Think **safety**, Think **HSS**
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8 Thread milling
9 Chamfer forms
10 Chamfer length
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12 Basic thread forms
13 Clamping taps

TAPPING PROCESS
14 The basics of tapping
15 Typical cutting speeds
16 Cooling
17 Problem solving
18 Wear
Clamping

Coating

Type of flute

Tool material

Chamfer form and length

Dimensions
### TOOL MAKER’S TIP
Reach the highest performance with HSS-PM taps

<table>
<thead>
<tr>
<th>HSS</th>
<th>HSS-E 5% cobalt or high vanadium</th>
<th>HSS-E 8% cobalt</th>
<th>HSS-PM</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Mainly for hand taps</td>
<td>• Basic choice</td>
<td>• For higher cutting speeds and increased productivity</td>
<td>• For higher performance and longer tool life</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• For nickel alloys, titanium alloys and hard steels</td>
</tr>
</tbody>
</table>

### WHICH HSS FOR MAXIMUM EFFICIENCY?

- HSS
- HSS-E 5% cobalt or high vanadium
- HSS-E 8% cobalt
- HSS-PM
## Tool Maker’s Tip

For maximum coating efficiency, prefer a HSS-PM substrate

<table>
<thead>
<tr>
<th>Surface Treatment</th>
<th>Applications</th>
</tr>
</thead>
</table>
| **Steam oxide**   | - Basic choice  
                    - For a lower friction coefficient  
                    - For cast iron, silicon alloys, and thermosetting plastics |
| **Nitride**       | - Basic choice  
                    - For mild steels, hard steels, tool steels and hardened steels  
                    - For dry tapping  
                    - For hard steels, tool steels and hardened steels |
| **TiN**           | - For high speed tapping  
                    - For dry tapping  
                    - Good anti-welding properties, reduces friction  
                    - Used in combination with other coatings  
                    - Suitable for dry machining |
| **Gold**          | - For copper alloys, brass, bronze etc. |
| **TiCN**          | - For high speed tapping  
                    - For dry tapping  
                    - Good anti-welding properties, reduces friction  
                    - Used in combination with other coatings  
                    - Suitable for dry machining |
| **CrN**           | - For copper alloys, brass, bronze etc. |
| **MoS₂ or WC-C**  | - For high speed tapping  
                    - For dry tapping  
                    - Good anti-welding properties, reduces friction  
                    - Used in combination with other coatings  
                    - Suitable for dry machining |
| **Metal**         | - For copper alloys, brass, bronze etc. |
VOCABULARY

A TAP AROUND THE WORLD

French: un taraud
German: ein Gewindebohrer
Italian: un maschio
Spanish: un macho de roscar

Flute
Web diameter
Chamfer length
Thread length
Overall length
Shank diameter
Square width
Chamfer length
Thread length
Overall length
Square width
Land width
(Female) Center
(Female) Center
(Male) Center
(Male) Center
Shank diameter
Square length
Square length
Land width
Web diameter
Chamfer length
Thread length
Overall length
Square width
TAPPING

- **Straight fluted tap with spiral point**
  - For through holes
  - Removes the chips in the cutting direction

- **Left hand spiral fluted tap**
  - For through holes
  - Removes the chips in the cutting direction

- **Straight fluted tap with long chamfer lead**
  - For through holes

- **Straight fluted tap with short chamfer lead**
  - For blind holes
  - For general purpose
  - Chamfer lead length calculated to prevent chips from jamming during the return movement. Chips are sheared off clearly

- **Right hand spiral fluted tap**
  - For blind holes
  - Removes the chips up the flutes
Fluteless taps produce internal threads without chip removal. Fluteless taps are recommended for non-ferrous metals such as aluminum and copper alloys, soft brass and soft steels.

Advantages:
- no chips
- no cutting errors
- no pitch errors
- higher tensile strength
- better surface finish
- long tool life
- high cutting speeds (double that of tapping)

For deep holes, fluteless taps with oil grooves are recommended.

SUCCESS STORY

Operation
- Tapping of holes M8x1.25 mm, height 9.7 mm

Problem
- Too long swarf, requiring constant removal by operator and checking each thread for chip fragments

Solution
- TiN coated HSS fluteless tap, without oil grooves

Benefits
- Tool life x 20, i.e. 5000 threads (vs. 250 with former tap)

Boron alloyed Steel
800 N/mm²
Thread milling cutters produce internal threads by helical interpolation: the tool moves with axial (rotation) and orbital (revolution) motions, requiring simultaneous 3-axis control and high machine and tool rigidity.

Advantages:
- For large hole diameters
- Only one tool needed to produce threads for different nominal diameters
- Fine chips, preventing clogging
- Internal threading over the length of blind holes
- No stop marks
TOOL MAKER’S TIP
In tapping, all the machining is carried out by the cutting teeth of the chamfer

<table>
<thead>
<tr>
<th>Form</th>
<th>Characteristics</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Long, 6-8 threads, for short through holes, increases torque and prevents breakage</td>
</tr>
<tr>
<td>B</td>
<td>Medium, 3.5-5 threads, with spiral point, useful for blind holes, for all through holes and deep tapping holes, efficient in tough and tough hard materials</td>
</tr>
<tr>
<td>C</td>
<td>Short, 2-3 threads, for blind holes, generally for aluminum, grey cast iron and brass</td>
</tr>
<tr>
<td>D</td>
<td>Medium, 3.5-5 threads, for through and blind holes with sufficient run-out depth</td>
</tr>
<tr>
<td>E</td>
<td>Extremely short, 1.5-2 threads, for blind holes with little run-out depth, avoid use if possible</td>
</tr>
</tbody>
</table>
Tapping process with a four-flute tap and five-thread chamfer

Chamfer lead length for sets of three taps
In most cases, after tapping, the internal thread size is larger than the tap size.

**Internal Thread**

- \(D_{\text{min}}\) = Min. major diameter
- \(D_{2\text{ max}}\) = Max. pitch diameter
- \(D_{2\text{ min}}\) = Min. pitch diameter
- \(D_{1\text{ max}}\) = Max. minor diameter
- \(D_{1\text{ min}}\) = Min. minor diameter

- \(d\) = Major diameter
- \(d_{2}\) = Pitch diameter
- \(d_{1}\) = Minor diameter
- \(P\) = Pitch
- \(\alpha\) = Thread angle
BASIC THREAD FORMS

British Standard Whitworth

British Standard Pipe Tap & ISO Taper Pipe

American Standard Pipe Taper

British Association CYCLE

British & American Standard GENERAL PURPOSE ACME

ISO Metric ISO Inch Unified

British Standard BUTTRESS

American Standard STUB ACME

American Standard Pipe Taper DRYSEAL NPTF

American Standard PIPE STRAIGHT

American Standard BUTTRESS

BUTTRESS (Continental)

Whitworth thread BS 84

Metric thread ISO R68 (DIN13)
Square shank (with solid cone)
Square shank (with chamfer)
Square shank (with internal hole)
Weldon shank (with clamping flat)
Seldom used
Tapping is a machining operation which produces internal threads in a drilled hole.

Tapping is the most efficient way to produce precise internal threads with cost efficiency.

Tapping is an easy operation but subject to chip packing in deep blind holes.

Tapping can be performed on all types of machines or with a self-reversing tap holder.
Cutting fluids in tapping
Lubricating, cooling and chip removal are essential in the tapping operation because the cutting speed is slow and chips tend to pack.

In tapping, oils are usually preferred but high performance soluble oils are increasingly used.

SUCCESS STORY - Dry tapping in...

<table>
<thead>
<tr>
<th>Carbon steel</th>
<th>Operation</th>
<th>Tool</th>
<th>Benefits</th>
</tr>
</thead>
<tbody>
<tr>
<td>C45, 650 N/mm²</td>
<td>Through hole tapping of a hole 1.6 x dia., without coolant</td>
<td>HSS Co5 + TiCN coating tap with special geometry</td>
<td>High speed tapping ( v_c ) 50 m/min (vs. 15-20 m/min with 5% emulsion)</td>
</tr>
</tbody>
</table>

Oil-hole taps
Oil-hole taps are recommended for high performance tapping or for difficult-to-machine materials.

Dry tapping
Tapping with micro-lubrication is also possible.

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Dry tapping
Tapping with micro-lubrication is also possible.
<table>
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<tr>
<th>Problem</th>
<th>Solutions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oversized internal thread</td>
<td>Select a tap with tighter thread tolerance or with a longer chamfer length. Avoid tap deflection. Use a tap with a spiral flute. Decrease the speed. Use a coated tap to prevent edge built-up. Increase coolant flow.</td>
</tr>
<tr>
<td>Undersized internal thread</td>
<td>Use an oversized tap, when machining copper, aluminium alloys and cast iron or when tapping thin plates, or if meeting holes. Increase the speed. Decrease the speed during the return motion. Increase coolant flow.</td>
</tr>
<tr>
<td>Galling and torn internal thread</td>
<td>Select a tap with a longer chamfer length. Use a coated tap and increase coolant flow. Reduce the cutting speed. Use a tap with a spiral flute. Prevent excessive cutting torque by enlarging the hole before tapping.</td>
</tr>
<tr>
<td>Rough surface of internal thread</td>
<td>Use a more rigid tap holder and piece clamping. Increase coolant flow or use a high quality coolant.</td>
</tr>
<tr>
<td>Breakage of tap</td>
<td>Use a tap with a spiral flute. Prevent excessive cutting torque by enlarging the hole before tapping. Reduce the cutting speed. Prevent the tap from colliding with the bottom of the hole.</td>
</tr>
<tr>
<td>Chipping of tap thread</td>
<td>Select a tap with a longer chamfer length. Use a tap with a spiral flute. Reduce the cutting speed. Use a high quality coolant.</td>
</tr>
<tr>
<td>Early tap wear</td>
<td>Use a coated tap. Select a tap with a longer chamfer length. Reduce the cutting speed. Use a high quality coolant.</td>
</tr>
<tr>
<td>Welding on the tap</td>
<td>Increase coolant flow. Adjust the cutting speed. Use a coated tap.</td>
</tr>
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