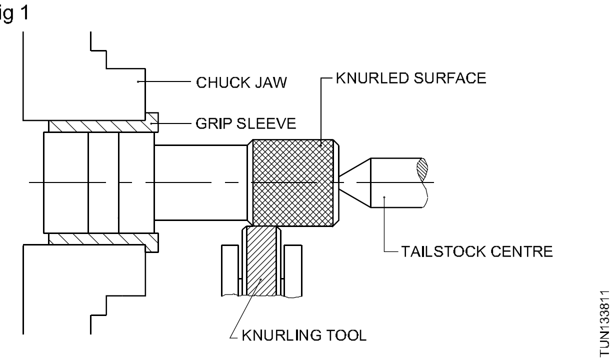
Knurling, meaning, necessity, types, grades & cutting speed for knurling

Objectives : At the end of this lesson you shall be able to
- **define knurling operation**
- **state the purpose of knurling**
- **list out the different types of knurls and knurling patterns**
- **list out the grades of knurls**
- **distinguish between the various types of knurling tool-holders.**

Knurling (Fig 1)

It is the operation of producing straight lined, diamond shaped pattern or cross lined pattern on a cylindrical external surface by pressing a tool called knurling tool. Knurling is not a cutting operation but it is a forming operation. Knurling is done at a slow spindle speed (1/3 times the turning speed). Soluble oil is to be used as coolant mostly and, sometimes straight cutting oil may be used to get better finish.

Fig 1



Purpose of knurling

The purpose of knurling is to provide:

- a good grip and make for positive handling.
- good appearance
- for raising the diameter to a small range for assembly to get a press fit.

Types of knurls and knurling patterns

The following are the different types of knurling patterns.

Diamond knurling, Straight knurling, Cross knurling, Concave knurling and Convex knurling.

Diamond knurling (Fig 2)

It is a knurling of diamond shaped pattern. It is done by using a set of rolls. One roller has got right hand helical teeth and the other has left hand helical teeth.

Straight knurling (Fig 3)

It is a knurling of straight lined pattern. This is done by using either a single roller or a double roller with straight teeth.

Fig 2

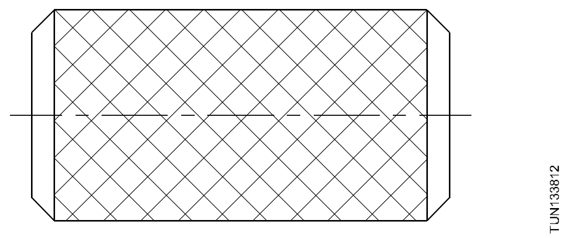
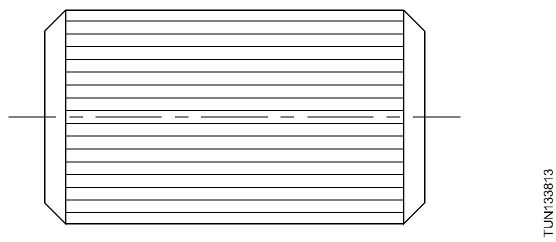


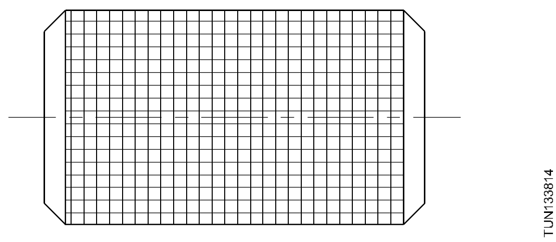
Fig 3



Cross knurling (Fig 4)

It is a knurling having a square shaped pattern. It is done by a set of rollers, one having straight teeth the other having teeth at right angles to the axis of knurl.

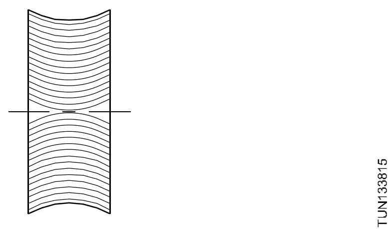
Fig 4



Concave knurling (Fig 5)

This is done by a convex knurl on a concave surface. This is done only by plunging the tool. The tool should not be moved longitudinally. The length of the knurling is limited to the width of the roller.

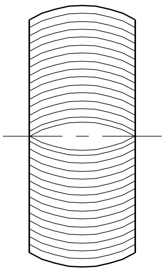
Fig 5



Convex knurling (Fig 6)

This is done by using a concave knurl on a convex surface. This is also done by plunging the tool.

Fig 6



Grades of knurling (Fig 7)

Knurling can be done in three grades.

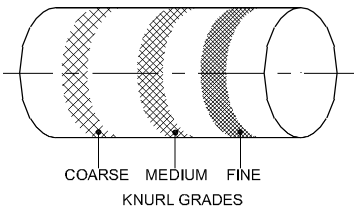
Coarse knurling, Medium knurling and Fine knurling

Coarse knurling is done by using coarse pitched knurls of 1.75 mm pitch. (14 TPI)

Medium knurling is done by using medium pitched knurls of 1.25 mm pitch. (21 TPI)

Fine knurling is done by using fine pitched knurls of 0.75 mm pitch. (33 TPI)

Fig 7



Types of knurling tool-holders

The different types of knurling tool-holders are:

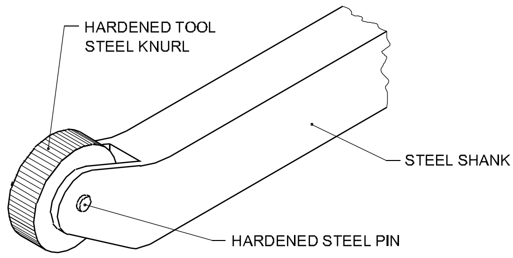
- single roller knurling tool-holders (parallel knurling tool-holders)
- knuckle joint type knurling tool-holders
- revolving type knurling tool-holders (universal knurling tool-holders).

A knurling tool-holder has a heat-treated steel shank and hardened tool steel knurls. The knurls rotate freely on hardened steel pins.

Single roller knurling tool-holder (Fig 8)

It has only one single roller which produces a straight lined pattern.

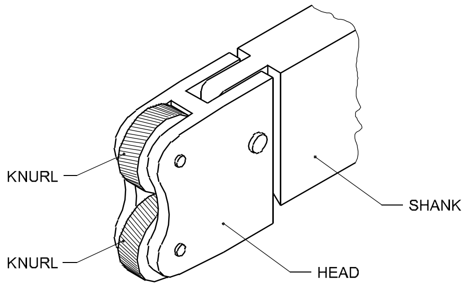
Fig 8



Knuckle joint type knurling tool-holders (Fig 9)

This tool holder has a set of two rollers of the same knurling pitch. The rollers may be of straight teeth or helical teeth. It is self-centering.

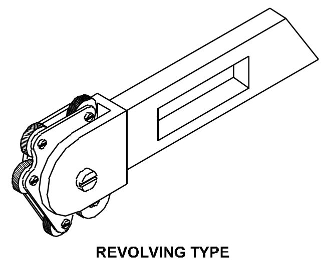
Fig 9



Revolving head knurling tool (Fig 10)

This tool-holder is also called a universal knurling tool-holder. It is fitted with 3 pairs of rollers having coarse, medium and fine pitches. These are mounted on a revolving head which pivots on a hardened steel pin. It is also self-centering.

Fig 10



Differences between different types of knurling tool-holders are given in Table -1

Table -1

Single roller	**Knuckle joint**	**Revolving type**
Only one roller is used.	A pair of rollers are used.	Three pairs of rollers are used.
Only one pattern of knurling can be produced with this type of knurling tool-holder.	Cross or diamond knurling pattern can be produced.	Knurling patterns of different pitches can be produced.
It is not self-centering.	It is self-centering.	It is self-centering.

Knurling - Speed and Feed

The tables shown be used as a guide for determining the amount of end-feed or in-feed per revolution of the work. The rate of the feed for diamond pattern knurling is slower than that for straight or diagonal knurling.

Straight or Diagonal
End - FEED KNURLING
Approximate
FEED per REVOLUTION

T.P.I	**Alum Brass**	**Mild Steel**	**Alloy Steel**
12	.008”	.006”	.004”
16 - 20	.010”	.008”	.005”
25 - 35	.013”	.010”	.007”
40 - 80	.017”	.012”	.009”

Straight or Diagonal
IN - FEED KNURLING
Approximate
REVOLUTION

T.P.I	**Alum Bras**	**Mild Steel**	**Alloy Steel**
12	12	15	25
16-20	10	13	22
25-35	8	11	20
40-80	6	9	18

Lathe mandrels - different types and their uses

Objectives : At the end of this lesson you shall be able to
- **define a mandrel**
- **state the constructional features of a solid mandrel**
- **identify and name the different types of mandrels**
- **enumerate the uses of different mandrels.**

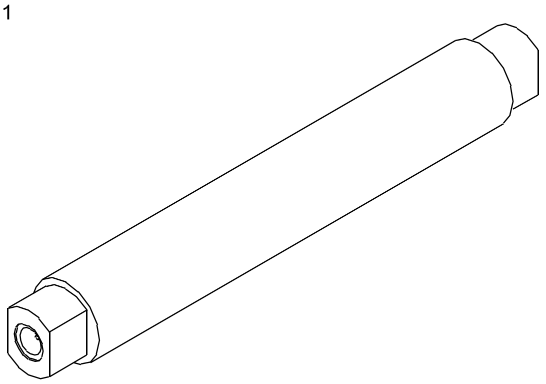
Types of mandrels and their uses

Sometimes it is necessary to machine the outer surfaces of cylindrical works accurately in relation to a hole concentric that has been previously bored in the centre of the work. In such cases the work is mounted on a device known as a mandrel.

Mandrel (Fig 1)

Lathe mandrels are devices used to hold the job for machining on lathes. They are mainly used for machining outside diameters with reference to bores which have been duly finished by either reaming or boring on a lathe.

Fig 1

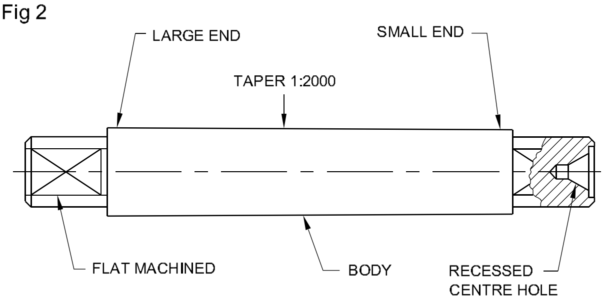


MANDREL

Constructional features of a solid mandrel (Fig 2)

The standard solid mandrel is generally made of tool steel which has been hardened and ground to a specific size and is ground with a taper of 1:2000.

Fig 2



DETAILS OF THE STANDARD SOLID MANDREL

It is pressed or driven into a bored or reamed hole in a workpiece so that it can be mounted on a lathe. The ends of the mandrel are machined smaller than the body and and are provided with a flat for the clamping screw of the lathe carrier. This preserves accuracy and prevents damage to the mandrel when the lathe carrier is clamped on.

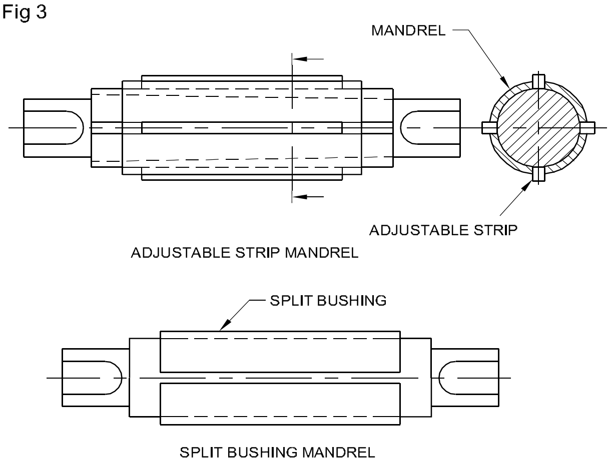
The centres made in these mandrels are 'B' type i.e. protected centres. In such centres the working portion is deep and does not get damaged while handling.

Types of mandrels

- Expansion mandrel
- Gang mandrel
- Stepped mandrel
- Screw or threaded mandrel
- Taper shank mandrel
- Cone mandrel

Expansion mandrel (Fig 3)

Fig 3



EXPANSION MANDRELS

The two most common types of expansion mandrels are:

- split bushing mandrel
- adjustable strip mandrel.

Split bushing mandrel

A split bushing mandrel consists of a solid tapered mandrel, and a split bushing, which expands when forced on to the mandrel. The range of application of each solid mandrel is greatly increased by fitting any number of different sized bushings. As a result only a few mandrels are required.

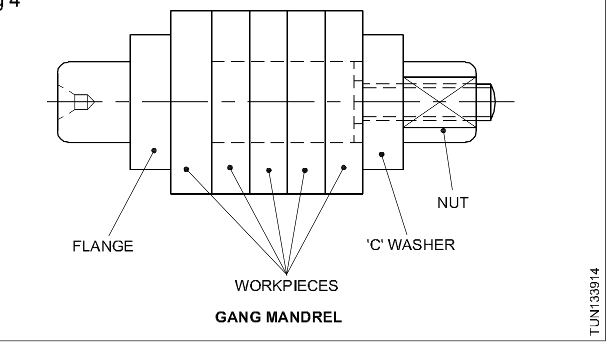
Adjustable strip mandrel

The adjustable strip mandrel consists of a cylindrical body with four tapered grooves cut along its length, and a sleeve, which is slotted to correspond with the tapered grooves. Four strips are fitted in the slots.

When the body is driven in,the strips are forced out by the tapering grooves and expanded radially. Sets of different sized strips greatly increase the range of each mandrel. This type of mandrel is not suitable for thin walled work, since the force applied by the strips may distort the workpiece.

Gang mandrel (Fig 4)

Fig 4



GANG MANDREL

A gang mandrel consists of a parallel body with a flange at one end and a threaded portion at the other end. The internal diameters of workpieces are larger than the mandrel body diameters by not more than 0.025 mm. A number of pieces can be mounted and held securely when the nut is tightened against the 'U' washer. The nut should not be over-tightened, otherwise inaccuracies will result.

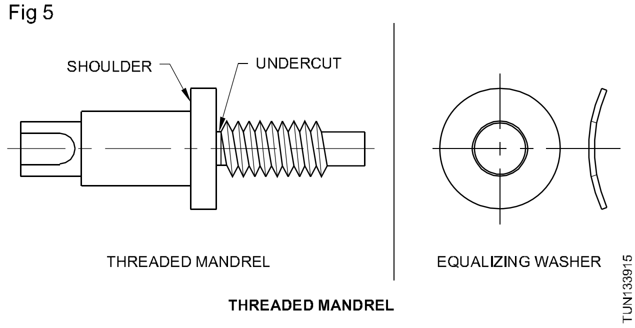
A gang mandrel is especially useful when machining operations have to be performed on a number of thin pieces which might easily be distorted, if held by any other method.

Stepped mandrel

The stepped mandrel is manufactured in order to reduce the number of mandrels. It differs from the plain mandrel in the fact that a number of steps are provided on it. Its use saves time in holding various bored works.

Screw or threaded mandrel (Fig 5)

Fig 5



THREADED MANDREL

A threaded mandrel is used when it is necessary to hold and machine workpieces having a threaded hole.

This mandrel has a threaded portion which corresponds to the internal thread of the work to be machined. An undercut at the shoulders ensures the work to fit snugly (tightly) against the flat shoulder.

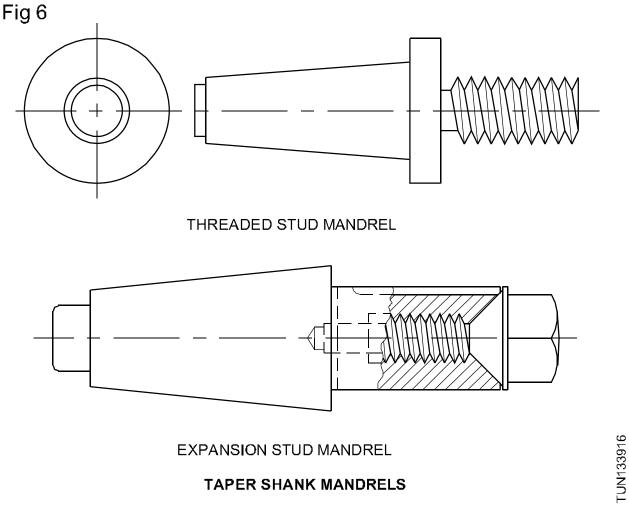
Taper shank mandrel (Fig 6)

Taper shank mandrels are not used between lathe centres. They are fitted to the internal taper of the headstock spindle. The extending portion can be machined to suit the workpiece to be turned. Taper shank mandrels are generally used to hold small workpieces.

Two common types of taper shank mandrels are:

- expansion stud mandrel
- threaded stud mandrel.

Fig 6



TAPER SHANK MANDRELS

Expansion stud mandrel

The expansion stud mandrel is slotted and has an internal thread. When a tapered screw is tightened, the outside diameter of the stud expands against the inside of the workpiece. This type of mandrel is useful when machining a number of similar parts whose internal diameters vary slightly.

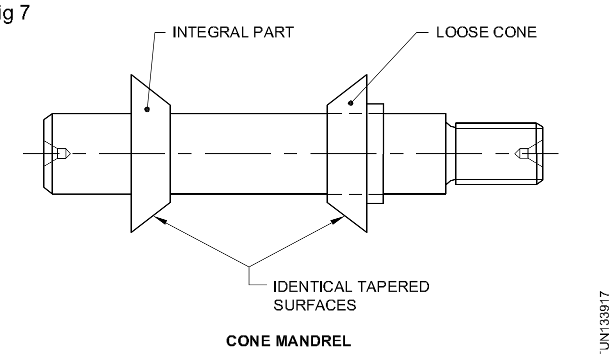
Threaded stud mandrel

The threaded stud mandrel has a projecting portion which is threaded to suit the internal thread of the work to be machined. This type of mandrel is useful for holding workpieces which have blind holes.

Cone mandrel (Fig 7)

A cone mandrel is a solid mandrel. It has a portion taper turned with a steep taper and integral with the body. One end of the mandrel is threaded. A loose cone slides over the plain turned portion of the body of the mandrel. It has the same steep taper as that of the tapered integral part. A job of large bore, can be held between these two tapers and tightly secured by means of nut, washer and spacing collars.

Fig 7



CONE MANDREL

Concept of interchangeability, limits & fits

Objectives : At the end of this lesson you shall be able to
- **state what is mass production and interchangeable manufacture**
- **state the necessity of the limits system**
- **name the different standard systems of limits and fits accepted and adopted internationally.**

Mass production

When identical components are manufactured in large quantities it is stated that they are mass produced. These identical components should fulfil:

- dimensional accuracy
- degree of surface finish
- interchangeability.
- Standardization

Mass production has the advantage of interchangeable manufacture of components machined by different operators on different machine tools under different environments that can be assembled without any rectification with their mating parts. This avoids selective assembly which is time consuming.

Necessity of limit system

It is practically impossible to machine components to an exact size, due to the varying skills of the operators, the condition of the machine tools, the quality of the cutting tools and the accuracy of the precision instrument used. Hence some permissible deviations to the exact size are accepted and given, and the operator is expected to produce the components within the limits, which, even though not necessarily equal to the exact size, will not affect the functioning of the components. This necessitates the introduction of the limit system.

Internationally accepted systems of limits and fits

- British Standard System of Limits and Fits (B.S.).
- International Standard Organization System of Limits and Fits. (I.S.O.)
- Bureau of Indian Standard System of Limits and Fits (B.I.S.)

Apart from the above most commonly used limit systems, various countries follow their own standards to manufacture components for some of their industries.

Advantages of the limit system

- Interchangeability is assured.
- Not necessary to employ highly skilled operators.
- Not necessary to use conventional measuring instruments.
- Time for the manufacture of components will be comparatively less.

Limits, Fits and Tolerance

The B.I.S. standard system of limits and fits is followed by the industries in our country as the standard. It is adopted from the I.S.O. and B.S. standards with modifications to suit our conditions and requirements. For the purpose of B.I.S. standard, the following definitions and symbols are followed.

Size

It is a number expressed in a particular unit in the measurement of length.

Basic size

It is the size based on which the dimensional deviations are given. (Fig 1)

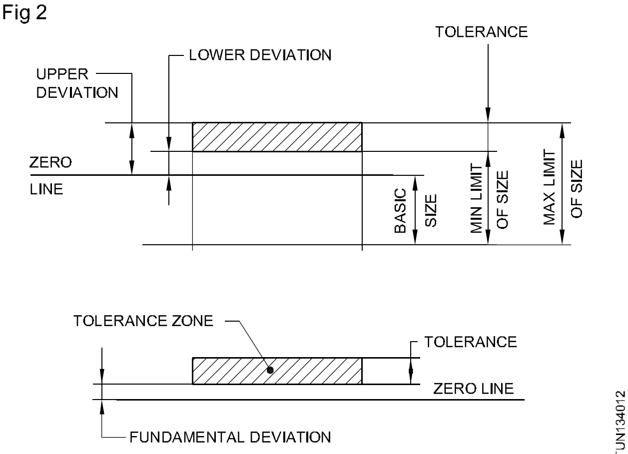
Maximum limit of size

It is the greater of the two limit sizes..(Fig 2) (Table 1)

Minimum limit of size

it is the smaller of the two limits of size. (Fig 2).(Table 1)

Fig 2



Actual size

It is the size of the component by actual measurement after it is manufactured, it should lie between the two limits of size if the component is to be accepted.

Limits of size

These are the extreme permissible sizes within which the operator is expected to make the component. (Fig 2) (Maximum and minimum limits)