Machinist 2nd Year – Transparencies

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CENTRAL INSTRUCTIONAL MEDIA INSTITUTE, CHENNAI

ANINDO – GERMAN PROJECT

Directorate General of Employment & Training, Ministry of Labour, Govt. Of India

Developed by
CENTRAL INSTITUTIONAL MEDIA INSTITUTE
in collaboration with Deutsche Gesellschaft für Technische Zusammenarbeit (GTZ) Germany

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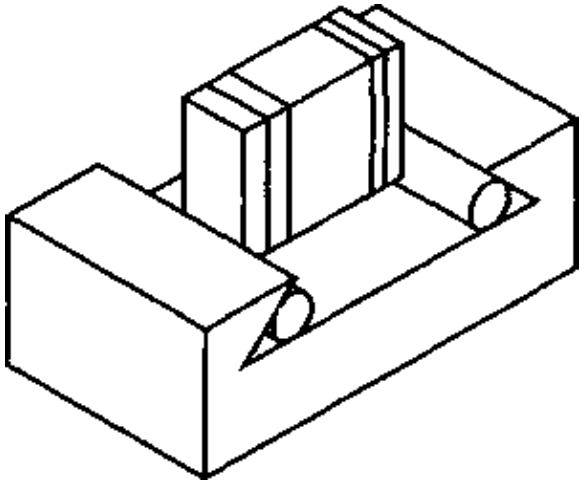
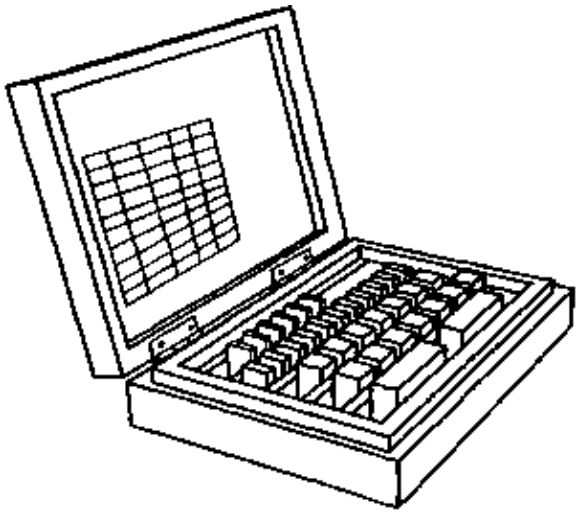
Slip Gauges

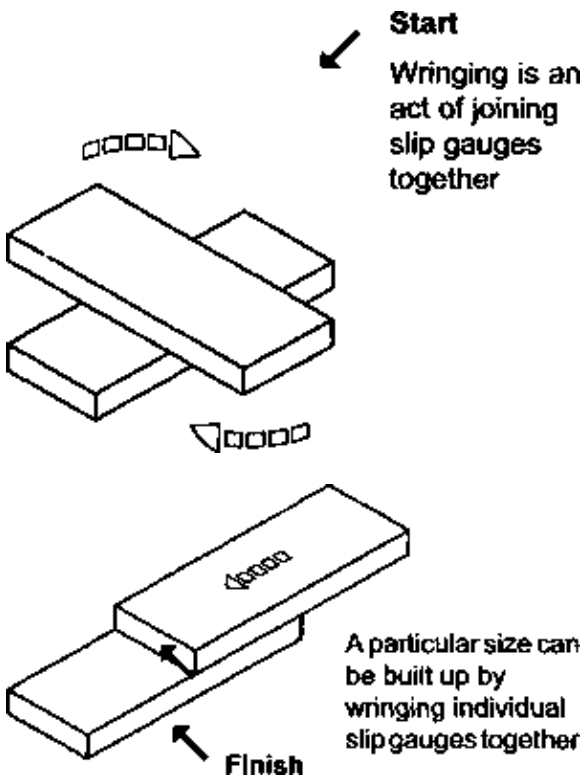
TR 01 01 01 01 02

Slip gauges/Gauge blocks are used as standards for length measurement

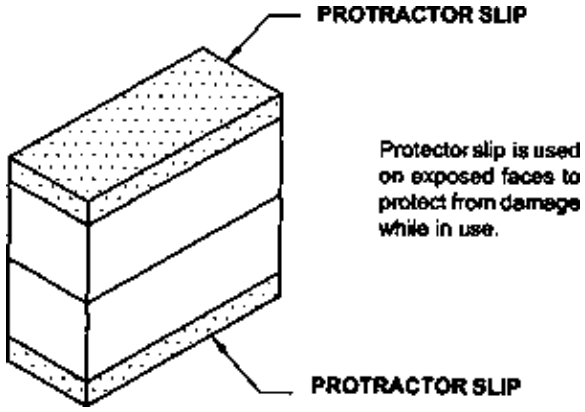


Available in sets with different numbers & different combinations. Eg., 112,103, 78,47,87 pieces etc.





Protector slips of standard thicknesses from higher wear resistance steel or tungston carbide are available in some sets.



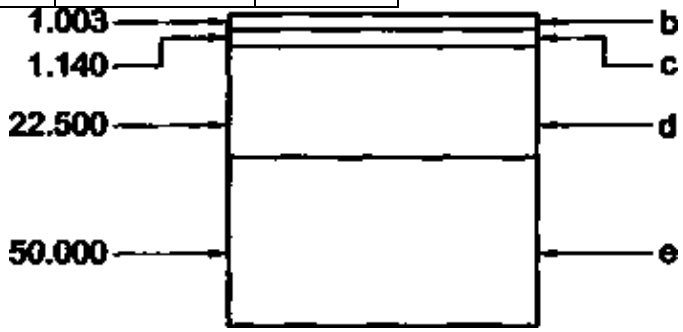
Determining slip gauge size

TR 01 01 01 02 02

PROCEDURE	SLIPS USED	CALCULATION
a) Write the required dimension		74.643
b) Select 1st series slip that has the same last digit	(Subtract1.003)	1.003
		73.640
c) Select 2nd series slip – same last figure & the remainder must be either 0.0 or 0.5	(Subtract 1.140)	1.140
		72.500
d) Select a 3rd series slip – expected remainder must be a 4th series figure	(Subtract 22.500)	22.500

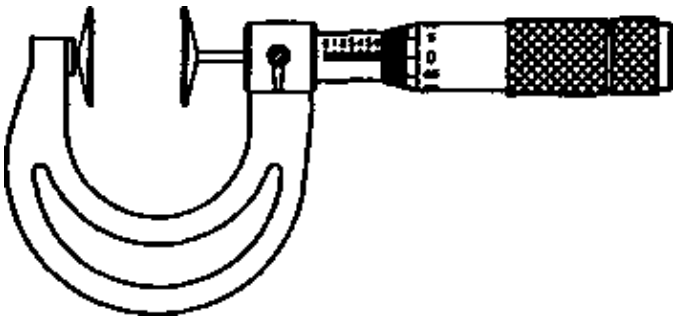
		50.000
e) Select the 4th series slip –remainder must be zero	(Subtract 50.000)	50.000
		0

Range (mm)	Steps (mm)	No. of pieces
Special pieces 1.0005		1
1st Series 1.001 to 1.009	0.001	9
2nd series 1.01 to 1.49	0.01	49
3rd series 0.5 to 24.5	0.5	49
4th series 25.0 to 100.0	25.0	4
Total pieces		112



Special micrometers

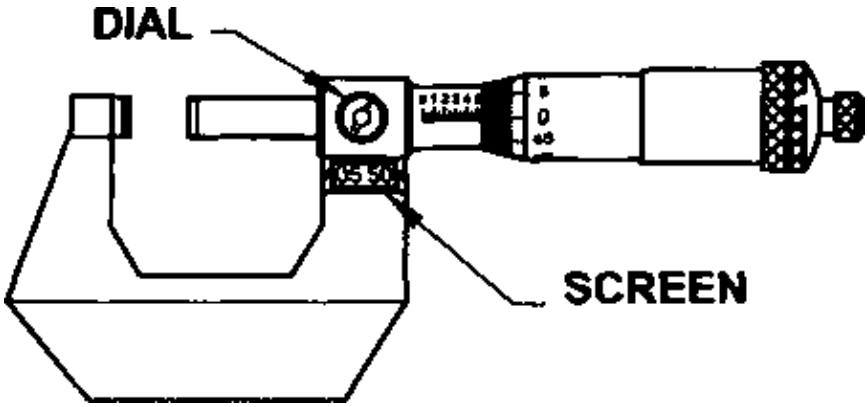
TR 01 01 06 03 02



Flange micrometer

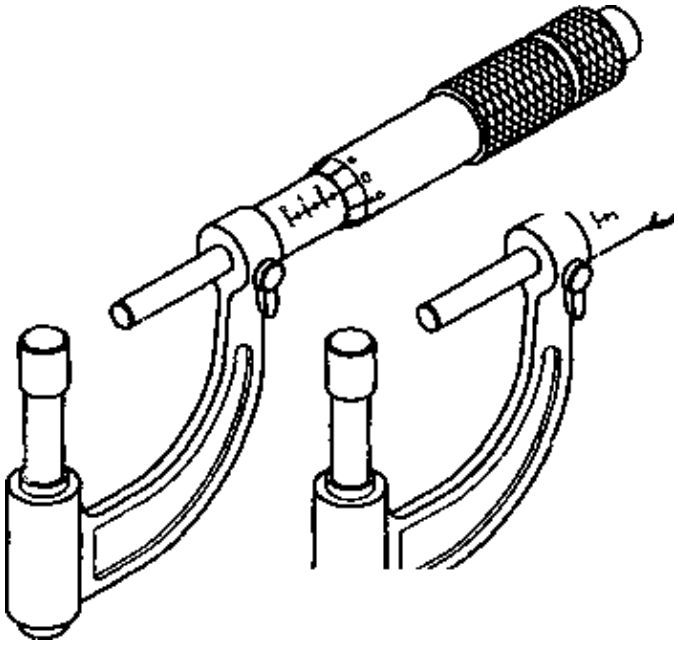
Flange micrometer is used to measure

– Chordal thickness of gear tooth
– thickness of engine fins
– coller of jobs etc.



Digital micrometer

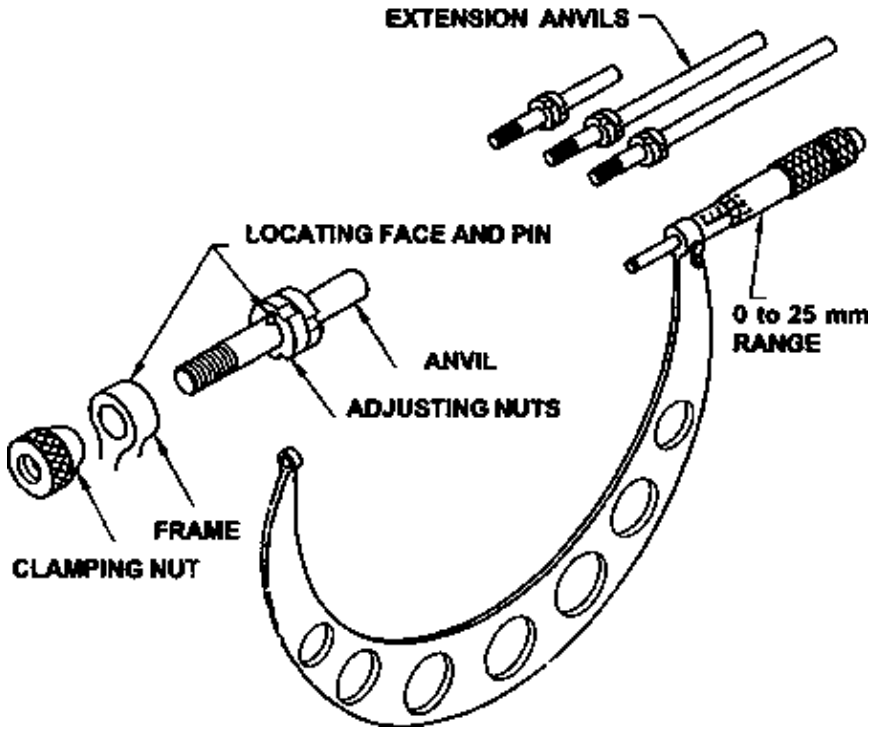
Digital micrometer is similar to outside micrometer. Measurements can also be read directly from the digital display.



Tube micrometer

Tube micrometer is used to measure the wall thickneses of

Pipes tubes and other hollow parts.



A Single External micrometer

A Single External micrometer with interchangeable anvils can replace many outside micrometers of different ranges.

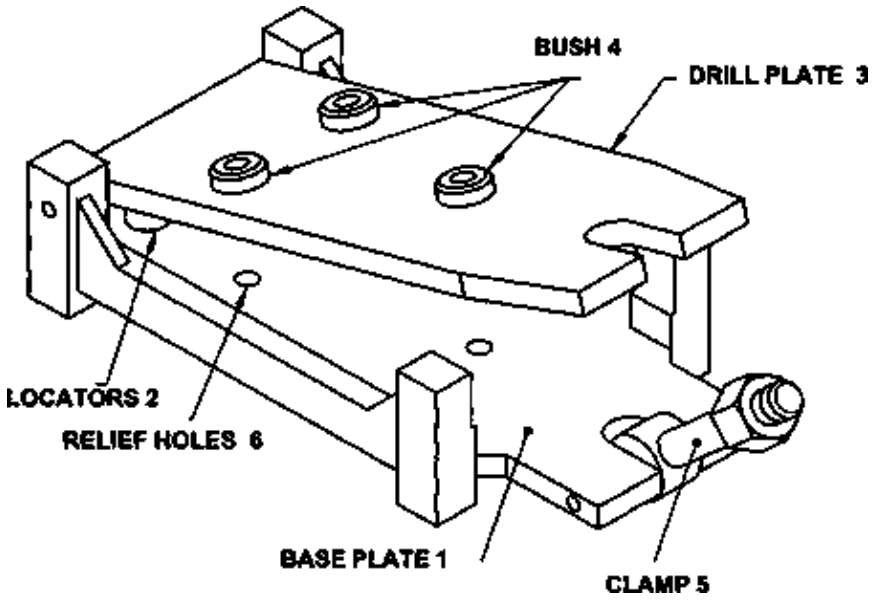
A single micrometer can be used by merely changing different anvils.

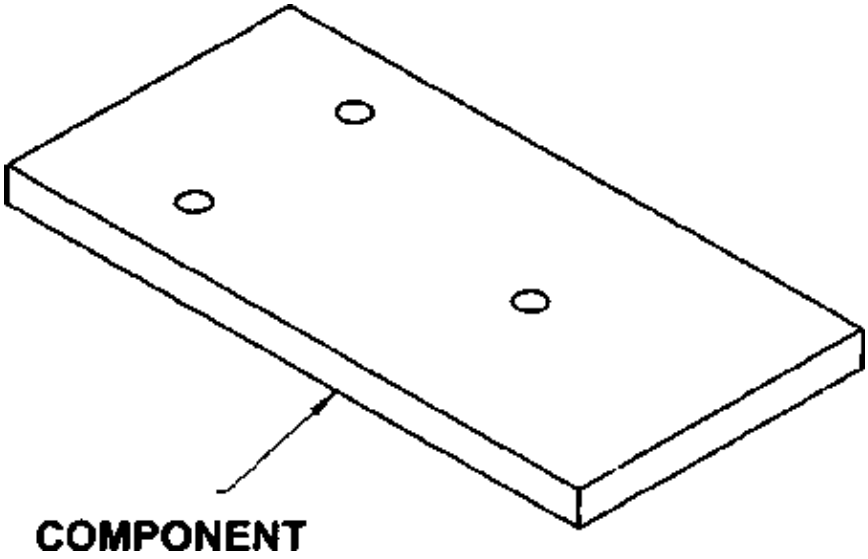
Drill jig

TR 01 01 09 04 02

Jigs are used in mass production for drilling and allied operations.

Jig holds, supports and locates the component. Locates and guides the cutting tool.



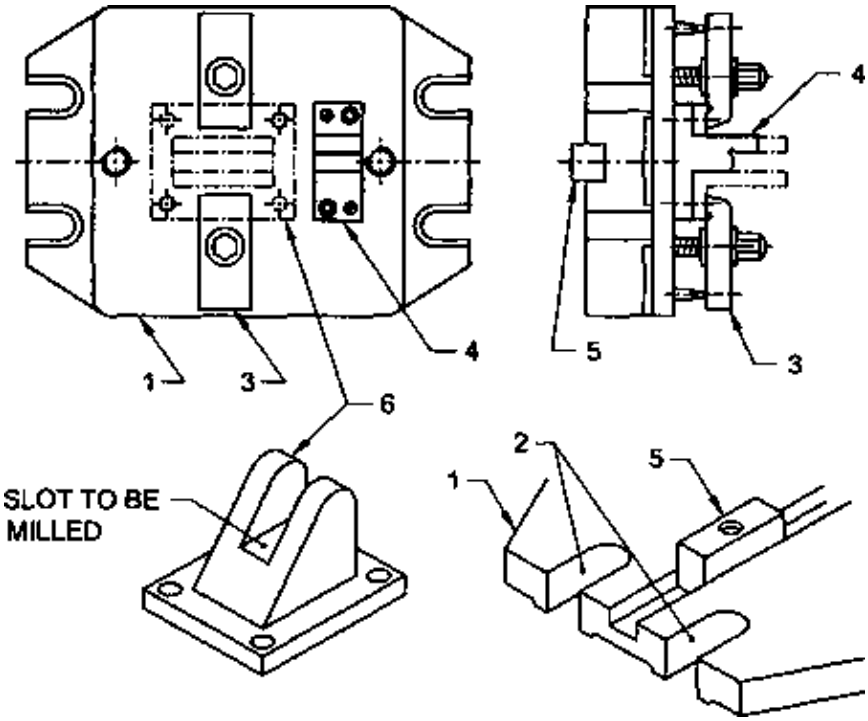


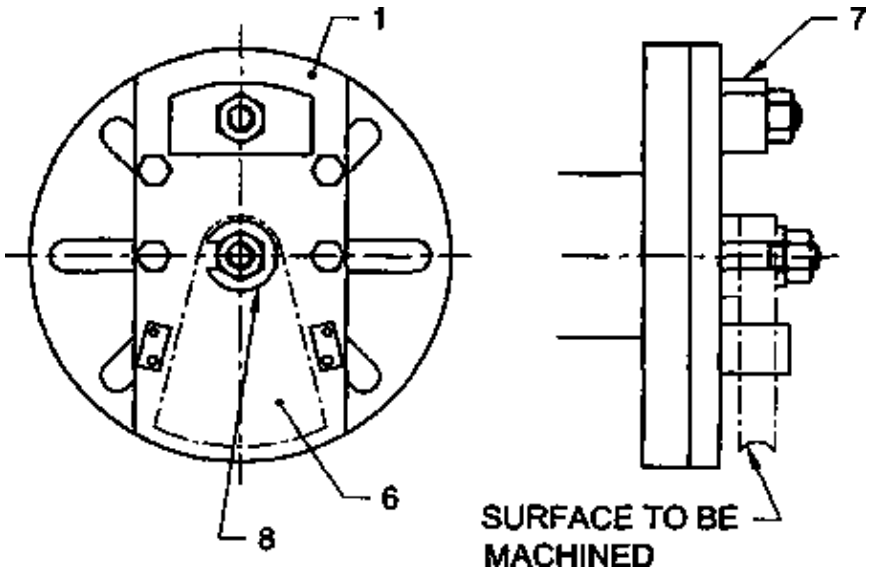
Features and functions:

Base plate (1) is a solid support for mounting component. Locators (2) are positioned on this. These locators are used to position and restrains the movement of the component. Drill plate (3) holds bush/bushes (4) for cutting operation. Purpose of these bushes to locate and guide drill/reamer etc. clamp (5) is to be designed in such a way that loading and unloading of component must be easy and quick. Relief holes (6) are drilled on the base plate for clearing chips.

Fixtures

TR 01 01 09 05 02





Fixtures are made and used for:

- Maching operations like milling, turning, grinding.
- Welding
- Bending
- Assembly, etc.

Base plate (1) of the milling fixture is provided with tenons (5) at its bottom for the correct location of the fixture with machaine table through Tee Slots. Two or four holding down slots (2) meant for the rigid clamping of fixture base with the machine table. Setting block (4) is used to position fixture and work (6) relative to the milling cutter before machining.

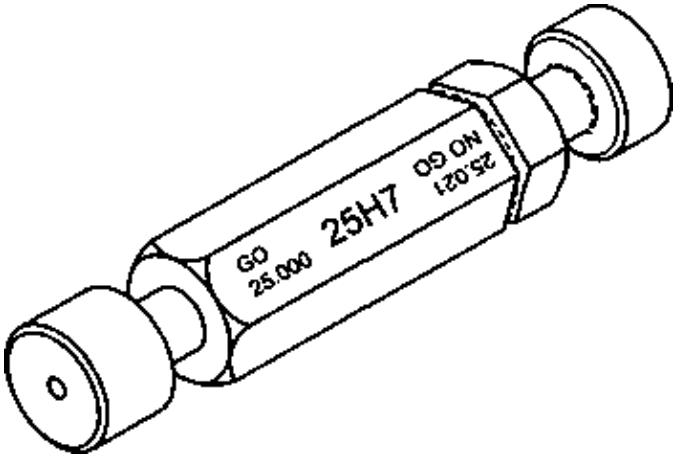
Balancing weight (7) of turning/grinding fixture is used to balance the irregular work piece (6) 'C' washer (8) is helpful for easy loading and unloading of workpieces.

Limit plug gauges

TR 01 01 11 06 02

Limit plug gauges are used to check whether the hole portion of the component lie within the limits of size prescribed by the manufacturer.

Cylindrical limit plug gauges are used to check the inside diameter of a straight hole of the component.



DOUBLE ENDED PLUG

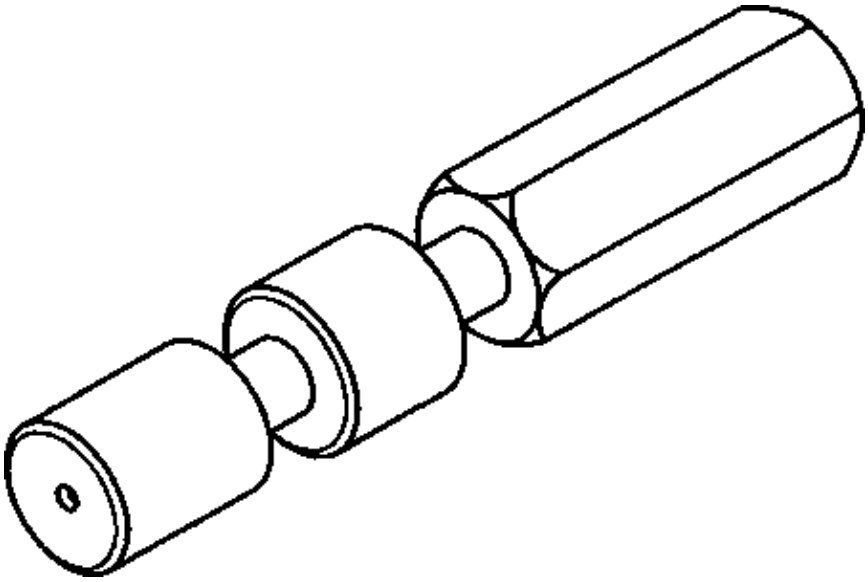
GAUGE

For easy identification.

– Go end is made longer than the nogo end.

OR

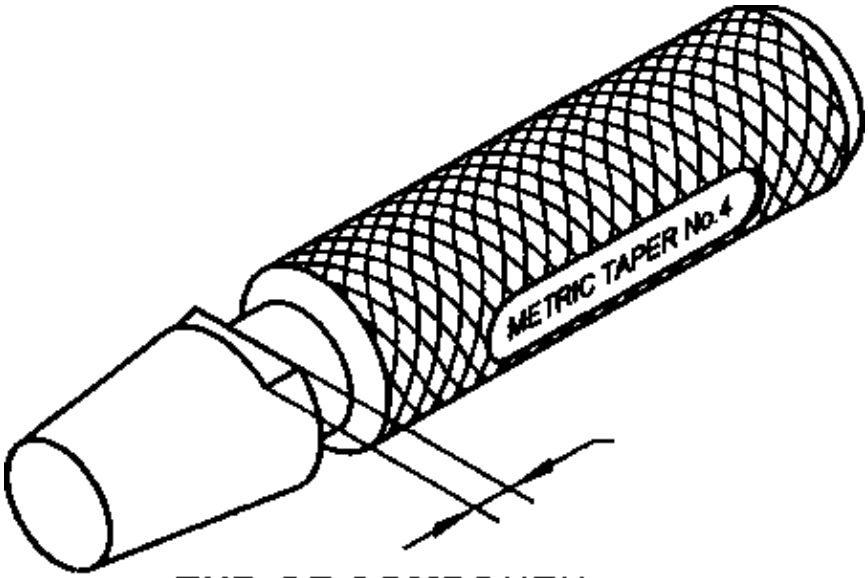
– a groove is cut on the handle near the no go end.



PROGRESSIVE PLUG GAUGE

PROGRESSIVE PLUG GAUGE

More convenient to use – How? In one action checking of go and no go limits possible



TAPER PLUG GAUGE

TAPER PLUG GAUGE

Used to check standard taper jobs and also special taper jobs for specific use.

Check

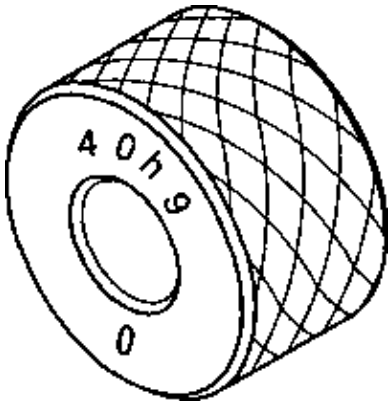
– size of hole
– Accuracy of taper

The gauge is made to slide into the hole for a prescribed depth and at the same time fit properly.

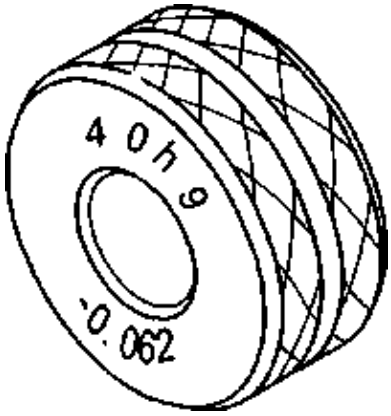
Incorrect taper–gauge will wobble inside the hole.

Limit ring and snap gauges

TR 01 01 11 07 02



GO RING GAUGE



NO GO RING GAUGE

TAPER RING GAUGES are used to check both the accuracy of taper and the outside diameter of an external taper.

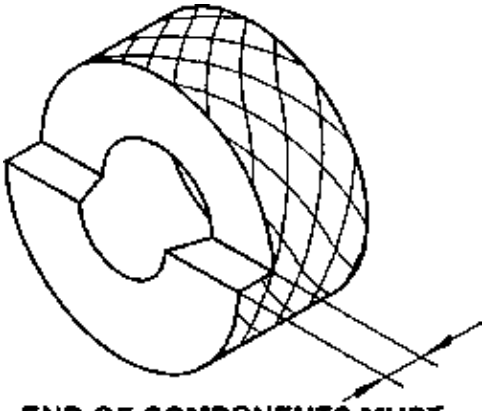
A step ground on the smaller end to indicate Go and nogo positions.

Accepted taper component's smaller end must lie within the step.

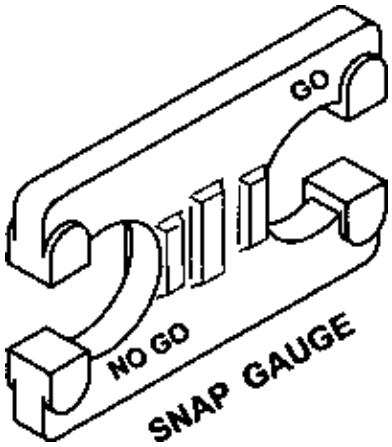
LIMIT RING GAUGES

are used for checking whether the circular shaft portion of a component lie within the limits of size or not.

No go gauge is identified by an annular groove cut on the knurled surface.

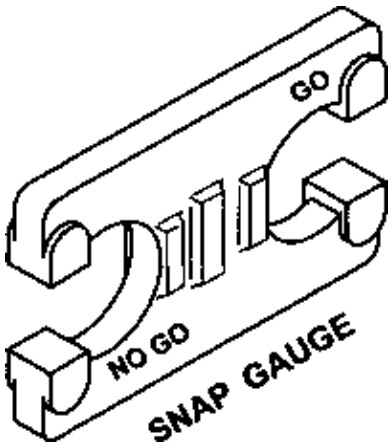


LIMIT RING GAUGES



SNAP GAUGES

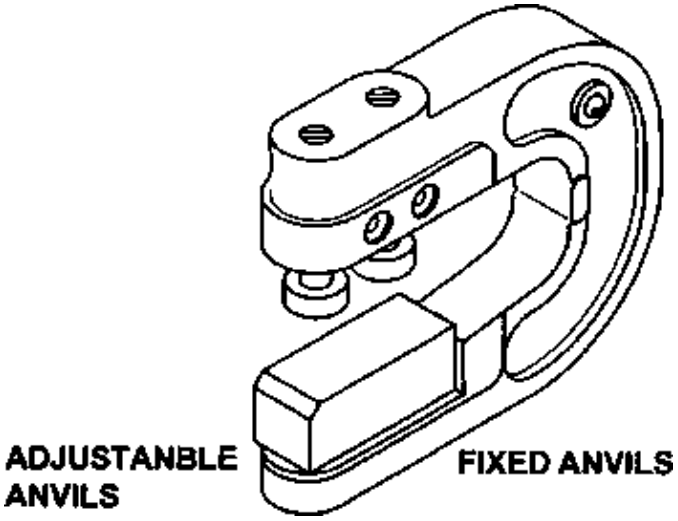
SNAP GAUGES are used to check external dimensions of jobs other than cylindrical ones also.



ADJUSTABLE SNAP GAUGES

ADJUSTABLE SNAP GAUGES possible to set and check different go and nogo deviations of the component.

Checking can be done after setting and locking adjustable anvils to the required maximum and minimum limits of size using slip gauges.



ADJUSTABLE SNAP GAUGES

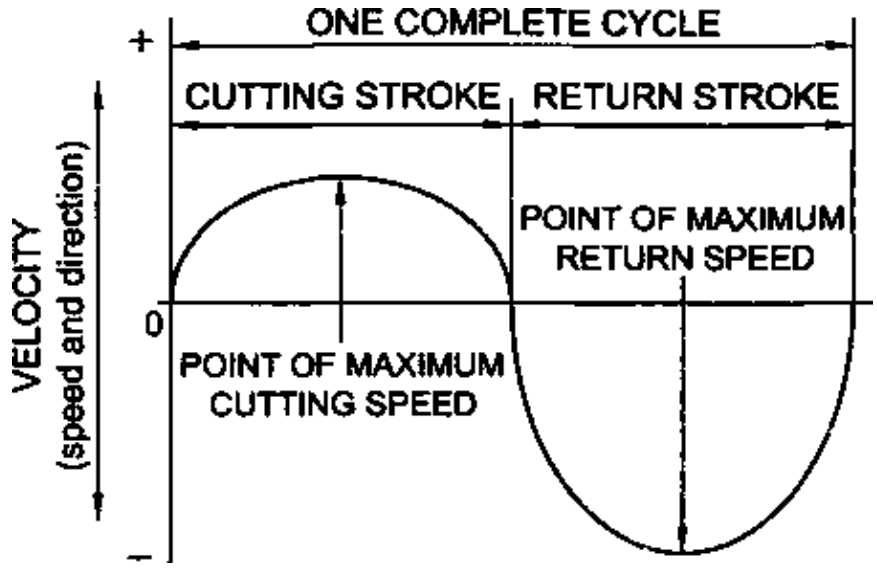
Shaper stroke length & cutting speed

TR 01 01 11 08 02

Conversion of rotary motion of bull gear into the linear motion of shaper is a simple harmonic motion.

Speed characteristic of simple harmonic motion is that the

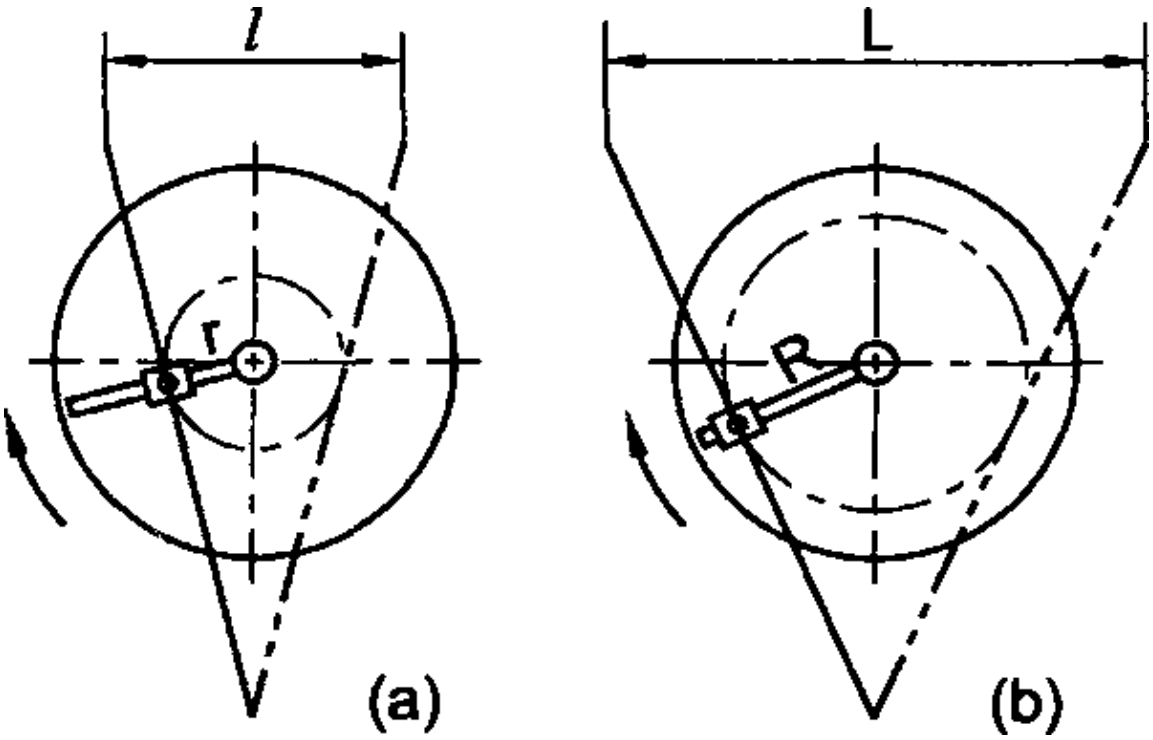
- zero speed at the starting of the stroke.
- Maximum speed at the middle of the stroke.
- Again zero speed at the end of the stroke.



3 or 5 speed ranges are available for setting the rpm of the bull gear of shaper. Even the bull gear is set to a particular rpm stroke length can be changed by changing the radial distance (R/r)

This change of length (L/l) of ram causes a change in cutting speed of ram.

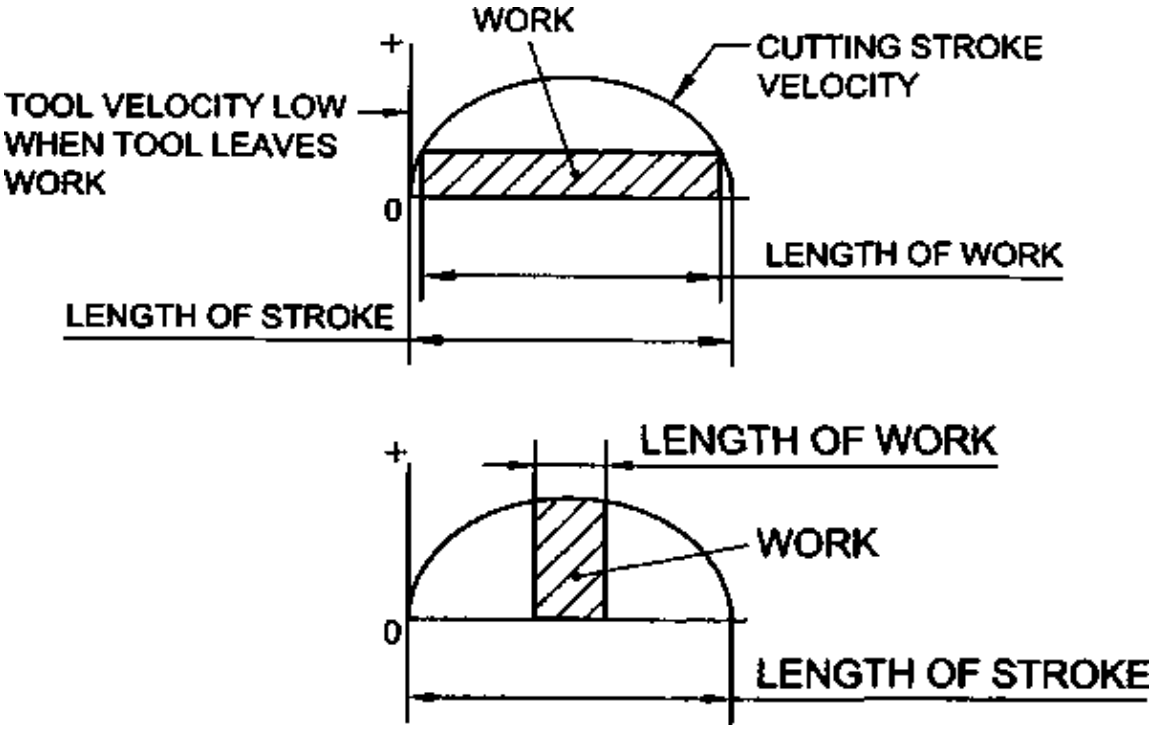
Longer the length of stroke of ram greater the cutting speed of ram.



If the stroke length is very much longer than length of the job, tool velocity will be very much high when the tool strikes the job.

Due to the high velocity

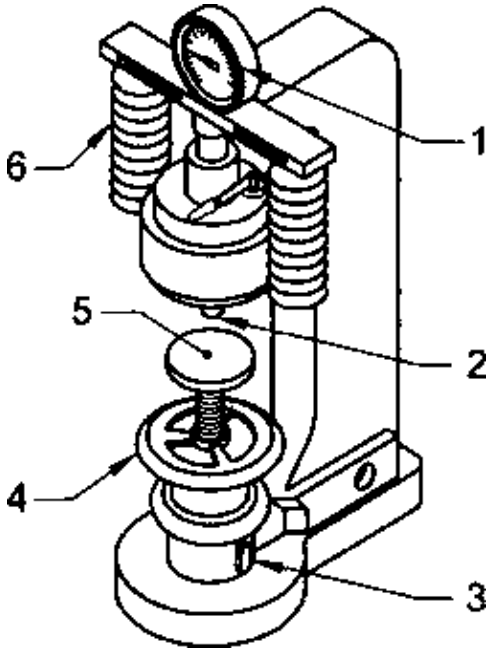
- Cutting edge of tool may chip.
- Work may be disloged
- excessive machine wear.



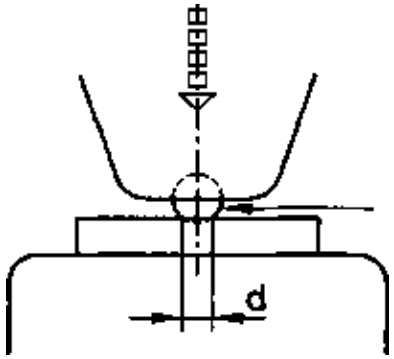
Hardness testing – Brinell

Suitable for testing hardness of soft materials like

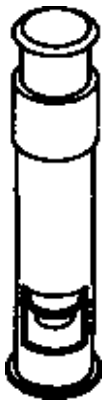
Cast iron, Lead, Copper alloys, Aluminium etc.



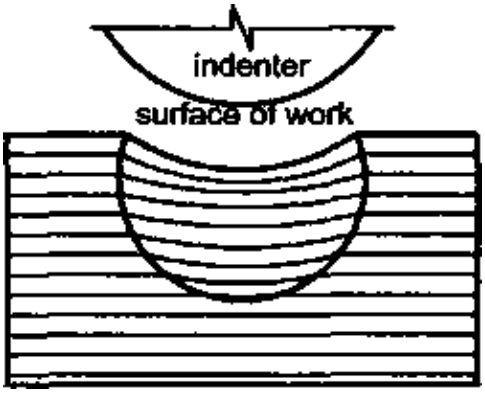
Applying load – 100, 250, 500, 1000, 1500, 2000, 2500 or 3000 kgf



1. Apply load



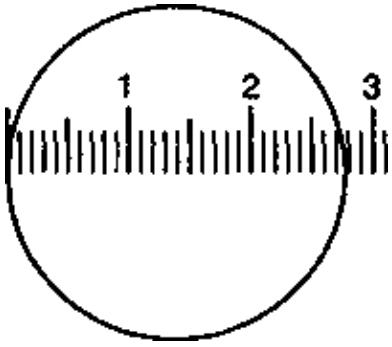
Circular impression is made by the indenter



2. Create impression on job

3. Measure mean diameter of impression

Impression made is measured by using a microscope and a scale



Formula for finding hardness where (HB) = ?

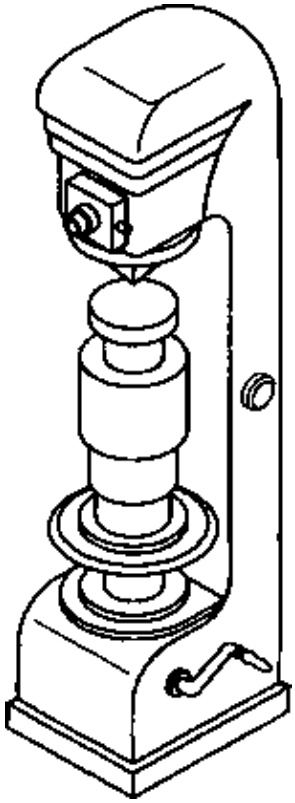
where

P = Applied Load (kgf)
D = Diameter of ball
d = Mean diameter of impression

4. Apply formula and get hardness value (HB)

Hardness testing – Vicker

TR 01 02 13 10 02

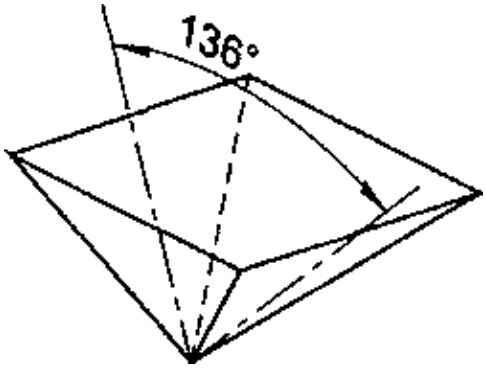


VICKER'S HARDNESS TESTER

This method of testing is done using Vicker hardness tester

The load used is from 5 to 120 kgf. (5, 10, 20, 30, 50, 100 or 120 kgf)

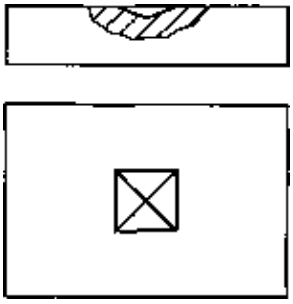
This test is used for testing hard specimens like: Cutting tools and heat treated components



Indenting tool used is the highly polished diamond pyramid.

Indenting tool will make diamond shaped impression on the job due to the application of the load.

Mean diagonal of the impression can be measured using a microscope and scale.



Formula for finding Hardness Vicker (HV) =

where

P is the load in kgf and
d is the mean diagonal of the impression in mm.

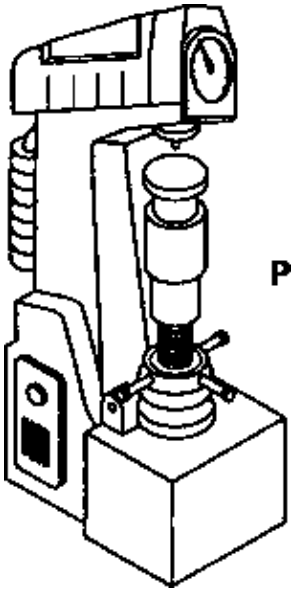
Hardness testing – Rockwell

TR 01 02 13 11 02

Many scales are available in this Rockwell hardness testing method (P) Standard scales are:

Hardness Rockwell B–scale (HRB) for Copper, Aluminium alloy, Mild Steel.

Hardness Rockwell C–scale (HRC) for Steel, Hardened steel.

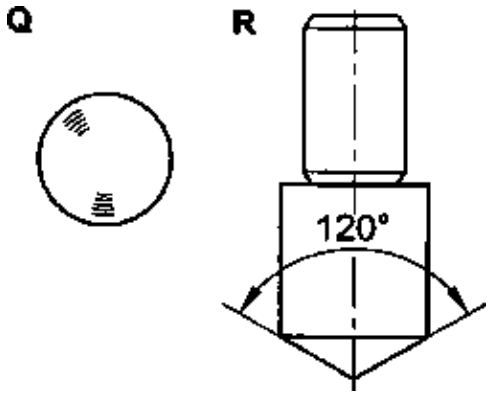


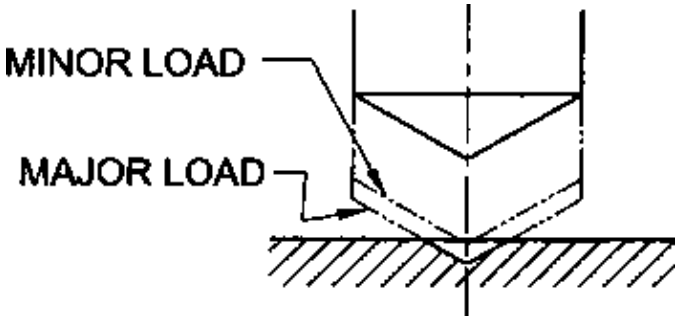
Indenting tool

A steel ball (Q) for B–Scale (HRB 0 to 130)

A diameond cone (R)for C– Scale (HRC 0 to 100)

First a minor load of 10 kgf (98.1 N) is applied on the job to avoid getting wrong reading due to the hardness of the top layer of job and also due to the backlash of machine.

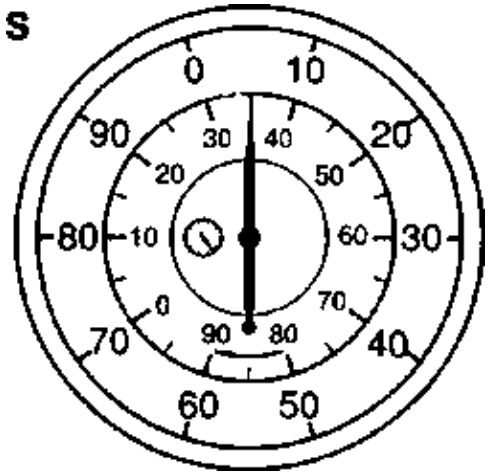




Then a major load of

- 100 kgf (981 N) is applied B–Scale.
- 150 kgf (1471 N) is applied C–Scale.

Due to the major load application a further deep impression is formed on the job.



The difference in depth of penetration is directly read from the dial (S) of the machine.

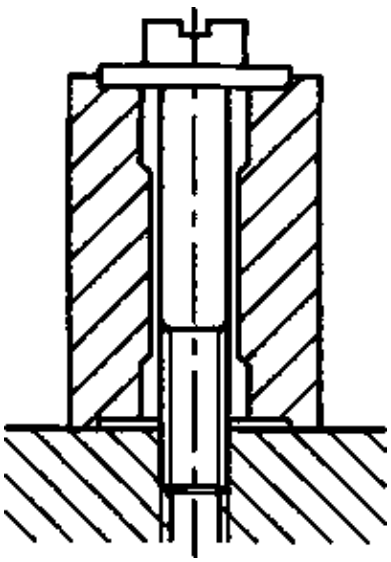
Refer table and convert the difference of depth of penetration to the hardness value of the respective scale.

Tool Maker's Button

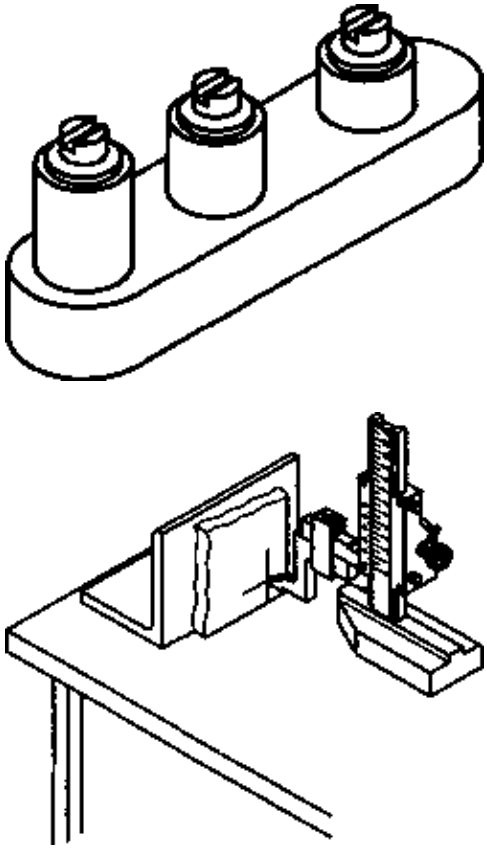
TR 01 03 09 12 02

Tool Maker's button is used to produce bored holes to a high degree of positional accuracy with reference to both axis

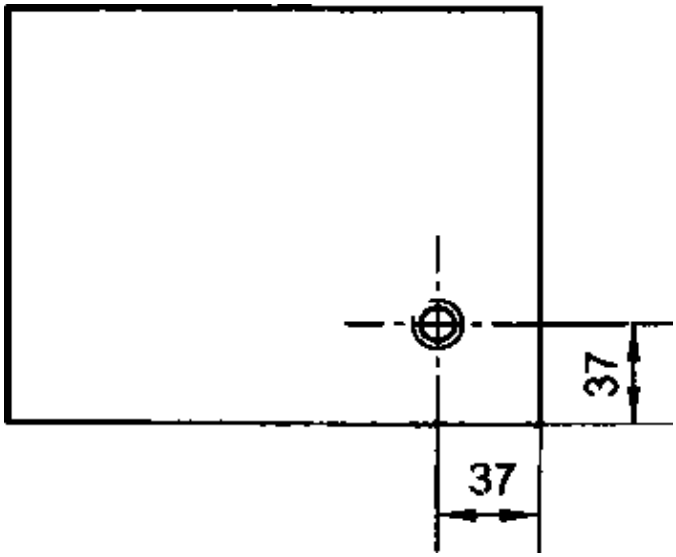
Tool Maker's button is a hardened and ground steel cylinder of ?8, 10 or 12 mm available in set of 3 or 4 cylinders.



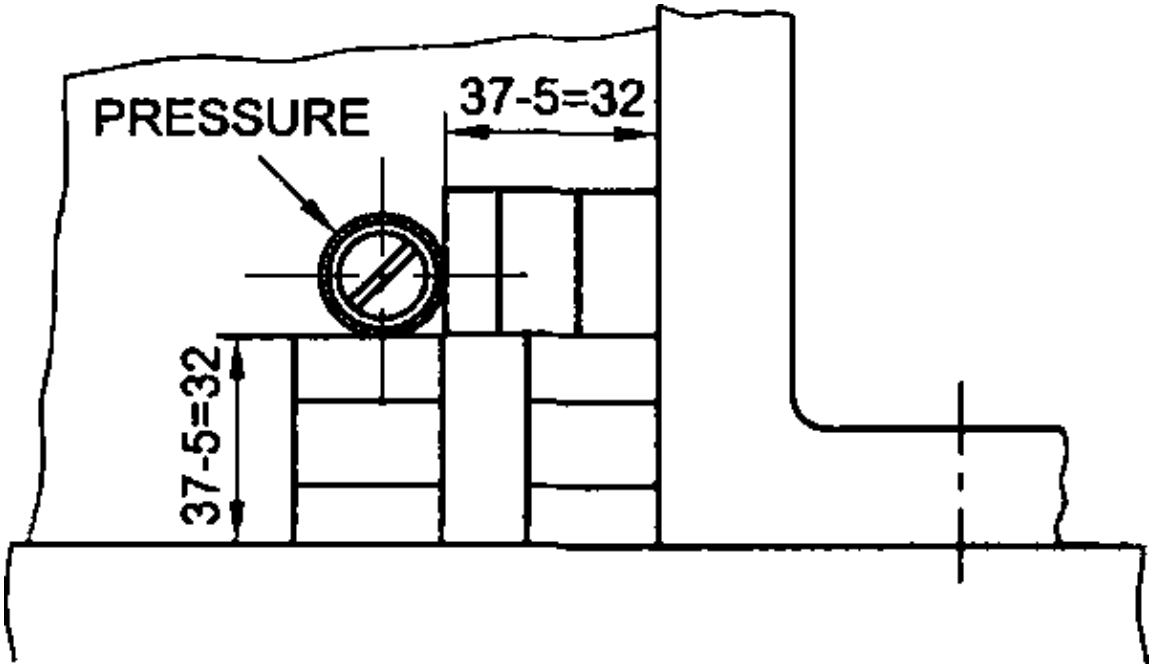
Step 1. Mark the position of hole from the reference edges.



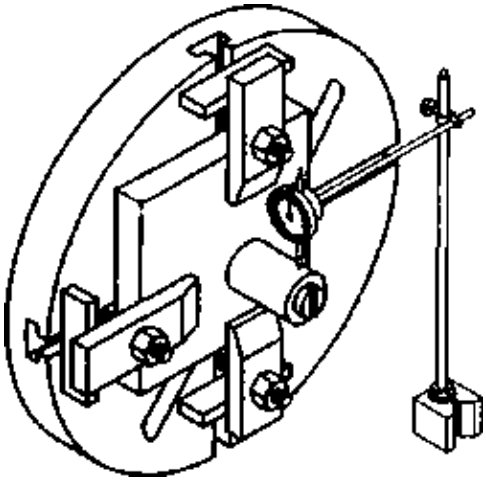
Step 2. Drill a hole for tapping BA thread in the position marked. Tap BA thread for fixing ?10 tool maker's button.



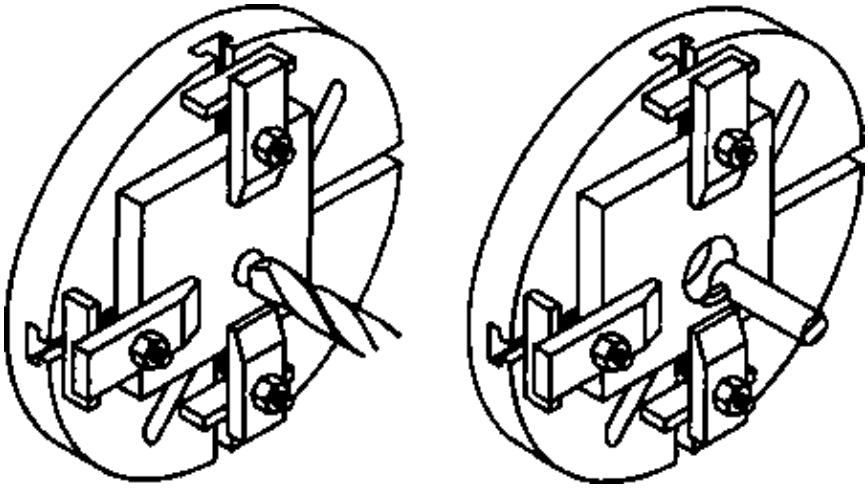
Step 3. Set the button in position using slip gauges.



Step 4. After fixing the button, set and align the job.



Step 5. Remove button, drill and bore the hole.



Measurement of screw thread elements – I

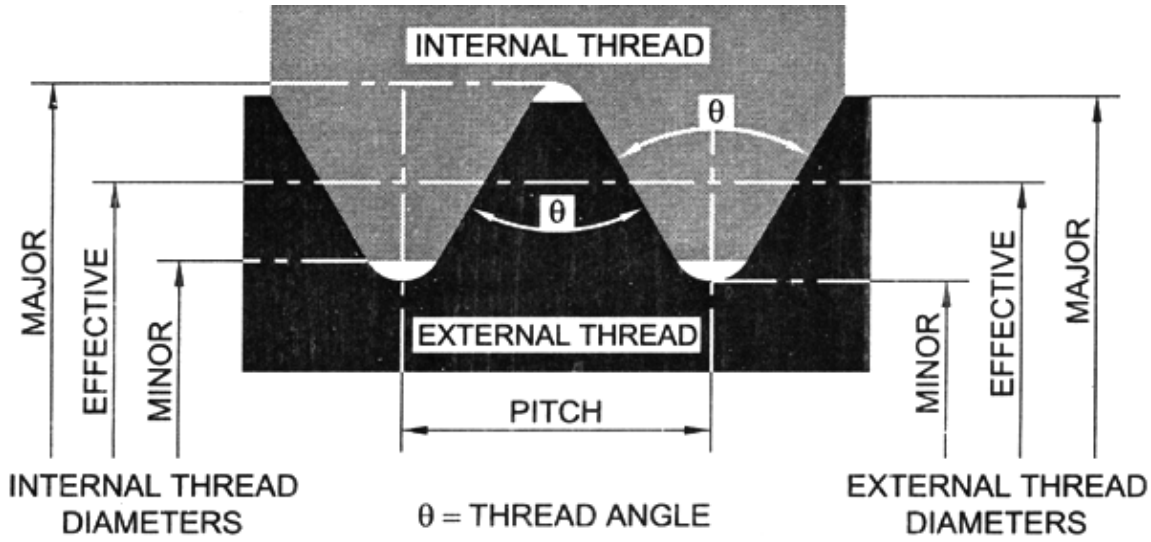
TR 01 03 23 13 02

ELEMENTS FOR MEASUREMENT

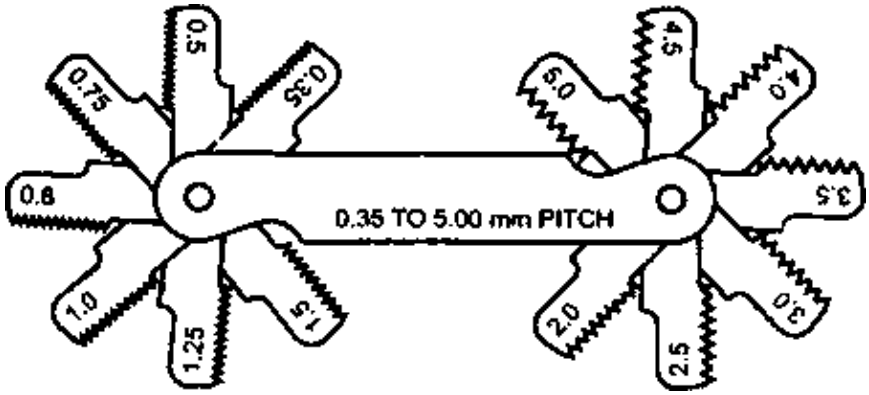
Following elements of a Vee thread is required to be checked according to the requirement.

- Major diameter
- Minor diameter
- Pitch
- Effective diameter
- Profile Angle
- Form of Crest and root

Forchecking the elements different instrument/method can be used.

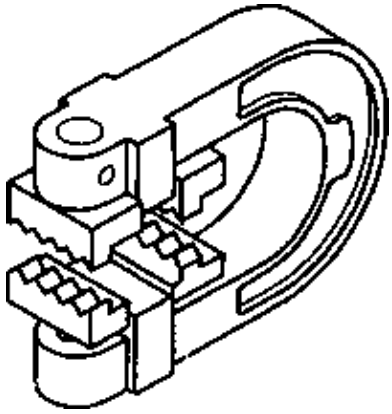


SCREW PITCH GAUGE is used to check pitch of the screw threads (both external and internal)



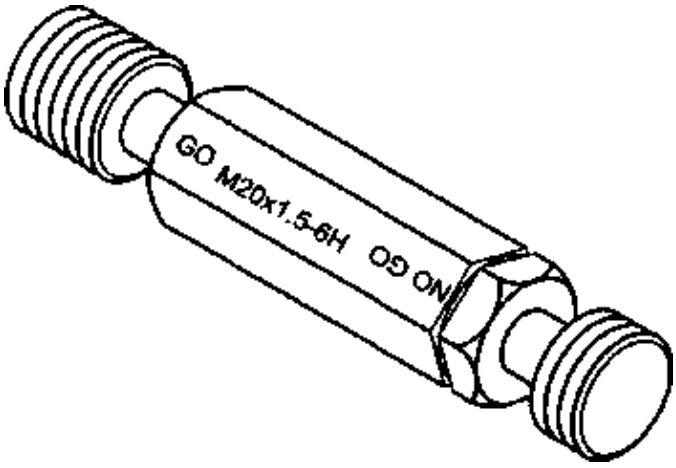
SCREW PITCH GAUGE

SCREW THREAD CALIPER GAUGE is used to check pitch of the screw threads (both external and internal)



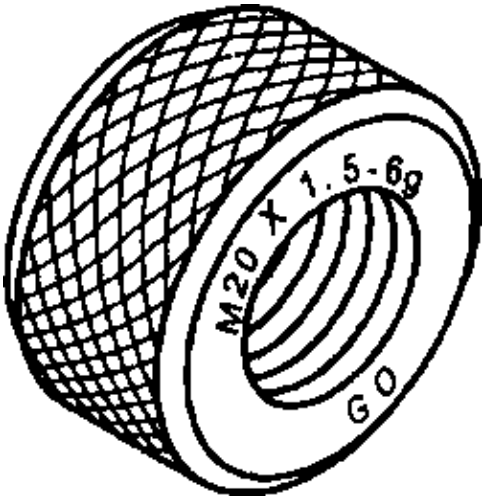
SCREW THREAD CALIPER GAUGE

SCREW THREAD PLUG GAUGE is used to check all the main elements of internal Vee threads within limits



SCREW THREAD PLUG GAUGE

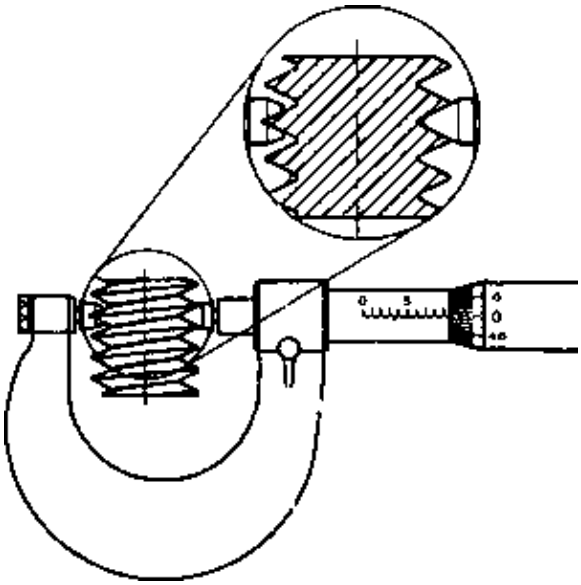
SCREW THREAD RING GAUGE is used to check all the main elements of external Vee threads within limits.



SCREW THREAD RING GAUGE

Measurement of screw thread elements – II

TR 01 03 24 14 02



SCREW THREAD MICROMETER

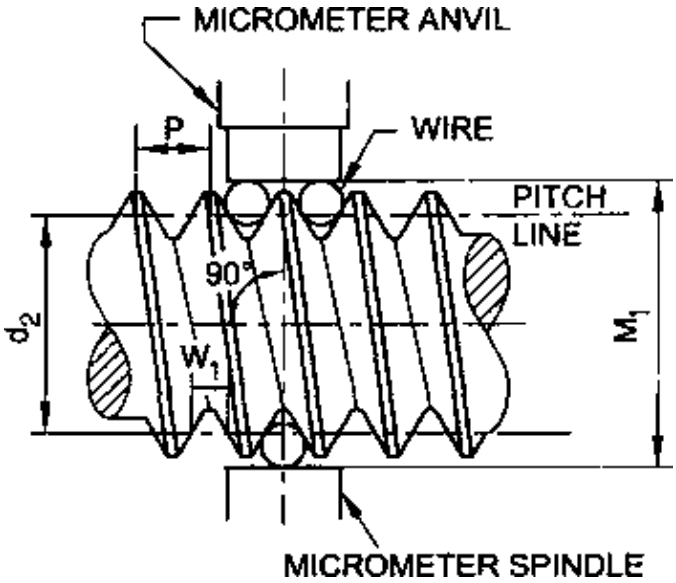
SCREW THREAD MICROMETER is used to measure the effective diameter of the thread.

Anvils of the micrometer are replaceable, according to the profile and pitch of different systems of Vee thread, they are changed and used.

THREE WIRE METHOD is used for measuring the effective diameter of the screw threads.

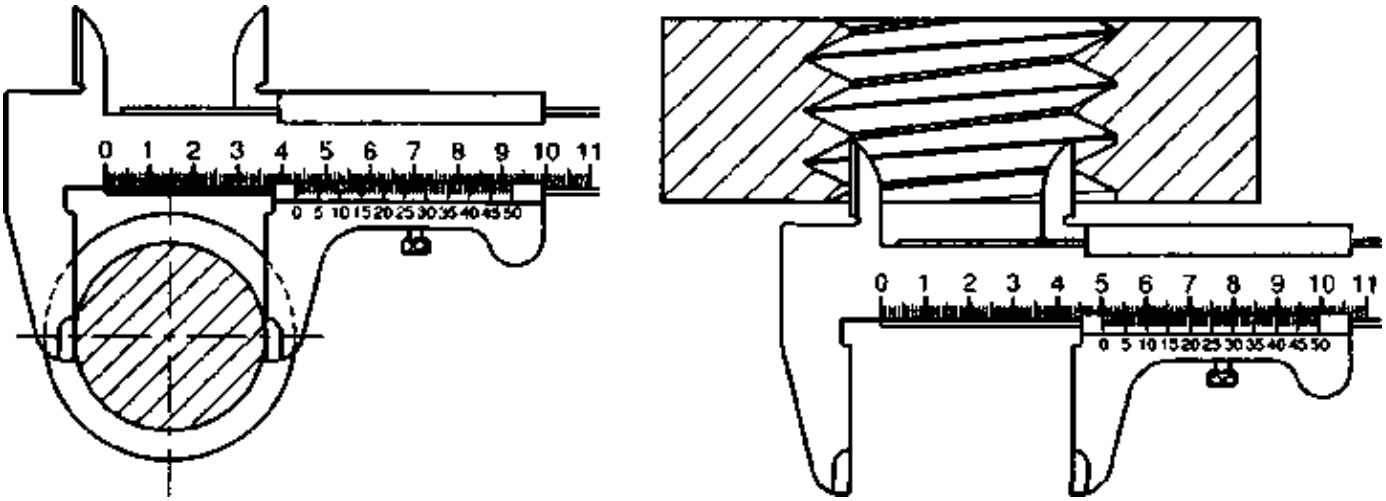
Three wires suitable for thread pitch are placed between the threads.

Diameter M_1 can be measured using outside micrometer. Using the values of M_1 diameter of the wire and thread angle, effective diameter can be calculated precisely.



THREE WIRE METHOD

VERNIER CALIPER is used to measure the root diameter of both external and internal threads.

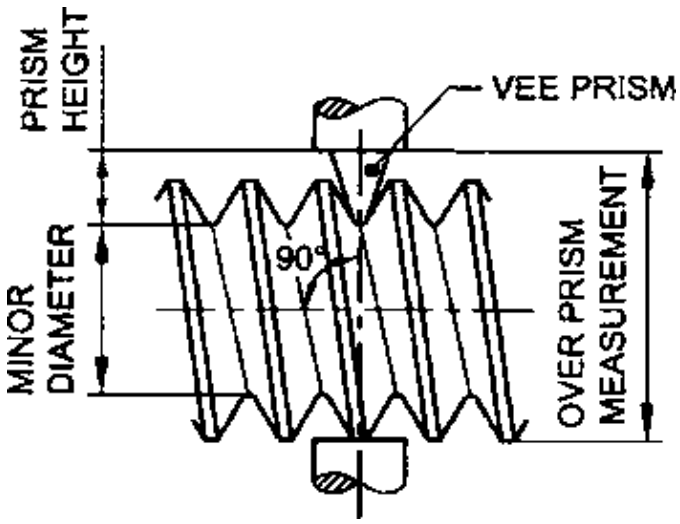


VERNIER CALIPER

OUTSIDE MICROMETER AND A VEE PRISM can be used to measure the minor diameter threads.

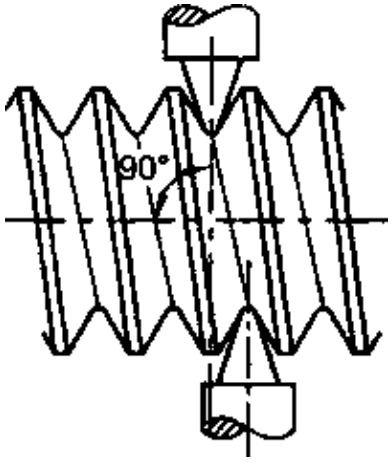
First measure the outside diameter of the thread using outside micrometer or vernier caliper. Then measure and get value over prism.

Outside diameter – (Measurement over prism – height of prism) = 1 depth
Outside diameter – 2 depth = root/corediameter.



OUTSIDE MICROMETER AND A VEE PRISM

SPECIAL MICROMETER with the anvils as shown can be used to get the root diameter directly.

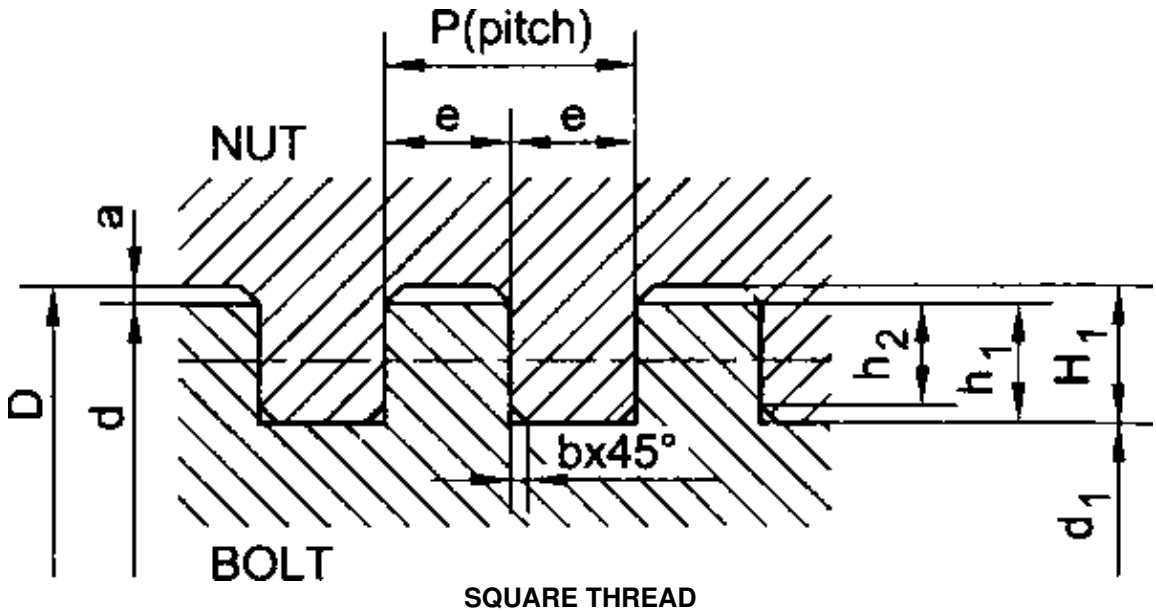


SPECIAL MICROMETER

Types of screw thread

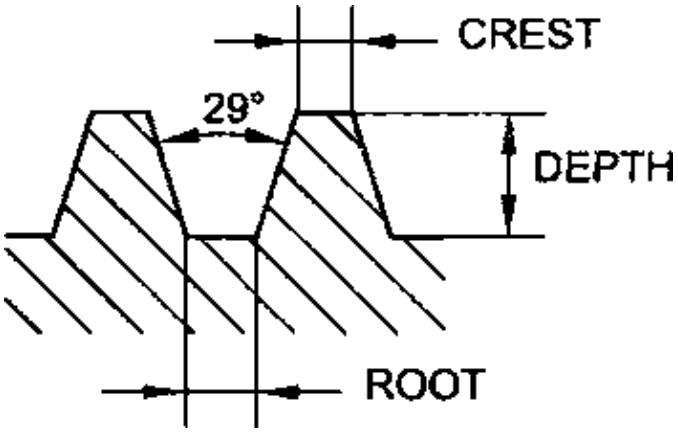
TR 01 03 25 15 02

SQUARE THREAD flanks are perpendicular to the axis of the thread. Crest and root are bevelled to 45°. Depth of the nut is longer than the bolt. These threads are used for transmitting motion or power. Eg. Screw Jack, Vice Spindle, Cross slide and Compound slide screws.



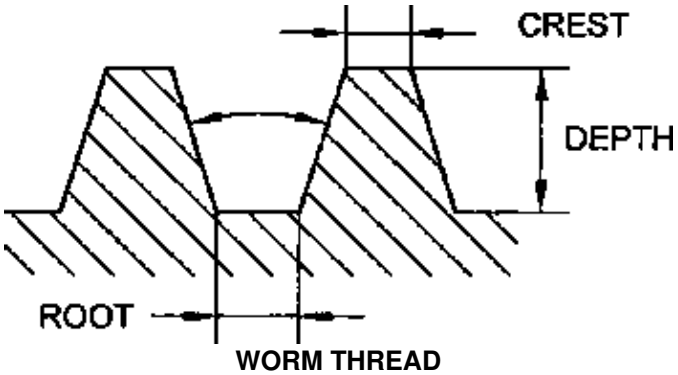
SQUARE THREAD

BRITISH ACME THREAD is used in the lead screw of lathe.



BRITISH ACME THREAD

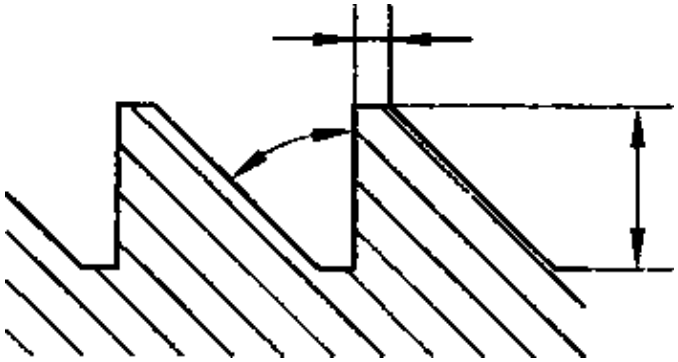
WORM THREAD is cut on the worm shaft which engages with worm wheel. The worm wheel and worm shaft are used in places where motion is to be transmitted between shafts at right angle.



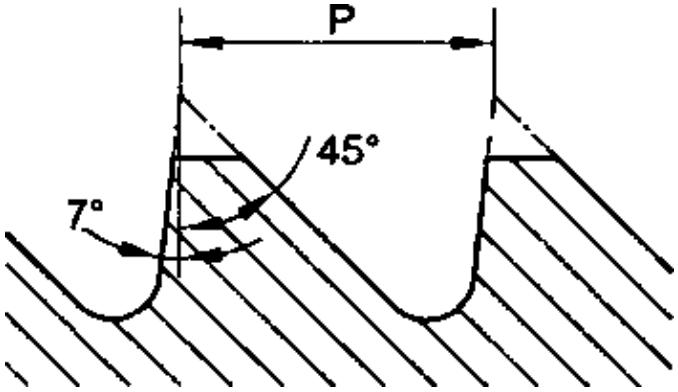
WORM THREAD

BUTRESS THREAD: These threads are used on parts where force acts at one flank of the thread during transmition.

Eg. Carpentry Vice, Ratchet etc.

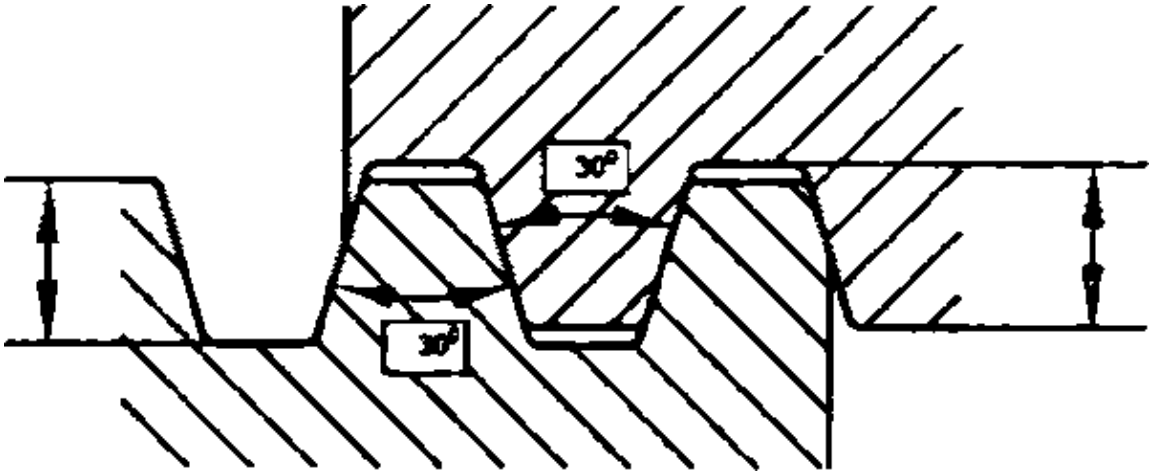


BUTRESS THREAD



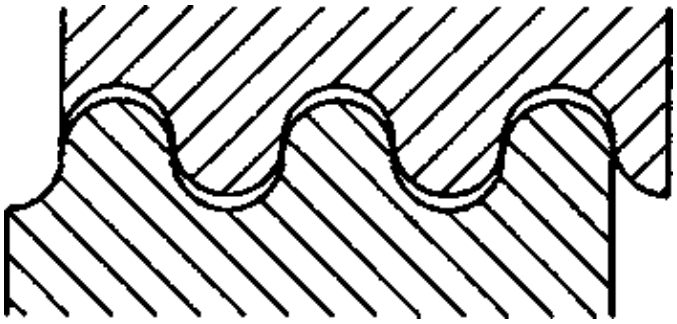
MODIFIED BUTRESS THREAD

METRIC ACME THREAD: Similar to british acme, but angle of the thread is 30°.



METRIC ACME THREAD

KNUCLE THREAD: These threads are used in railway carriage couplings etc.



KNUCLE THREAD

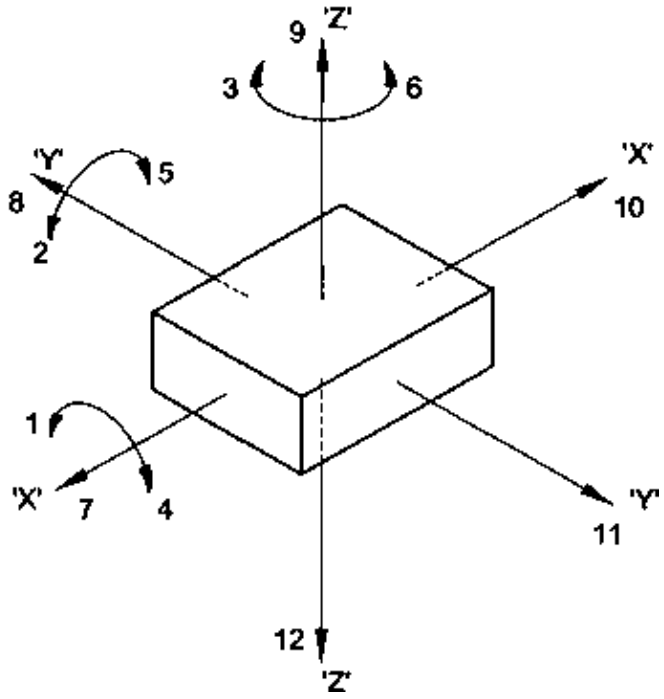
Movements & restraints of work – I

TR 01 03 38 16 02

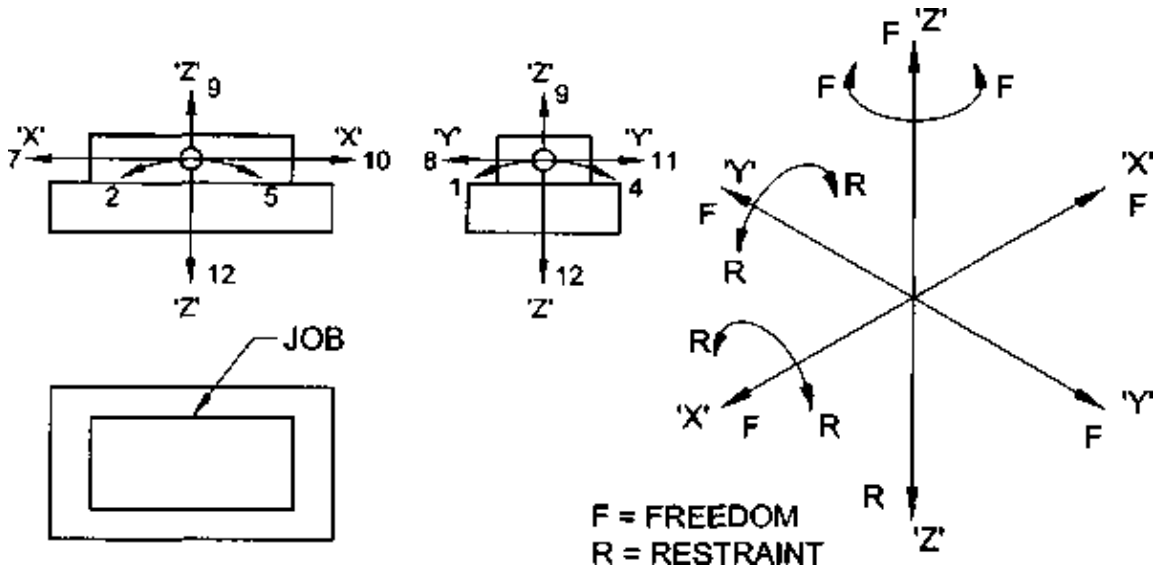
There are twelve possible movements for any object.

Front & Back (7 & 10)–	Clockwise and Anticlockwise (4 & 1)	4 movements
Right & Left (11 & 8) –	Clockwise and Anticlockwise (2 & 5)	4 movements
Up & Down (9 & 12) –	Clockwise and Anticlockwise (6 & 3)	4 movements

According to the requirement, particular movement/movements can be arrested using clamps, pins, etc.



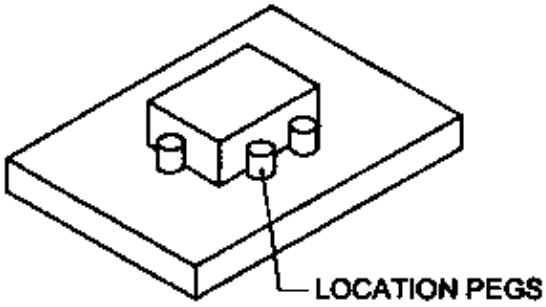
By placing a job on a base five movements of the job are arrested. They are 2, 5, 1, 4 and 12.

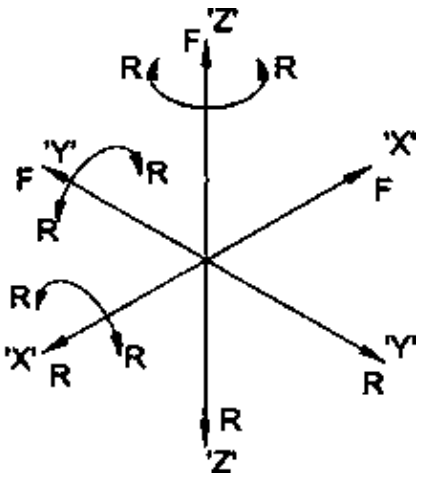


Movements & restraints of work – II

TR 01 03 38 17 02

Job is placed on a base with three pegs are supporting the job in two positions. Number of movements restricted in nine directions.

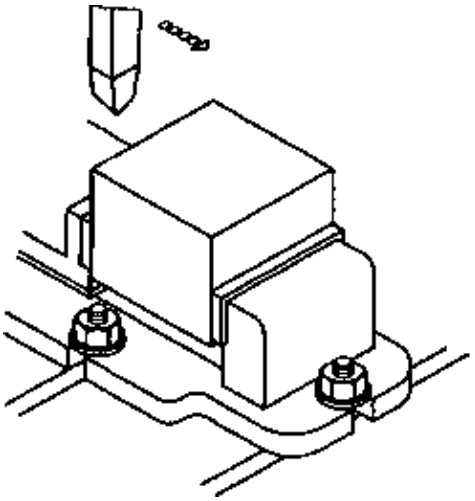


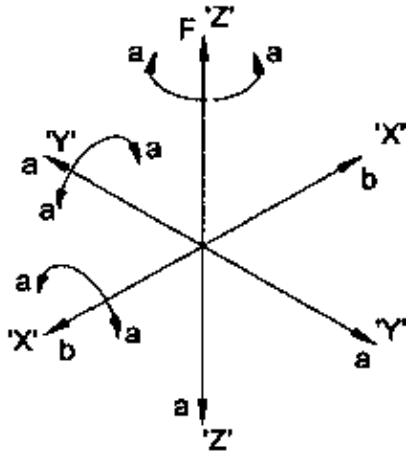


F = Freedom
R = Restraint

MACHINE VICE – Number of movements restricted (a) are nine

Freedom (F) – one direction; Cutting force is against the fixed jaw – A positive restraint to resist the cutting force. Friction resistance (b) – two directions.

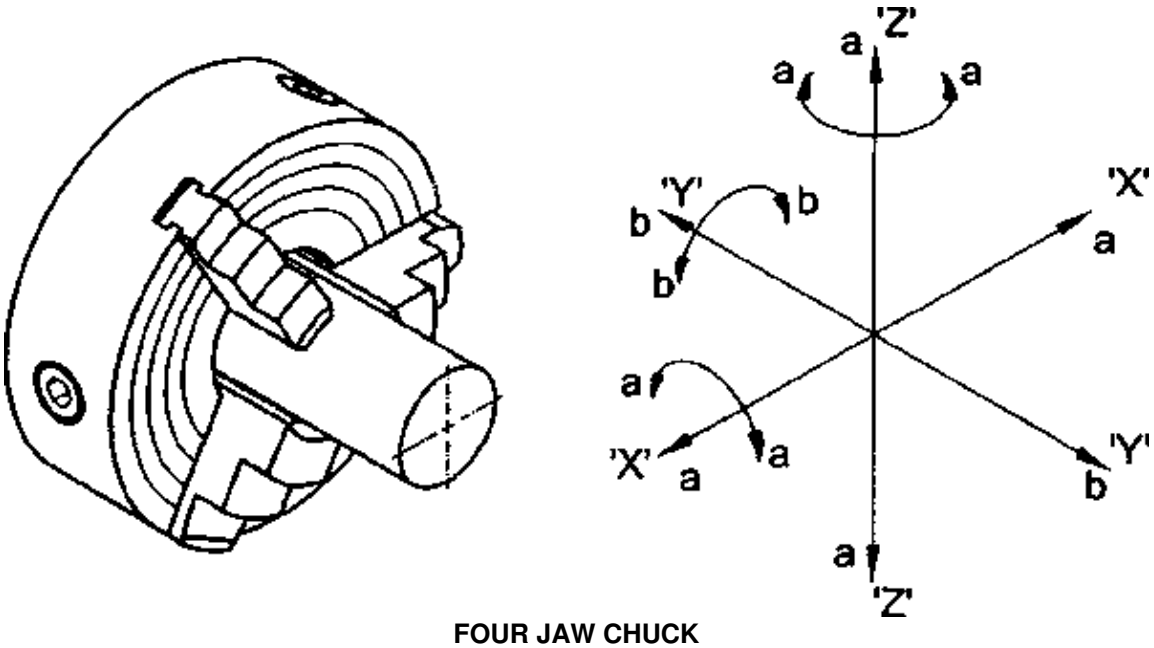




MACHINE VICE

a = Positive restraint
b = Frictional restraint

FOUR JAW CHUCK – Movement of the job is restricted in <u>eight</u> directions fully. 'FR' is the frictional resistance between the job and the jaws of the chuck, both sliding and rotating about its axis during turning and facing etc. in four directions.



FOUR JAW CHUCK

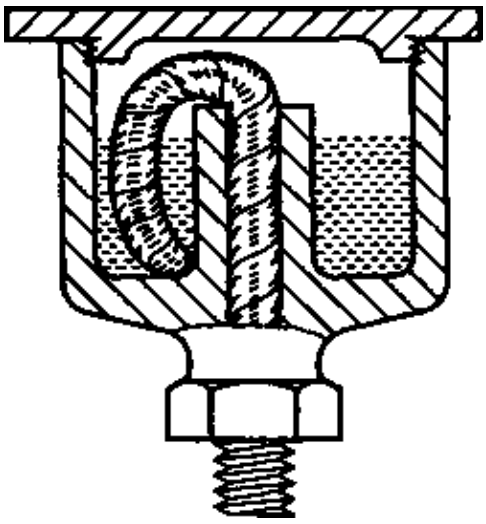
Methods of applying lubricant

TR 01 04 03 18 02

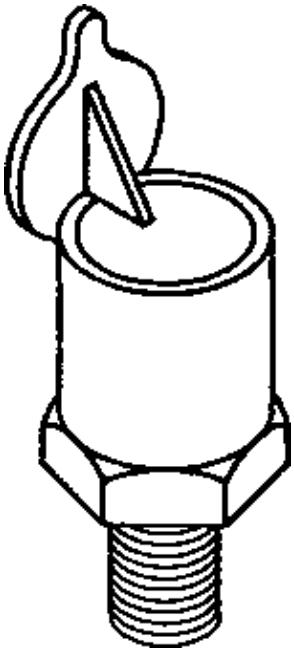
For efficient lubrications of machine tools, following methods are employed for applying lubricants.

• Gravity feed method; • Force feed method; • Splash method;

GRAVITY FEED METHOD

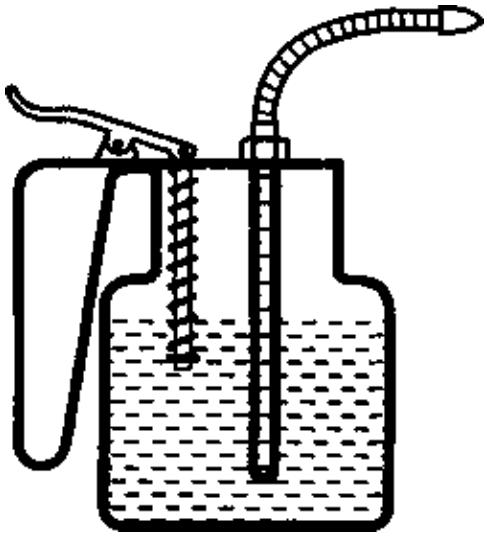


WICK FEED LUBRICATOR

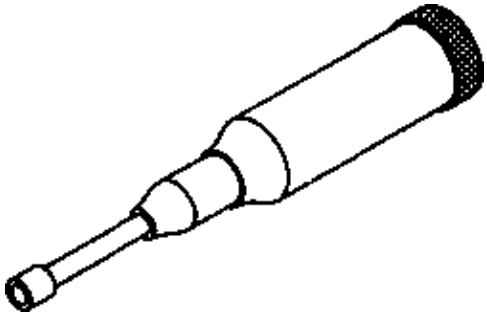


OIL CUP

FORCE FEED METHOD

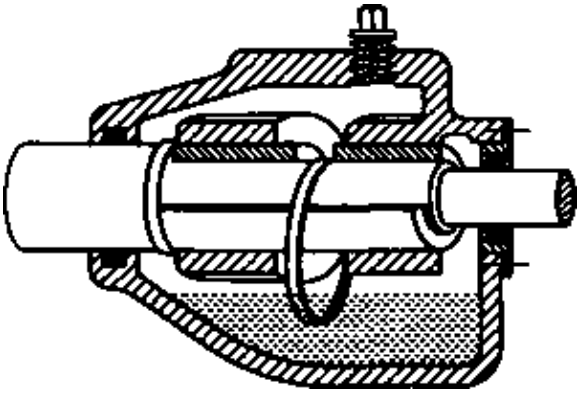


OIL CAN

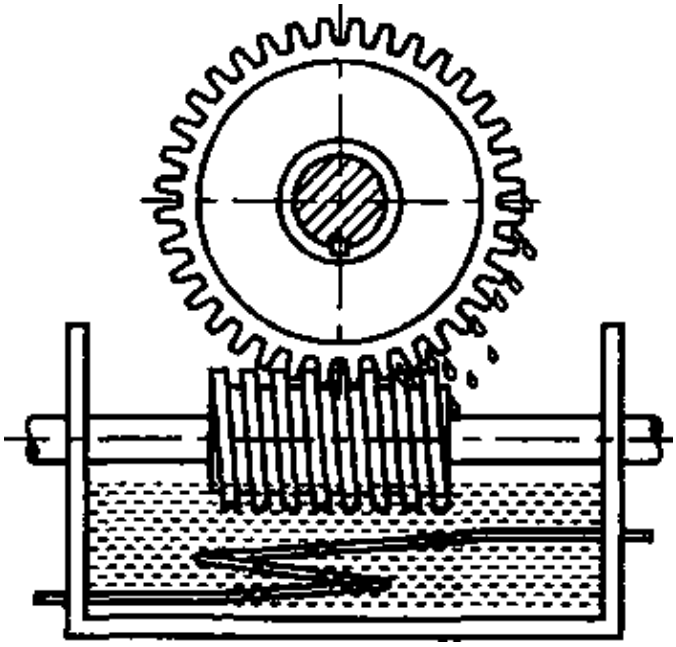


GREASE GUN

SPLASH METHOD



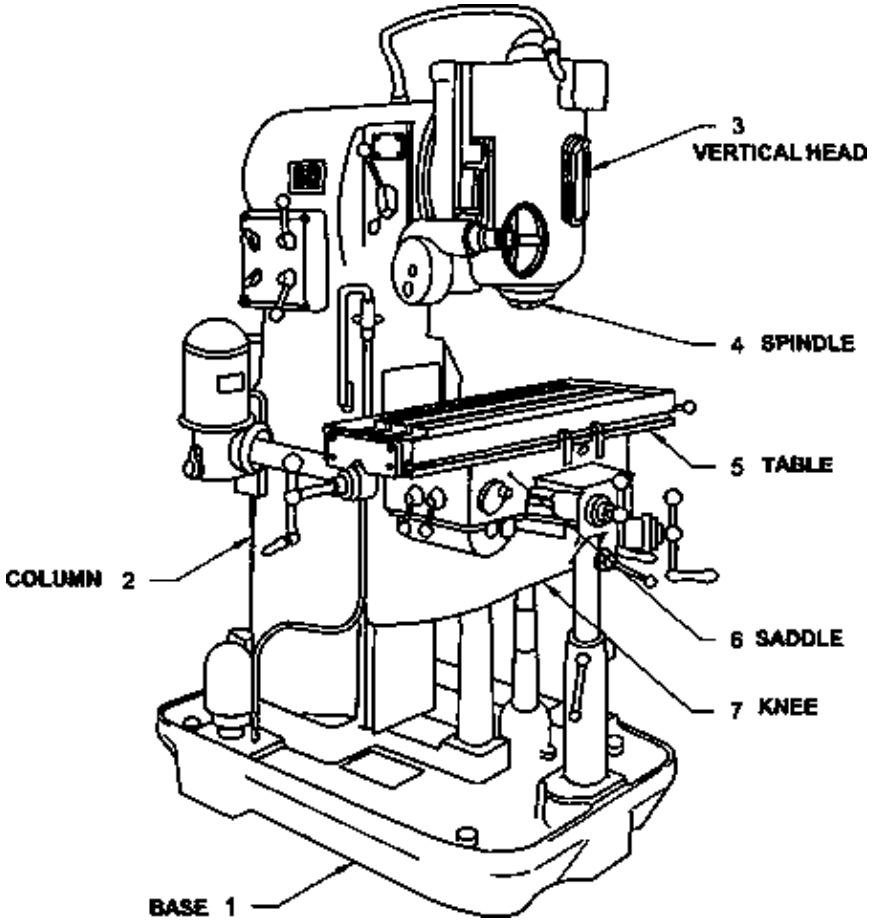
RING OILING



WORM – GEAR BATH OILER

Vertical milling machine

TR 01 05 01 19 02

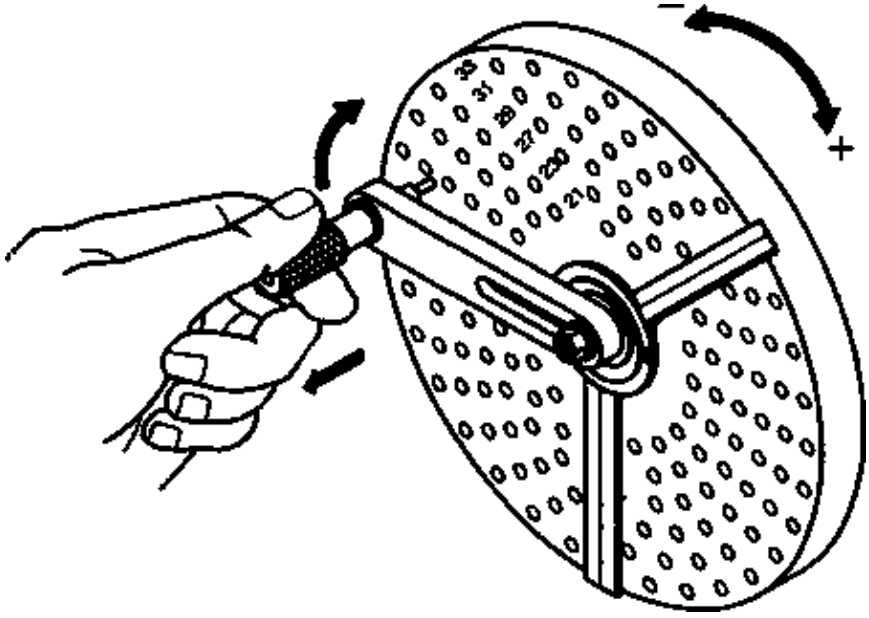


Construction and function of Parts (1) (2) (5) (6) (7) are similar to horizontal milling machine. The Vertical head (3) is connected to column (3). The vertical head can swivel in both clockwise and anticlockwise upto 45°. The spindle (4) is fixed to the vertical head (3) and can move up and down. Face milling and end milling operations can be performed using face mills and end mills. Angular milling can also be performed by swivelling the vertical head.

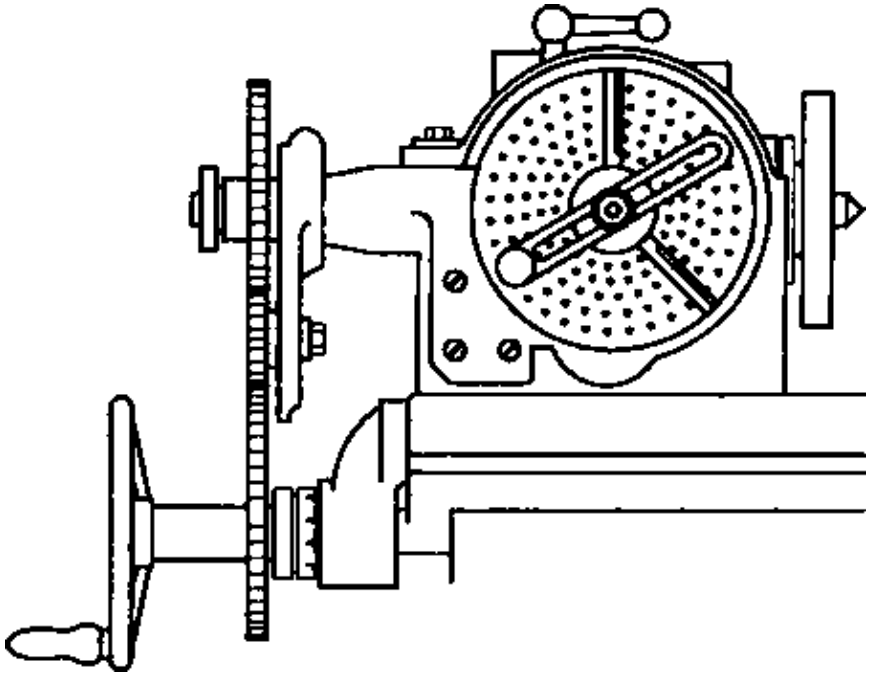
Differential indexing – I

TR 01 05 12 20 02

Divisions which cannot be obtained by simple indexing can be done using differential indexing. Eg., 51,57, 59, 127, etc.

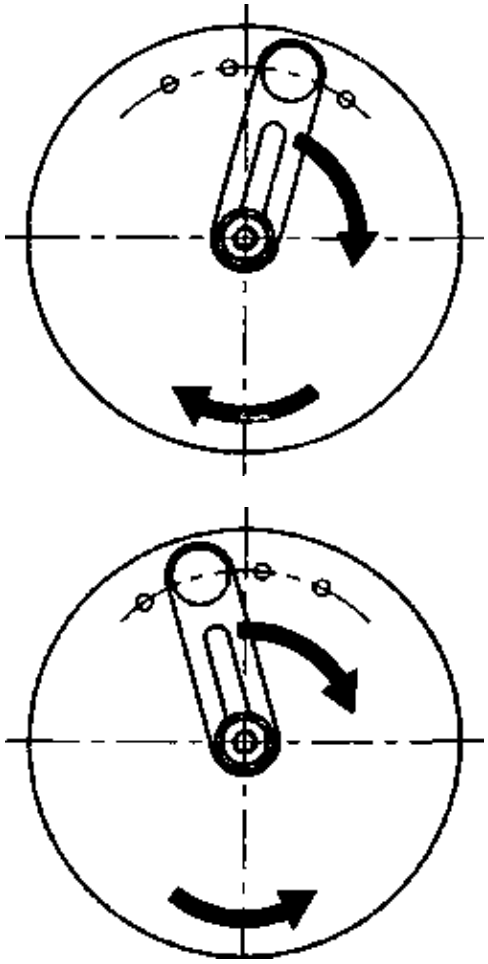


Differential indexing means the difference of two combined movements of both index crank and index plate.



To achieve the combined motion, connect the extended spindle and the auxiliary worm shaft with gear train.

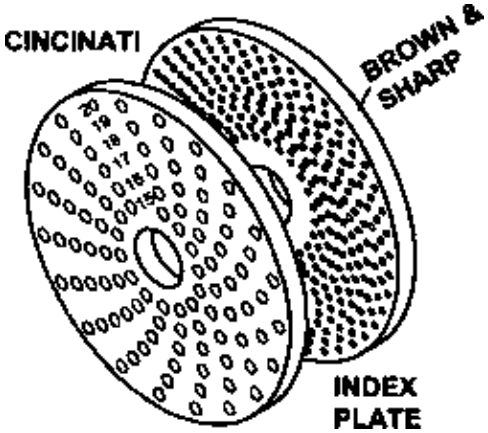
According to the required number of division (N) and the assumed number of Division (A), index plate is set to move in the same or in the opposite to the direction of crank depending on the number of idler gears used and the design of the indexing head.



Differential indexing – II

TR 01 05 13 21 02

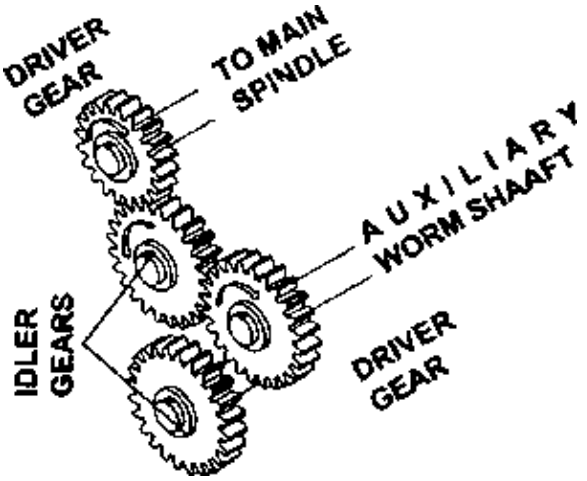
REQUIRED NUMBER OF DIVISION (N) TO BE INDEXED IS 57.

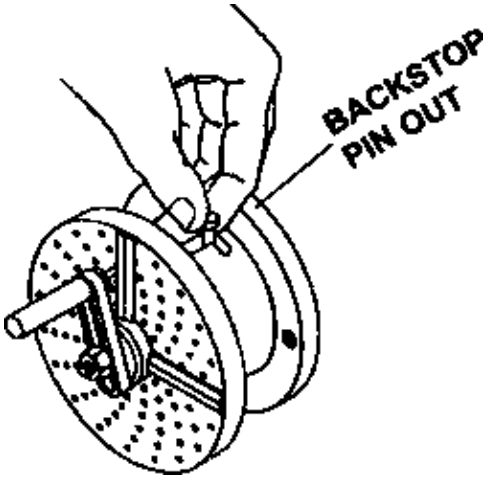


* Select assumed number of division (A) (within ± 10% of required number. • Assumed number must be suitable for simple indexing	* Select any suitable number (± 10%) considering the available index plates.
	Numbers selected are go)

	(55)	(60)
	Selected assumed number (A) is 55 (less than 57)	Selected assumed number (A) is 60 (more than 57)
* Select index plate and spacing using simple indexing • Simple indexing = * Select driver and driven gears	plate No. 2 of Brown & Sharp 33 hole circle – 24 spacing	Plate no. 2 of Brown & Sharp. 27 hole circle –18 spaces 33 hole circle – 22 spaces
Gear ratio =		
* Direction of index plate rotation with respect to the rotation of index crank.	A (55) is less than N(57)–Gear ratio (–). In this case, index plate is to turn against the rotation of the index crank.	A (60) is more than N (57) –Gear ratio (+). In this case, index plate is to turn in the same direction of rotation of index. crank.
Index plate rotation (same/Opposite) is regulated by employing/engaging idler gears. One/two – according to the design of index head.		

Prior to indexing disengage the back stop pin to permit the rotation of the index plate

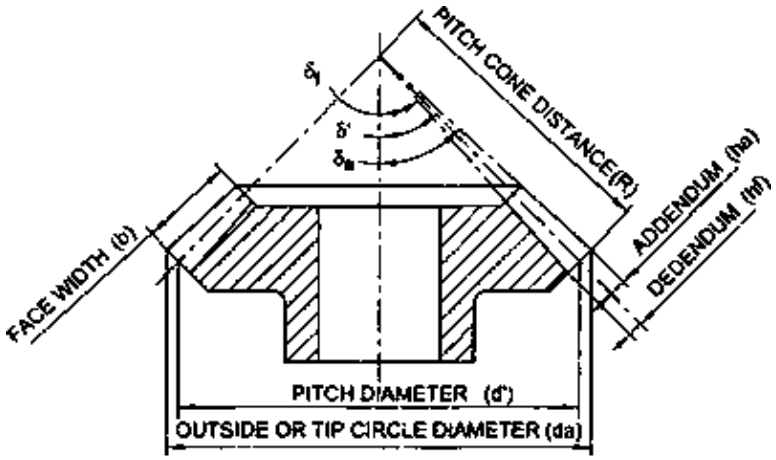


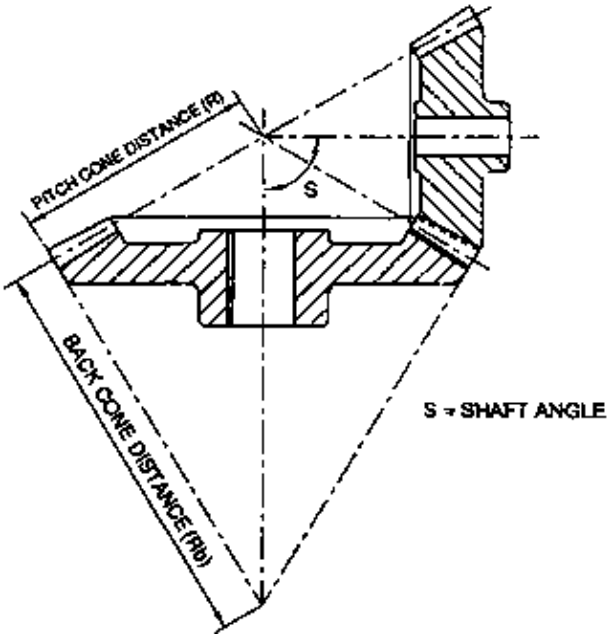


Elements of a straight bevel gear

TR 01 05 15 22 02

$?_a$ = FACE ANGLE
$?_f$ = ROOT ANGLE
?‘ = PITCH CONE ANGLE





Module (m), number of teeth (z) and the pitch cone angle (5^1) are the elements only be given normally for milling bevel gears. Other elements and data are to be calculated using different formulae.

Essential elements/datas which are mainly required for milling a bevel gears:

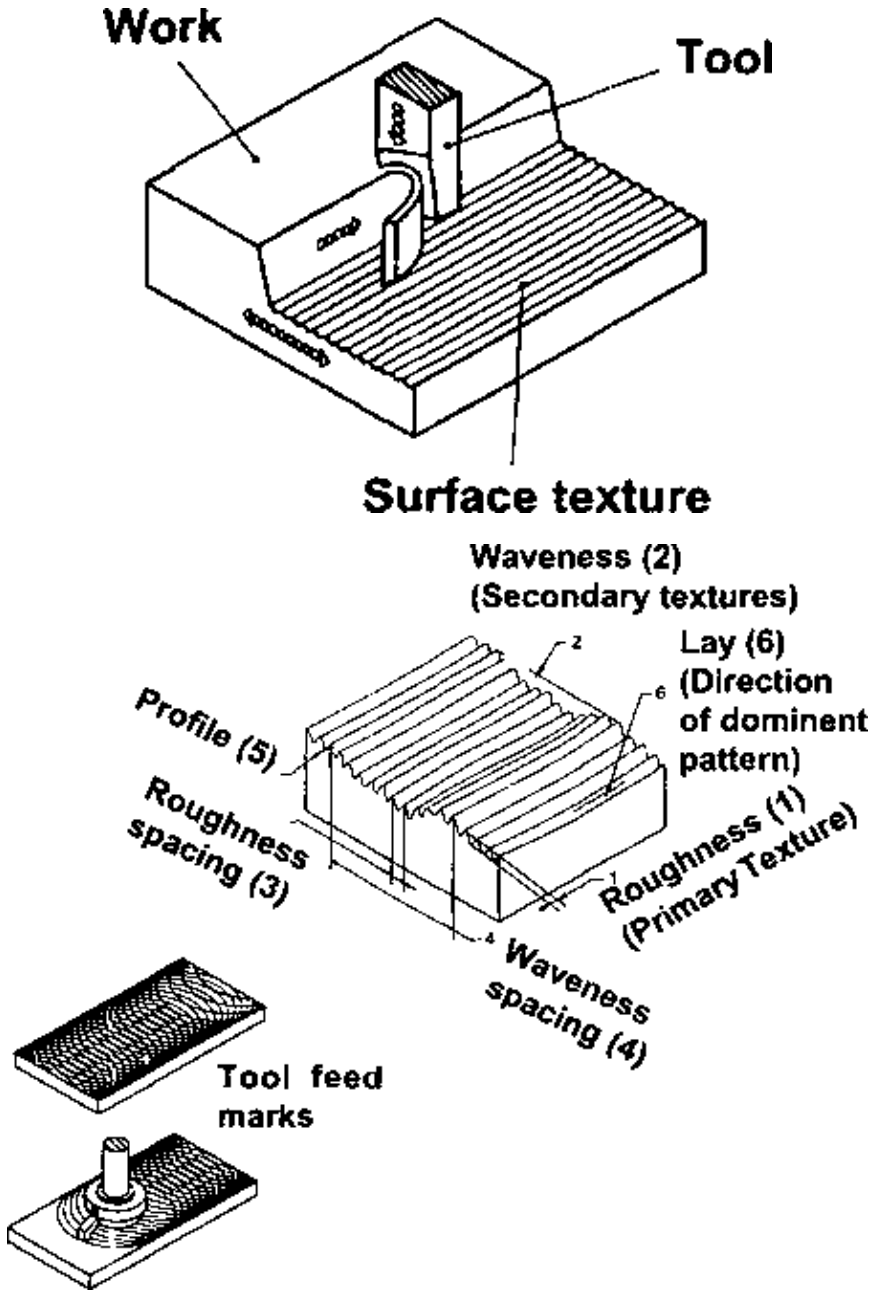
Virtual number of teeth (z^1) for cutterselection, offset of first flank, first angular movement of the blank, offset of the second flank (from first offset position) and second angular movement of the blank (from first offset position).

Surface texture measurement

TR 01 05 26 23 02

All the manufactured surfaces are not fully perfect. There are ups and downs. These ups and downs are varying in heights and spaces.

Difference in appearance/feeling of touch/sliding/reflection due to the ups and downs in a surface is called surface texture.

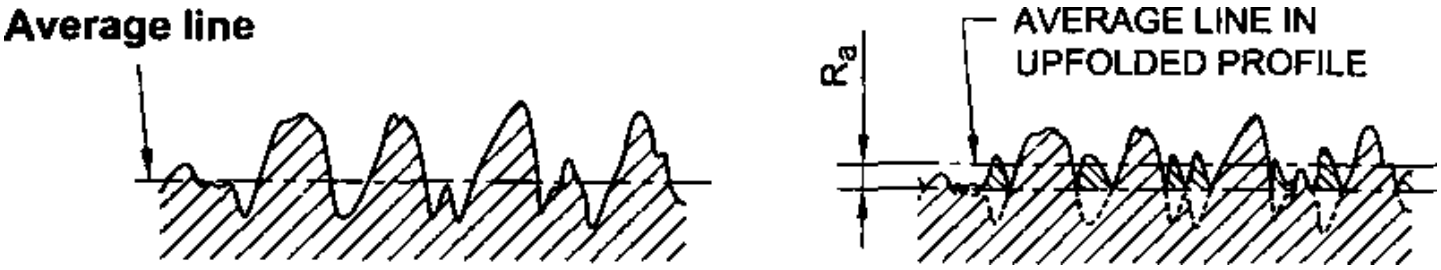


The components of surface texture are surface roughness (Primary texture) and waviness (secondary texture).

Surface roughness is the irregularities of short wave lengths, are generated due to the cutting action of tools, abrasives etc.

Waviness is a component of surface having irregularities of longer wave lengths. Surface roughness is superimposed on this component. This is resulting from the deflection of machine or work, vibration, etc.

Quality of surface texture is numerically expressed by Ra value. This Ra value is expressed in 0.000001 m or Mm). This can also indicated in the corresponding grade numbers ranging from N_1 to N_{12}.



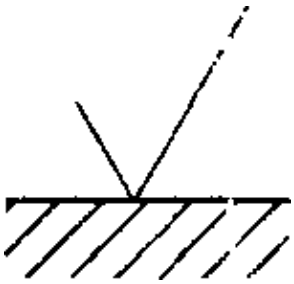
Average (mean) line is placed cutting through the surface profile considering cavities below and the material above are equal.

Cavities below the average line brought above and a profile curve (a fold of bottom half) is drawn. A new average (meanline) is then calculated and drawn. The distance between the two lines is the Ra value of the surface.

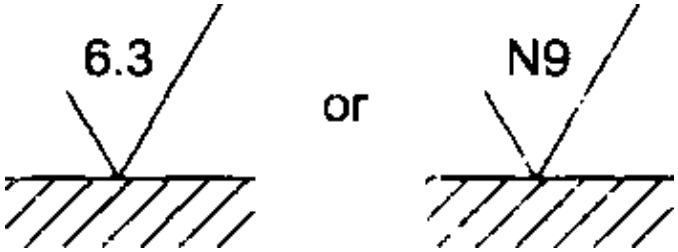
Methods of indicating surface roughness

TR 01 05 26 24 02

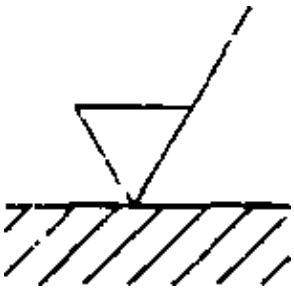
1. Surface represented by this basic symbol is under consideration.



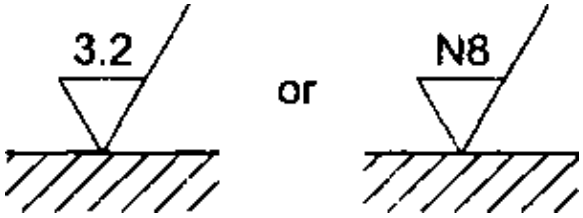
1a Add a roughness value or roughness grade symbol to make the symbol more meaningful.



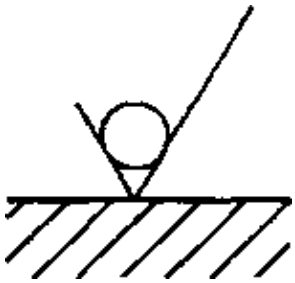
2. Added bar to the basic symbol expresses that removal of material by machining.



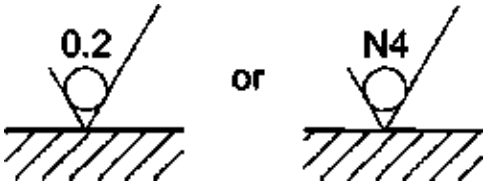
2a Added roughness value/roughness grade symbol specifies the expected surface finish and the type of machining.

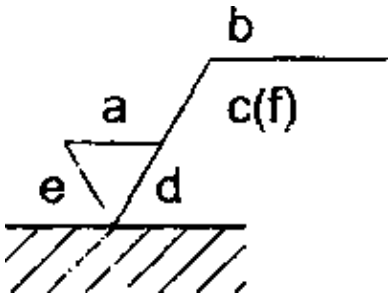


3 Added circle to the basic symbol expresses that the removal of material is not permitted.



3a Added roughness value/roughness grade symbol tells that the surface finish can be obtained by processes like electro plating, lapping, etc.





a = Roughness value Rain micron or roughness grade number N1 to N12 or roughness value in jam.

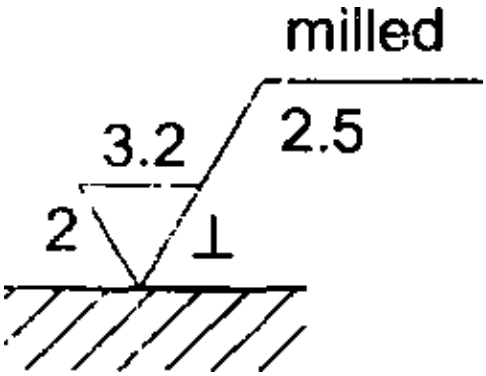
b = Production method (Treatment coating)

c = Sampling length in mm

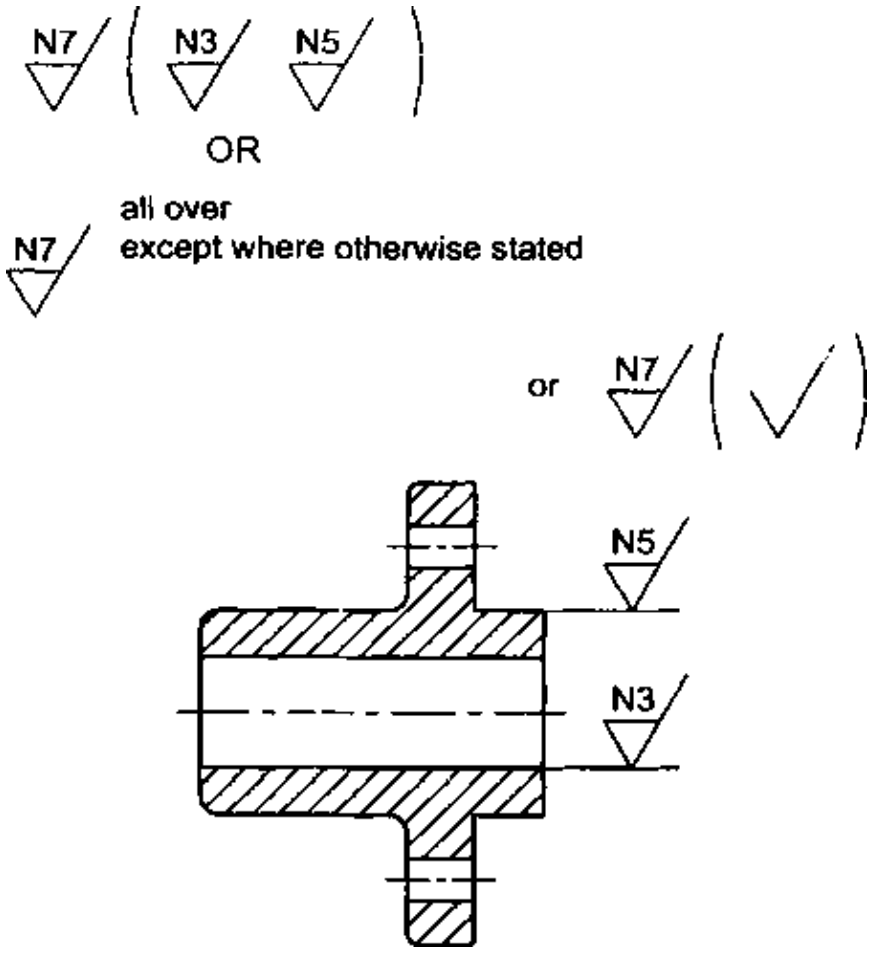
d = direction of lay

e = Machining allowance in mm

f = Other roughness value (in bracket)



Surface finish of N3 and N5 has to be achieved on the specified surfaces and on the other surfaces achieve only N7.

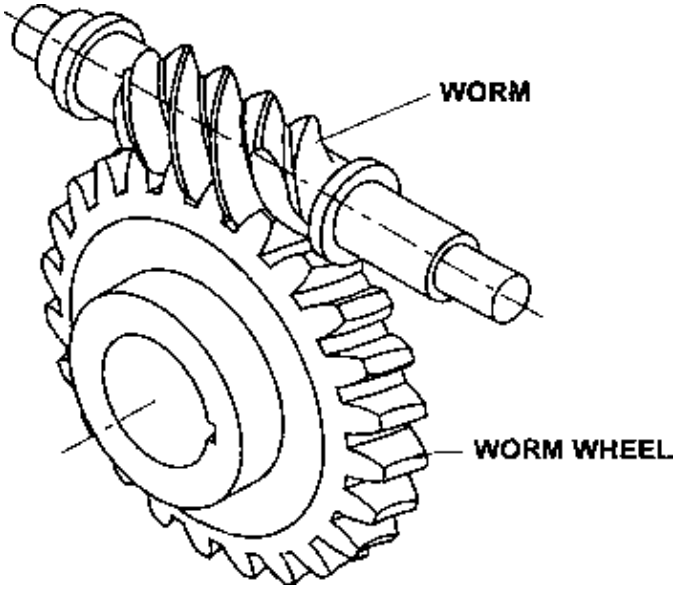


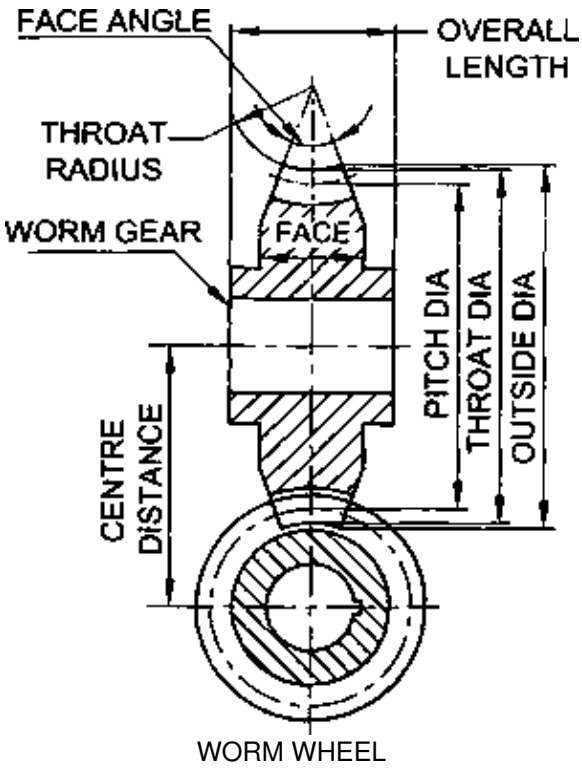
Worm and worm wheel

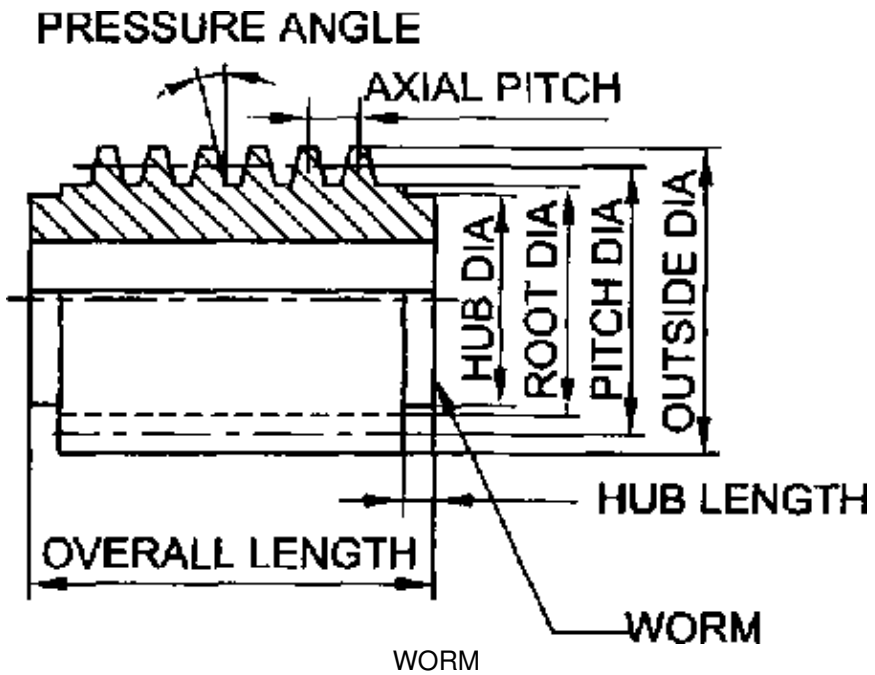
TR 01 05 29 25 02

Worm and Worm wheel drive is used to connect two non−parallel, non−intersecting shafts which are at right angles to each other.

Mainly used for large speed reduction.


WORM
WORM WHEEL


FACE ANGLE
OVERALL LENGTH
THROAT RADIUS
WORM GEAR
FACE
PITCH DIA
THROAT DIA
OUTSIDE DIA
CENTRE DISTANCE
WORM WHEEL


PRESSURE ANGLE
AXIAL PITCH
HUB DIA
ROOT DIA
PITCH DIA
OUTSIDE DIA
HUB LENGTH
OVERALL LENGTH
WORM

WORM