Thread Cutting by Dies and Taps – Course: Techniques for Machining of Material. Trainees' Handbook of Lessons

Table of Contents

Thread Cutting by Dies and Taps – Course: Techniques for Machining of Material. Trainees' Handbook of Lessons

Institut für berufliche Entwicklung e.V.
Berlin

Original title:
Arbeitsmaterial für den Lernenden
“Gewindeschneiden mit Schneideisen und Gewindebohrer”

Author: Horst Köth

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

Order No.: 90–35–3205/2

1. Purpose and importance of thread cutting by dies and taps

Threads are disconnectable, solid connections of machine parts. Where the parts are held against one another such threads are called fastening threads, i.e. vee–threads. Similarly, where the parts are set in motion towards each other they are known as travelling threads, i.e. acme threads (in the leadscrew of the lathe).

The two threads each consist of a couple of parts, namely an internal thread and an external thread. The mode of operation is determined by shape, diameter and pitch of the thread. Thread cutting is a sort of chip removal and can be undertaken by mean of a die, tap or lathe. Thread cutting by dies and taps is very easy and serves to manufacture vee–threads which, in turn, are perfectly adequate for moat fastening threads regarding:

- dimensional accuracy,
- forming,
- top surface quality, and
- sound fitting.

Vee–threads are either metric or inch–measure screw threads (Whitworth threads)

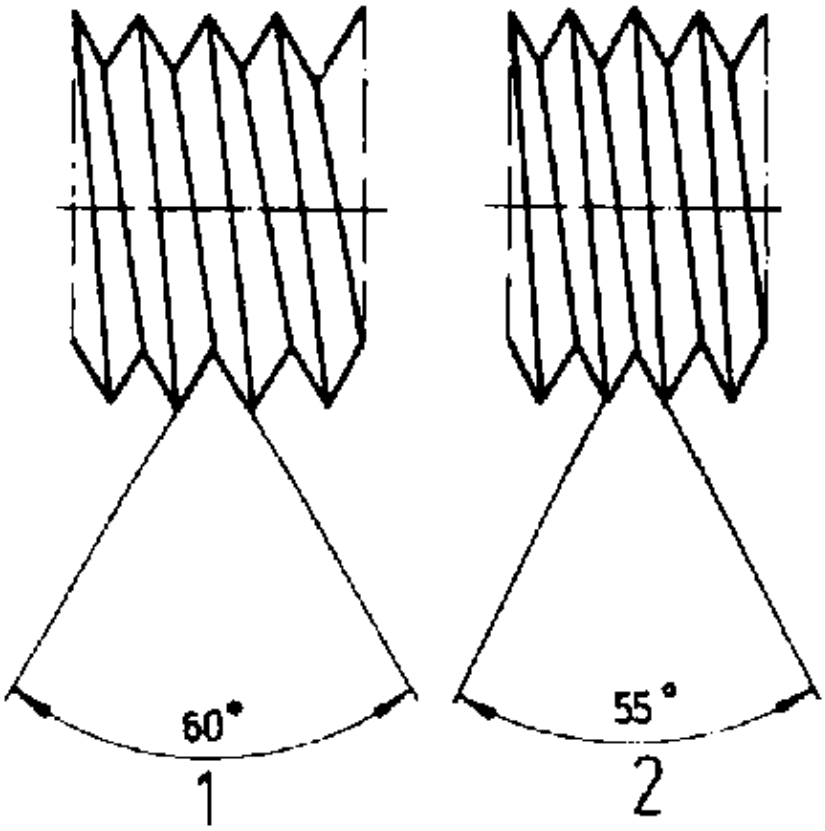

Figure 1. Different flank angles in vee–threads

1 metric thread, 2 Whitworth thread

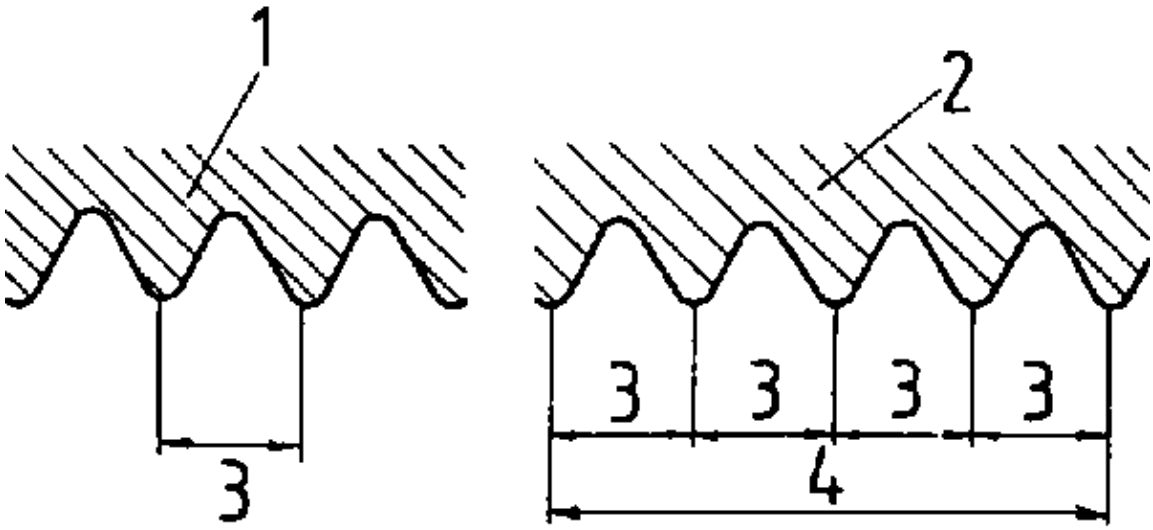

Figure 2. Thread increase

1 metric thread (thread increase in mm), 2 inch thread (thread increase = ¼ inch = 4 turns = 1 inch), 3 thread increase, 4 = one inch

What are the differences between a metric thread and a Whitworth thread?

_____
_____
_____

2. Construction and types of dies and taps

Thread cutting on the external cylindrical surface is made by means of a die. The internal cylindrical surface is processed by using a tap.

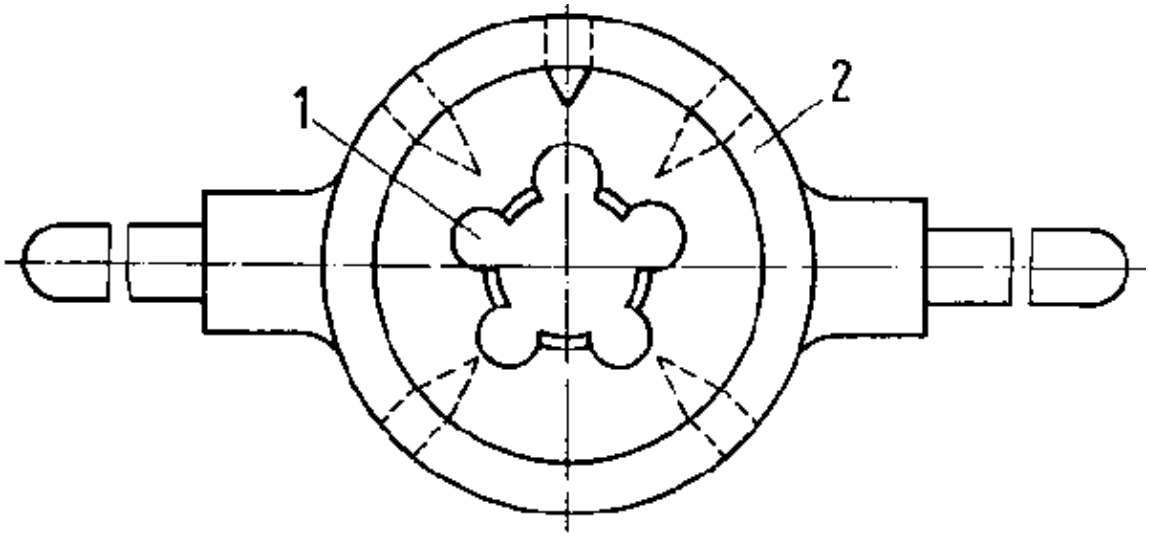

Figure 3. Die with holder

1 die, 2 holder

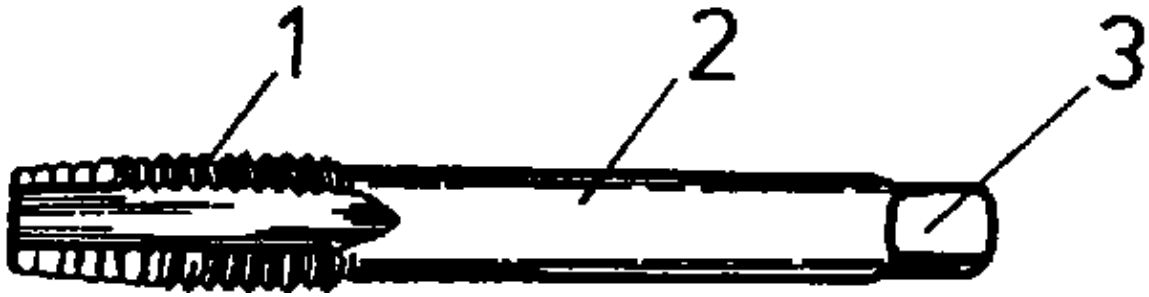

Figure 4. Machine tap

1 tap head (with entering, plug and plug third taps), 2 tap shank, 3 square to hold the tap wrench

The die consists of a die body, chip chambers and starting taper. The rake angles are formed by the chip chambers. Chip removal is made by means of the starting tapers produced by tapered counter–borings. The remaining thread turns are used for ensuring alignment and smoothing.

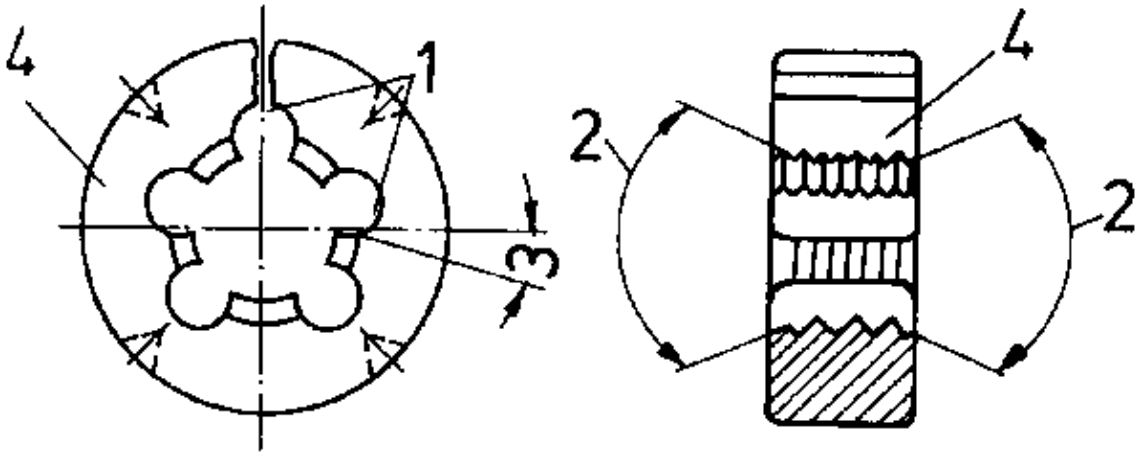

Figure 5. Die arrangement

1 chip chambers, 2 starting taper, 3 chip angle, 4 die body

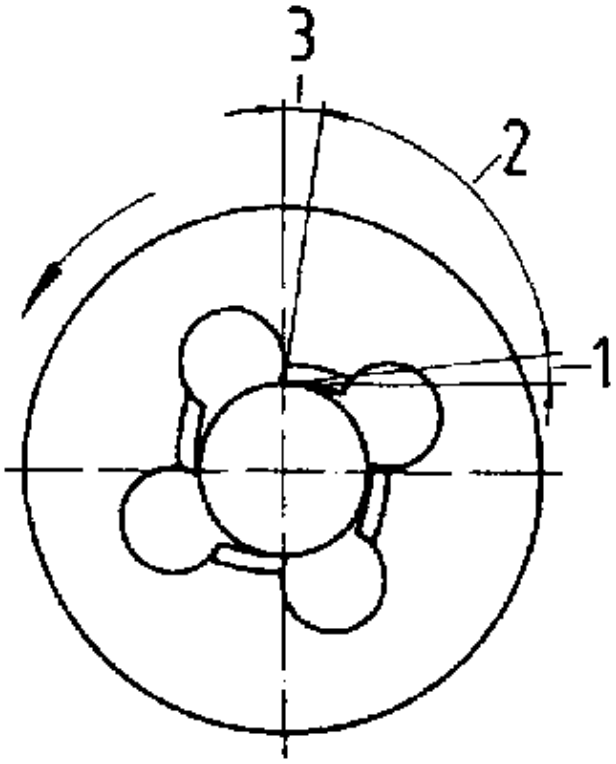

Figure 6. Die and tap angles

1 free angle, 2 taper angle, 3 chip angle

What is the purpose of the rake angle and which are its functions?

_____
_____
_____

The following types are distinguished:

– open dies,
– closed dies, and
– prenotched dies.

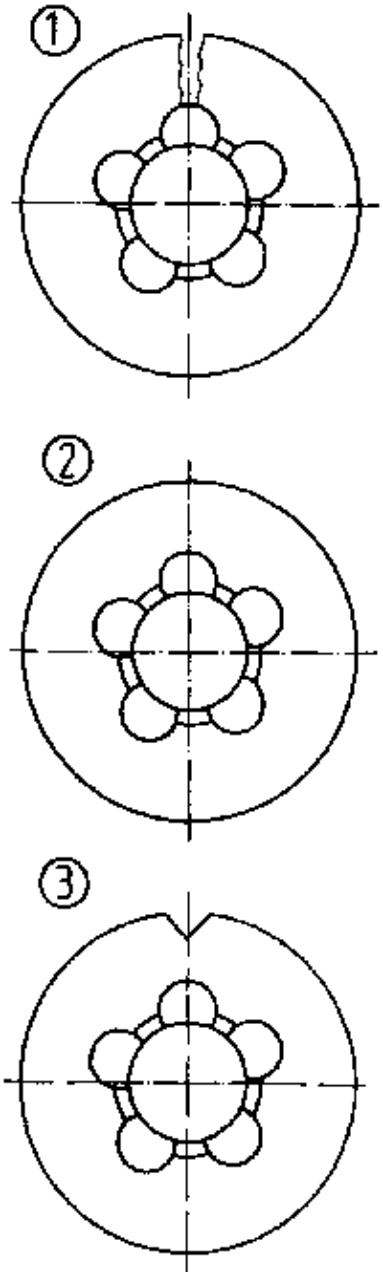

Figure 7. Types of dies

① open die, ② closed die, ③ prenotched die

A closed die cannot be adjusted. The die featuring a groove–like prenotching may initially be used like its closed counterpart.

If required, the web is removed by grinding and it is then used like an open die.

The open die can also be varied in diameter, that is to say either increased or decreased.

The following taps are distinguished:

– hand tap, and
– machine tap.

Cutting generally pertains to entering, plug and plug (third) taps.

In the case of manual taps, one distinguishes between

– entering tap,
– plug tap, and

– plug third tap.

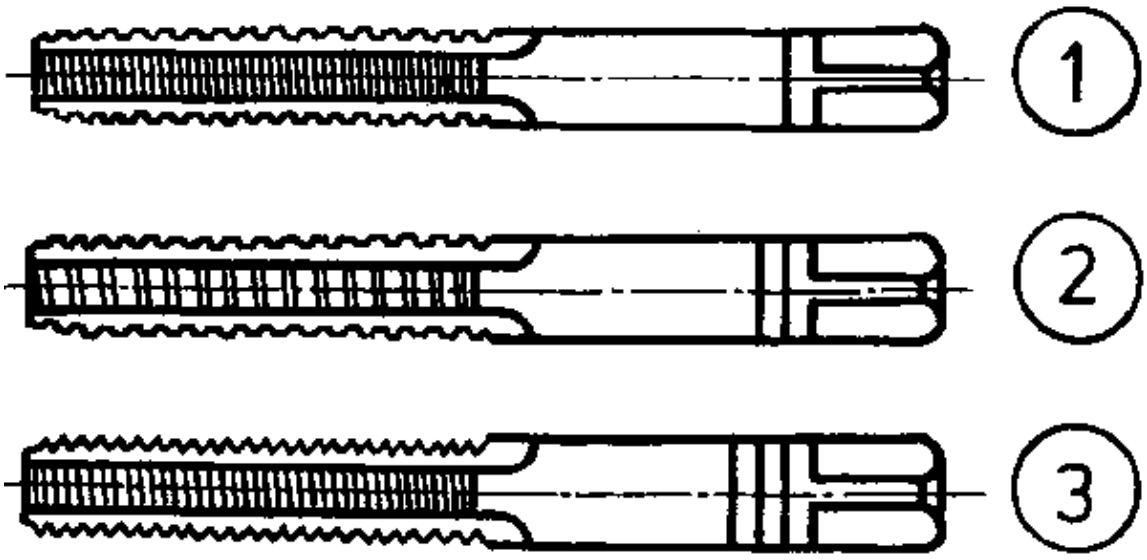

Figure 8. Hand tap

① entering tap
② plug tap
③ plug third tap

Thereby, the globe–like starting taper ensures proper chip removal, the remaining thread section serves to guarantee alignment.

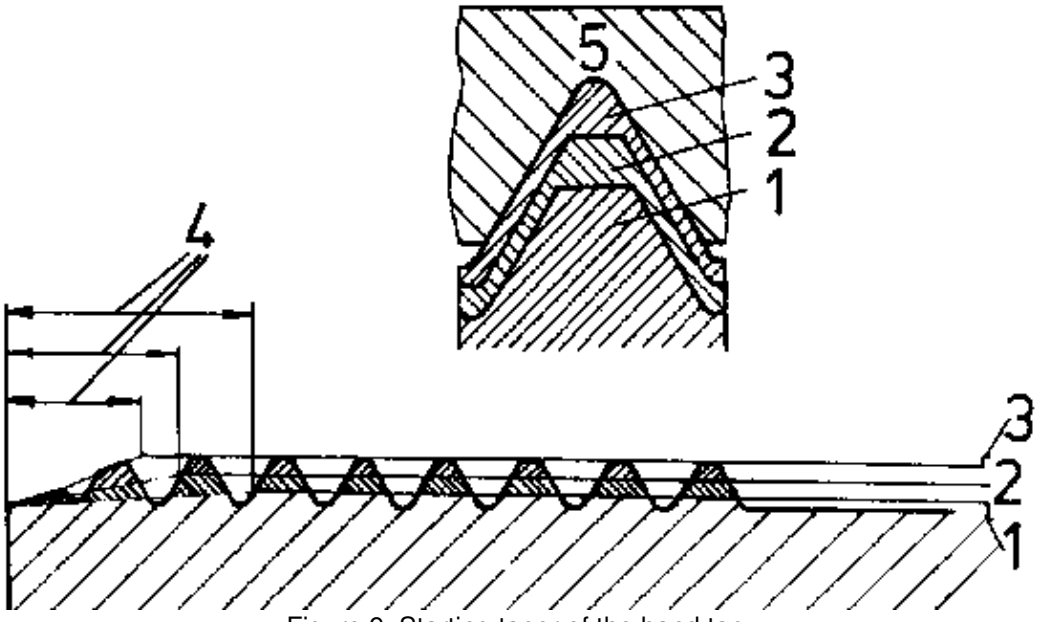

Figure 9. Starting taper of the hand tap

1 entering tap, 2 plug tap, 3 plug third tap, 4 starting taper, 5 internal thread

Plug and plug third taps are turned in a little by hand so that the tap fits into the prenotched thread.

In the case of machine taps (see Fig. 4) all cutting is made by only one tap with a relatively short starting taper.

Nut taps are used in order to cut the thread with one cut in short through holes or in nuts.

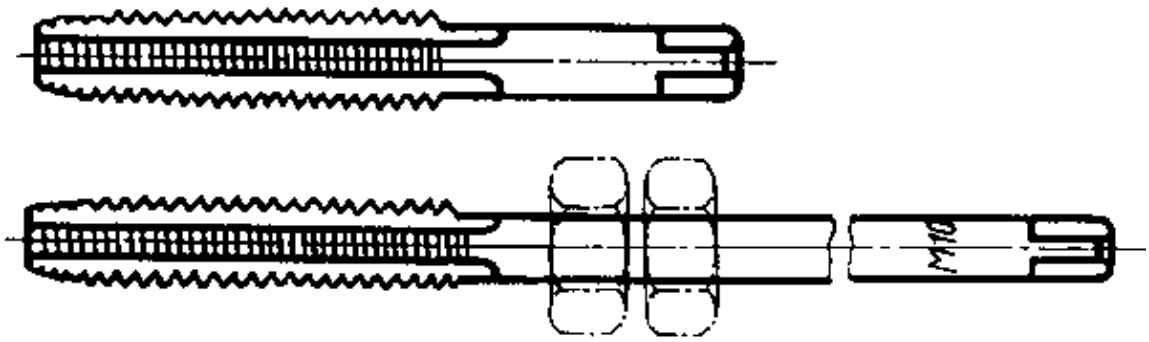

Figure 10. Machine internal tap

The drills combine entering, plug and plug third taps in one long starting taper.

The starting taper is five to sixfold on the thread pitch.

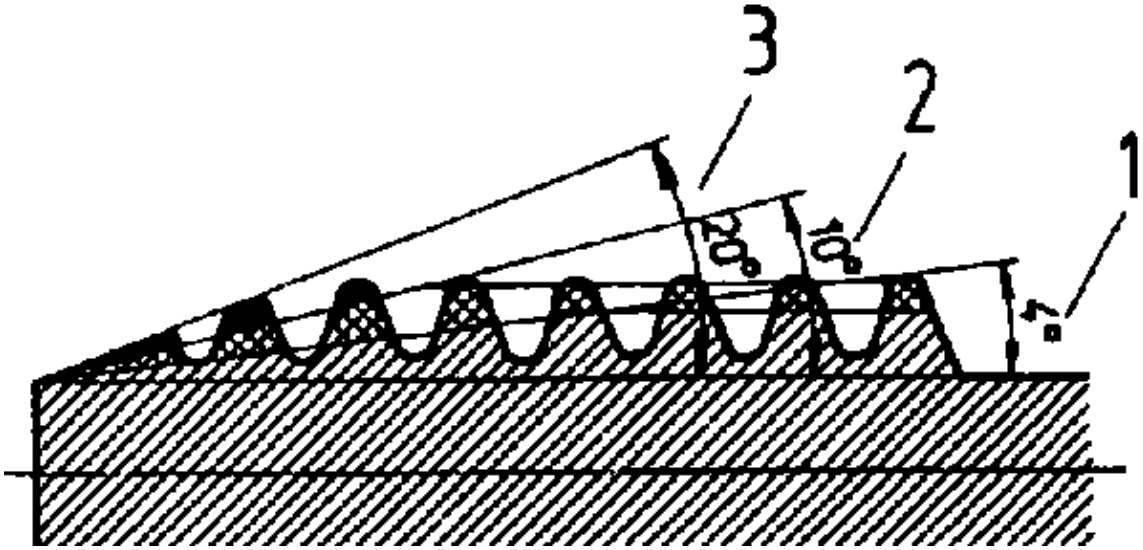

Figure 11. Starting taper of the machine tap

1 entering tap, 2 plug tap, 3 plug third tap

Which types of dies are known?

_____
_____
_____

Which are the principal parts of dies and taps?

_____
_____
_____

3. Preparations for thread cutting by dies and taps

Prior to thread cutting by dies and taps, position in readiness and in proper order all required tools and auxiliary means, allowing so quickest possible access times.

In this connection, pay attention to the following rules:

- Check that all tools function properly; do not use defect tools.
- Working means to be used must not be stacked one above the other.
- Place all measuring and testing tools at the places provided therefore.

– Lay aside tools only when properly cleaned.

– Select all necessary auxiliary means in line with the work assignment and position solely on the provided supports.

Which parameters must be followed when checking the functionality of the tools?

_____
_____
_____

The setting–up of the lathe is mainly made according to the following points:

– Chucking the workpieces for thread cutting

• Extending soft chuck jaws as, normally speaking, the lathe parts to be processed have already been preworked. Extending the chuck jaws ensure the true running of the parts and the workpiece surfaces are not impaired.

• Checking the proper dimensional preparation of the thread diameter and deburring.

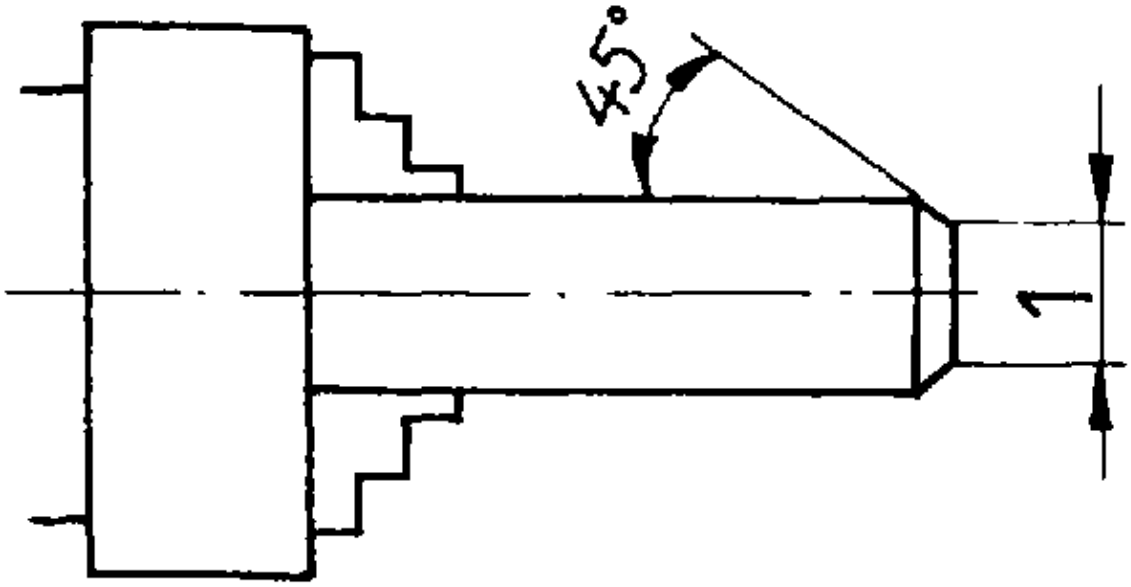

Figure 12. Deburring the workpiece

1 minor diameter

The thread diameter roust be turned about 1/10 smaller than the thread pitch as, whilst cutting, the tool somewhat compresses the material, pressing it outwards. Consequently, the external diameter increases and the die may tear out the thread turns.

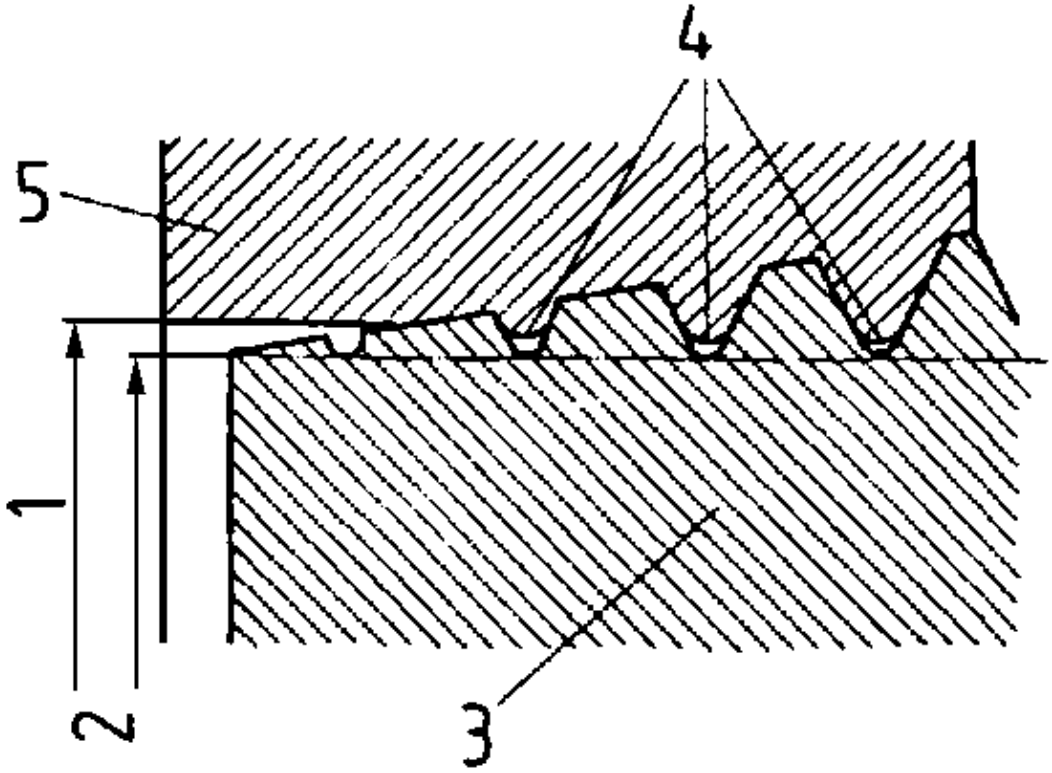

Figure 13. Compression during thread cutting (1/10 greater pitch)

1 minor diameter of the bore, 2 thread minor diameter, 3 tap, 4 compression, 5 workpiece

Example:

Thread M 16
– thread increase 2 mm
1/10 of 2 mm a 0.2 mm
the thread diameter is turned to 15.8 mm

A thread M 30 is to be cut on a shaft. What must be the nominal diameter of the turn?

_____
_____
_____

If the diameter is too small the thread cannot be fully cut. Sound deburring ensures a faultless starting taper. Precise true running of the workpiece is the precondition for a uniform starting taper of the thread turns.

Why must the nominal or minor diameters when thread cutting be 1/10 less or greater than the corresponding increase?

_____
_____
_____

– Clamping the tools for thread cutting

• The die is fixed to a die capsule and then, together with the capsule, accommodated in a die holder (or directly in the die holder).

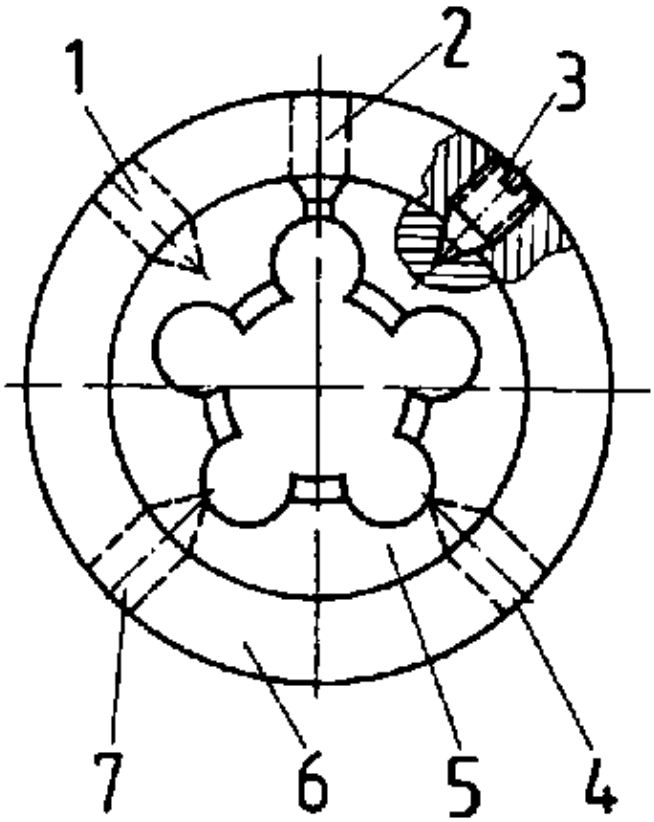

Figure 14. Die capsule

1 clamping nut, 2 expanding nut, 3 clamping nut, 4 holding nut, 5 die, 6 die capsule, 7 holding nut

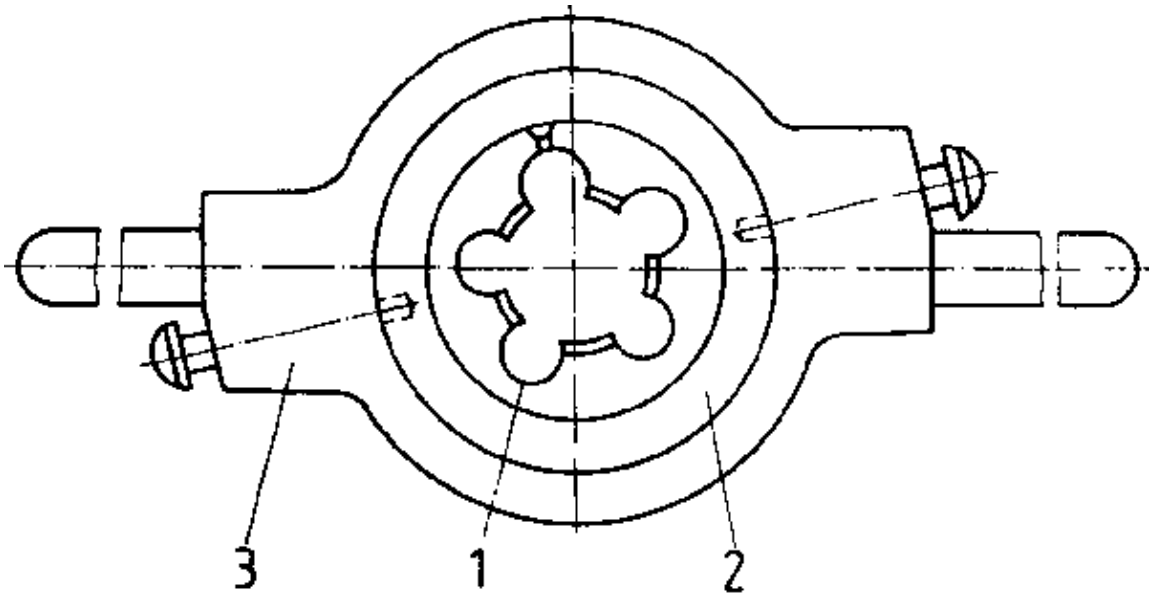

Figure 15. Die holder with capsule

1 die, 2 die capsule, 3 die holder

• The die holder inclusive of the capsule and die must be thoroughly cleaned so that the front surfaces are positioned properly and in a distinctly angular manner.

• The expanding screw roust mesh into the slot of the die. The expanding screw opens the die whilst the adjusting screw closes it (see Fig. 12).

• Use an unhardened thread bolt to set the die.

• A support for the die holder is chucked in the tool holder.

• The support for the die or tap wrench holder must be securely chucked and selected according to the thread length.

• The tailstock quill is brought into working position (Fig. 14) whereby special attention must be given to quill cleanliness.

• When thread cutting by a tap, the tap wrench is positioned on the tap square.

• When thread cutting by a tap ensure correct centring and tailstock middle–positioning.

– Set the cutting values.

Generally speaking, low cutting speeds are selected because of the substantial cutting operation (entering, plug tap and plug third tap in one work sequence), coupled with complicated chip removal. The selected cutting speed depends on the workpiece material and the thread size. When using a die on steel workpieces the cutting speed is 3 – 4 m min^{-1} and 4 – 15 m min^{-1} when employing a tap.

Which rotational speed shall be selected where a thread M 24 x 100 is required for 100 bolts given an St. 60 material?

Formula:

$$v = \frac{d \cdot \pi \cdot n}{1000} \text{ m min}^{-1}$$

$$n = \frac{v \cdot 1000}{d \cdot \pi} \text{ min}^{-1}$$

Calculation:

_____
_____
_____

Explain your reasons for selecting the speed?

_____
_____
_____

Why is only a low speed chosen when thread cutting by a die and tap?

_____
_____
_____

4. Thread cutting by dies on simple cylindrical workpieces

Thread cutting by dies produces an external thread. The work–pieces are processed on the external surface.

– Operations are carried out in chucked conditions.

– Often extended chuck jaws are employed in order to ensure true workpiece running and not to damage the surface of the pre–worked parts.

– The die is positioned in the die holder.

– The die is positioned by means of the quill.

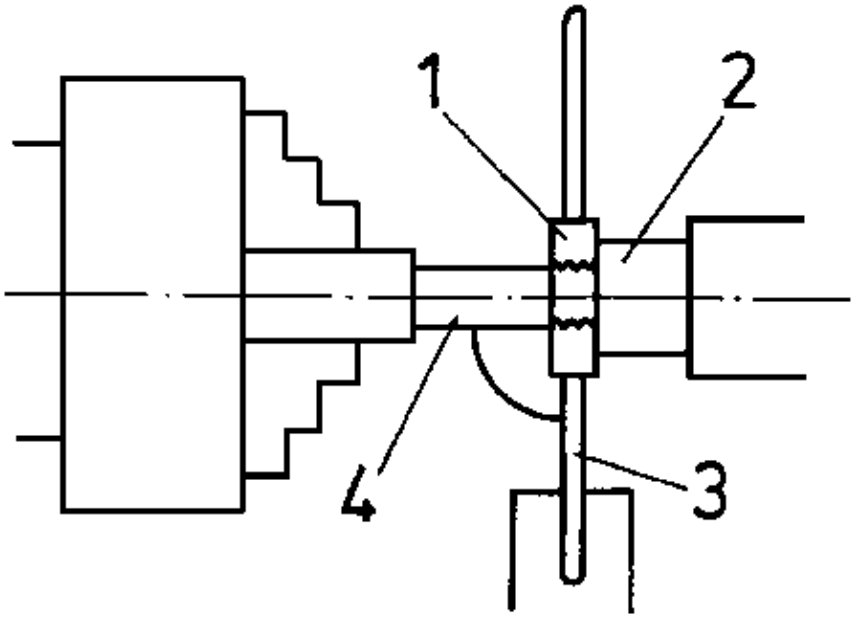

Figure 16. Positioning the die

1 die, 2 quill, 3 support for die holder, 4 workpiece

– The first thread turns must be cut by hand.

– After the initial cut machine processing follows with the help of a support for the die holder. (see Fig. 14)

– Ensure proper cooling and lubrication.

– The chip chambers must always be kept clean.

– Turn back the die by hand after having completed the work sequence.

– The thread is checked by means of a thread ring gauge.

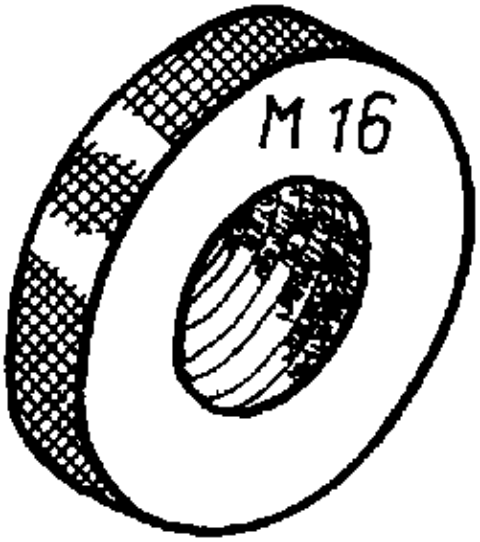

Figure 17. Normal thread ring gauge to check an M 16 thread

What is checked by means of the thread ring gauge and what must be heeded?

_____
_____
_____

5. Thread cutting by dies on recessed cylindrical workplaces

External thread results from outer surface processing of the workpiece.

– Work is made in the chuck.

– The workpiece is clamped in the extended chuck jaws.

– The die is positioned in the die holder.

– The die is brought into position with the help of the quill.

– The first thread turns are cut by hand.

– Following the starting cut machine processing is made with the help of a support for the die holder.

– Ensure that the chip chambers are kept clean.

– Switch off the lathe 2 – 3 mm before reaching the shoulder and cut the remaining thread turns by hand in order to prevent tool breakage and ensure sound quality.

– Turn the die back by hand upon ending the work sequence. Having completed the thread, deburr all sharp edges with a finishing file.

– Ensure proper cooling and lubrication. Only measure and check with the machine at rest.

– The thread is checked by means of a thread ring gauge.

How is the die positioned on the workpiece?

_____

_____

6. Thread cutting by taps on through holes

Internal threads are produced by thread cutting by using taps. The workpiece surfaces are processed by means of bores.

– Work is made in the chuck.

– The workpieces are clamped in the extended chuck jaws in order to guarantee true running and top surface quality as the parts have generally already been processed.

– The tap wrench is positioned on the square of the tap.

– The tap is positioned by means of the tailstock tip which is aligned to the centring of the tap.

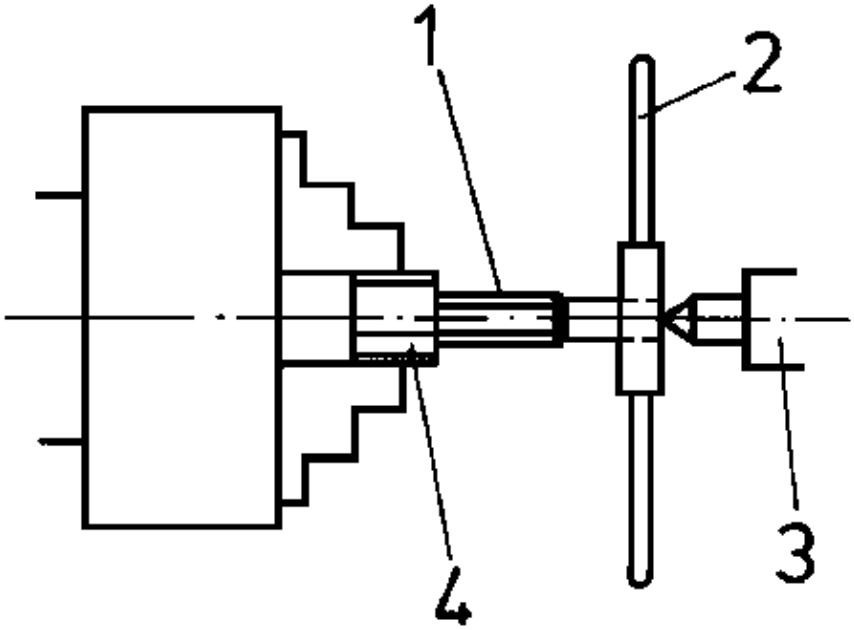

Figure 18. Positioning the tap

1 tap, 2 tap wrench, 3 tailstock quill, 4 workpiece

– The tap wrench holder is positioned on a surface clamped into the tool holder.

– Generally speaking, the machine tap is used (economical mode of operation).

– Turn back the tap several times to remove the chips and clean the chip grooves.

– Ensure proper cooling and lubrication.

– Turn back the tap by hand upon completing the work sequence.

– The thread is checked by means of a thread ring mandrel.

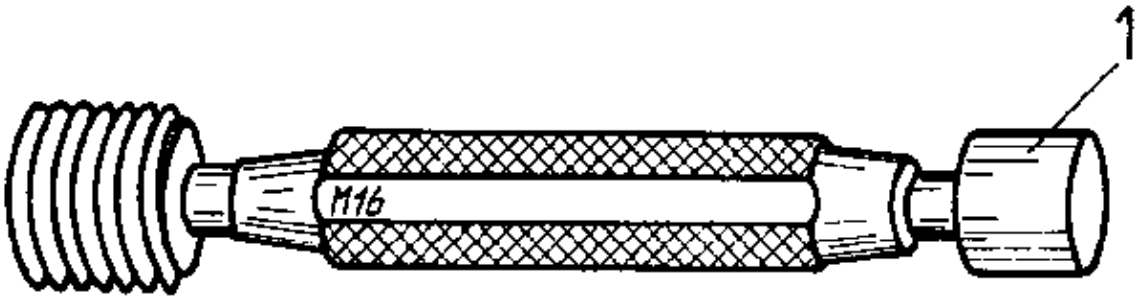

Figure 19. Normal thread ring mandrel

1 thread mandrel for minor diameter

What must be heeded when thread cutting by taps?

_____
_____
_____

7. Thread cutting by taps on blind holes

The internal threads are produced by processing the workpiece surfaces by means of bores.

– work is made in the chuck.

– the workpieces are clamped in extended chuck jaws.

– the tap wrench is positioned on the square of the tap.

– the tap wrench holder is on a support.

– turn back the tap several times to remove the chips.

– the required thread depth is controlled on the quill by means of a steel band measure.

– switch off the machine 2 – 3 mm before ending the work sequence and cut the remaining thread turns by hand in order to prevent tool breakage and ensure sound quality.

– ensure proper cooling and lubrication.

– turn back the tap by hand after having completed the work sequence.

– the thread is checked by means of a thread ring mandrel.

When are dies and taps used for thread cutting?

_____
_____
_____

Appendix 1

Metric thread (standardized)			**Metric fine thread (standardized)**					**Whitworth thread (standardized)**		
Thread	**Drill diameter mm**	**Thread**	**Drill diameter mm**	**Thread**	**Drill diameter mm**	**Thread**	**Drill diameter mm**	**Thread inch**	**Drill diameter**	
									series 1	**series 2**
M 6	5.00	M 6 x 0.75	5.2	M 22 x 1.5	20.5	M 42 x 4	38.0	1/4	5.0	5.10
M 8	6.75	M 8 x 0.75	7.2	M 22 x 2	20.0	M 45 x 2	43.0	5/16	6.40	6.50
M 10	8.50	M 8 x 1	7.0	M 24 x 1	23.0	M 45 x 3	42.0	3/8	7.70	7.90
M 12	10.25	M 9 x 1	9.0	M 24 x 1.5	22.5	M 45 x 4	41.0	7/16	9.10	9.25
M 14	12.00	M 10 x 0.75	9.2	M 24 x 2	22.0	M 48 x 2	46.0	1/2	10.25	10.50
M 16	14.00	M 10 x 1	9.0	M 27 x 1	26.0	M 48 x 3	45.0	5/8	13.25	13.50
M 18	15.50	M 10 x 1.25	8.8	M 27 x 1.5	25.5	M 48 x 4	44.0	3/4	16.25	16.50
M 20	17.50	M 12 x 1	11.0	M 27 x 2	25.0	M 52 x 2	50.0	7/8	19.00	19.25
M 22	19.50	M 12 x 1.25	10.8	M 30 x 1	29.0	M 52 x 3	49.0 1	–	21.75	22.00

M 24	21.00	M 12 x 1.5	10.5	M 30 x 1.5	28.5	M 52 x 4	48.0 1	1/8	24.50	24.75
M 27	24.00	M 14 x 1	13.0	M 30 x 2	28.0	M 56 x 2	54.0 1	1/4	27.50	27.75
M 30	26.50	M 14 x 1.25	12.8	M 30 x 3	27.0	M 46 x 3	53.0 1	3/8	30.00	30.50
M 33	29.50	M 14 x 1.5	12.5	M 33 x 1.5	31.5	M 56 x 4	52.0 1	1/2	33.00	33.50
M 36	32.00	M 16 x 1	15.0	M 33 x 2	31.0	M 60 x 2	58.0 1	5/8	35.00	35.50
M 39	35.00	M 16 x 1.5	14.5	M 33 x 3	30.0	M 60 x 3	57.0 1	3/4	38.50	39.00
M 42	37.50	M 18 x 1	17.0	M 36 x 1.5	34.5	M 60 x 4	56.0 1	7/8	41.00	41.50
M 45	40.50	M 18 x 1.5	16.5	M 36 x 2	34.0	M 64 x 2	62.0 2		44.00	44.50
M 48	43.00	M 18 x 2	16.0	M 36 x 3	33.0	M 64 x 3	61.0			
M 52	47.00	M 20 x 1	19.0	M 39 x 2	37.0	M 64 x 4	60.0			
M 56	50.50	M 20 x 1.5	18.5	M 39 x 3	36.0	M 68 x 2	66.0			
M 60	54.50	M 20 x 2	18.0	M 42 x 2	40.0	M 68 x 3	65.0			
M 64	58.00	M 22 x 1	21.0	M 42 x 3	39.0	M 68 x 3	64.0			
M 68	62.00									

Series one **Materials which squeeze up slightly**		**Series two** **Materials which squeeze up considerably**	
grey cast iron	brittle copper alloys	steel	zinc alloys
bronze	some aluminium alloys	cast steel	some aluminium alloys
brass	magnesium, iron, die and wrought alloys	malleable cast iron	pressed materials