Drilling, Countersinking and Counterboring – Course: Technique for Manual Working of Materials. Instruction Examples for Practical Vocational Training

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Drilling, Countersinking and Counterboring – Course: Technique for Manual Working of Materials. Instruction Examples for Practical Vocational Training

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Berlin

Original title:
Lehrbeispiele für die berufspraktische Ausbildung
“Bohren und Senken”

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Order No.: 90–33–3107/2

Introduction

The present material includes 6 selected instruction examples by means of which the essential operations of drilling, countersinking and counterboring can be practised.

For that purpose, through–hole and bottom–hole bores, holes on flat and inclined surfaces as well as counterbores and countersinks will be made.

Apart from the mere exercise of drilling, countersinking and counterboring on a special workpiece, the jaws for round material, the drill stand as well as the rivet set and the rivet header can be used in the workshop. The rotary head for a threaded spindle is a single part of a C clamp; the bottle–opener can be used by the trainees themselves.

In order to facilitate the preparation and execution of works, the required materials, working tools, measuring and testing tools as well as accessories are given for each of the practical examples. Furthermore, the previous knowledge is mentioned that is necessary for executing the exercises.

In addition to the working drawing attached, a favourable sequence of operations is described.

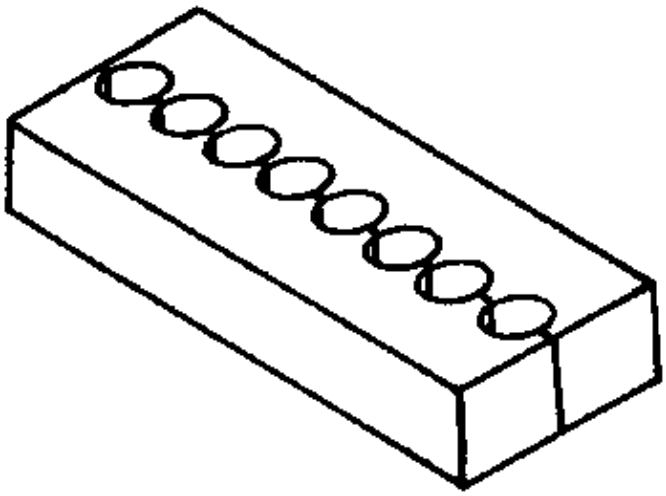
Explanation to material data:

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

Instruction example 7.1. Drilling, countersinking and counterboring training workpiece

Practise drilling and counterboring/countersinking in medium–hard and soft materials to given dimensions.

Material



2 x squares made of steel (380 MPa) and of aluminium or copper

Thickness: approx. 24 mm

Length: 130 mm

Working tools

Steel scriber or marking gauge, centre punch, locksmith's hammer, three–square scraper, drills ("Normal" type) of 6.75, 8. 8.4. 9 mm dia., drills ("Soft" type) of 6.75, 8, 8.4. 9 mm dia., three–groove twist drill of 10 mm dia., counterboring tool of 15 mm dia. with pilot of 8.9 mm dia., drill with flat drill point and centre point of 15 mm dia., countersink 60, 75°, 90°

Measuring and testing tools

Steel rule, vernier caliper with depth gauge

Accessories

2 C clamps, machine vice, diluted soluble oil, spirit

Required previous knowledge

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

Sequence of operations	**Comments**
1. Arrange workplace Prepare working material	– Check for completeness
2. Check initial length of workpieces; if necessary, saw and deburr to 130 mm	– Begin with workpieces made of steel!
3. Clamp workpieces together by means of C clamp; scribe and punch hole centres onto the centre line visible through edges	– Condition: distance between finished upper edges of holes shall be 4 mm each!
4. Fix workpieces clamped together into a machine vice, set up the drilling machine	

5. Produce holes and counterbores/countersinks

5.1. Through hole of 8 mm dia. – (1)

– Chuck drill of 8 mm dia.	
– Adjust drill point onto punch mark and fix machine vice	
– Select speed of machine	– n = 1100 r.p.m.
– Put into operation and take the drill into workpiece by slowly applying a pressure onto feed lever	– Add diluted soluble oil
– Reduce pressure before drill point is through	
– Clean and deburr hole	– (Three–square scraper)

5.2. Bottom hole Ø 8 x 20 – (2)

– Adjust drill point above punch mark	– Fix machine vice!
– Put machine into operation and spot–drill workpiece	– To nominal dimension of 8 mm (take drill point completely into the workpiece)
– Stop machine and adjust depth gauge on machine	– To 20 mm depth
– Put machine into operation and push drill down to stop by means of feed lever	– Add diluted soluble oil
– Clean and deburr after drilling	

5.3. Counterbore a through hole of 8 mm dia. to 10 mm dia. up to 15 mm depth – (3)

– Produce through hole of 8 mm dia.	
– Chuck three–groove twist drill of 10 mm dia., centre	– Clamp workpiece!
– Select speed of the machine	– n = 350 r.p.m.
– Put three–groove twist drill on hole and adjust depth gauge	– To 15 mm depth
– Put into operation and counterbore to stop	– Cool
– Clean and deburr hole	

5.4. Drilling and counterboring for socket head cap screw M 8 – (4)

– Produce through hole of 9 mm. dia.	– n = 1100 r.p.m.
	– To 8 mm depth

– Centre counterboring tool of 15 mm dia. Above hole with machine stopped, press pilot into hole and adjust depth	
– Select speed	– n = 350 r.p.m.
– Put into operation and counterbore to stop	– Add coolant
– Clean hole	

5.5. Drilling and counterboring for fillister head screw with slot M 8 – (5)

– Centre drill with flat drill point and centre point of Ø 15 above the hole	– Clamp workpiece!
– Select speed	– n = 710 r.p.m.
– Put drill on workpiece and adjust depth gauge	– To 6 mm depth
– Put into operation and drill to stop	– Cool
– Adjust drill of 9 mm dia. above hole centre and drill through	– n = 1100 r.p.m.
– Clean and deburr hole	

5.6. Drilling and countersinking for countersunk screw M 8 – (6)

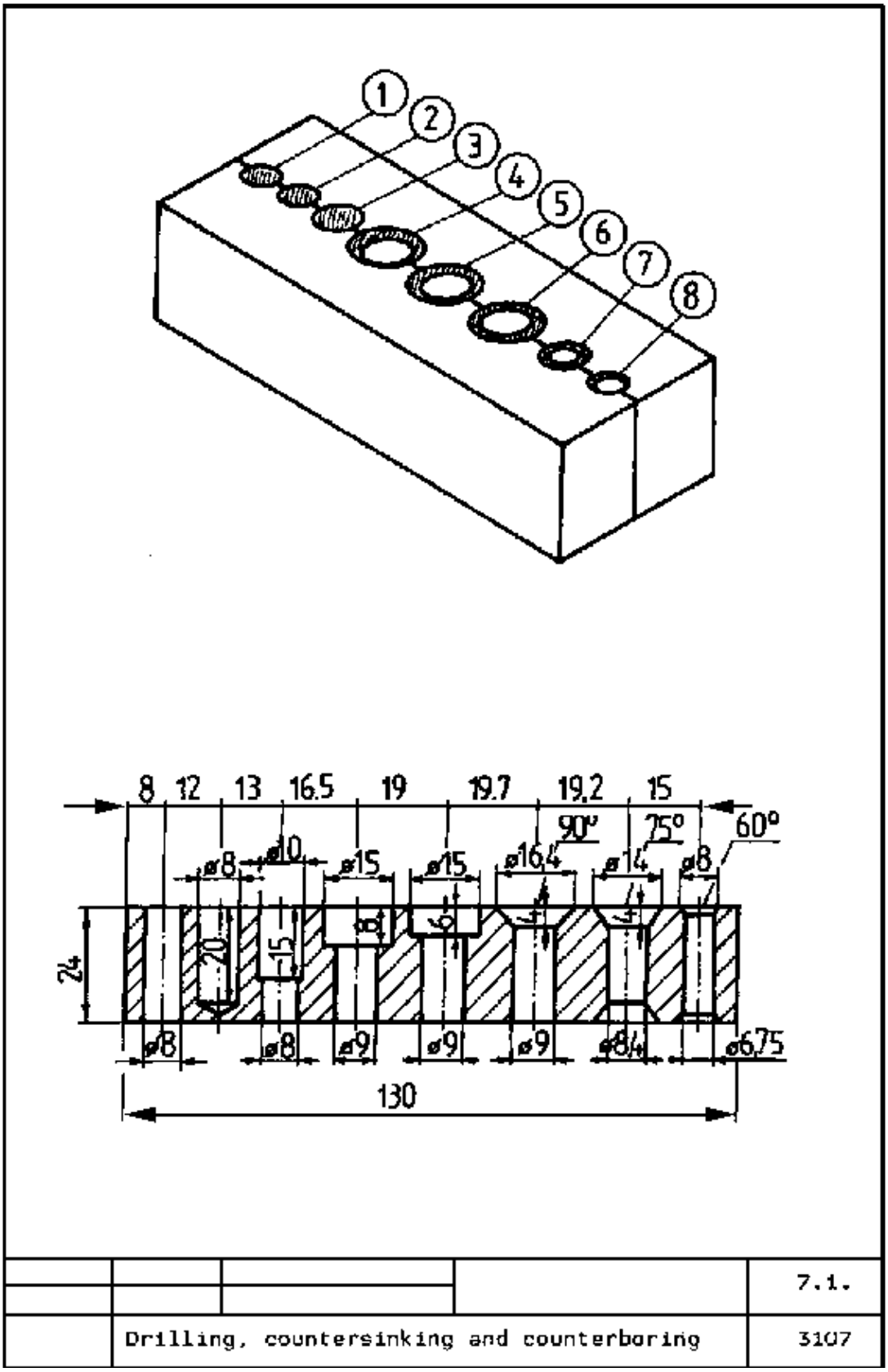
– Produce through hole of 9 mm dia.	– n = 1100 r.p.m.
– Centre 90° countersink above hole, put it on hole and adjust depth gauge	– To 4 mm depth – Clamp workpiece!
– Select speed	– n = 350 r.p.m.
– Put into operation and countersink to stop	– D_s = 16,4 mm
– Clean hole	

5.7. Drilling and countersinking for countersunk rivet Ø 8 – (7)

– Produce through hole of 8.4 mm dia.	– n = 1100 r.p.m.
– Centre 75° countersink above hole and countersink step by step until countersinking dia. of 14 mm is reached	– n = 350 rpm. – Check intermediately by means of vernier caliper
– Unclamp workpiece, reverse and adjust, clamp again	– Press countersink into hole with machine stopped – hole draws to centre!
– Repeat countersinking	
– Clean hole	

5.8. Drilling and countersinking for tapped hole M 8 (8)

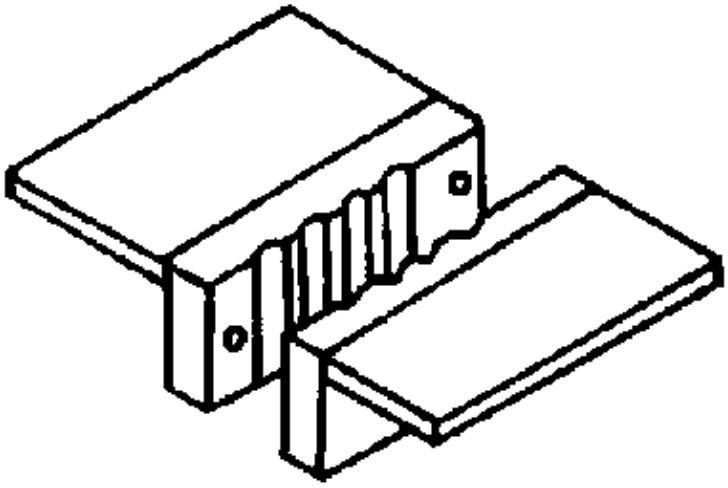
– Produce through hole of 6.75 mm dia.	– n = 1400 r.p.m.
– Centre 60° countersink above hole and countersink to 8 mm countersinking dia.	– Check by means of vernier caliper
– Unclamp workpiece, reverse and adjust	
– Repeat countersinking	
– Clean hole	
6. Unclamp workpiece, loosen C clamps	
7. Repeat operations No. 2 to 6 on workpieces made of aluminium or copper, determine new speeds for drilling operations	– Use drill of “Soft” type. Use spirit as coolant
8. Final check on halves of workpieces	– Holes and counterbores can be checked on sections!



Instruction example 7.2. Clamping jaws for round material

Practise the production of simple through holes by drilling with spacer

Material



– 2 x steel sheet (380 MPa)

thickness: 3 mm

width: 80 mm

length: 120 mm

– 2 x flat steel (380 MPa)

thickness: 10 mm

width: 25 to 30 mm

length: 120 mm

– 4 x countersunk rivet Ø 4

Working tools

Centre punch, locksmith's hammer, steel scriber or marking gauge, drills ("Normal" type) of 3, 4. 4.1., 5, 6, 8. 10. 12 mm dia., countersink 75°, portable electric drill

Measuring and testing tools

Steel rule, vernier caliper

Accessories

2 C clamps, machine vice, diluted soluble oil, steel sheet of 2 mm x (30) x 120 as spacer

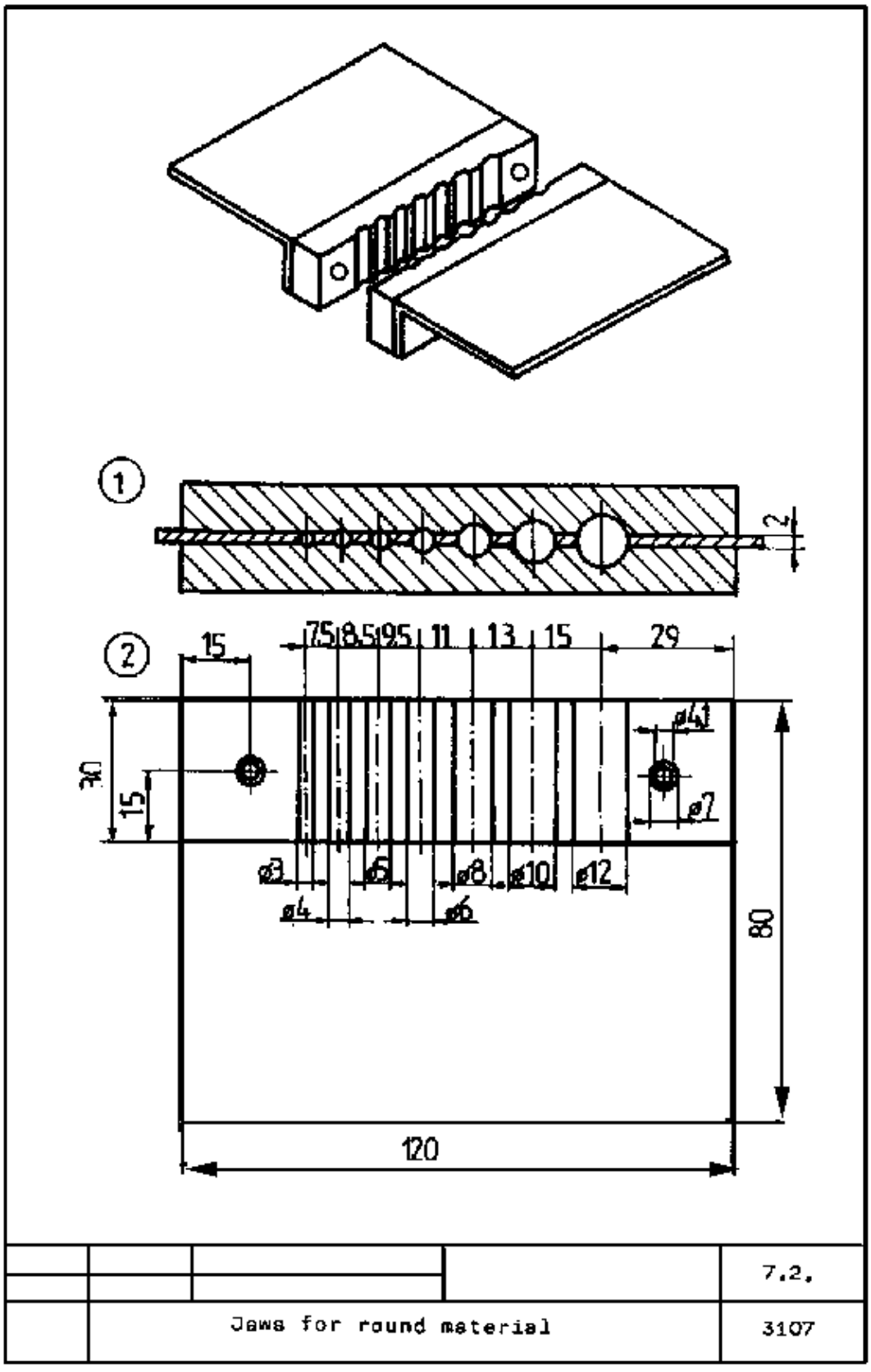
Required previous knowledge

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

Sequence of operations	**Comments**
1. Arrange workplace Prepare working material	– Check for completeness
2. Check initial dimensions of workpieces; if necessary, finish as to given dimensions, deburr	– (shearing, sawing, filing)

3. Clamp flat material together with spacer into C clamps	– Top faces in the same level! Stage (1)
4. Scribe bore centres on top face	– Punch marks on the spacer
5. Clamp clamped workpieces into machine vice	
6. Produce holes as to drawing dimensions	
– Select speed	– determine by formula $n = \frac{V \cdot 1000}{d \cdot \pi}$
– Chuck drill	
– Adjust punch mark below drill point	
– Fix machine vice	
– Drill	
– Clean and deburr bore	– Cool
7. Unclamp workpieces, scribe bores for riveted joints	
8. Clamp together one flat steel with steel sheet, drill together and countersink (on both sides) by electrical/hand drill	– drill Ø 4.1 mm countersink 75° to 7.0 mm dia. Stage (2)
9. Check holes	

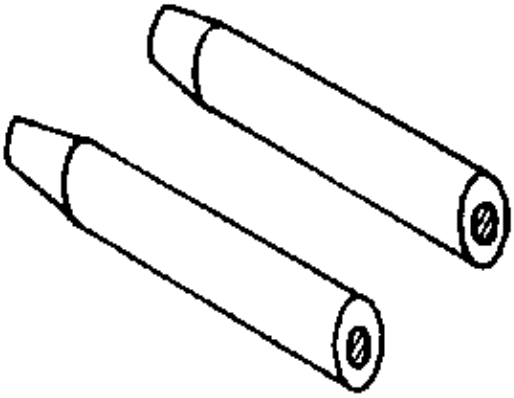
Finishing: Joint flat steel and steel sheet by means of countersunk rivets, bend steel sheet behind the flat steel (90°).



Instruction example 7.3. Rivet set and rivet header

Practise the production of concentric holes and counterbores/countersinks in round material

Material



2 x round material made of silver steel (1.1 to 1.25 % of carbon)

diameter: 12 mm

length: 100 mm

Working tools

Steel scriber, centre punch, locksmith's hammer, drill of 4.3 mm dia., form counterbore (rotary file – ball dia.: 8 mm)

Measuring and testing tools

Steel rule, vernier caliper

Accessories

Centre square, machine vice with vee jaws, diluted soluble oil

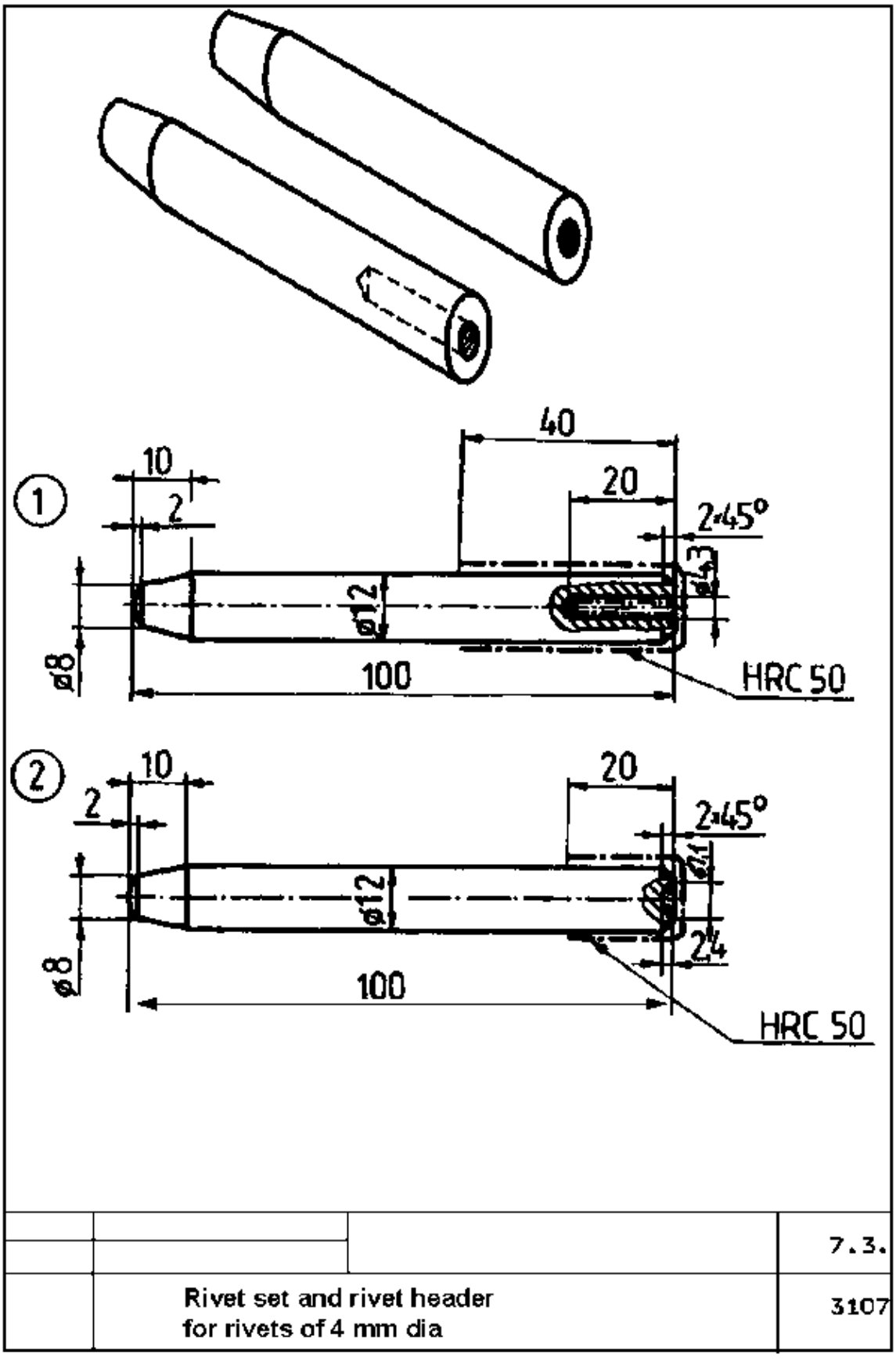
Required previous knowledge

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

Sequence of operations	**Comments**
1. Arrange workplace Prepare working material	– Check for completeness
2. Check workpieces for initial length; if necessary, finish	– Sawing, Filing
3. Scribe and punch hole on end face by means of centre square	
4. Drill hole for rivet set (1) of 4.3 mm dia. to 20 mm depth	– Clamp round material vertically into vice – n = 2240 r.p.m.
5. Drill hole for rivet header (2) of 4.3 mm dia. to 2 mm depth, subsequently counterbore to 2.4 mm depth by means of form counterbore (rotary file)	– n = 2240 r.p.m.

6. Check hole and counterbore – Concentricity, accuracy to size

Finishing: Grind tool heads true–to–size as to drawing by means of grinding machine, the same goes for chamfer 2 x 45°, harden rivet set 40 mm on hole end, harden rivet header 20 mm on counterbore end to HRC 50

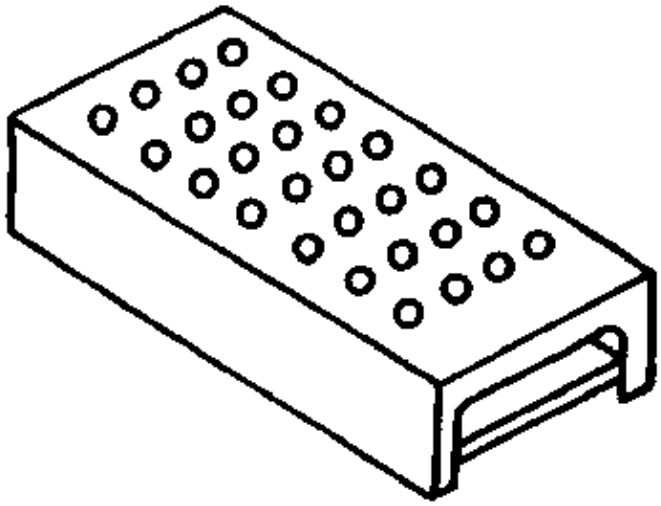


			7.3.
	Rivet set and rivet header for rivets of 4 mm dia		3107

Instruction example 7.4. Drill stand

Practise drilling of small bottom holes and through holes

Material



– channel–section steel (380 MPa) 80 x 45 x 6 x 8 length: 120 mm (or from training examples 2.3 or 4.2)

– plate made of steel or plastic material

thickness: approx.	10 mm
width: approx.	80 mm
length:	120 mm

– 4 x slotted nail Ø 4 x 10

Working tools

Hand hacksaw, bastard file of 300 mm (flat), surface gauge, centre punch, locksmith's hammer, drills of 1.1 to 5.0 mm dia., countersink 90°

Measuring and testing tools

Steel rule, vernier caliper

Accessories

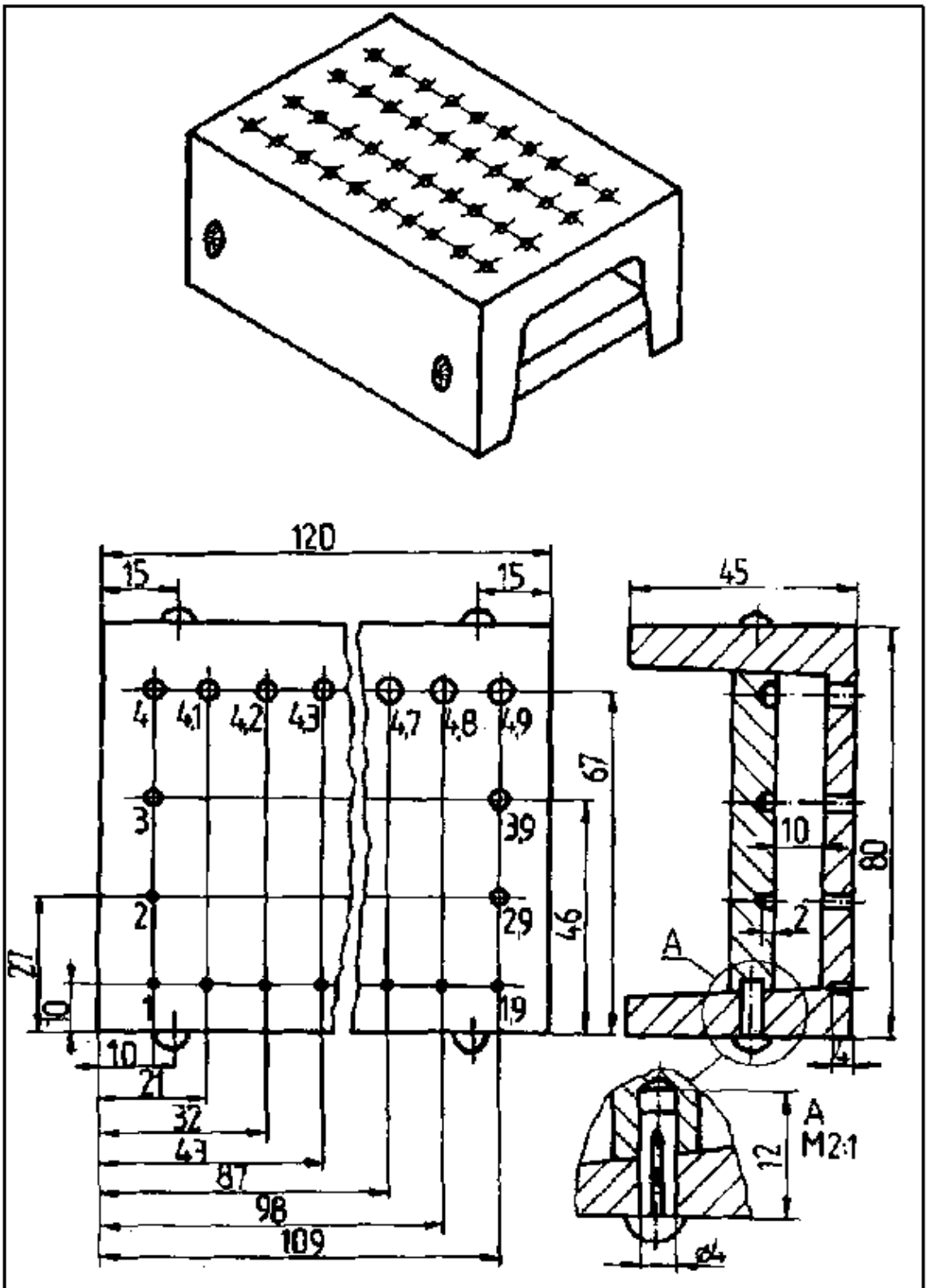
Machine vice, diluted soluble oil, 2 x C clamps, spacer

Required previous knowledge

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

Sequence of operations	**Comments**
1. Arrange workplace Prepare working material	– Check for completeness

2. Take workpiece from training examples 2.3 or 4.2 or pre–finish as to drawing and scribe holes	
3. Fit plate into channel section, subsequently clamp together	– Sawing, filing
4. Scribe lateral holes of 4 mm dia. for slotted nails, punch, drill together and deburr	– n = 2240 r.p.m.
5. Drive in slotted nails	
6. Produce holes as to drawing:	
– drill holes of 1.1 to 2.0 mm dia. as bottom holes to 4 mm depth into the channel section	– Drill holes specified in drawing by 0.1 mm greater, e.g. for (1) hole of 1.1 mm dia.
– Drill holes of 2.1 to 5.0 mm dia. as through holes into channel section and as bottom holes to 2 mm depth into the plate	– Drill in one pass – Insert spacers as gap fillers
7. Deburr holes (by means of countersink)	
8. Mark holes by number punch as to drawing	
9. Check the holes	– Accuracy to size

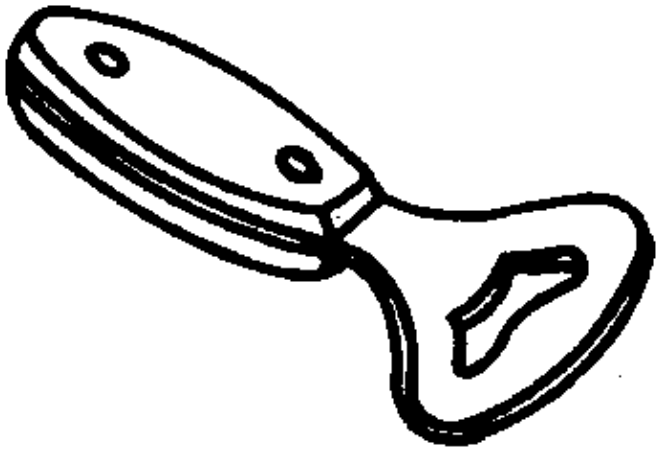


				7.4.
	Drill stand			3107

Instruction example 7.5. Bottle–opener

Practise drilling of curved contours in steel sheet

Material



– sheet made of stainless steel (chromium–nickel alloy)

thickness: approx. 2.5 mm

width: 90 mm

length: approx. 150 mm

– 2 x flat material made of plastic material or wood (timber)

thickness: 4 mm

width: 25 mm

length: 90 mm

Working tools

Hand lever shear, hand hacksaw, steel scriber, centre punch, double–point punch (y = 3.2 mm), locksmith's hammer, drill with flat drill point and centre point (type hard) of 3 mm dia., cross–cut chisel, flat chisel, smooth files of 250 mm (half round, round), drill of 4.1 mm dia., countersink 75°

Measuring and testing tools

Steel rule, vernier caliper

Accessories

Scribing stencil as to drawing, C clamps, clamp dogs, rape–oil, drilling support, surface plate

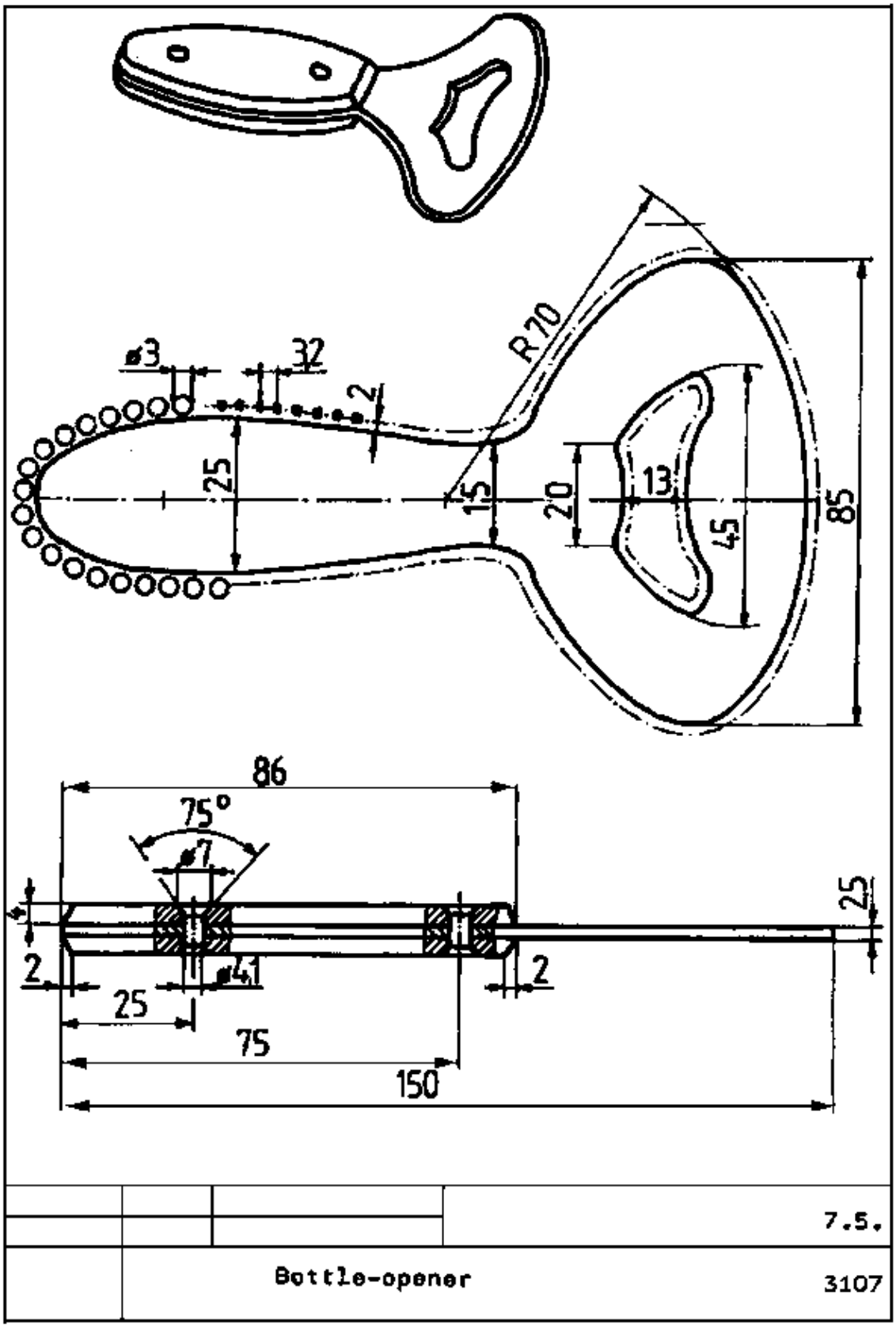
Required previous knowledge

Reading of drawings, scribing, prick–punching, measuring, testing, chiselling, filing

Sequence of operations	**Comments**
1. Arrange workplace Prepare working material	– Check for completeness

2. Scribe contour by means of scribing stencil applied	– subsequently punch check marks
3. Scribe hole line and punch by double–point punch, re–punch by means of centre punch	
4. Drill the hole line:	
– Chuck drill of 3 mm dia.	
– Clamp sheet into clamp dog	
– Select speed	– n = 350 r.p.m.
– Adjust punch mark	
– Drill every second hole	– Cool (rape–oil)
– Check distances between holes	– When the distance is smaller than 3.4 mm, intermediate holes have to be made with a suitable drill of smaller size.
– Drill intermediate holes	
– Deburr	
5. Check holes	– No hole must overlap another hole

Finishing: Chisel, file contour on scribed line, scribe flat material (as grip halves) and work true–to–size, clamp together with steel sheet, drill, countersink, rivet, smooth or pattern–scrape the outer contour



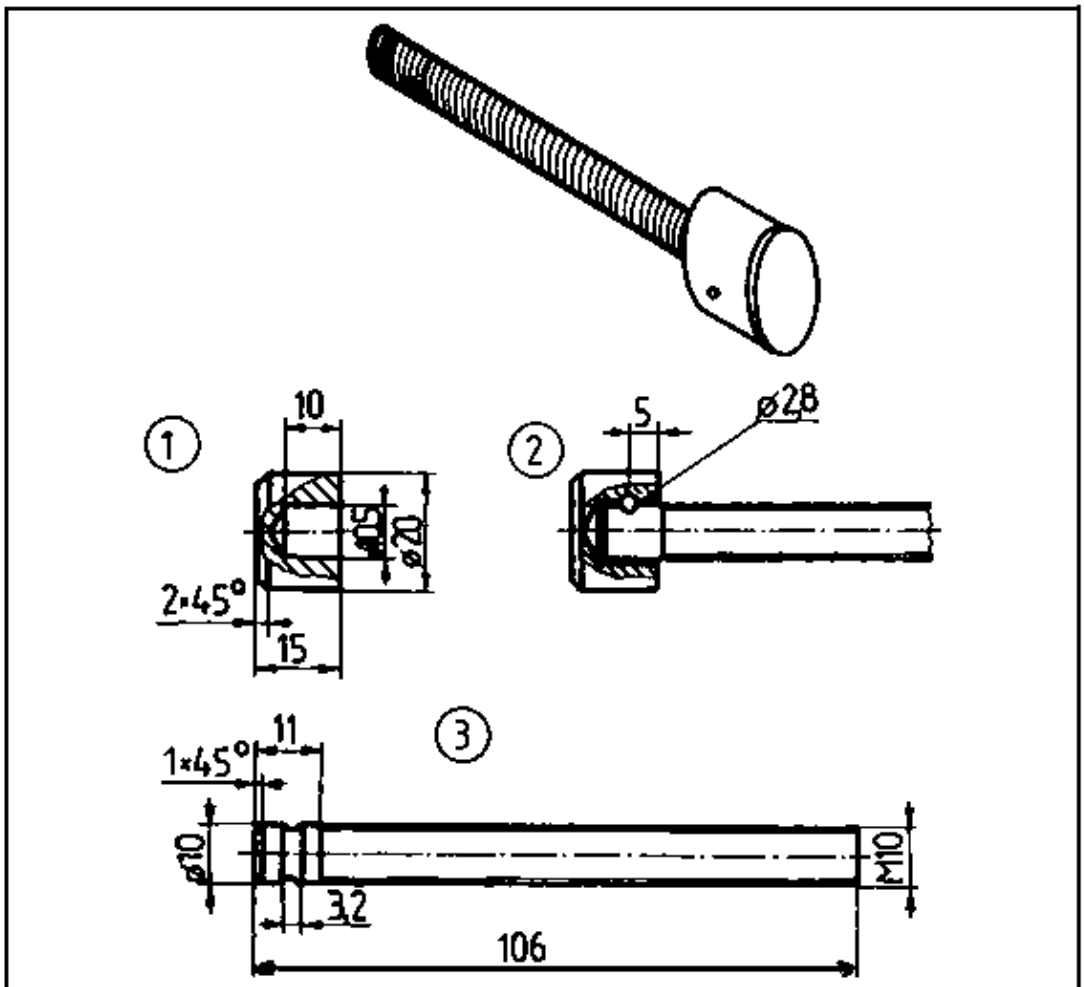
Instruction example 7.6. Rotary head for threaded spindle

[...]

Sequence of operations	Comments

1. Arrange workplace Prepare working material	– Check for completeness
2. Check initial dimensions as to drawing	
3. Scribe hole in head by centre square and punch, drill bottom hole of 10.5 mm dia. to 10 mm depth	– Stage (1) – n = 900 r.p.m.
4. Scribe and punch hole of 2.8 mm dia. as to drawing, clamp head in machine vice and spot–drill	– Stage (2) – Let drill point penetrate only
5. Loosen machine vice, turn head together with hole 1 mm outwards, spot–drill again until drill point does not walk off centre any more	– Apply only slight pressure onto drill
6. Repeat operation No. 5 until hole centre is 5 mm off centre	
7. Insert threaded bolt's thread–free part into head, drill hole through head and threaded bolt with threaded bolt held in position	
8. Disassemble the parts, deburr the hole	
9. Check the hole	

Finishing: Ream hole in the head by means of reamer Ø 3 K 7, file groove in the threaded bolt in height of hole mark as to drawing stage (3); assemble parts and secure by means of straight pin Ø 3 m 6, check for rotatory movement of the head on the bolt.



				7.6.
	Rotary head for threaded spindle			3107