Counter sinking

Objectives: At the end of this lesson you shall be able to
- **state countersinking**
- **list the purposes of countersinking**
- **state the angles of countersinking for the different applications**
- **name the different types of countersinks**
- **distinguish between Type A and Type B counter sink holes.**

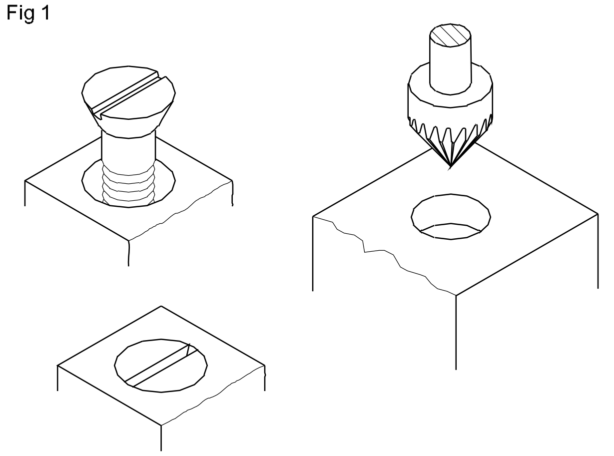
What is countersinking?

Countersinking is an operation of bevelling the end of a drilled hole. The tool used is called a countersink.

Countersinking is carried out for the following purposes:

- To provide a recess for the head of a countersink screw, so that it is flush with the surface after fixing (Fig 1)

Fig 1



- To deburr a hole after drilling
- For accommodating countersink rivet heads
- To chamfer the ends of holes for thread cutting and other machining processes.

Angles for countersinking

Countersinks are available in different angles for different uses.

75° countersink riveting

80° countersink self tapping screws

90° countersink head screws and deburring

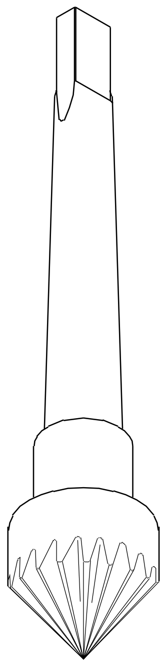
120° chamfering ends of holes to be threaded or other machining processes.

Countersinks

Countersinks of different types are available.

The commonly used countersinks have multiple cutting edges and are available in taper shank and straight shank. (Fig 2)

Fig 2



For countersinking small diameter holes special countersinks with two or one flute are available. This will reduce the vibration while cutting.

Countersinks with Pilot (Fig 3)

For precision countersinking, needed for machine tool assembling and after machining process, countersinks with pilots are used.

They are particularly useful for heavy duty work.

The pilot is provided at the end for guiding the countersink concentric to the hole.

Countersinks with pilots are available with interchangeable and solid pilots.

Countersink hole sizes

The countersink holes according to Indian Standard IS 3406 (Part 1) 1986 are of four types: Type A, Type B, Type C and Type E.

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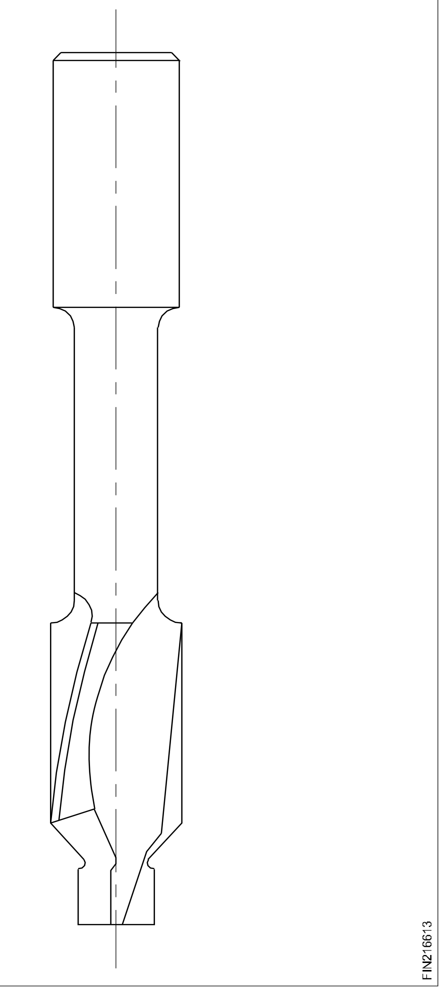
Fig 3



Type A is suitable for slotted countersink head screws, cross recessed and slotted raised countersink head screws.

These screws are available in two grades i.e. medium and fine.

The dimensions of various features of the Type 'A' countersink holes, and the method of designation are given in Table 1.

Type 'B' countersink holes are suitable for countersink head screws with hexagon socket.

The dimensions of the various features and the method of designation are given in Table II.

Type 'C' countersink holes are suitable for slotted raised countersink (oval) head tapping screws and for slotted countersink (flat) head tapping screws.

The dimension of the various features and the method of designation are given in Table III.

Type 'E' countersinks are used for slotted countersink bolts used for steel structures.

The dimensions of the various features and the method of designation are given in Table IV.

TABLE I

Dimensions and designation of countersink - Type A according to IS 3406 (Part 1) 1986

Fig 4

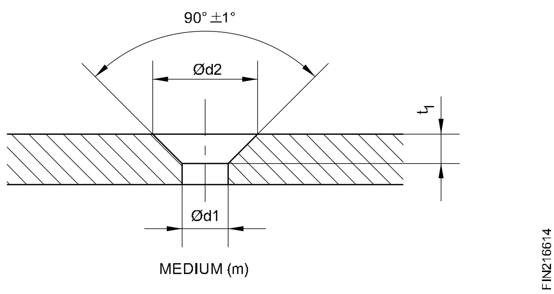


Fig 5

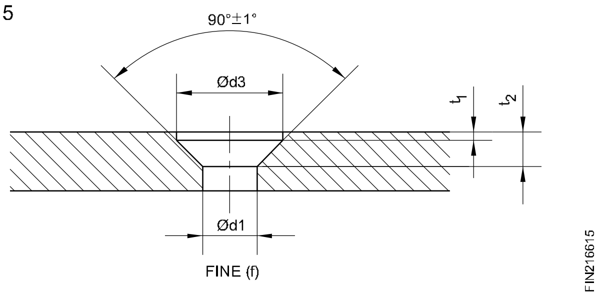


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TABLE I

For Nominal Size		1	1.2	(1.4)	1.6	(1.8)	2	2.5	3	3.5	4	(4.5)
Medium	d_1 H13	1.2	1.4	1.6	1.8	2.1	2.4	2.9	3.4	3.9	4.5	5
Series	d_2 H13	2.4	2.8	3.3	3.7	4.1	4.6	5.7	6.5	7.6	8.6	9.5
(m)	t_1 ^{3}	0.6	0.7	0.8	0.9	1	1.1	1.4	1.6	1.9	2.1	2.3
Fine	d_1 H12	1.1	1.3	1.5	1.7	2	2.2	2.7	3.2	3.7	4.3	4.8
Series	d_3 H12	2	2.5	2.8	3.3	3.8	4.3	5	6	7	8	9
(f)	t_1 ^{3}	0.7	0.8	0.9	1	1.2	1.2	1.5	1.7	2	2.2	2.4
	t_2 + 0.1 0	0.2	0.15	0.15	0.2	0.2	0.15	0.35	0.25	0.3	0.3	0.3

For Nominal Size		5	6	8	10	12	(14)	16	(18)	20
Medium	d_1 H13	5.5	6.6	9	11	13.5	15.5	17.5	20	22
Series	d_2 H13	10.4	12.4	16.4	20.4	23.9	26.9	31.9	36.4	40.4
(m)	t_1 ^{3}	2.5	2.9	3.7	4.7	5.2	5.7	7.2	8.2	9.2
Fine	d_1 H12	5.3	6.4	8.4	10.5	13	15	17	19	21
Series	d_3 H12	10	11.5	15	19	23	26	30	34	37
(f)	t_1 ^{3}	2.6	3	4	5	5.7	6.2	7.7	8.7	9.7
	t_2 + 0.1 0	0.2	0.45	0.7	0.7	0.7	0.7	1.2	1.2	1.7

Note 1 : **Size shown in brackets are of second preference.**

Note 2 : Clearance hole d_1 according to medium and fine series of IS : 1821 ' Dimensions for clearance holes for bolts and screws (second revision)'

Designation : A countersink Type A with clearance hole of fine (f) series and having nominal size 10 shall be designated as – Countersink A f 10 - IS : 3406.

TABLE II

Dimensions and designation of countersink - Type B according to IS 3406 (Part 1) 1986

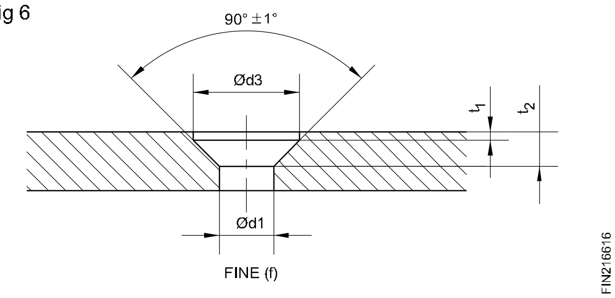

Fig 6

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For Nominal Size		3	4	5	6	8	10	12	(14)	16	(18)	20	22	24
Fine	d_1 H12	3.2	4.3	5.3	6.4	8.4	10.5	13	15	17	19	21	23	25
Series	d_2 H12	6.3	8.3	10.4	12.4	16.5	20.5	25	28	31	34	37	48.2	52
(f)	t_1 [3]	1.7	2.4	2.9	3.3	4.4	5.5	6.5	7	7.5	8	8.5	13.1	14
	t_2 + 0.1	0.2		0.3		0.4				0.5			1	

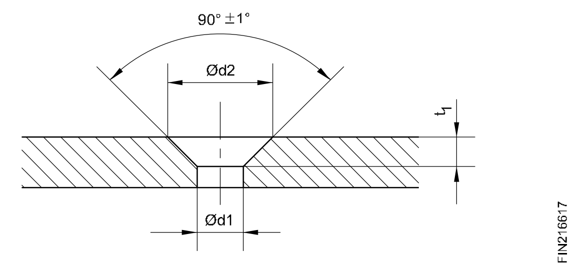
Note 1: **Sizes shown in brackets are of second preference.**
Note 2: Clearance hole d1 according to medium and fine series of IS : 1821- 1982.

Designation : A countersink Type B with clearance hole of fine (f) series and having nominal size 10 shall be designated as – Countersink B *f* 10 - IS : 3406.

TABLE III

Dimensions and designation of countersink - Type C according to IS 3406 (Part 1) 1986

Fig 7



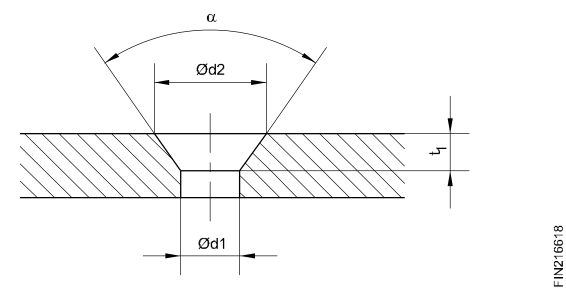
For Screw Size No.	(0)	(1)	2	(3)	4	(5)	6	(7)	8	10	(12)	14	(16)
d_1 H12	1.6	2	2.4	2.8	3.1	3.5	3.7	4.2	4.5	5.1	5.8	6.7	8.4
d_2 H12	3.1	3.8	4.6	5.2	5.9	6.6	7.2	8.1	8.7	10.1	11.4	13.2	16.6
t_1 [3]	0.9	1.1	1.3	1.5	1.7	1.9	2.1	2.3	2.6	3	3.4	3.9	4.9

Note : Sizes given in brackets are of second preference.

Designation : A countersink Type C for screw size 2 shall be designated as – Countersink C 2 - IS : 3406.

TABLE IV

Fig 8



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Dimension and designation of countersink - Type E according to IS 3406 (Part 1) 1986

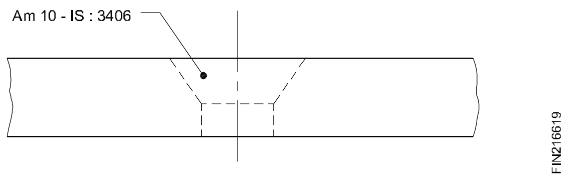
For Nominal No.	10	12	16	20	22	24
d_1 H12	10.5	13	17	21	23	25
d_2 H12	19	24	31	34	37	40
t_1 [3]	5.5	7	9	11.5	12	13
$\alpha \pm 1°$		75°			60°	
Note: Clearance hole d_1 according to fine series of IS : 1821 - 1982						

Designation : A countersink Type E for nominal size 10 shall be designated as – Countersink E 10 - IS : 3406.

Methods of representing countersink holes in drawings

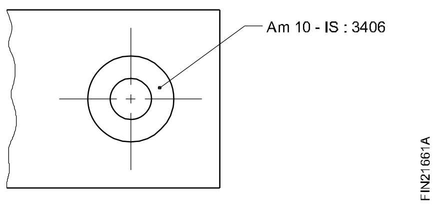
Countersink hole sizes are identified by code designation or using dimension.

Fig 9



Use of code designation

Fig 10



Use of dimension

The dimension of the countersink can be expressed by the diameter of the countersink and the depth of the countersink.

Fig 11

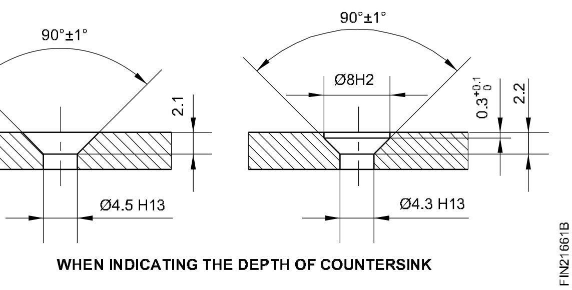
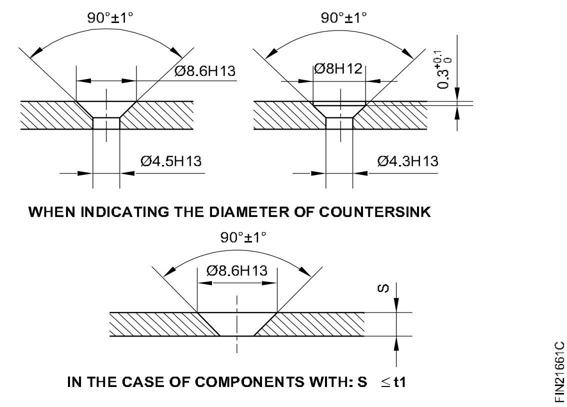


Fig 12



Counterboring and spot facing

Objectives: At the end of this lesson you shall be able to
- **differentiate counterboring and spot facing**
- **state the types of counterbores and their uses**
- **determine the correct counterbore sizes for different holes.**

Counterboring

Counterboring is an operation of enlarging a hole to a given depth, to house heads of socket heads or cap screws with the help of a counterbore tool. (Fig 1)

Counterbore (Tool)

The tool used for counterboring is called a counterbore. (Fig 2) Counterbores will have two or more cutting edges.

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Fig 1

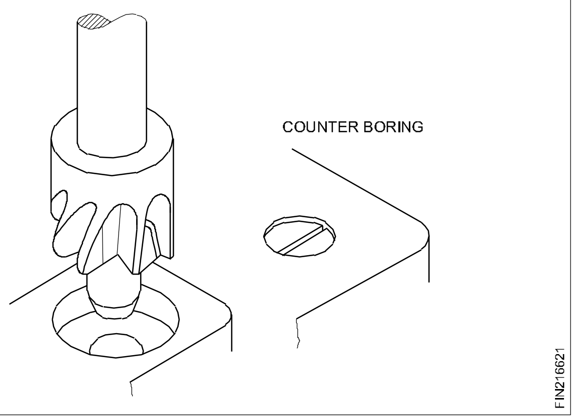
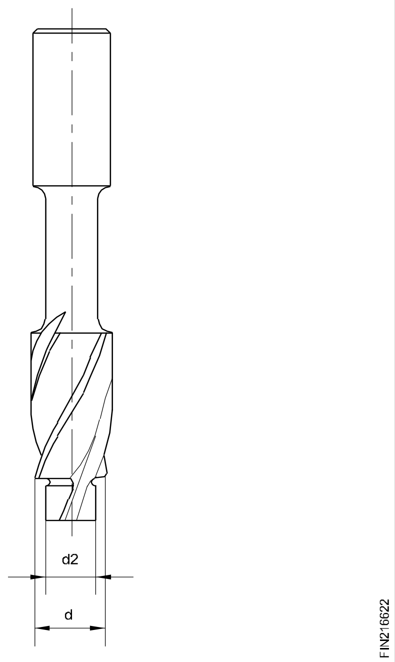
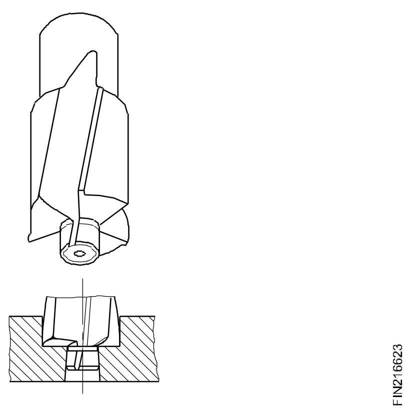


Fig 2



At the cutting end, a pilot is provided to guide the tool concentric to the previously drilled hole. The pilot also helps to avoid chattering while counterboring. (Fig 3)

Fig 3

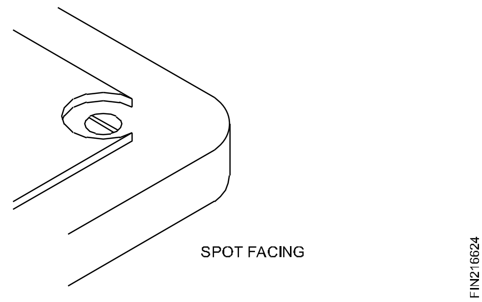


Counterbores are available with solid pilots or with interchangeable pilots. The interchangeable pilot provides flexibility of counterboring on different diameters of holes.

Spot facing

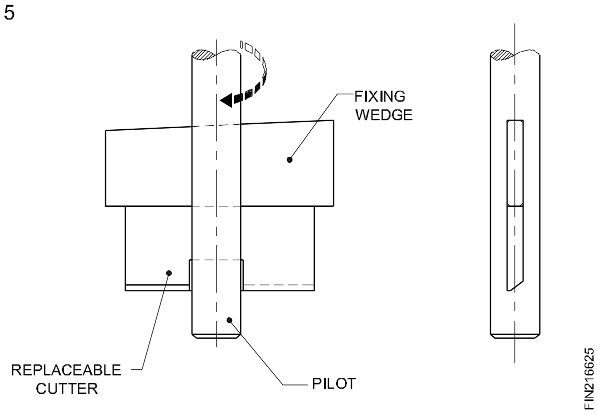
Spot facing is a machining operation for producing a flat seat for bolt head, washer or nut at the opening of a drilled hole. The tool is called a spot facer or a spot facing tool. Spot facing is similar to counterboring, except that it is shallower. Tools that are used for counterboring can be used for spot facing as well. (Fig 4)

Fig 4



Spot facing is also done by fly cutters by end-cutting action. The cutter blade is inserted in the slot of the holder, which can be mounted on to the spindle. (Fig 5)

Fig 5



Counterbore sizes and specification

Counterbore sizes are standardised for each diameter of screws as per BIS.

There are two main types of counterbores. Type H and Type K.

The type H counterbores are used for assemblies with slotted cheese head, slotted pan head and cross recessed pan head screws. The type K counterbores are used in assemblies with hexagonal socket head capscrews.

For fitting different types of washers the counterbore standards are different in Type H and Type K.

The clearance hole d1 are of two different grades i.e. medium (m) and fine (f) and are finished to H13 and H12 dimensions.

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The table given below is a portion from IS 3406 (Part 2) 1986. This gives dimensions for Type H and Type K counterbores.

Counterbore and Clearance Hole Sizes for Different Sizes of Screws

Dimensions for H and K Type counter bores

While representing counterbores in drawings, counterbores can be indicated either by code designation or using the dimensions.

Table - 1

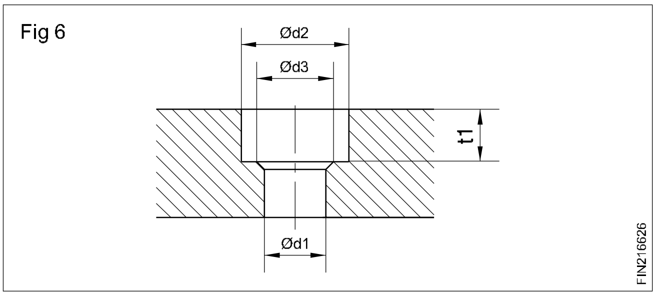

Fig 6

		1	1.2	1.4	1.6	1.8	2	2.5	3	(3.5)	4	5	6	8	10	12	(14)	16	18	20	22	24	27	30	33	36
For Nominal size		1	1.2	1.4	1.6	1.8	2	2.5	3	(3.5)	4	5	6	8	10	12	(14)	16	18	20	22	24	27	30	33	36
d1	**Medium (m) H13**	1.2	1.4	1.6	1.8	2.1	2.4	2.9	3.4	3.9	4.5	5.5	6.6	9	11	13.5	15.5	17.5	20	22	24	26	30	33	36	39
	fine (f) H12	1.1	1.3	1.5	1.7	2	2.2	2.7	3.2	3.7	4.3	5.3	6.4	8.4	10.5	13	15	17	19	21	23	25	-	-	-	-
d2 H13		2.2	2.5	2.8	3.3	3.8	4.3	5	6	6.5	8	10	11	15	18	20	24	26	30	33	36	40	43	48	53	57
d3		-	-	-	-	-	-	-	-	-	-	-	-	-	-	15.5	17.5	19.5	22	24	26	28	33	36	39	42
t1	**Type H**	0.8	0.9	1	1.2	1.5	1.6	2	2.4	2.9	3.2	4	4.7	6	7	8	9	10.5	11.5	12.5	13.5	14.5	-	-	-	-
	Type K	-	-	1.6	1.8	-	2.3	2.9	3.4	-	4.6	5.7	6.8	9	11	13	15	17.5	19.5	21.5	23.5	25.5	28.5	32	35	38
Tolerances			+0.1 0					+0.2 0								+0.4 0						+0.6 0				

Note : Sizes given in brackets are of second preference. For details refer IS : 3406 (Part2) 1986.

Using code designation (Fig 7)

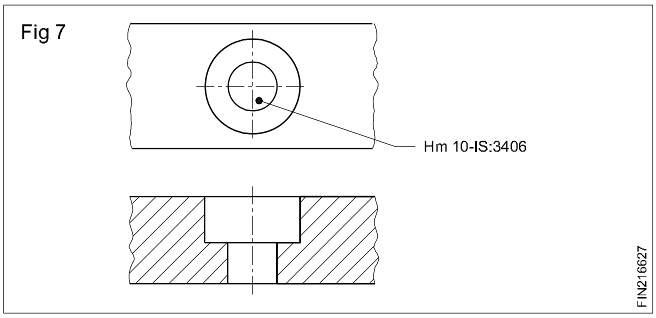

Fig 7

Using dimensions (Fig 8)

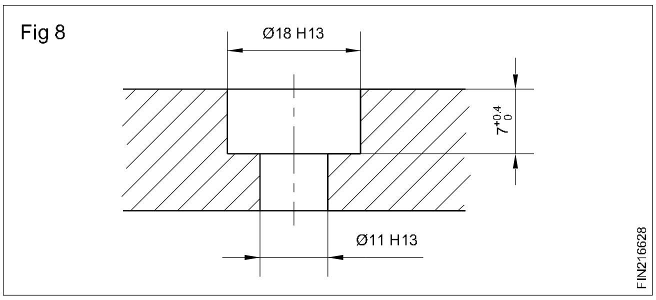

Fig 8

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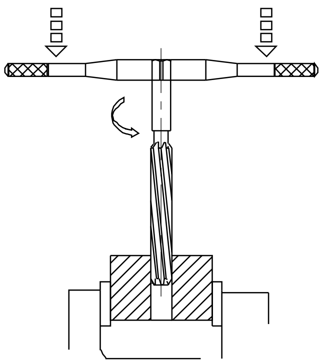
Reamers

Objectives: At the end of this lesson you shall be able to
- **state the use of reamers**
- **state the advantages of reaming**
- **distinguish between hand and machine reaming**
- **name the elements of a reamer and state their functions.**

What is a reamer?

A reamer is a multipoint cutting tool used for enlarging by finishing previously drilled holes to accurate sizes. (Fig 1)

Fig 1



Advantages of 'reaming'

Reaming produces

High quality surface finish

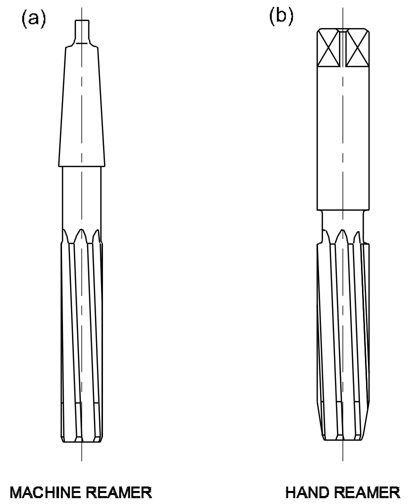
Dimensional accuracy to close limits.

Also small holes which cannot be finished by other processes can be finished.

Classification of reamers

Reamers are classified as hand reamers and machine reamers. (Figs 2a and 2b)

Fig 2



Reaming by using hand reamers is done manually for which great skill is needed.

Machine reamers are fitted on spindles of machine tools and rotated for reaming.

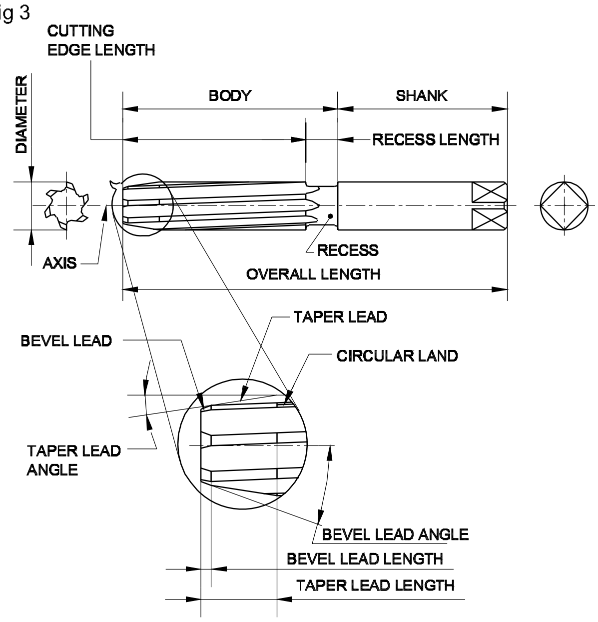
Machine reamers are provided with morse taper shanks for holding on machine spindles.

Hand reamers have straight shanks with 'square' at the end, for holding with tap wrenches. (Figs 2 (a) and (b)

Parts of a hand reamer

The parts of a hand reamer are listed hereunder. Refer to Fig 3.

Fig 3



Axis

The longitudinal centre line of the reamer.

Body

The portion of the reamer extending from the entering end of the reamer to the commencement of the shank.

Recess

The portion of the body which is reduced in diameter below the cutting edges, pilot or guide diameters.

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Shank

The portion of the reamer which is held and driven. It can be parallel or taper.

Circular land

The cylindrically ground surface adjacent to the cutting edge on the leading edge of the land.

Bevel lead

The bevel lead cutting portion at the entering end of the reamer cutting its way into the hole. It is not provided with a circular land.

Taper lead

The tapered cutting portion at the entering end to facilitate cutting and finishing of the hole. It is not provided with a circular land.

Bevel lead angle

The angle formed by the cutting edges of the bevel lead and the reamer axis.

Taper lead angle

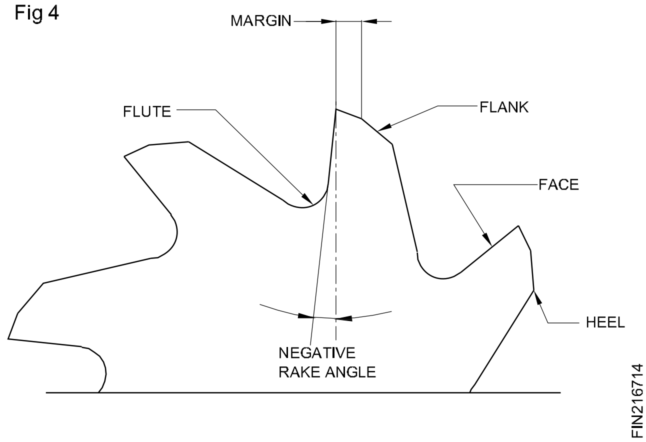
The angle formed by the cutting edges of the taper and the reamer axis.

Terms relating to cutting geometry

Flutes

The grooves in the body of the reamer to provide cutting edges, to permit the removal of chips, and to allow the cutting fluid to reach the cutting edges. (Fig 4)

Fig 4



Heel

The edge formed by the intersection of the surface left by the provision of a secondary clearance and the flute. (Fig 4)

Cutting edge

The edge formed by the intersection of the face and the circular land or the surface left by the provision of primary clearance. (Fig 4)

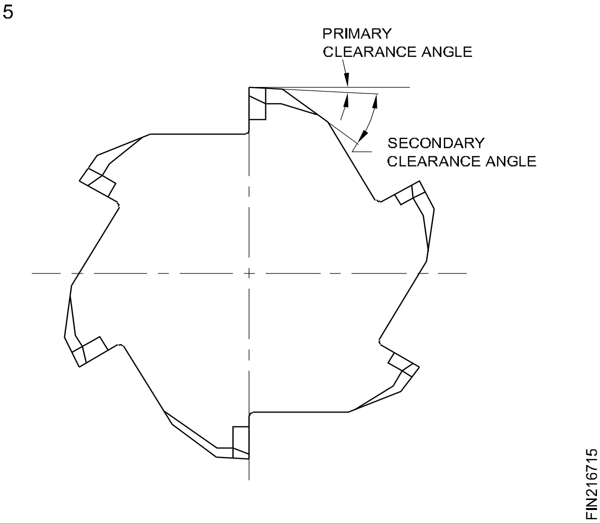
Face

The portion of the flute surface adjacent to the cutting edge on which the chip impinges as it is cut from the work. (Fig 4)

Rake angles

The angles in a diametral plane formed by the face and a radial line from the cutting edge. (Fig 5)

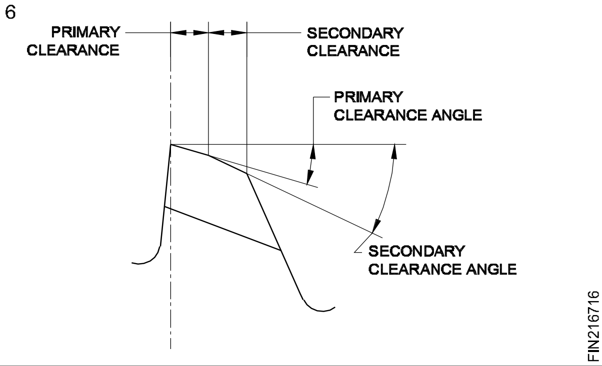
Fig 5



Clearance angle

The angles formed by the primary or secondary clearances and the tangent to the periphery of the reamer at the cutting edge. They are called primary clearance angle and secondary clearance angle respectively. (Fig 6)

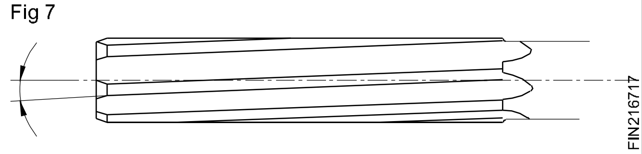
Fig 6



Helix angle

The angle between the edge and the reamer axis. (Fig 7)

Fig 7



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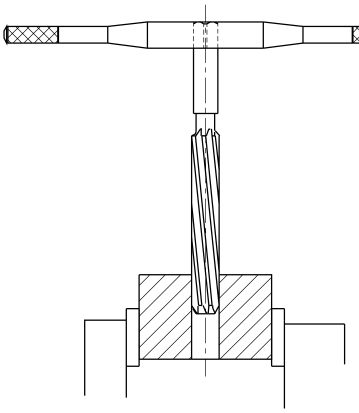
Hand reamers

Objectives: At the end of this lesson you shall be able to
- **state the general features of hand reamers**
- **identify the types of hand reamers**
- **distinguish between the uses of straight fluted and helical fluted reamers**
- **name the materials from which reamers are made and specify reamers.**

General features of hand reamers (Fig 1)

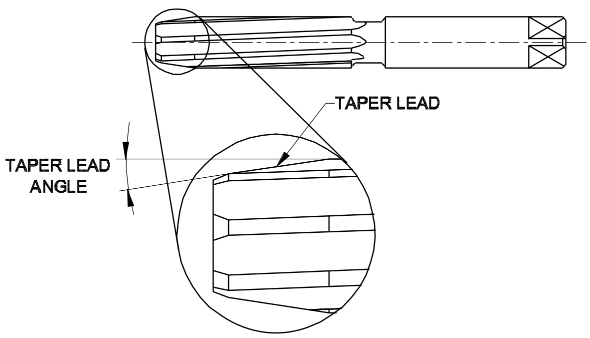
Fig 1



Hand reamers are used to ream holes manually using tap wrenches.

These reamers have a long taper lead.(Fig 2) This allows to start the reamer straight and in alignment with the hole being reamed.

Fig 2



Most hand reamers are for right hand cutting.

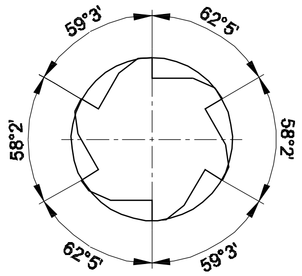
Helical fluted hand reamers have left hand helix. The left hand helix will produce smooth cutting action and finish.

Most reamers, machine or hand, have uneven spacing of teeth. This feature of reamers helps to reduce chattering while reaming. (Fig 3)

Types, features and functions

Hand reamers with different features are available for meeting different reaming conditions. The commonly used types are listed here under:

Fig 3



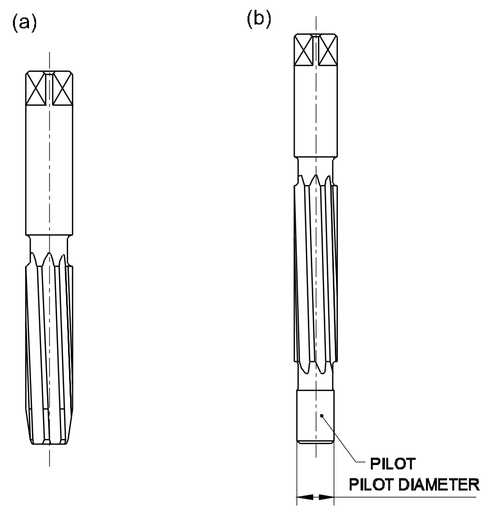
Parallel hand reamer with parallel shank (Fig 4a)

A reamer which has virtually parallel cutting edges with taper and bevel lead. The body of the reamer is integral with a shank. The shank has the nominal diameter of the cutting edges. One end of the shank is square shaped for tuning it with a tap wrench. Parallel reamers are available with straight and helical flutes. This is the commonly used hand reamer for reaming holes with parallel sides.

Reamers commonly used in workshop produce H7 holes.

Hand reamer with pilot (Fig 4b)

Fig 4



For this type of reamer, a portion of the body is cylindrically ground to form a pilot at the entering end. The pilot keeps the reamer concentric with the hole being reamed.

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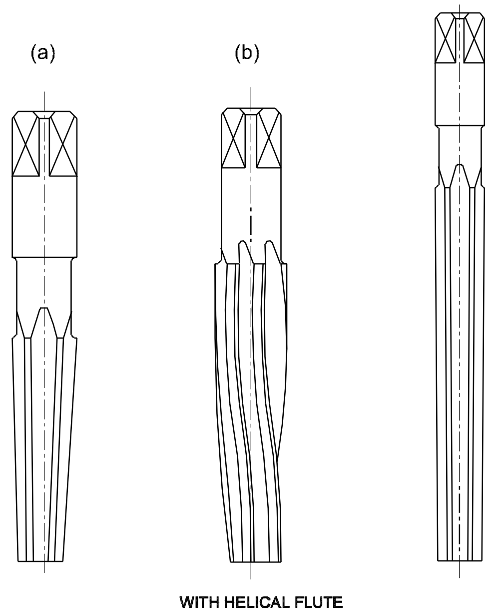
Socket reamer with parallel shank (Figs 5a and 5b)

This reamer has tapered cutting edges to suit metric morse tapers. The shank is integral with the body, and is square shaped for driving. The flutes are either straight or helical.

The socket reamer is used for reaming internal morse tapered holes.

Taper pin hand reamer (Fig 5c)

Fig 5

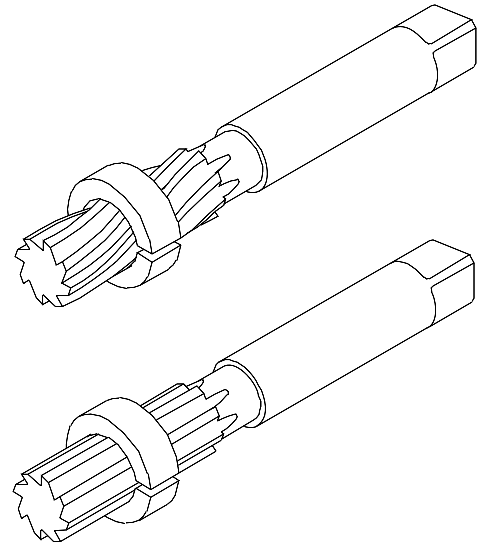


This reamer has tapered cutting edges for reaming taper holes to suit taper pins. A taper pin reamer is made with a taper of 1 in 50. These reamers are available with straight or helical flutes.

Use of straight and helical fluted reamers (Fig 6)

Straight fluted reamers are useful for general reaming work. Helical fluted reamers are particularly suitable for reaming holes with keyway grooves or special lines cut into them. The helical flutes will bridge the gap and reduce binding and chattering.

Fig 6



Material of hand reamers

When the reamers are made as a one-piece construction, high speed steel is used. When they are made as two-piece construction then the cutting portion is made of high speed steel while the shank portion is made of carbon steel. They are butt-welded together before manufacturing.

Specifications of a reamer

To specify a reamer the following data is to be given.

Type

Flute

Shank end

Size

Example : Hand reamer, Straight flute, Parallel shank of Ø 20 mm.

Drill size for reaming

Objective: At the end of this lesson you shall be able to
- **determine the hole size for reaming.**

For reaming with a hand or a machine reamer, the hole drilled should be smaller than the reamer size.

The drilled hole should have sufficient metal for finishing with the reamer. Excessive metal will impose a strain on the cutting edge of the reamer and damage it.

Calculating drill size for reamer

A method generally practised in workshop is by applying the following formula.

Drill size = Reamed size – (Undersize + Oversize)

Finished size

Finished size is the diameter of the reamer.

Undersize

Undersize is the recommended reduction in size for different ranges of drill diameter. (Table 1)

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Undersizes for reaming

TABLE 1

Diameter of ready reamed hole (mm)	Undersize of rough bored hole (mm)
under 5	0.1.....0.2
5......20	0.2.....0.3
21....50	0.3.....0.5
over 50	0.5.....1

Oversize

It is generally considered that a twist drill will make a hole larger than its diameter. The oversize for calculation purposes is taken as 0.05 mm - for all diameters of drills.

For light metals the undersize will be chosen 50% larger.

Example

A hole is to be reamed on mild steel with a 10 mm reamer. What will be the diameter of the drill for drilling the hole before reaming?

Drill size = Reamed size – (Undersize + Oversize)

(Finished size)	=	10 mm
Undersize as per table	=	0.2 mm
Oversize	=	0.05 mm
Drill size	=	10 mm -- 0.25 mm
	=	9.75 mm

Determine the drill hole sizes for the following reamers:

i 15 mm

ii 4 mm

iii 40 mm

iv 19 mm

Answer

i ____

ii ____

iii ____

iv ____

Note: If the reamed hole is undersize, the cause is that the reamer is worn out.

Always inspect the condition of the reamer before commencing reaming.

For obtaining good surface finish

Use a coolant while reaming. Remove metal chips from the reamer frequently. Advance the reamer slowly into the work.

Defects in reaming - Causes and Remedies

- **Reamed hole undersize**
  - If a worn out reamer is used, it may result in the reamed hole bearing undersize. Do not use such reamers.
  - Always inspect the condition of the reamer before using.
- **Surface finish rough**
  - The causes may be any one of the following or a combinations thereof.
  - Incorrect application
  - Swarf accumulated in reamer flutes
  - Inadequate flow of coolant
  - Feed rate too fast
  - While reaming apply a steady and slow feed-rate.
  - Ensure a continuous supply of the coolant.
  - Do not turn the reamer in the reverse direction.

Determining the drill size for reaming

Use the formaula,

drill diameter = reamed hole size. (undersize + oversize)

Refer to the table for the recommended undersizes in Related Theory on DRILL SIZES FOR REAMING.

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Reaming

Objectives : At the end of this lesson you shall be able to
- **state the procedure for hand reaming and machine reaming.**

Reaming

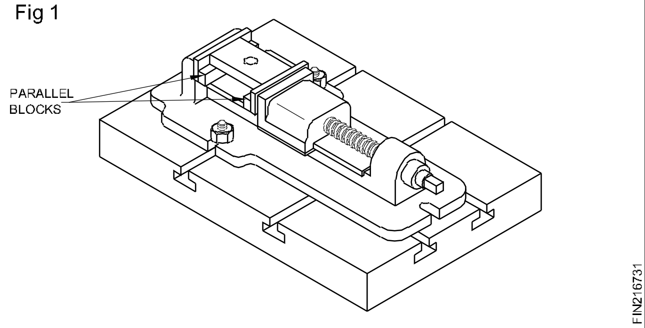
Reaming is the operation of finishing and sizing a hole which has been previously drilled, bored, casteed holes. The tool used is called a reamer, which has multiple cutting edges. Manually it is held in a tap wrench and reamed. Machine reamer are used in drilling machine using sleeves (or) socket. Normally the speed for reaming will be 1/3rd speed of drilling.

Hand Reaming

Drill holes for reaming as per the sizes determined.

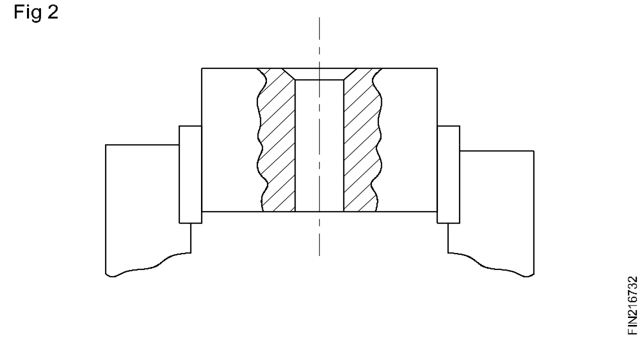
Place the work on parallels while setting on the machine vice. (Fig 1)

Fig 1



Chamfer the hole ends slightly. This removes burrs and will also help to align the reamer vertically. (Fig 2) Fix the work in the bench vice. Use vice clamps to protect the finished surfaces. Ensure that the job is horizontal. (Fig 2)

Fig 2

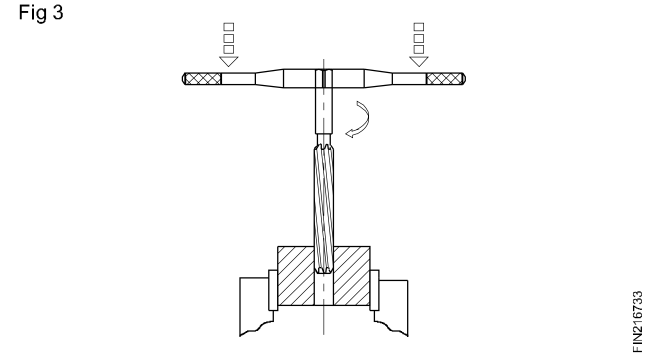


Fix the tap wrench on the square end and place the reamer vertically in the hole. Check the alignment with a try square. Make corrections, If necessary. Turn the tap wrench in a clockwise direction applying a slight downward pressure at the same time. (Fig 3) Apply pressure evenly at both ends of the tap wrench.

Apply cutting force

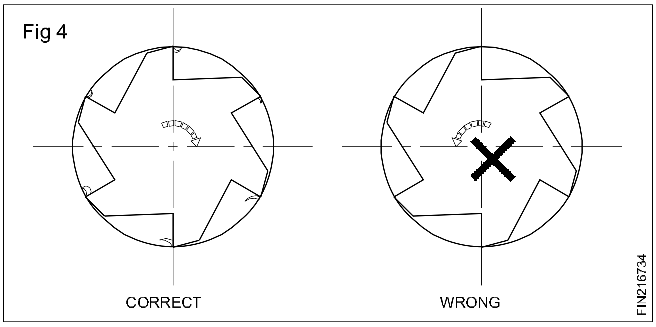
Turn the tap wrench steadily and slowly, maintaining the downward pressure.

Fig 3



Do not turn in reverse direction it will scratch the reamed hole. (Fig 4)

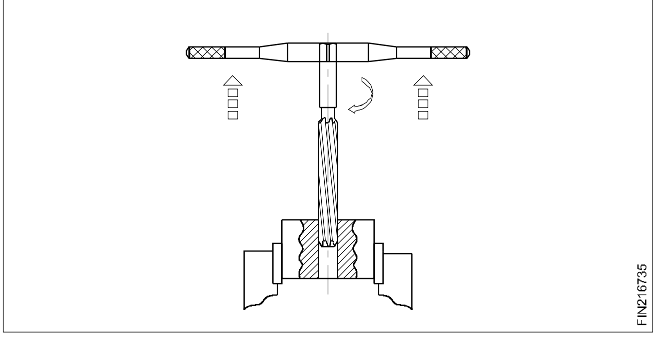
Fig 4



Ream the hole through, ensure that the taper lead length of the reamer comes out well and clear from the bottom of the work. Do not allow the end of the reamer to strike on the vice.

Remove the reamer with an upward pull until the reamer is clear of the hole. (Fig 5)

Fig 5



Remove the burrs from the bottom of the reamed hole.

Clean the hole. Check the accuracy with the cylindrical pins supplied.

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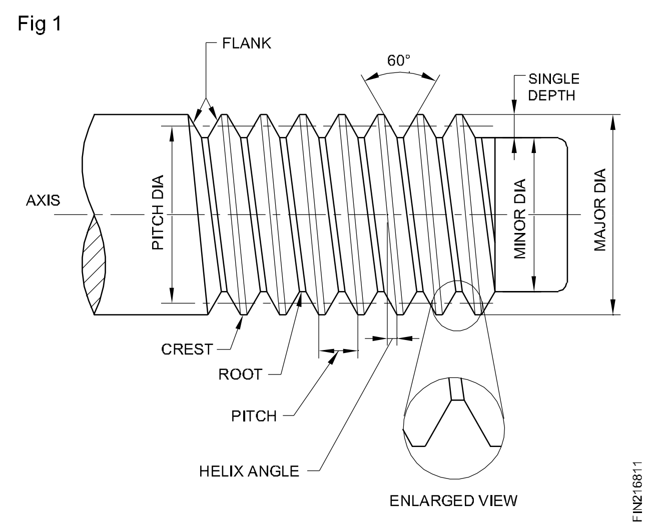
Screw thread and elements

Objectives: At the end of this lesson you shall be able to
- **state the terminology of screw threads**
- **state the types of screw threads.**

Screw thread terminology

Parts of screw thread (Fig 1)



Crest

The top surface joining the two sides of a thread.

Root

The bottom surface joining the two sides of adjacent threads.

Flank

The surface joining the crest and the root.

Thread angle

The included angle between the flanks of adjacent threads.

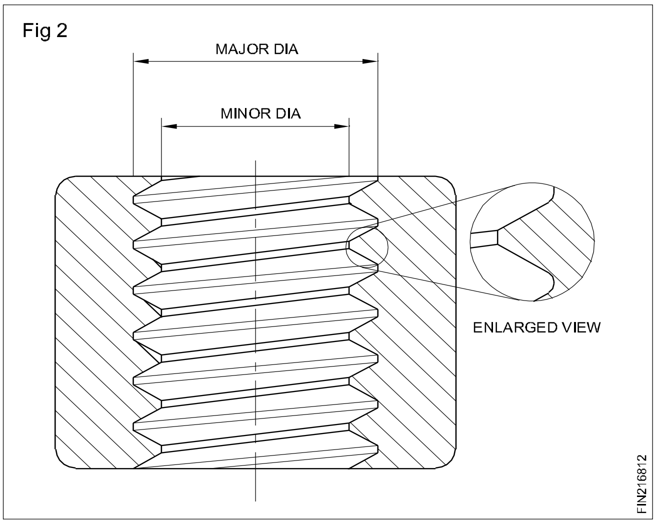
Depth

The perpendicular distance between the roots and crest of the thread.

Major Diameter

In the case of external threads it is the diameter of the blank on which the threads are cut and in the case of internal threads it is the largest diameter after the threads are cut that are known as the major diameter. (Fig 2)

This is the diameter by which the sizes of screws are stated.



Minor Diameter

For external threads, the minor diameter is the smallest diameter after cutting the full thread. In the case of internal threads, it is the diameter of the hole drilled for forming the thread which is the minor diameter.

Pitch Diameter (effective diameter)

The diameter of the thread at which the thread thickness is equal to one half of the pitch.

Pitch

It is the distance from a point on one thread to a correspond ing point on the adjacent thread measured parallel to the axis.

Lead

Lead is the distance of a threaded component moves along the matching component during one complete revolution. For a single start thread the lead is equal to the pitch.

Helix Angle

The angle of inclination of the thread to the imaginary perpendicular line.

Hand

The direction in which the thread is turned to advance. A right hand thread is turned clockwise to advance, while a left hand thread is turned anticlockwise.(Fig 3)

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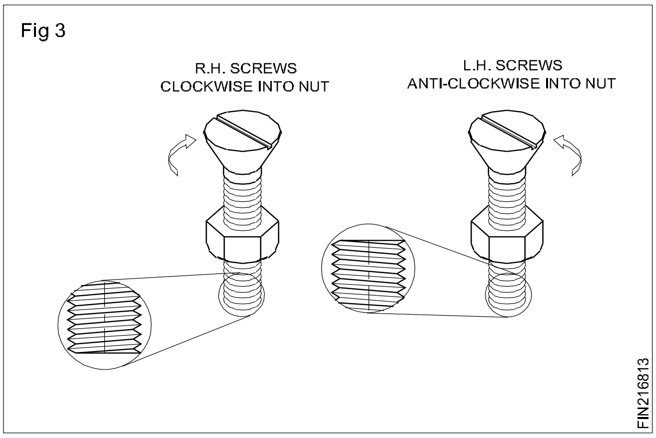


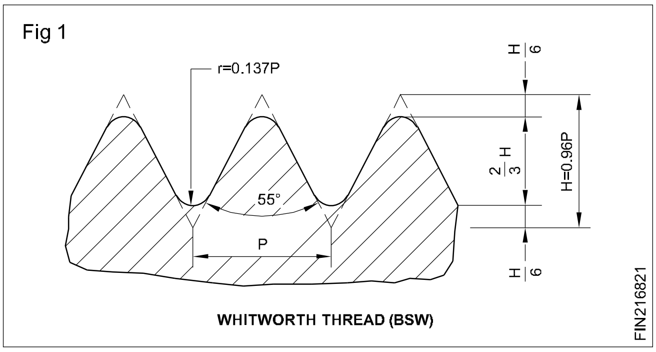
Screw threads - types of V threads and their uses

Objectives: At the end of this lesson you shall be able to
- **state the different standards of V threads**
- **indicate the angle and the relation between the pitch with the other elements of the thread**
- **state the uses of the different standards of V threads.**

The different standards of V threads are:

- BSW thread: British Standard Whitworth thread
- BSF thread: British Standard fine thread
- BSP thread: British Standard pipe thread
- B.A thread: British Association thread
- I.S.O Metric thread: International Standard Organisation metric thread
- ANS: American National or sellers' thread
- BIS Metric thread: Bureau of Indian Standard metric thread.

BSW thread (Fig 1)



It has an included angle of 55° and the depth of the thread is 0.6403 x P. The crest and root are rounded off to a definite radius . The figure shows the relationship between the pitch and the other elements of the thread.

BSW thread is represented in a drawing by giving the major diameter. For example : 1/2" BSW, 1/4" BSW. The table indicates the standard number of TPI for different diameters. BSW thread is used for general purpose fastening threads.

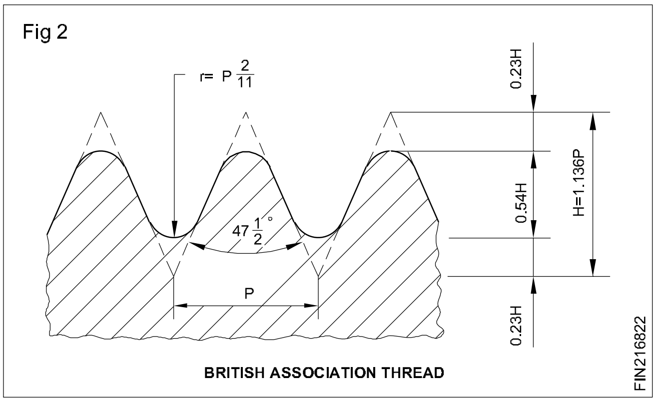
BSF thread

This thread is similar to BSW thread except the number of TPI for a particular diameter. The number of threads per inch is more than that for the BSW thread for a particular diameter. For Example, 1" BSW has 8 TPI and 1 "BSF has 10 TPI. The table indicates the standard number of TPI for different dia. of BSF threads. It is used in automobile industries.

BSP thread

This thread is recommended for pipe and pipe fittings. The table shows the pitch for different diameters. It is also similar to BSW thread. The thread is cut externally with a small taper for the threaded length. This avoids the leakage in the assembly and provides for further adjustment when slackness is felt.

BA thread (Fig 2)



This thread has an included angle of 47 1/2°. Depth and other elements are as shown in the figure. It is used in small screws of electrical appliances, watch screws, screws of scientific apparatus.

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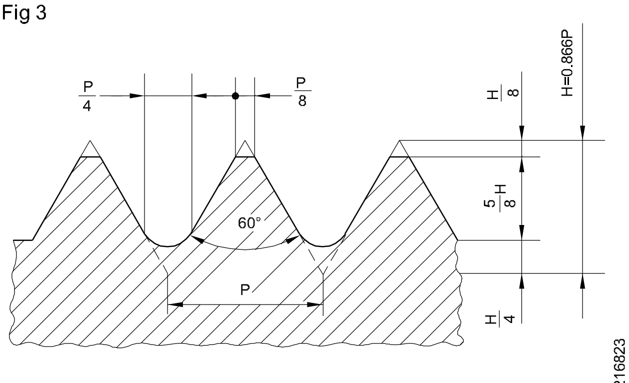
Unified thread (Fig 3)

For both the metric and inch series, ISO has developed this thread. Its angle is 60°. The crest and root are flat and the other dimensions are as shown in the figure. This thread is used for general fastening purposes.

Fig 3



ISO METRIC THREAD, UNIFIED INCH SERIES THREAD

This thread of metric standard is represented in a drawing by the letter 'M' followed by the major diameter for the coarse series.

Ex : M14, M12 etc.

For the fine series, the letter 'M' is followed by the major diameter and pitch.

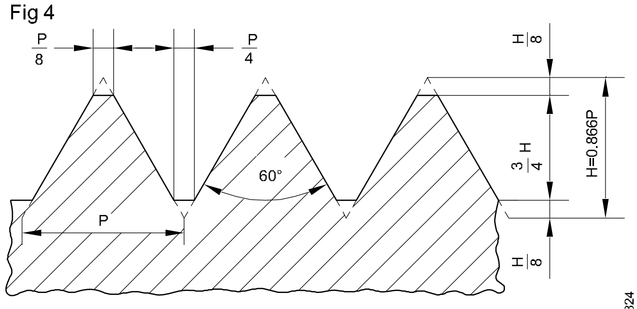
Ex : M14 x 1.5

M24 x 2

American National Thread (Fig 4)

These threads are also called as seller's threads. It was more commonly used prior to the introduction of the ISO unified thread.

Fig 4



AMERICAN NATIONAL THREAD,SI & DIN METRIC THREADS

Screw pitch gauge

Objectives: At the end of this lesson you shall be able to
- **state the purpose of a screw pitch gauge**
- **state the features of a screw pitch gauge.**

Purpose

A screw pitch gauge is used to determine the pitch of a thread.

It is also used to compare the profile of threads.

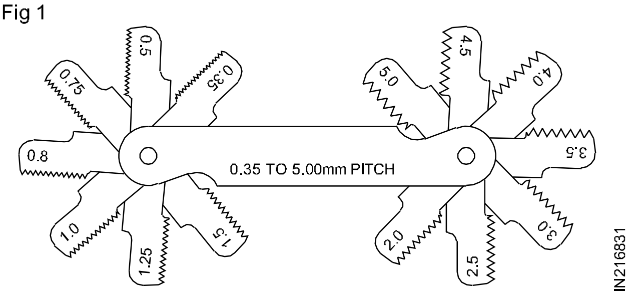
Constructional features

Pitch gauges are available with a number of blades assembled as a set. Each blade is meant for checking a particular standard thread pitch. The blades are made of thin spring steel sheets, and are hardened.

Some screw pitch gauge sets will have blades provided for checking British Standard threads (BSW, BSF etc.) at one end and the metric standard at the other end.

The thread profile on each blade is cut for about 25 mm to 30 mm. The pitch of the blade is stamped on each blade. The standard and range of the pitches are marked on the case. (Fig 1)

Fig 1



Taps

Objectives: At the end of this lesson you shall be able to
- **state the uses of hand taps**
- **state the features of hand taps**
- **distinguish between the different taps in a set.**

Use of hand taps: Hand taps are used for internal threading of components.

Features (Fig 1): They are made from high speed steel.

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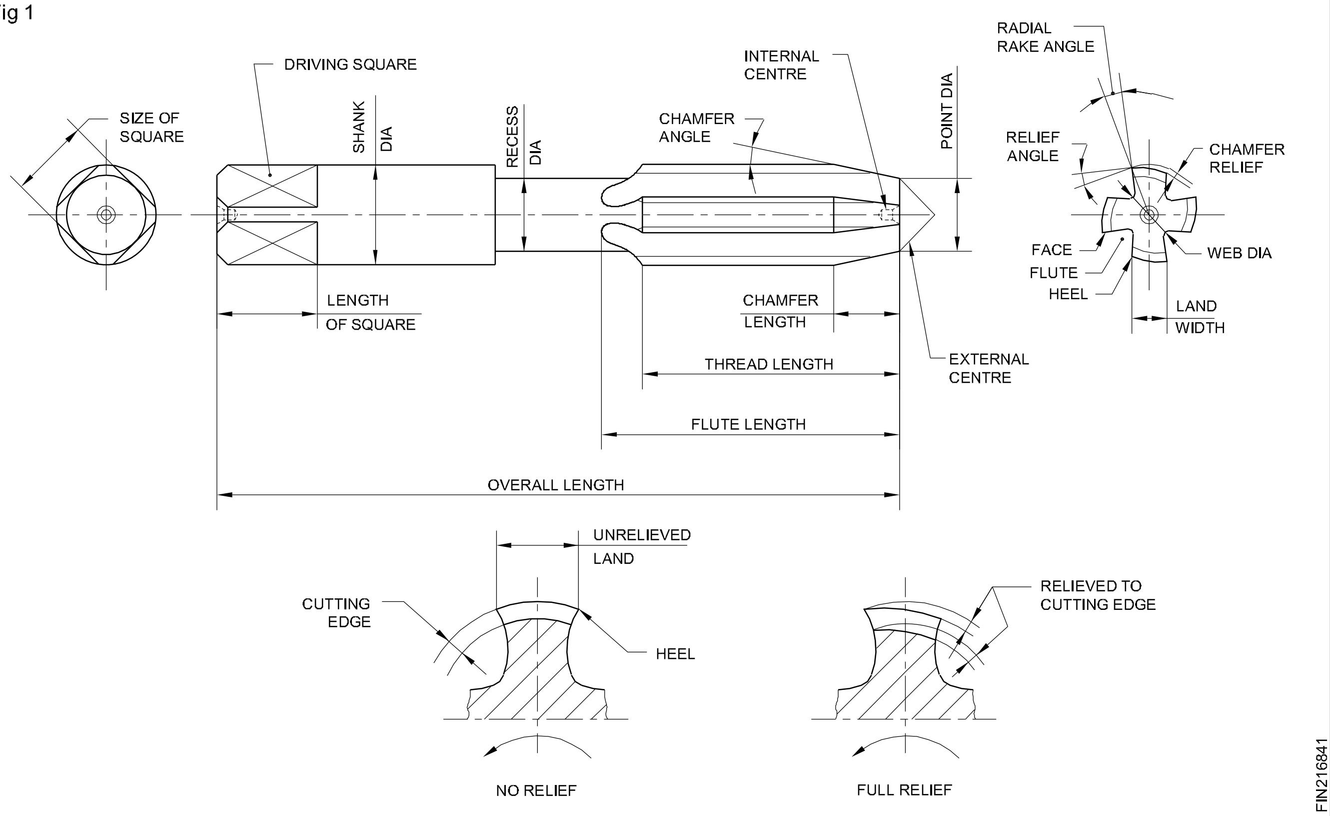
Fig 1



The threads are cut on the periphery and are accurately finished.

To form the cutting edges, flutes are cut across the thread.

The end of the shank of the tap is made of square shape for the purpose of holding and turning the taps.

The end of the taps are chamfered (taper lead) for assisting, aligning and starting of the thread.

The size of the taps, the thread standard, the pitch of the thread, the dia. of the tapping hole are usually marked on the shank.

Marking on the shank are also made to indicate the type of tap i.e. first, second and plug.

Types of taps in a set : Hand taps for a particular thread are available as a set consisting of three pieces. (Fig 2)

These are:

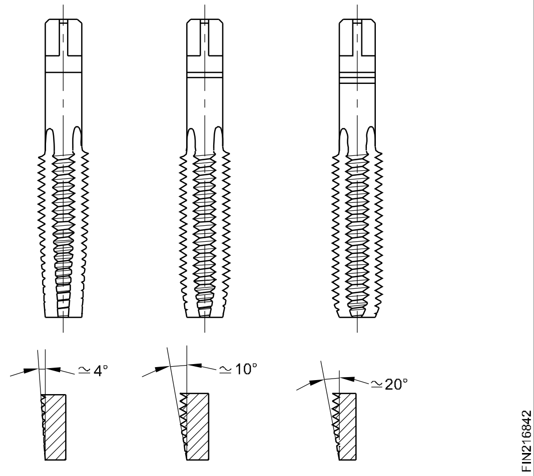
– First tap or taper tap

– Second tap or intermediate tap

– Plug or bottoming tap.

These taps are identical in all features except in the tap lead.

Fig 2



The taper tap is to start the thread. It is possible to form full threads by the taper tap in through holes which are not deep.

The bottoming tap (plug) is used to finish the threads of a blind hole to the correct depth.

For identifying the type of taps quickly - the taps are either numbered 1,2 and 3 or rings are marked on the shank.

The taper tap has one ring, the intermediate tap has two and the bottoming tap has three rings. (Fig 2)

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Table for tap drill size

B.S.W. (55°)		
Tap size (inch)	**Threads per inch**	**Tap drill size (mm)**
3/16	24	3.7mm
7/32	24	4.5mm
1/4	20	5.1mm
5/16	18	6.5mm
3/8	16	7.94mm
7/16	14	9.3mm
1/2	12	10.5mm
9/16	12	12.1mm
5/8	11	13.5mm
11/16	11	15mm
3/4	10	16.257mm
7/8	9	19.25mm
1”	8	22mm

B.S.F. (55°)		
Tap size (inch)	**Threads per inch**	**Tap drill size (mm)**
3/16	32	3.97mm
7/32	28	4.6mm
1/4	26	5.3mm
5/16	22	6.75mm
3/8	20	8.2mm
7/16	18	9.7mm
1/2	16	11.11mm
9/16	16	12.7mm
5/8	14	14mm
11/16	14	15.5mm
3/4	12	16.75mm
7/8	11	19.84mm
1”	10	22.75mm

NPT National pipe thread

Tap size (inch)	Threads per inch	Tap drill size inch	Tap size (inch)	Threads per inch	Tap drill size inch
1/8	27	11/32	1	11 1/2	1 5/32
1/4	18	7/16	1 1/4	11 1/4	1 1/2
3/8	18	19/32	1 1/2	11 1/2	1 23/32
1/2	14	23/32	2	11 1/2	2 23/16
3/4	14	15/16	2 1/2	8	2 5/8

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Tap drill sizes ISO Inch (Unified) thread

NC National coarse			NF National Fine		
Tap size (inch)	Threads per inch	Tap drill size inch	Tap size (inch)	Threads per inch	Tap drill size inch
1/4	20	13/64	1/4	28	7/32
5/16	18	17/64	5/16	24	17/64
3/8	16	5/16	3/8	24	21/64
7/16	14	3/8	7/16	20	25/64
1/2	13	27/64	1/2	20	29/64
9/16	12	31/64	9/16	18	33/64
5/8	11	17/32	5/8	18	37/64
3/4	10	21/32	3/4	16	11/16
7/8	9	49/64	7/8	14	13/16
1”	8	7/8	1”	14	15/16
1 1/8	7	63/64	1 1/8	12	1 3/6
1 1/4	7	17/64	1 1/4	12	1 11/6
1 3/8	6	17/32	1 3/8	12	1 19/64
1 1/2	6	1 11/32	1 1/2	12	1 27/64
1 3/4	5	1 9/16			
2”	4 1/2	1 25/32			

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Machine taps

Objectives: At the end of this lesson you shall be able to
- **state the characteristics of machine taps**
- **name the different types of machine taps**
- **state the features and uses of different types of machine taps.**

Machine taps: Machine taps of different types are available. The two important features of machine taps are

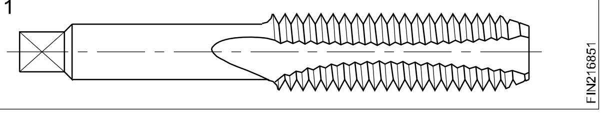
– Ability to withstand the torque needed for threading holes

– Provision for eliminating chip jamming.

Types of machine taps

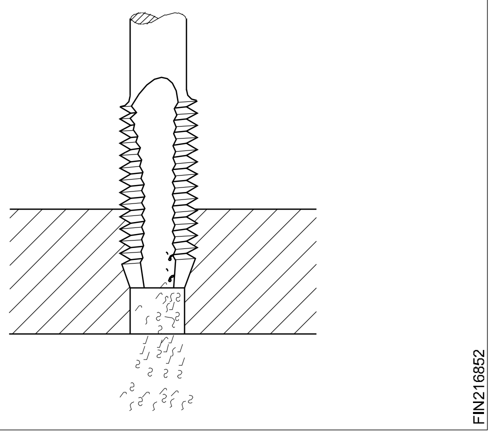
Gun tap (Spiral pointed tap) (Fig 1)

Fig 1



These taps are especially useful for machine tapping of through holes. In the case of blind hole tapping, there should be sufficient space below to accommodate the chips. While tapping, the chips are forced out ahead of the tap. (Fig 2)

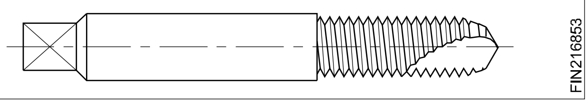
Fig 2



This prevents the clogging of the chips and thus reduces the chances of tap breakage. These taps are stronger since the flutes are shallow. The flutes of these taps do not convey chips.

Flute-less spiral pointed tap (Stub flute taps) (Fig 3)**:**

Fig 3

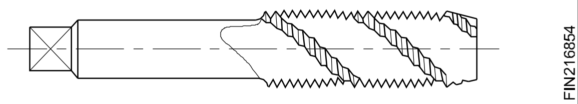


These taps have short angular flutes ground on the chamfered end, and the rest of the body is left solid. These taps are stronger than gun taps.

Flute-less taps are used for tapping through holes on materials which are not thicker than the diameter of the holes. Flutless spiral point taps are best suited for tapping soft materials or thin metal sections.

Helical fluted taps/spiral fluted taps: These taps have spiral flutes which bring out the chips from the hole being tapped. (Fig 4)

Fig 4



These are useful for tapping holes with slots. The helical land of the tap will bridge the interruption of the surface being threaded. The helical flutes of the tap provide a shear cutting action, and are mostly used to tap holes in ductile materials like aluminium, brass, copper etc.

Spiral fluted taps are also available with fast spiral. (Fig 5) These taps are best suited for tapping deep holes as these can clear the chips faster from the hole. (Fig 6)

Fig 5

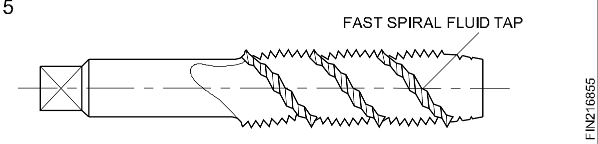
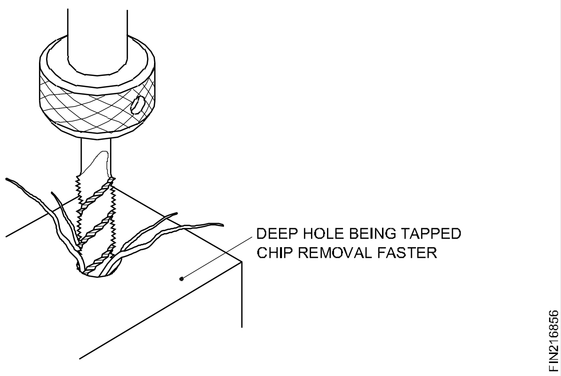


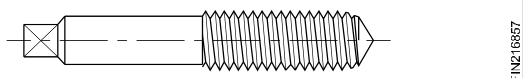
Fig 6



Thread forming taps (Fluteless taps)

These taps form threads in the hole by displacing the material and not by cutting action. (Fig 7)

Fig 7



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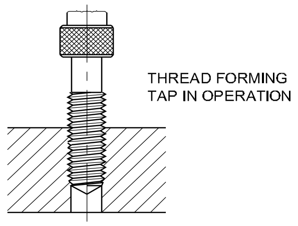
These taps have projecting lobes which actually help in forming the thread. (Fig 8) Since there are no chips in the process, it is very valuable in places where chip removal poses problems. These taps are excellent for tapping copper, brass, aluminium, lead etc. The thread finish is also comparatively better than in the fluted taps.

Fig 8

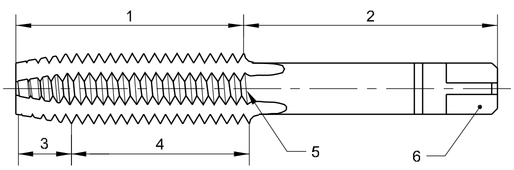


General informative points on taps

Objectives: At the end of this lesson you shall be able to
- **differentiate between hand tap and machine tap**
- **identify the parts of a machine tap**
- **state the constructional features of a machine tap.**

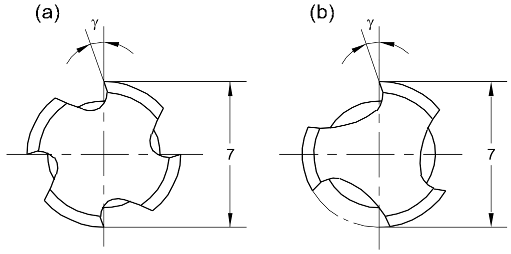
Unlike tapping with the three piece set of hand taps, the machine tap cuts the entire threaded profile in one operation. The machine tap is normally made of tool steel and consists of the shank (2) and the cutting section (1) as shown in (Fig 1). The cutting section itself is subdivided into two areas. The start (3), which serves for cutting, and the guiding section (4) for the feeding motion and smoothing of the newly cut thread. (Fig 1)

Fig 1



The number of flutes (5), may be even or odd. With an even number of flutes, measuring of the diameter (7) is easier. (Figs 2a and 2b)

Fig 2



Straight and spiral groove machine taps are available. The diameter of the shank and the shape of its end vary between the various standards. The shank diameter may be smaller, equal to or larger than the thread diameter. The shank ends are available in straight design, with square ends as shown in (6) or with driving shoulders.

Chip removal (flow) takes place at the start of the tap. The rake angle must be adapted to the material to be machined. Hard and brittle materials require a small rake angle and soft materials need a larger rake angle.

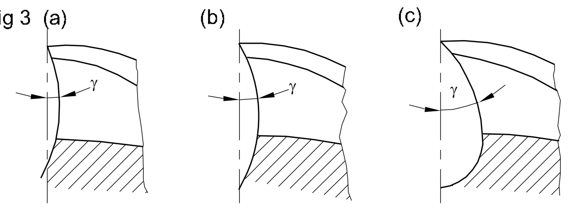
Accordingly three types of taps are available.

Type normal (Fig 3b) with a rake angle of approximately 12°.

Type soft (Fig 3c) with a rake angle of approximately 20°.

Type hard (Fig 3a) with a rake angle of approximately 3°.

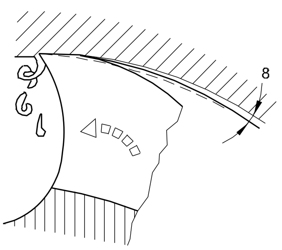
Fig 3



The normal type of rake angle taps can be used in most cases. The start must be ground symmetrical. Before using the tap, it is necessary to check that the cutting edges are not chipped, and all the edges are sharp.

The 'hard' type tap is used for tapping brittle materials like cast iron. In case a 'normal' type tap is used on cast iron, the tap cutting edges get blunt soon and the tap cannot be used again on ductile materials like mild steel. The fine cast iron splinters wear the external diameter of the cutting edges of the tap causing them to tend to become blunt, and when the same tap is used on steel which is more flexible it is elastically pressed away (8) at the cutting point. Behind the cutting edge the material returns to the machined diameter. The depth of the groove also causes jamming of the guiding section of the tap. (Fig 4)

Fig 4



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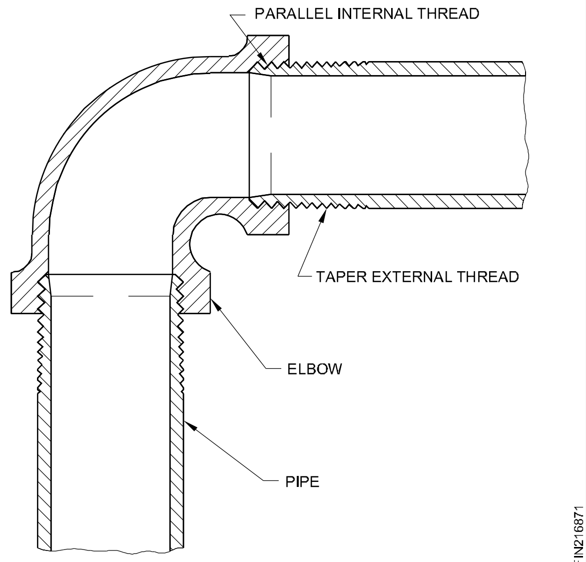
Pipe Threads and Pipe Taps

Objectives: At the end of this lesson you shall be able to
- **state parallel and taper pipes threads**
- **determine the wall thickness and threads per inch (TPI) of BSP threads**
- **state the method of sealing pipe joints**
- **determine blank sizes for threading as per B.S 21 - 1973 and I.S. 2643 - 1964.**

Pipe threads

The standard pipe fittings are threaded to British Standard pipe (BSP). The internal pipe threads have parallel threads whereas the external pipes have tapered threads as shown in Fig 1.

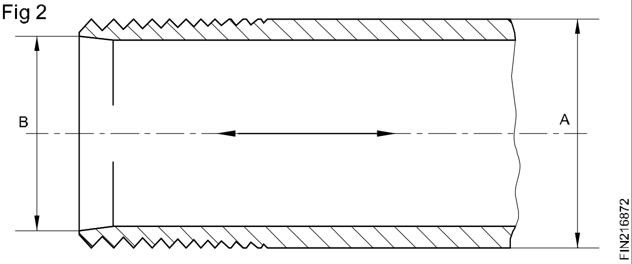
Fig 1



B.S.P. threads

Glavinized iron pipes are available in sizes ranging from 1/2" to 6" in several different wall thickness. The table shows outside diameters and threads per inch from 1/2" to 4". (Fig 2)

Fig 2



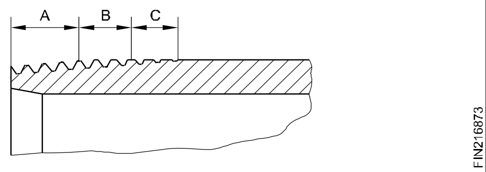
The next two threads have fully formed bottoms but that tops. (B)

The last four threads have flat tops and bottoms. (C)

Sealing pipe joint

Fig 3 shows that the pipe has several fully formed threads at the end. (A)

Fig 3



The pipe joint shown in Fig 4 consists of the following:

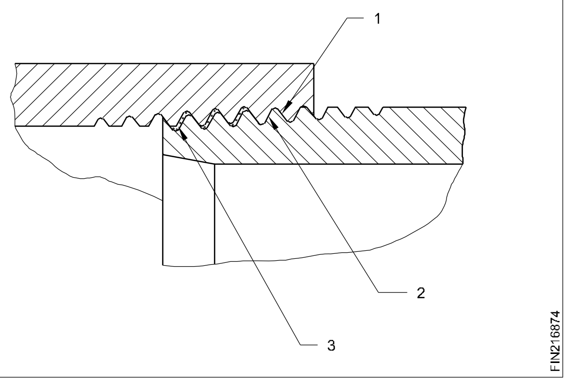
1 Parallel female thread

2 Tapered male thread

3 Hemp packing

The hamp packing isused to ensure that any small space between two metal threads (male and female threads) is sealed to prevent any leakage.

Fig 4



Table

BSP - Pipe sizes or DIN 2999 (inside) (B)	Threads inch	Outside diameter/ mm of the pipe (A)
1/2"	14	20.955 mm
3/4"	14	26.441
1"	11	33.249
11/4"	11	41.910
11/2"	11	47.803
2"	11	59.614
2 1/2"	8	75.184
3"	8	87.884
4"	8	113.030

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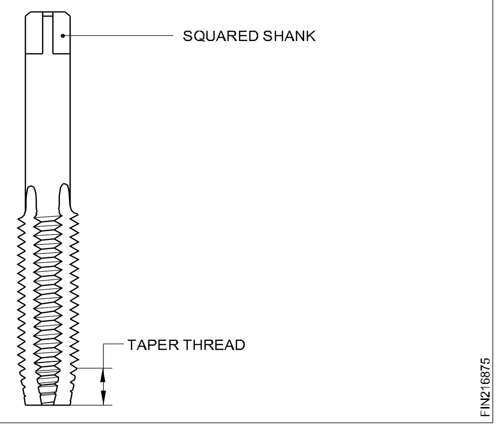
Pipe taps

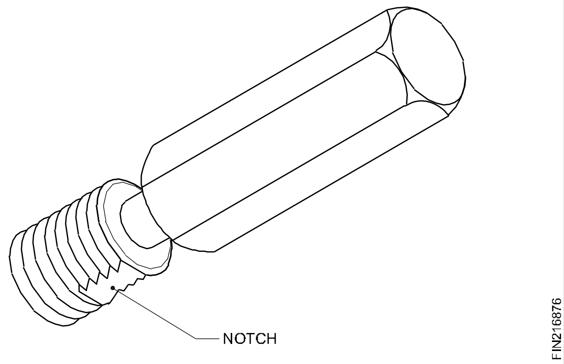
Internal pipe threads are usually cut with standard taper pipe taps. (Fig 5)

Fig 5



In gauging internal pipe threads, the pipe plug thread gauge should be screwed tight by hand into the pipe until the notch on the gauge is flush with the face. When the thread is chamfered the notch should be flushed with the bottom of the chamfer. (Fig 6)

Fig 6



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