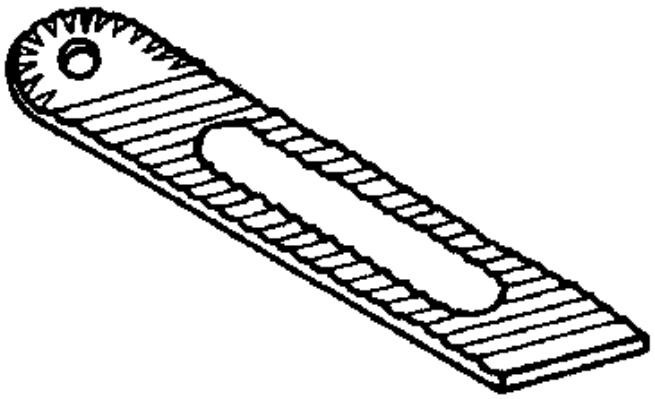
Required previous knowledge

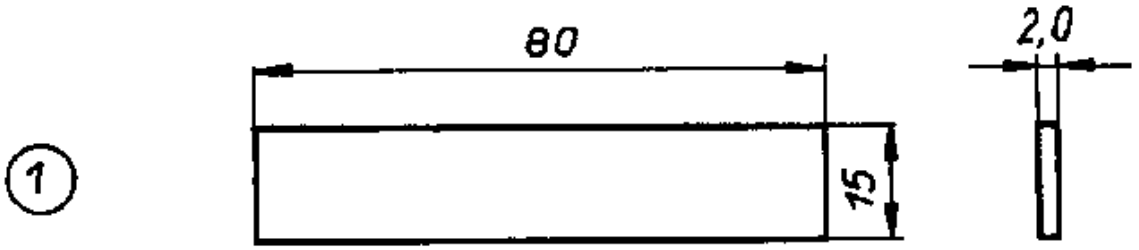
Reading of drawings, measuring and testing, marking and punch–marking.

Sequence of operations	**Comments**
1. Arrange the working place, prepare the working materials.	– Check for completeness.
2. Check for initial dimensions, otherwise scribe and cut the sheet strip to size, scribe the 12 mm size	–Stage (1) Use the hand hacksaw or lever shear.
3. Check for initial length, grip the scribed end by means of flat nose plier or pin vice and hammer with the hammer pane steadily towards the other end.	– Stage (2) Use vice anvil or surface plate as support.
4. Straighten the sheet strip, check for size; if necessary, repeat operation 3.	
5. Scribe the area for the name according to the number of letters and flatten it by means of hammer and sledge.	– Stage (3) Clamp the sheet strip adequately!
6. Punch the name.	– Further markings may be applied at the rear side of the sheet.
7. Final inspection.	– Dimensions, appearance.

Completion

Produce the bore hole and radius according to the size specified under supervision of the instructor, hammer all edges with gentle hammer blows (of the pane) obliquely.





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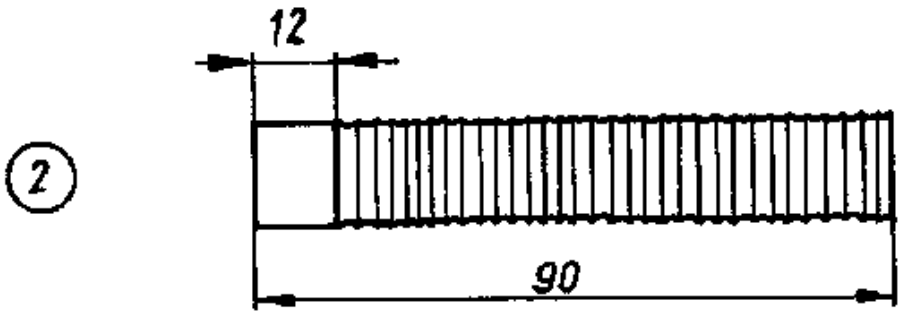

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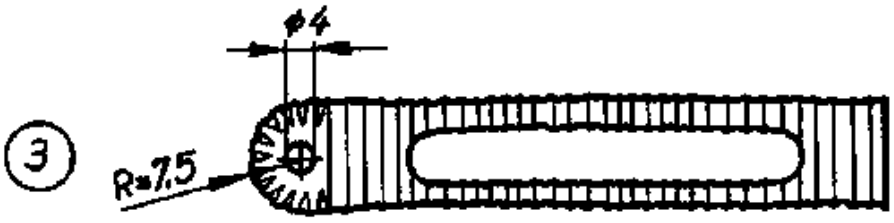


3

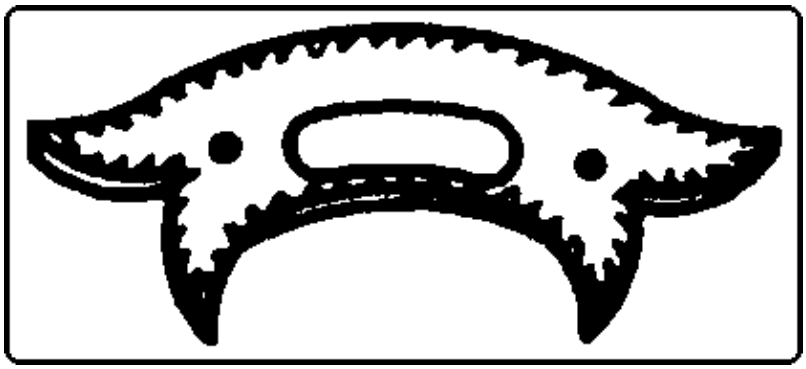
				3.1.
	Nameplate			3103

Instruction example 3.2. Number Plate for Locker

To practise curving of sheet steel by hammer blows with the pane according to the size specified, flattening of a surface section by a sledge and simple marking.

Material

General–purpose constructional
Steel sheet strip (340 MPa)
Thickness: 2 mm
Width: 20 mm
Length: 80 mm



Hand tools

Hand hacksaw or lever shear, engineers' hammer (500 g) or curving hammer, scriber, centre punch, 2 mm dia. drill, sledge, marking punch (figures).

Measuring and testing tools

Steel measuring tool, radius gauge (65 mm)

Accessories

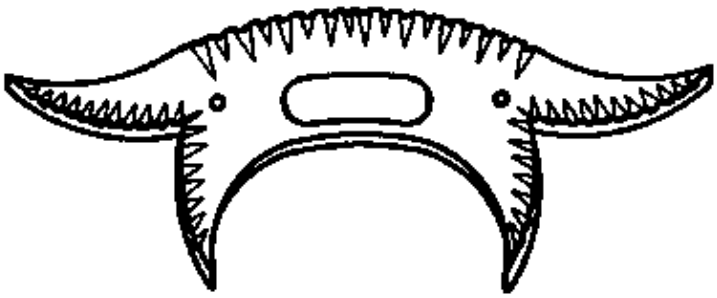
Surface plate, vice, flat nose plier or pin vice

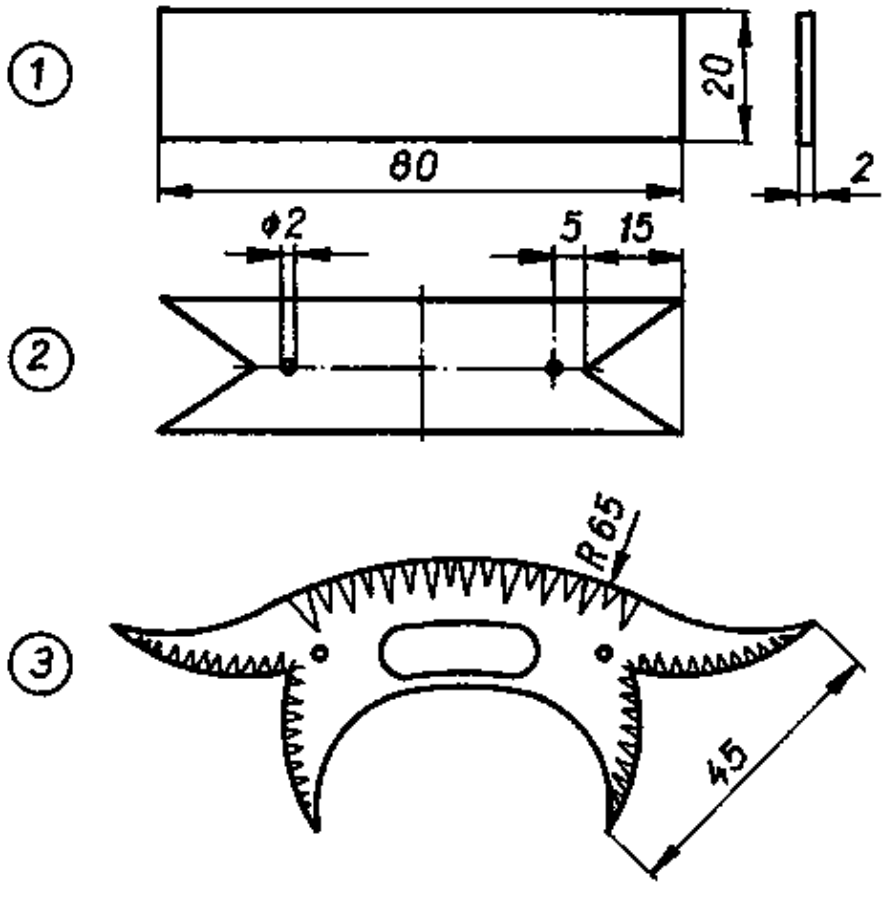
Necessary additional knowledge

Reading of drawings, measuring and testing, marking and punch–marking

Sequence of operations	**Comments**
1. Arrange the working place, prepare the working tools.	– Check for completeness.
2. Check for initial dimensions, otherwise cut the sheet strip to size according to size specified and scribe the notches.	– Stage (1) Use hand hacksaw or lever shear.
3. Saw out the notches of 15 mm length at both ends, scribe the bore holes, prick–punch and drill the holes of 2 mm dia.	– Stage (2) Drill under supervision of the instructor.

4. Grip the sheet strip at one end by means of flat nose plier or pin vice and hammer with the hammer pane from the centre of the sheet strip outward, then straighten the sheet strip.	– Stage (3) Work on upper edge only (as per drawing)!
5. Check radius 65 for size, if necessary repeat operation 4.	– Use the radius gauge.
6. Curve the inner edges of the notches at both ends of the sheet strip by hammer blows with the hammer pane as per drawing until the corner–to–corner size of 45 mm is reached.	
7. Flatten the area for the number according to the number of figures by means of hammer and sledge.	
8. Mark the number by means of marking punch.	
9. Final inspection.	– Dimensions, appearance, quality of the number.





				3.2.
	Number Plate for Locker			3103

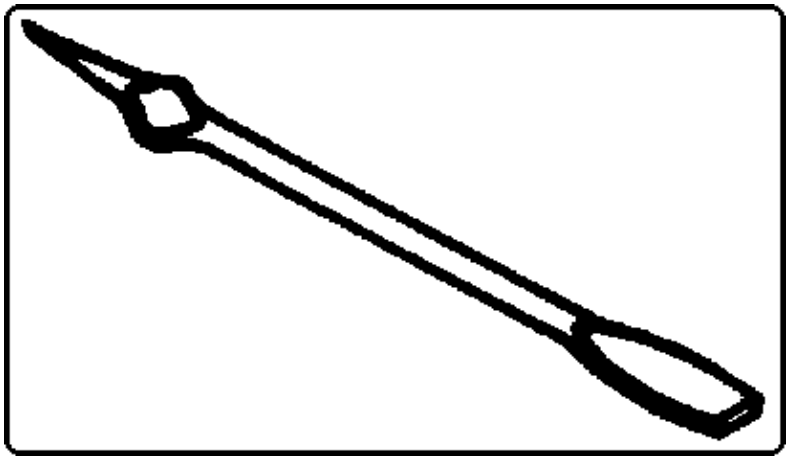
Number Plate for Locker

Instruction example 3.3. Screw Driver

To practise widening of round stock by hammering with the hammer pane.

Material

Round stock of cold work steel
(1 – 1.1 % carbon).
Diameter: 5 mm
Length: optional



Hand tools

Engineers' hammer (500g), smooth–cut file 200 mm (flat), hand hacksaw.

Measuring tools

Steel measuring tool, vernier caliper.

Accessories

Vice or surface plate.

Required previous knowledge

Reading of drawings, measuring and testing, scribing.

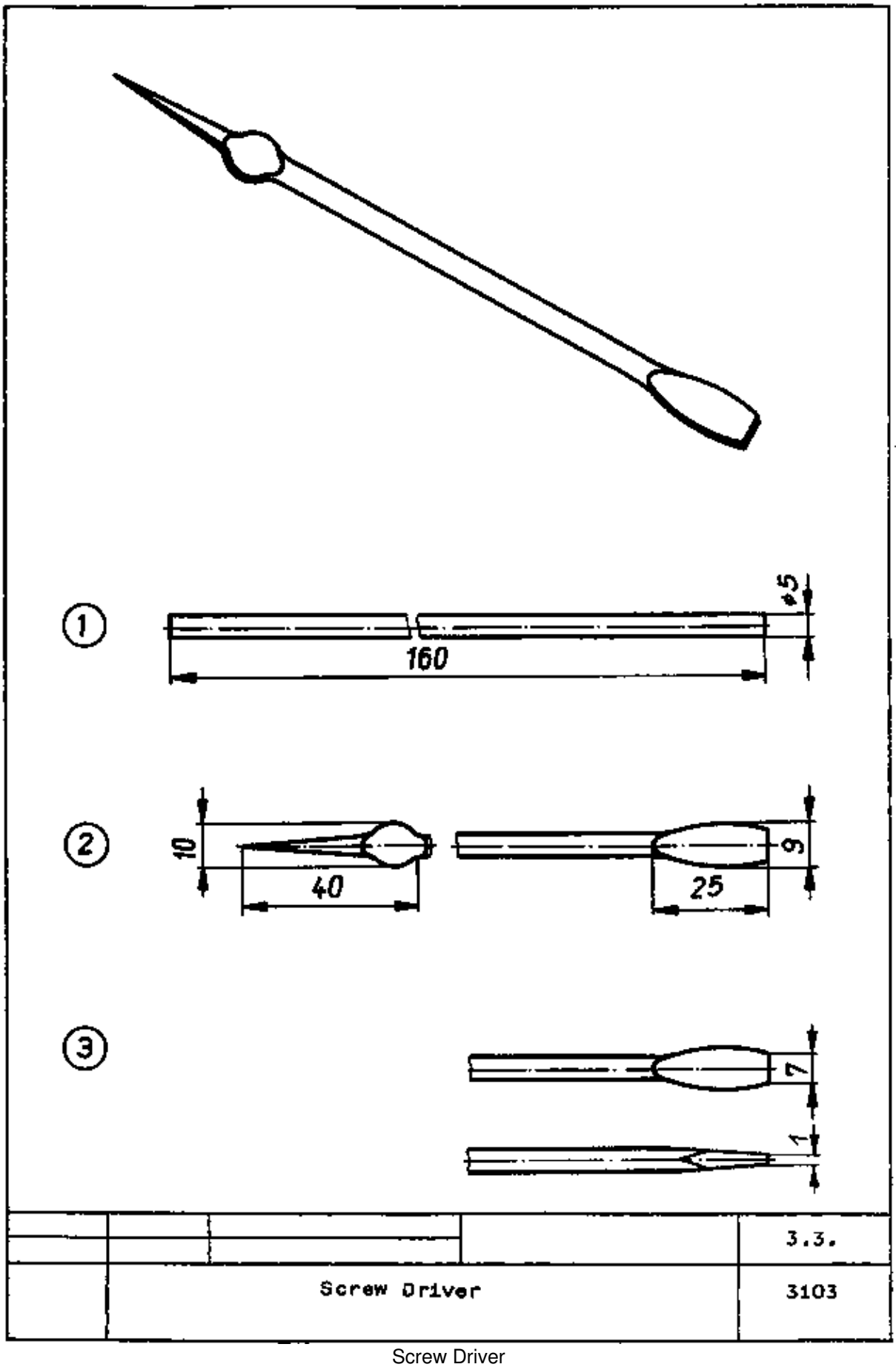
Sequence of operations	**Comments**
1. Arrange the working place, prepare working materials.	Check for completeness.
2. Saw round stock to length.	Stage (1)
3. Hammer both sides of screw driver blade with the hammer pane to the size specified.	Stage (2) Don't hammer notches!
4. Scribe handle end and hammer handle enlargement (other end of round stock) with hammer pane.	Make sure that the face is uniform 1
5. Straighten round stock.	
6. Final inspection.	Dimensions, appearance.

Completion

File the screw driver blade with the smooth–cut file to smooth the faces, file a point to the handle end, harden the blade, fix a handle.

To continue practising, if necessary

Produce other screw drivers of different diameters 8



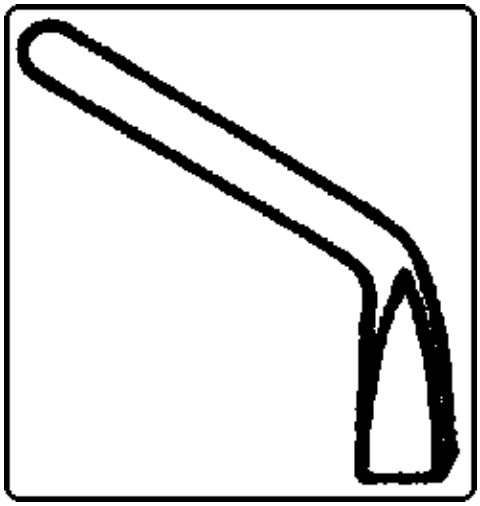
Screw Driver

Instruction example 3.4. Copper Bit of a Soldering Iron

To practise widening of copper by hammering with the hammer pane.

Material

Round stock of copper
8 mm diameter, 120 mm length



Hand tools

Engineers' hammer (500 g), smooth–cut file 200 mm (flat)

Measuring and testing tools

Steel measuring tool, protractor.

Accessories

Surface plate, vice, clamping jaws for round stock.

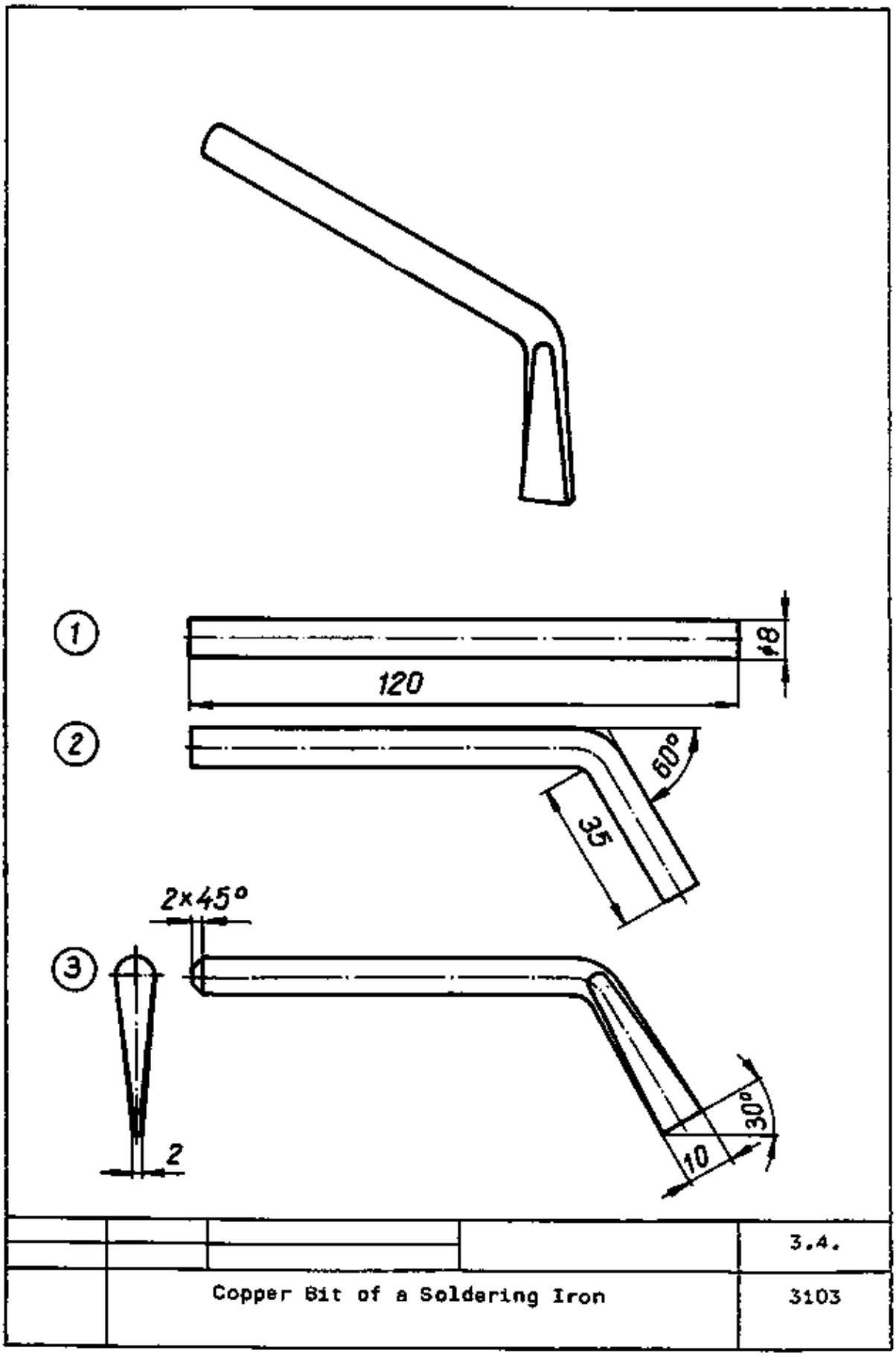
Required previous knowledge

Reading of drawings, measuring and testing, scribing

Sequence of operations	**Comments**
1. Arrange the working place, prepare working materials.	– Check for completeness.
2. Saw round stock to length.	– Stage (1)
3. Hammer to (60 degrees') angle in vice according to size specified.	– Stage (2) Clamp round stock in clamping jaws for round stock.
4. File 2 x 45 degrees in vice.	
5. Hammer both sides of the flanks of the soldering iron bit with the hammer pane.	– Use surface plate or vice anvil as support.
6. Smooth the flanks with the file.	– Stage (3) Make sure that the specified size is maintained.
7. Final inspection.	– Dimensions, appearance.

To continue practising, if necessary:

Produce soldering iron bits of required diameters (depending on the sizes of the soldering irons used in the workshop).



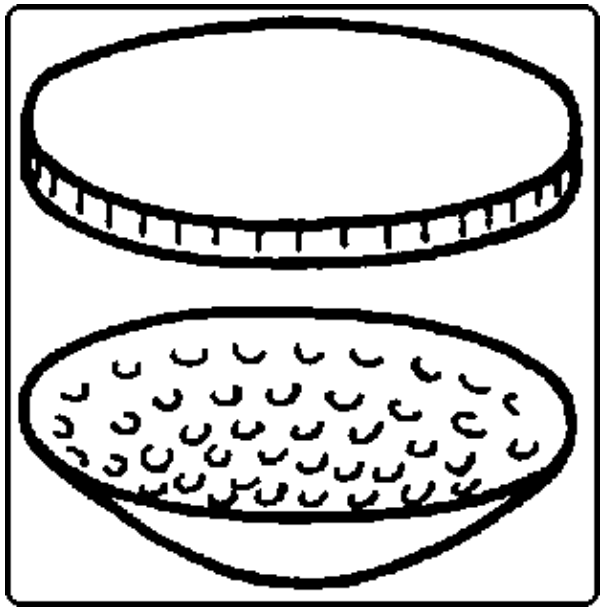
Copper Bit of a Soldering Iron

Instruction example 3.5. Bowl with Cover

To practise chasing and flanging of sheet copper.

Material

2 pcs. of copper sheets
Thickness: 0.8 – 1 mm
Diameter: 50 mm and 55 mm.



Hand tools

Dividers, chasing hammer, engineers' hammer (500 g), lever shear, wooden hammer (radiused).

Measuring and testing tools

Steel measuring tool.

Accessories

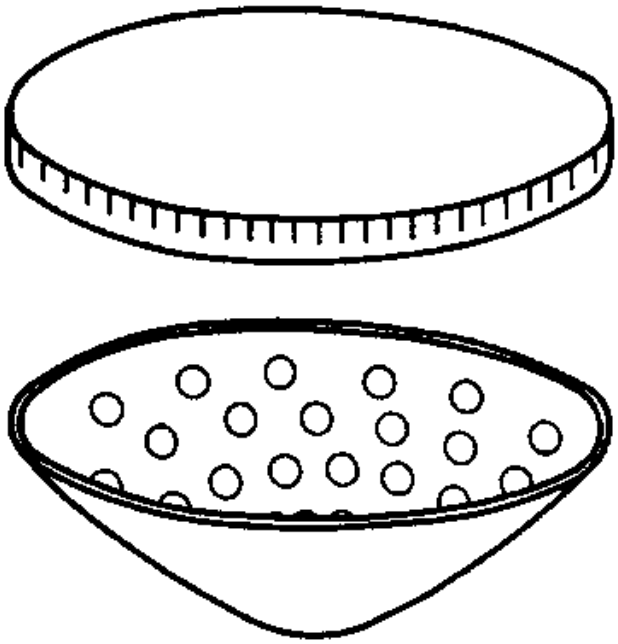
Anvil or surface plate, bordering tool, short piece of steel tube for cover of 80 mm diameter. C clamp, small sand–bag, fire, water.

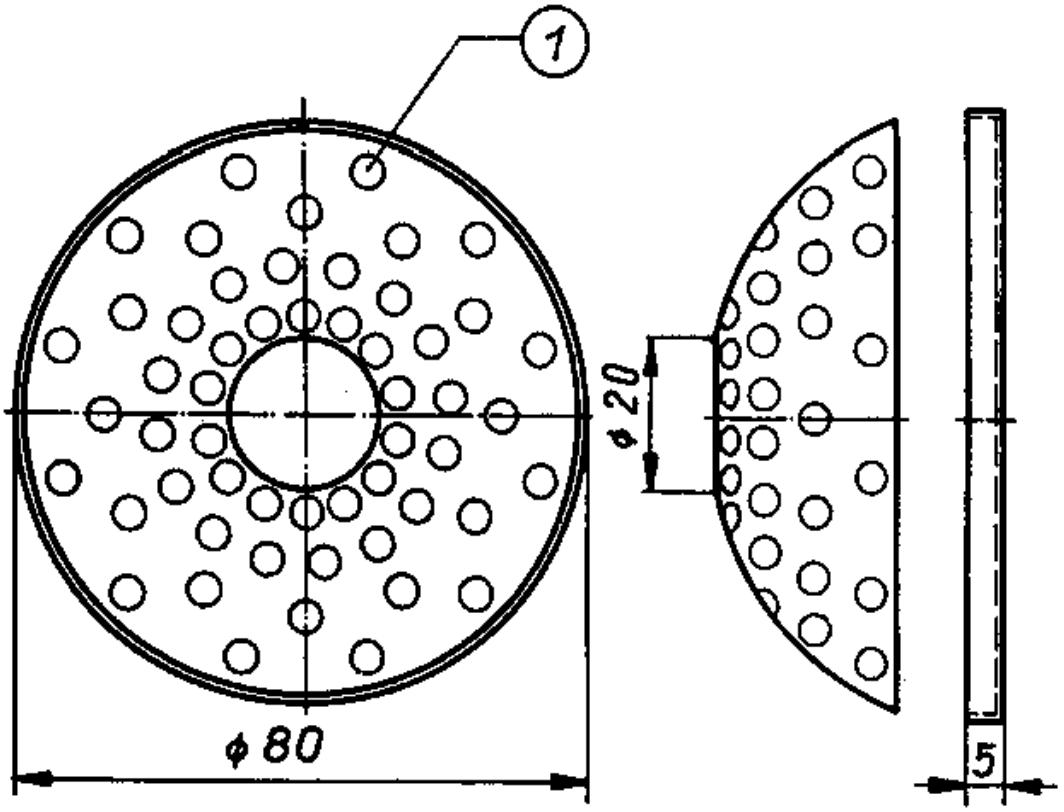
Required previous knowledge

Reading of drawings, measuring and testing, scribing.

Sequence of operations	**Comments**
1. Arrange working place, prepare working tools.	– Check for completeness.
2. Check the diameters, otherwise cut copper sheets to size (initial size) by means of lever shear.	– Scribe with dividers.
3. Hammer steadily with chasing hammer spirally from the centre outward.	– Turn sheet with the anvil! (1) hammer–blow marks
4. Fire–anneal in steps (check for clear, short sound), quench in cold water, then continue hammering until bowl form is reached (size 80).	

5. Produce final form of bowl (if necessary only) by hammering in the sand–bag constantly rotating the bowl.	– Apply gentle hammer blows only! Use wooden hammer (radiused)!
6. Hammer flat face for standing of bowl in opposite direction (size 20)	– Use hammer pane of engineers' hammer.
7. Check second copper sheet for diameter 85, put on steel – tube piece and clamp with C clamp.	– Put centrally on tube piece, scribe checking line dia. 80, if necessary.
8. Bend down (flange) projecting border by means of engineers' hammer and bordering tool or wooden hammer.	
9. Bulge–in and smooth puckers with engineers' hammer.	
10. Final inspection.	– Uniformity of roundness, fitting accuracy of cover.





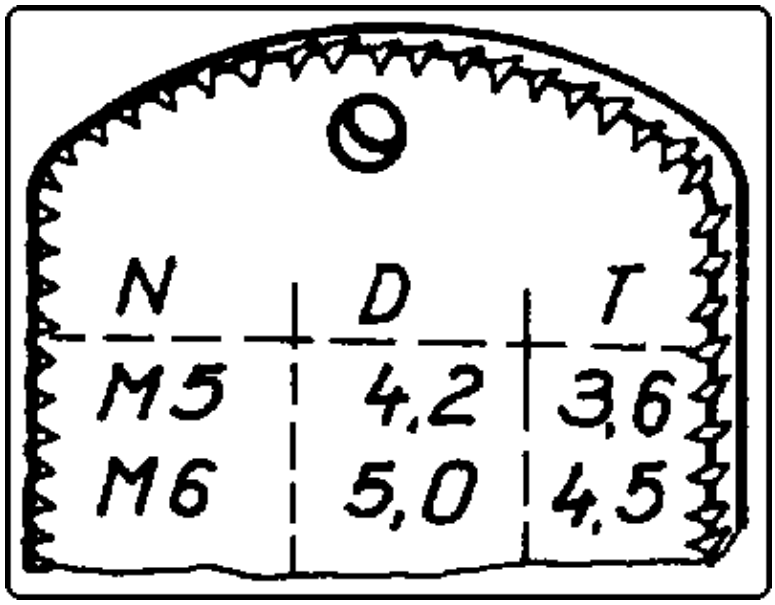
① hammer - blow marks

				3.5.
	Bowl with Cover			3103

Instruction example 3.6. Table to determine Tapping Drill Holes and Bore Depths

Material

General–purpose constructional steel sheet (350 MPa)
Thickness: 2 mm
Width: 50 mm
Length: 80 mm



Hand tools

Hand hacksaw or lever shear, scriber, centre punch, smooth–cut file 200 mm (flat), marking punch (figures and letters), 4.0 mm dia. drill, engineers' hammer (500 g)

Measuring and testing tools

Steel measuring tool, radius gauge 40 mm

Accessories

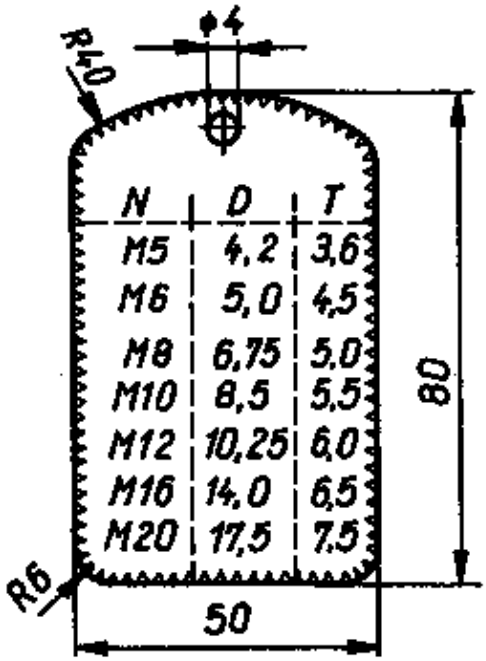
Surface plate

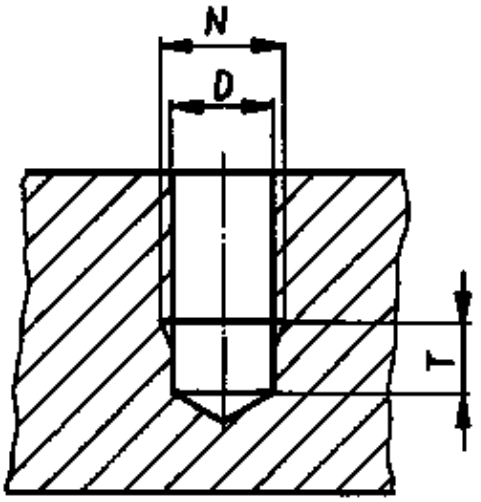
Required previous knowledge

Reading of drawings, measuring and testing, marking and punch–marking.

Sequence of operations	**Comments**
1. Arrange the working place, prepare the working materials.	– Check for completeness.
2. Check for initial dimensions, otherwise cut sheet to size (outside dimensions), scribe and file to size with flat file (including radii).	
3. Scribe the grid lines for guidance of the figure and letter punches.	The auxiliary lines must be in accordance with the height of figures and letters.

4. Punch−mark as specified.	
5. Fine−finish the surface. Hammer all outside edges by gentle oblique blows (with the hammer pane).	
6. Final inspection.	Dimensions, uniformity of table figures.





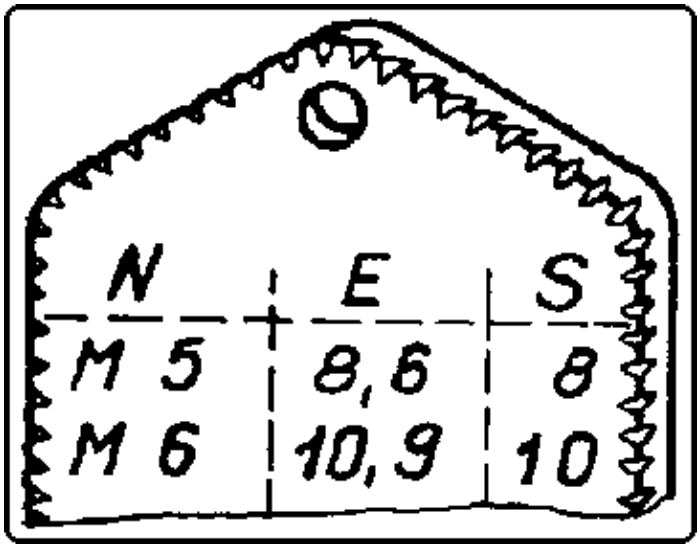
				3.6.
	Table			3103

Table

Instruction example 3.7. Table to determine Widths across Flats and Widths across Corners of Hexagonal–Head Screws

Material

General–purpose constructional steel sheet (380 MPa)
Thickness: 2 mm
Width: 50 mm
Length: 80 mm



Hand tools

Hand hacksaw or lever shear, scriber, centre punch, smooth–cut file 200 mm (flat), marking punch (figures and letters), 4.0 mm dia. drill, engineers' hammer (500 g).

Measuring and testing tools

Steel measuring tool, protractor or angle gauge 60°.

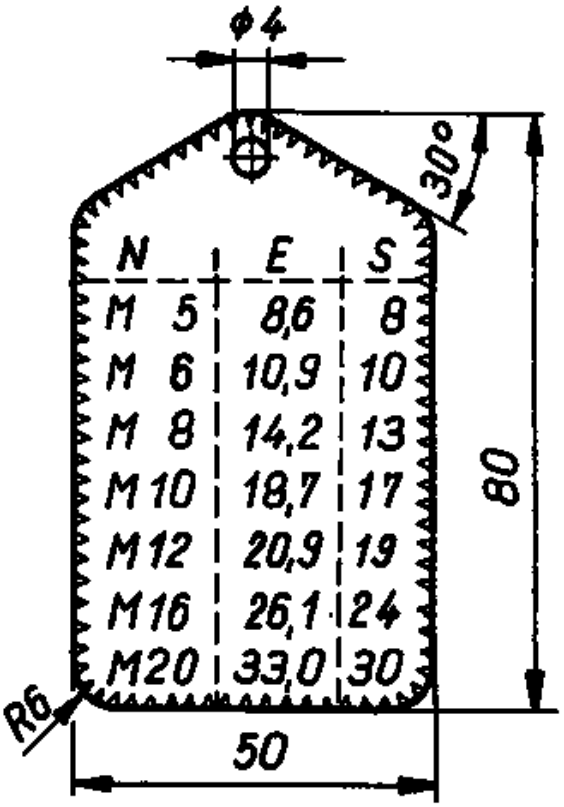
Accessories

Surface plate

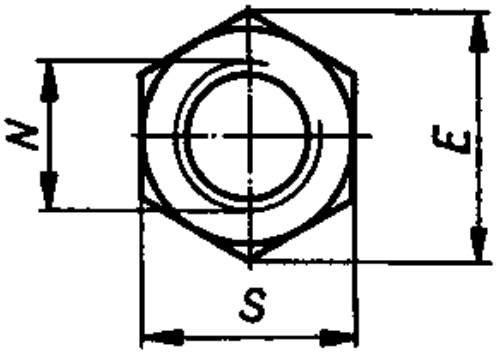
Required previous knowledge

Reading of drawings, measuring and testing, marking and punch–marking

Sequence of operations	**Comments**
1. Arrange the working place, prepare the working materials.	– Check for completeness.
2. Check for initial dimensions otherwise cut sheet to size (outside dimensions), scribe and file to size with flat file (including radii).	
3. Scribe the grid lines for guidance of the figure and letter punches.	– The auxiliary lines must be in accordance with the height of figures and letters.
4. Punch–mark as specified.	
5. Fine–finish the surface. Hammer all outside edges by gentle oblique blows (with the hammer pane).	
6. Final inspection.	– Dimensions, uniformity of table figures.



N	E	S
M 5	8,6	8
M 6	10,9	10
M 8	14,2	13
M 10	18,7	17
M 12	20,9	19
M 16	26,1	24
M 20	33,0	30



				3.7.
	Table			3103

Table

Hammering and Marking – Course: Technique for Manual Working of Materials. Trainees' Handbook of Lessons

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Hammering and Marking – Course: Technique for Manual Working of Materials. Trainees' Handbook of Lessons

Institut für berufliche Entwicklung e.V.
Berlin

Original title:
Arbeitsmaterial für den Lernenden
“Hämmern und Kenzeichnen”

Author Frank Wenghöfer

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

Order No.: 90–35–3103/2

1. Purpose of hammering and marking

Hammering is a technique of forming or straightening workpieces or increasing their strength and hardness by means of well–aimed hammer blows on sheet metal and sections.

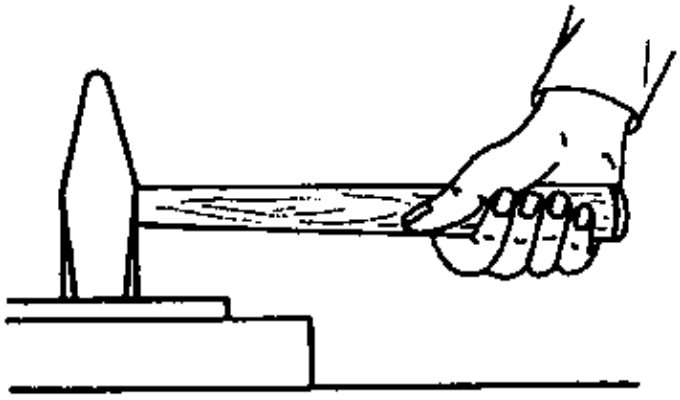

Figure 1 Hammering

It is used in single–piece production only, in special industries and trades or repair work.

Special hammering techniques are: lengthening, curving, chasing, flanging.

Marking is a technique of punching – by means of hammers and special marking punches – letters, figures or texts into the surface of workpieces for the purpose of identifying workpieces, giving sequences for assembly operations or durably noting down dates of manufacture.

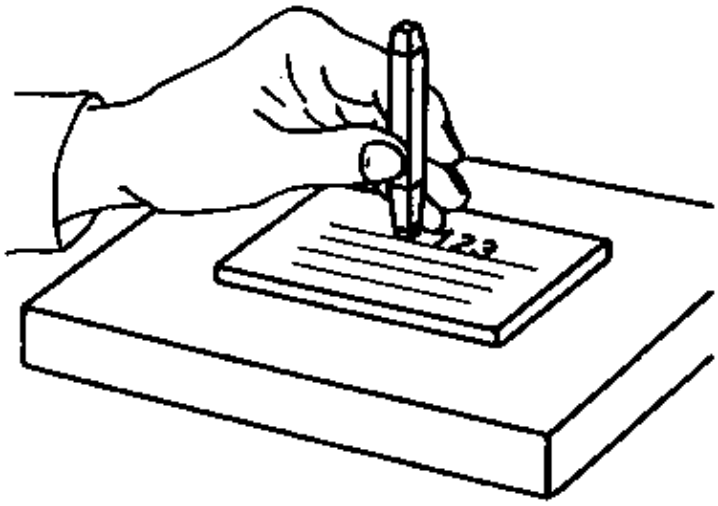

Figure 2 Marking

In modern batch or mass production such operations are performed on special machines by means of pressing, deep–drawing, bending and embossing tools

2. Tools and accessories

Main hammering tool is the hammer of various types.

Engineers' hammer

The hammer head is made of tough tool steel with hardened and ground face (2) and pane (4).

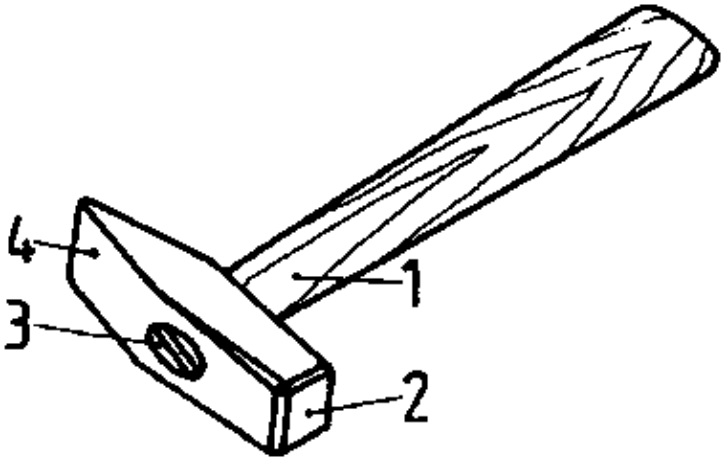

Figure 3 Engineers' hammer

The hammer handle (1) is made of strong and elastic wood and fixed to the hammer head by means of a cotter (3) in oblique position.

Different hammers are used, depending on the size of the workpiece and the purpose of use:

– Riveting hammer (50 g – 200 g),
used for smaller workpieces.

– Hand hammer (200 g – 400 g),
widely used for various fitting purposes.

– Bench hammer (400 g – 2000 g),
used for massive workpieces.

Special hammers for sheet metal working:

– Chasing hammer (250 g – 500 g),
ball face hammer for chasing of thin sheet metal.

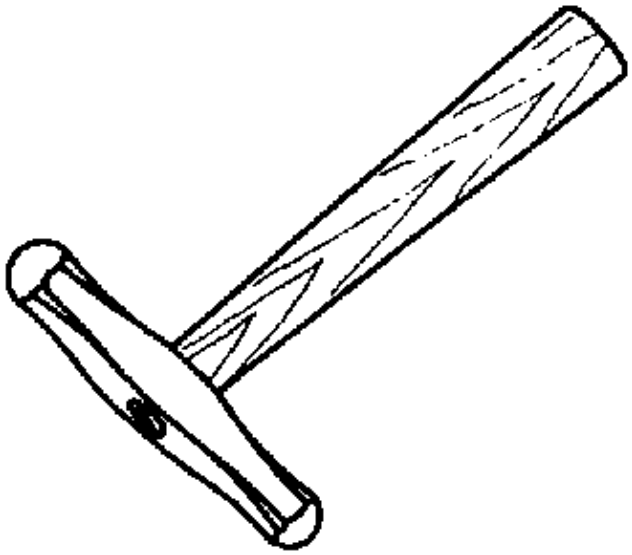

Figure 4 Chasing hammer

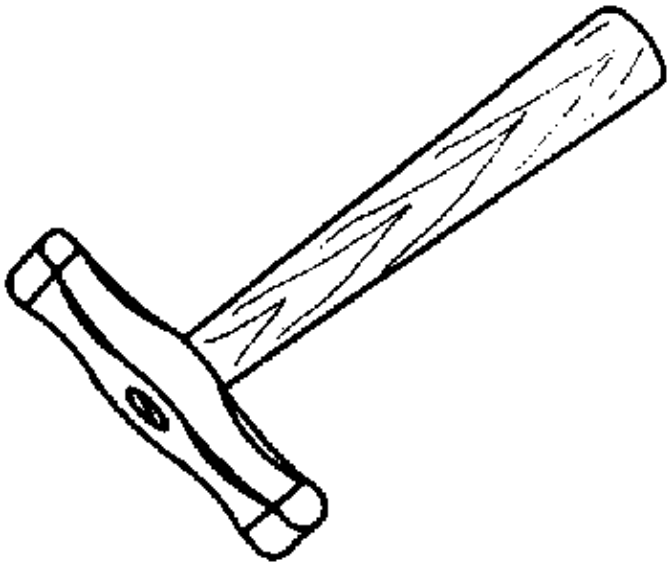

Figure 5 Curving hammer

– Curving hammer (250 g – 750 g),
barrel face hammer for notchless curving of sheet metal strips.

– Finishing hammer (250 g – 500 g) and smoothing hammer (350 g – 1000 g),
flat or oval face hammers for planishing of faces.

– Wooden hammer (170 g – 500 g),
rubber and aluminium hammers:

Hammers not damaging the surface of the sheet metal during forming and straightening operations.

For special purposes, wooden hammers may be bevelled or radiused.

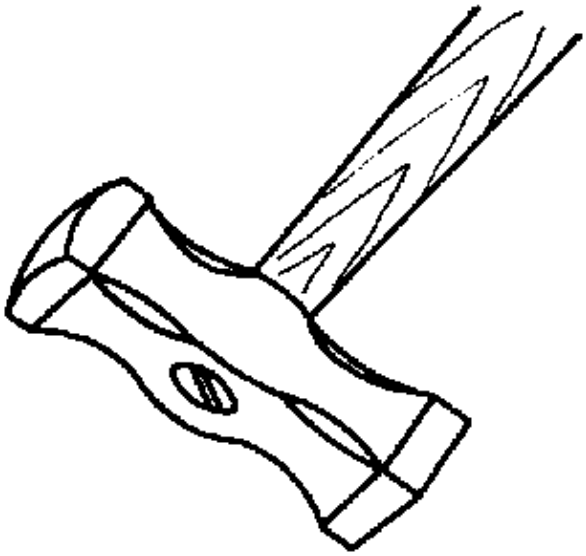

Figure 6 Finishing hammer

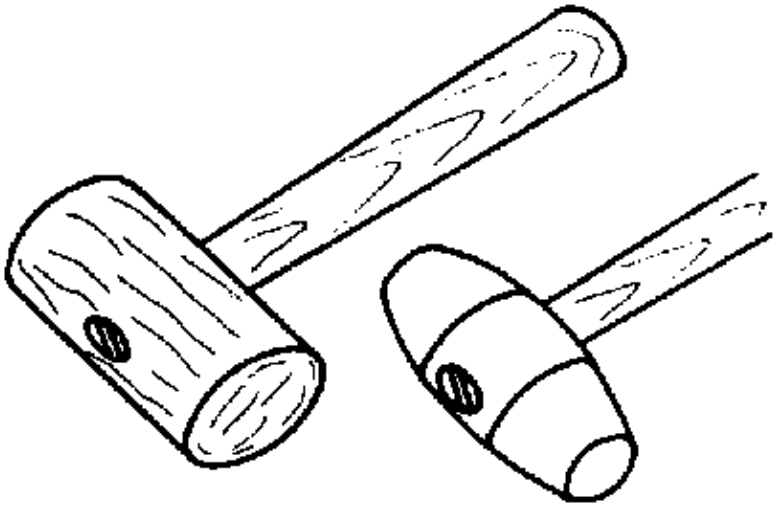

Figure 7 Wooden hammer and aluminium hammer

Hammering supports:

– Surface plates

Strong and flat cast–steel plates which are held by a stand or put on a work bench and are used for most hammering work.

Surface plates must not be damaged by chisel cuts!

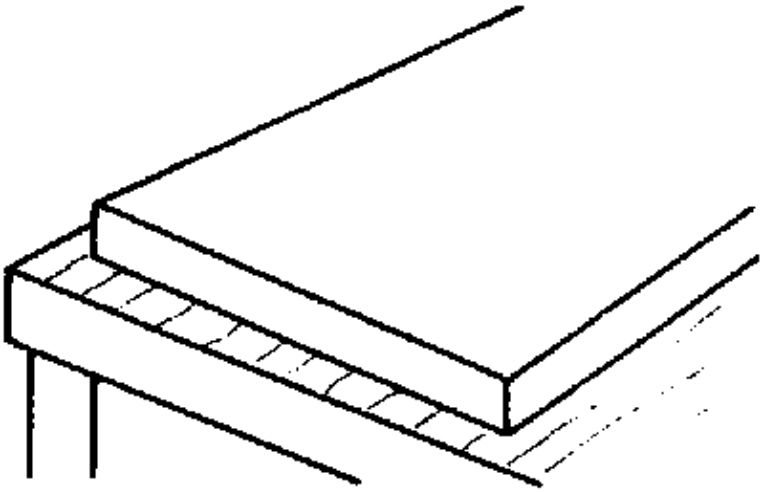

Figure 8 Surface plate

– Blacksmiths' anvil

Hardened support with face (2), round horn (1) and flat horn (3) for various forming and straightening operations.

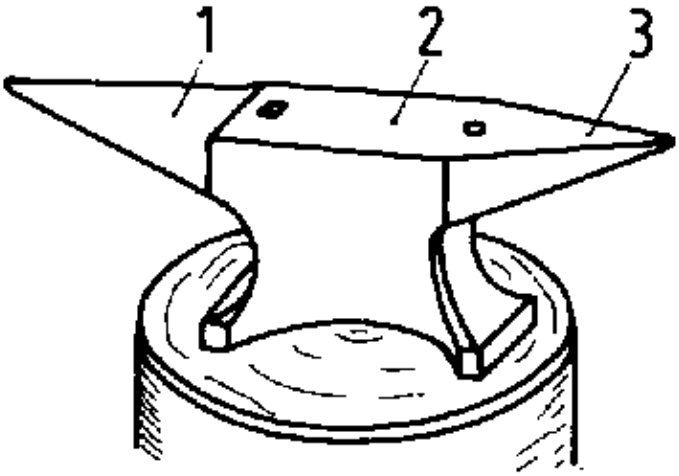

Figure 9 Blacksmiths' anvil

Special supports for sheet metal working

– Anvil tool
Flat surface of small size.

– Blacksmiths' double face sledge
Differently convex surfaces of small size.

– Blacksmiths' hardy and bordering tool
Differently shaped faces and edges, specifically for flanging work.

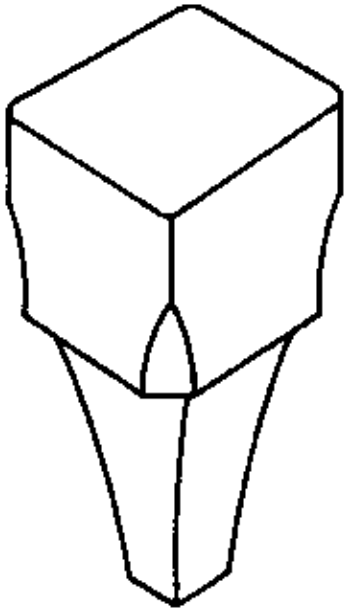

Figure 10 Anvil tool

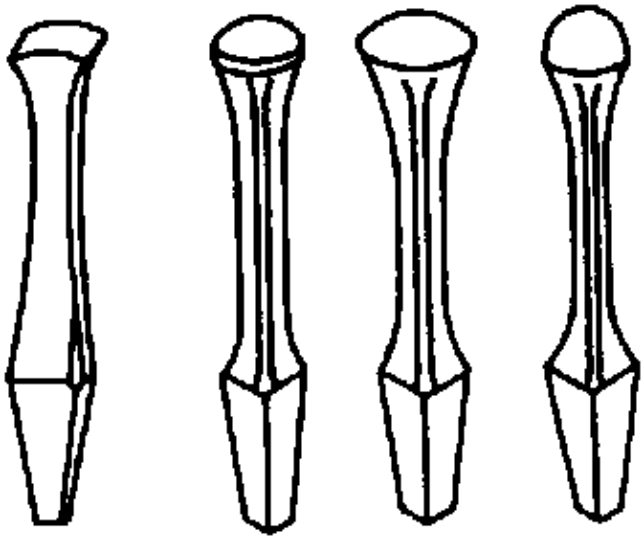

Figure 11 Blacksmiths' double face sledge

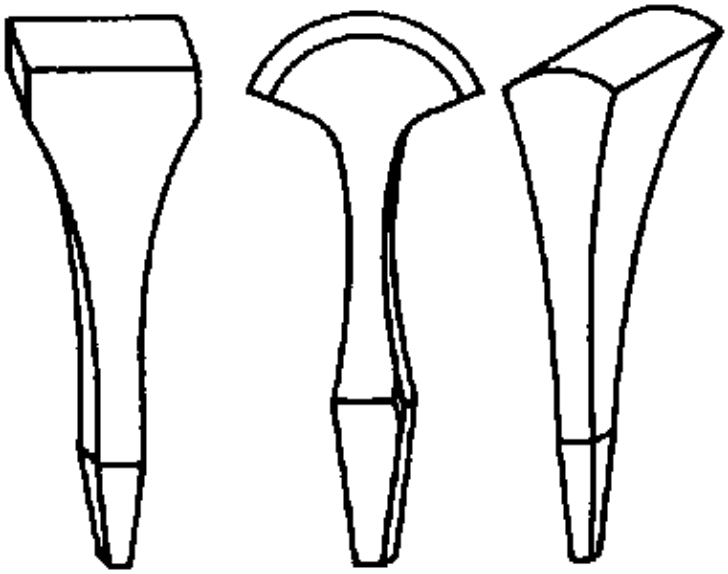

Figure 12 Blacksmiths' hardy and bordering tool

Main marking tool is the marking punch.

– Letter set
Set of marking punches of all alphabetic letters.

– Figure set
Set of marking punches of the figures 0 – 9.

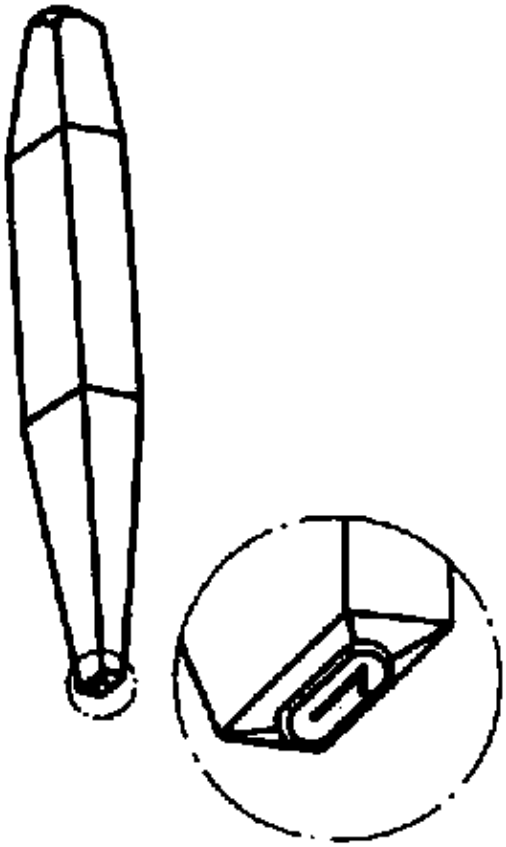

Figure 13 Marking punch (figure 1)

– Special number and word punches
Marking punches of groups of figures or complete words for special requirements.

What makes the difference between engineers' hammers and hammers for sheet metal working?

_____

Which properties are typical of hammering supports?

_____

Which supports are meeting the general requirements of hammering?

_____

What types of marking punches are in use?

_____

3. Working principle of hammering

The impact of the hitting hammer face is transmitted through the workpiece to the strong, inflexible support which is repelling the blow.

The material gets compressed – it cannot yield in the direction of the blow.

It yields to two or more sides, depending on the shape of the hitting hammer head and on the shape of the hammering support, with such shapes getting impressed into the surface of the workpiece.

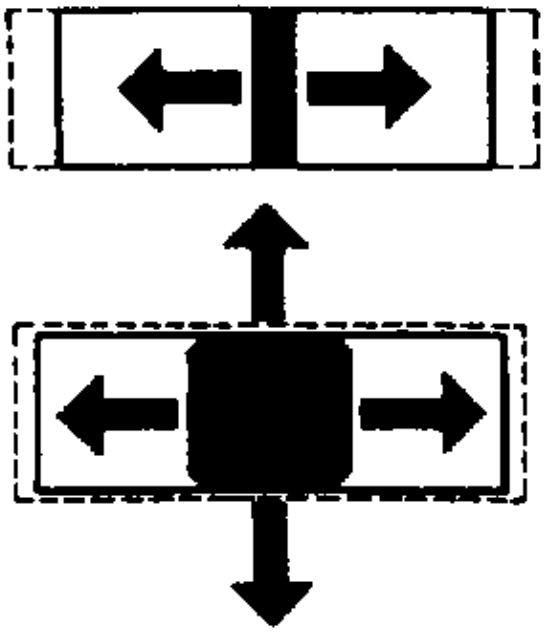

Figure 14 Effect of hammer pane and hammer face

Notes

– Ductile materials can be hammered only – brittle materials cannot be formed by hammering!

– The more hammer blows, the faster hardening and the harder the material!

– In case of extensive forming operations the hardness is to be reduced by “annealing” and “cooling down”!

– Sheet steel is to be cooled down gradually in the air after annealing – sheet copper is to be quenched in cold water immediately after annealing!

To ensure maximum hitting accuracy, the blow of the hammer should be directed from the wrist joint.

More powerful blows for heavy forming work should be directed from the shoulder joint.

What is the working principle of hammering?

_____

What property must materials have that shall be hammered?

_____

What is the effect of many hammer blows hitting one point of the workpiece?

_____

How can that effect be reduced or eliminated?

_____

4. Working techniques of hammering

The effects on the workpiece may be varied by different ways of hammering and selecting appropriate hammering faces.

4.1. Lengthening

Lengthening means elongating or combined elongating and widening of workpieces.

It is mostly applied to sheet metal strips or strip steel.

Principle

When the hammer pane of the engineers' hammer hits the entire width of the metal strip, the material is yielding to the front and rear.

Several successive blows lengthen the material – the strip gets longer.

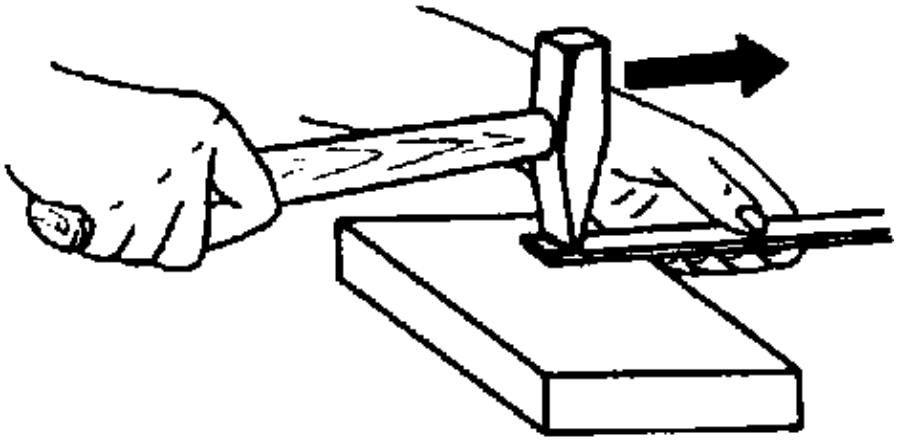

Figure 15 Lengthening with hammer pane

When the hammer face of the engineers' hammer hits the metal strip, the material is yielding to all sides.

Several successive blows lengthen and widen the material – the strip gets longer and wider.

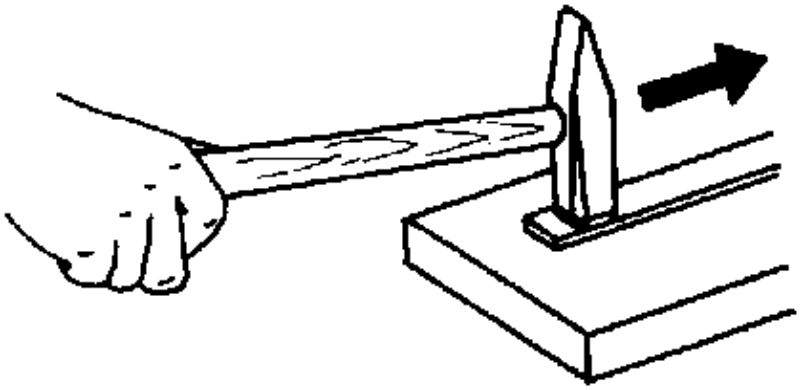

Figure 16 Lengthening and widening with hammer face

Note

The blows must be directed from front to rear or rear to front in rapid succession.

4.2. Curving

Curving means one–sided lengthening of sheet metal strips or strip steel to give a two–dimensional curved shape.

Principle

When the hammer pane of the engineers' hammer or the faces of the curving hammer obliquely hit one side of the strip, the material is yielding into two directions at this side only. Steady successive hammer blows result in one–sided lengthening of the material, the strip gets longer and curved.

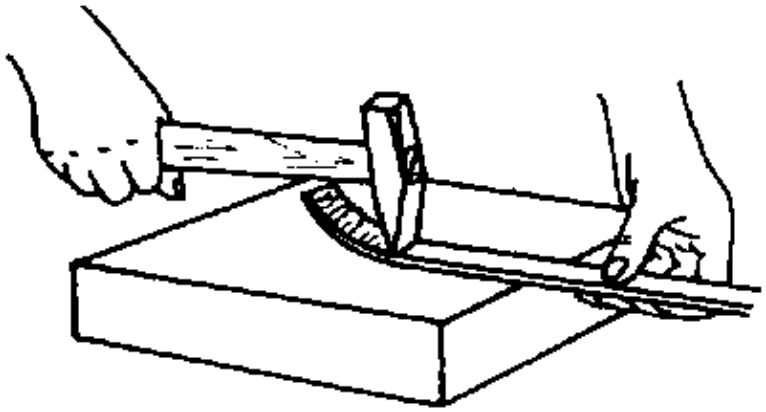

Figure 17 Two–dimensional curving with hammer pane

Note

The blows must be directed as described for lengthening!

4.3. Chasing

Chasing means three–dimensional shaping of thin sheet metal.

Principle

Version 1 – flat hammering support

When the hammer face of the chasing hammer hits a sheet metal disk, the material is yielding circularly to all sides.

Steady hammer blows spirally from the centre of the disk outward cause the border to curve upward.

The blows in the middle must be closer than outside!

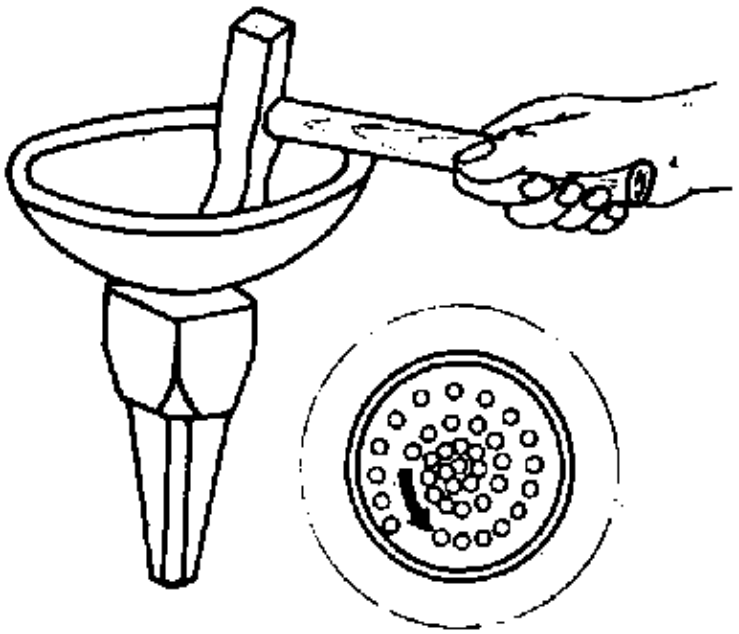

Figure 18 Chasing on flat hammering support

Notes

– The hammer blows must not reach the border!
– The many blows make the metal thinner and harder in the middle – it may easily tear!
– Therefore, sheet steel is to be annealed and gradually cooled down!
– Therefore, sheet copper is to be annealed and quickly cooled down!

Version 2 – hollow hammering support

The metal sheet is put on a steel tube with rounded upper edge and held.

Steady hammer blows with a radiused wooden hammer spirally from the border inward cause the sheet metal to curve downward.

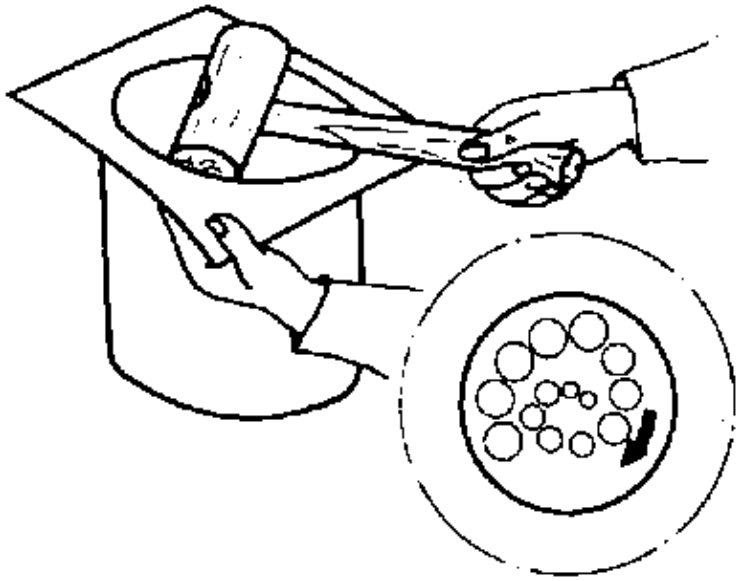

Figure 19 Chasing on hollow hammering support

The hammer blows must reach the centre at the end only!

Notes

– The many hammer blows make the metal thinner and harder – it may easily tear!
– Therefore, sheet metal is to be annealed and adequately cooled down!

What makes the difference between lengthening and curving of a sheet metal strip?

_____

How is the blow to be directed when lengthening and curving?

_____

4.4. Flanging

Flanging means bending down of borders of metal sheets obliquely or perpendicularly to the plane of the sheet. There are two types of flanging:
outside flanging and inside flanging.

Principle of outside flanging

– Rough–flanging

The circular sheet is put centrically on a somewhat smaller steel tube. With an engineers' hammer, bevelled wooden hammer or aluminium hammer the border projecting outside is bent down by blows hitting obliquely from outside – the border is loosely touching the outside wall of the tube with puckers.

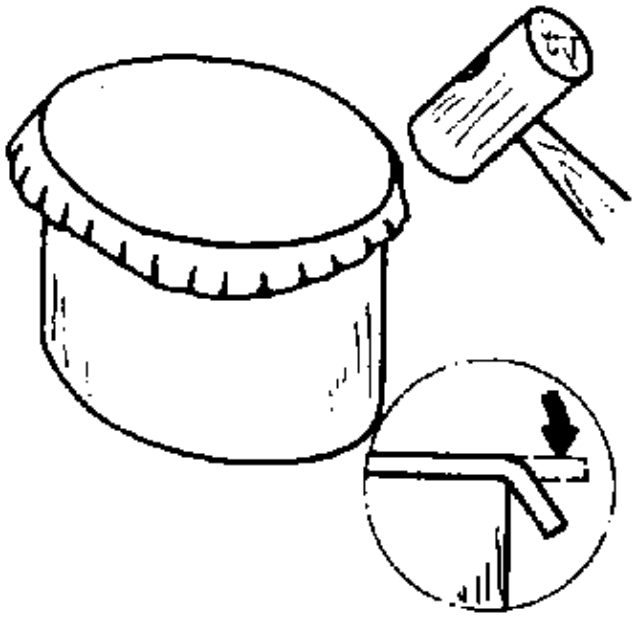

Figure 20 Rough–flanging: bending down of the outside border

Blacksmiths' hardies of various shapes, which have to be clamped in a vice, may also be used as hammering support.

– Finish–flanging:

with the face of the engineers' hammer the puckered border is bulged in on the outside wall of the tube and smoothed.

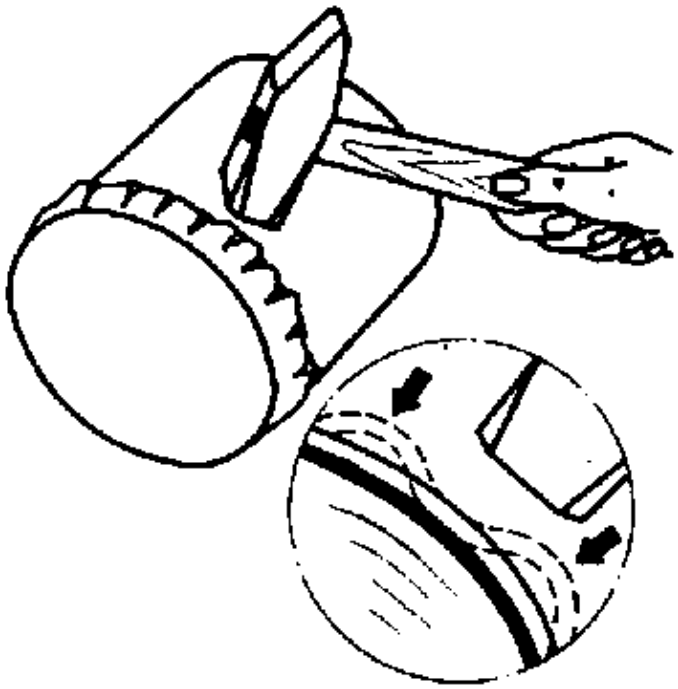

Figure 21 Finish–flanging: bulging in and smoothing of puckers

Principle of inside flanging

– Rough–flanging:

The sheet (1) with the punched hole is inserted in an adequate template (2).

With a bevelled wooden hammer (3).

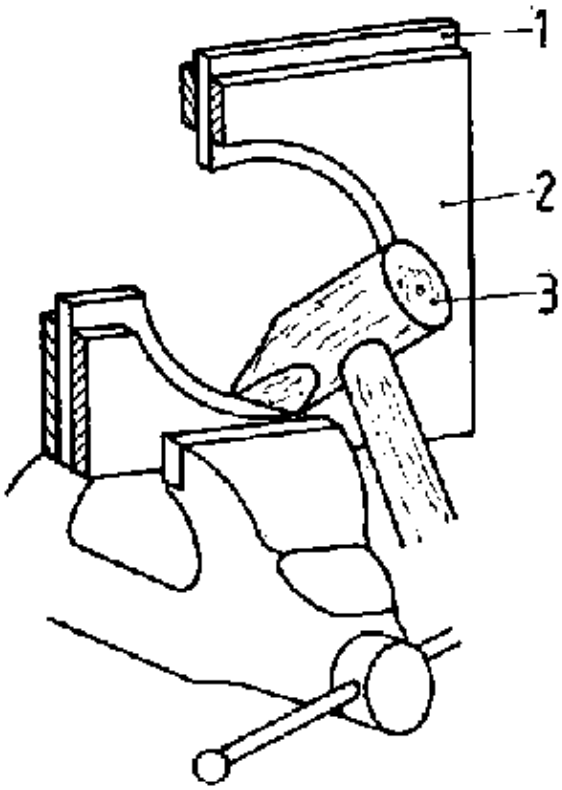

Figure 22 Rough–flanging: bending down of the inside border

a chasing hammer or curving hammer the border projecting inside is bent down with puckers by blows hitting obliquely.

Blacksmiths' hardies of various shapes, the anvil tool or blacksmiths' double face sledges may also be used as hammering support.

– Finish–flanging

With the chasing hammer or curving hammer the puckered border is bulged in and smoothed.

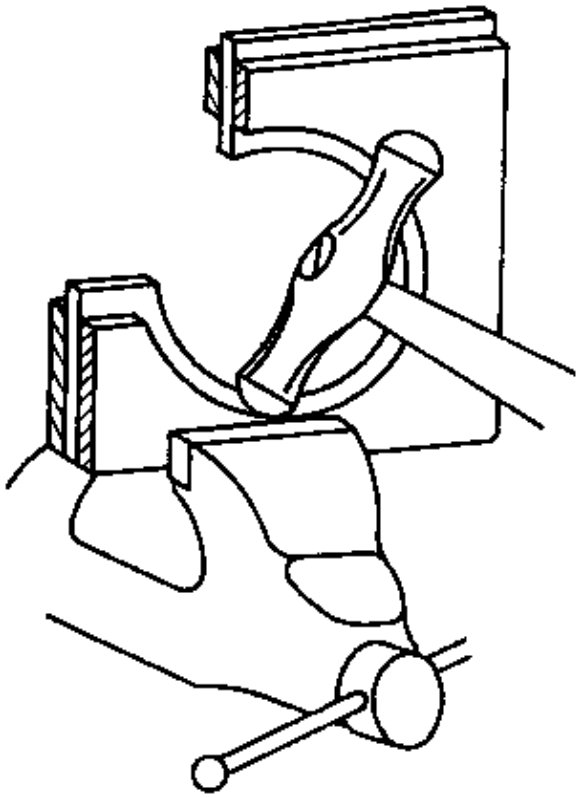

Figure 23 Finish–flanging: bulging in and smoothing of puckers

Notes

– When flanging very large borders, bending is to be performed step by step!

To avoid heavy puckers, a smooth hardwood counterpiece is used for complete bending down of the border!

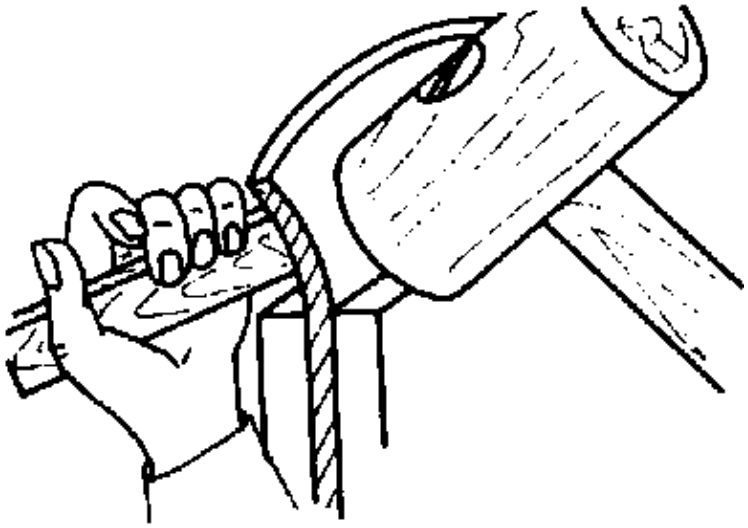

Figure 24 Use of hardwood counterpiece for bending down of large borders

– Sheet metal which is flanged to be used as lids or covering cap of containers should be hammered on the relevant container as hammering support to ensure perfect fit!

Which are the working steps when flanging sheet metal borders?

_____

5. Working technique of marking

The use of marking punches necessitates exact scribing of the line spacings wherever longer combinations of figures or letters shall be punched.

The following data may serve as guideline for the spacing of the lines (A) in relation to the height of the figures or letters (H):

A	H
3	2.5
5	4
8	6
10	8
12	10

Use a pencil or brass scriber for scribing! After marking remove the scribed line!

The marking punch is applied similar to a centre punch:

The marking punch is set on the scribed line in inclined position, aligned, set vertically and hit by <u>one</u> powerful blow.

<u>Notes</u>

– The direction of the row of figure or letter combinations should be selected so as to permit constant checking of the alignment!

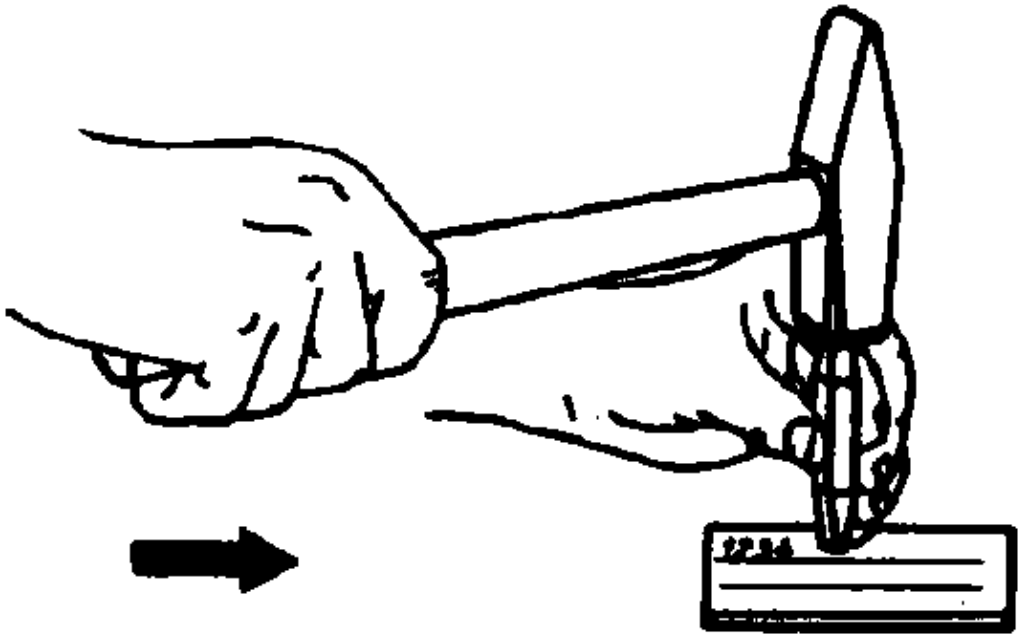

Figure 25 Marking in the direction of blow to the front

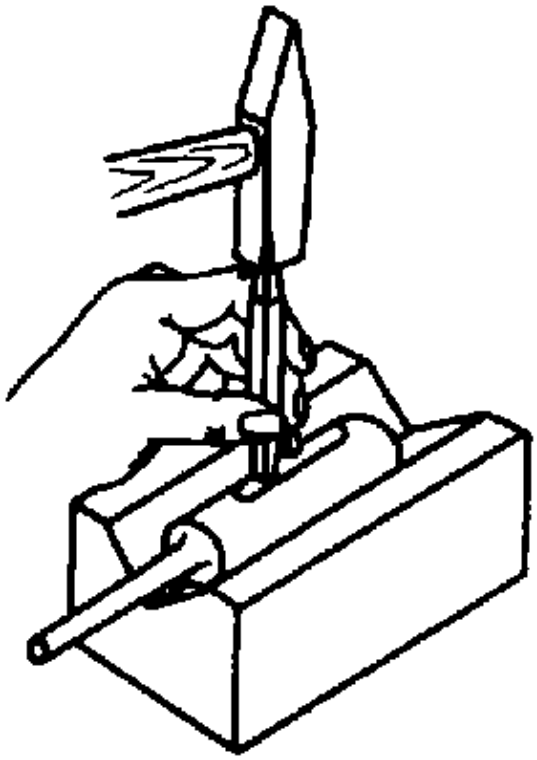

Figure 26 Marking on a filed face of a cylindrical workpiece

– When marking small workpieces a suitable hammering support is to be selected!

Put round stock on a vee!

– If the face to be marked is uneven or not flat, it should be smoothed or flattened’

How is scribing to be done for marking of combinations of figures or letters?

_____

6. Labour safety recommendations

Use properly fixed hammers only – hammer handle and head must be firmly cottered!

– Select the right hammering support – hard and inflexible surface is required!
– When using any fire for annealing of sheet metal, precautions against fire are to be taken!