ALIGNMENT TESTS ON MACHINE TOOLS

Alignment tests on machine tools

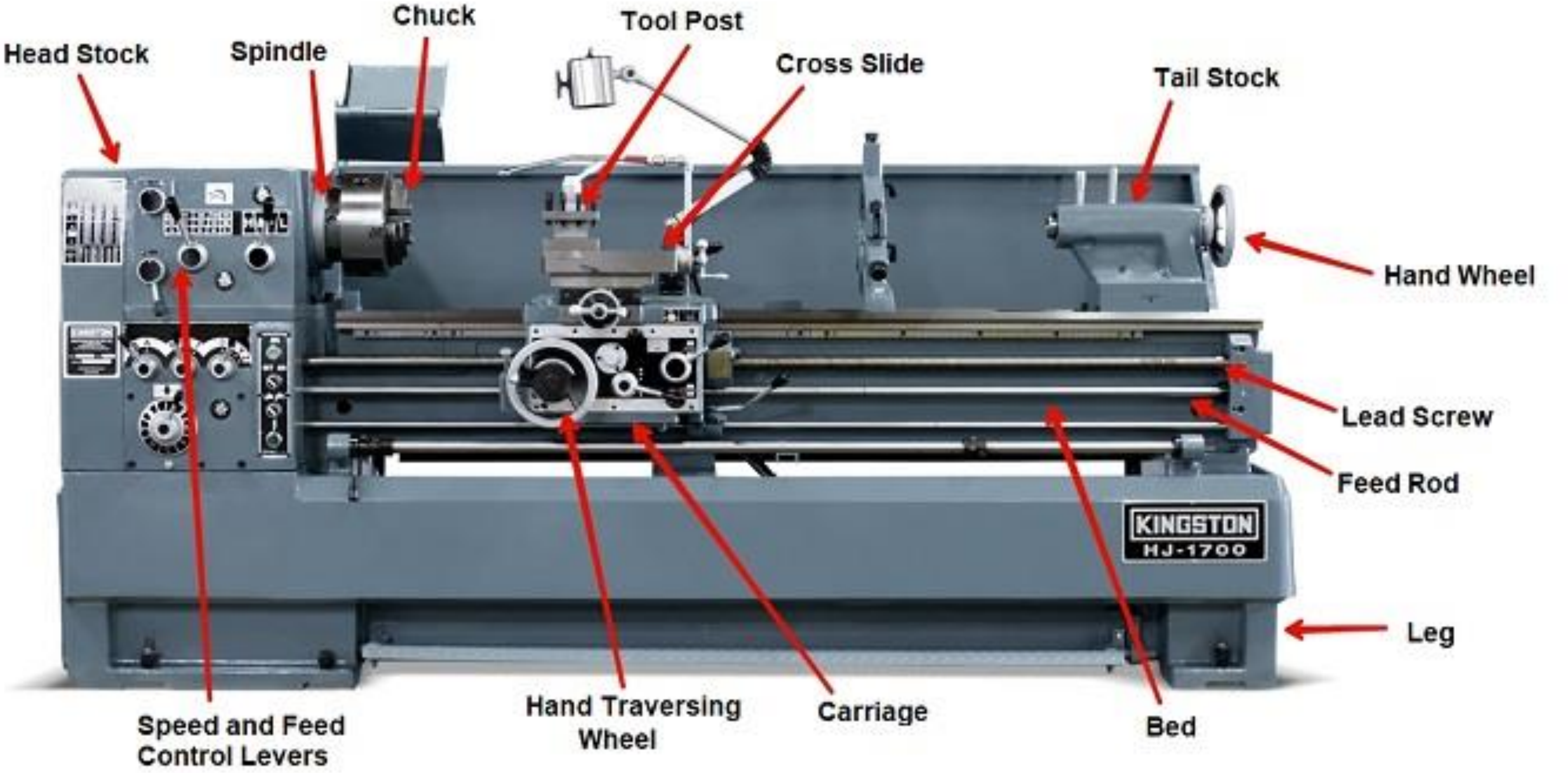
Machine tool metrology

The alignment test on a machine tool is carried out to check the grade of manufacturing accuracy of the machine tool.

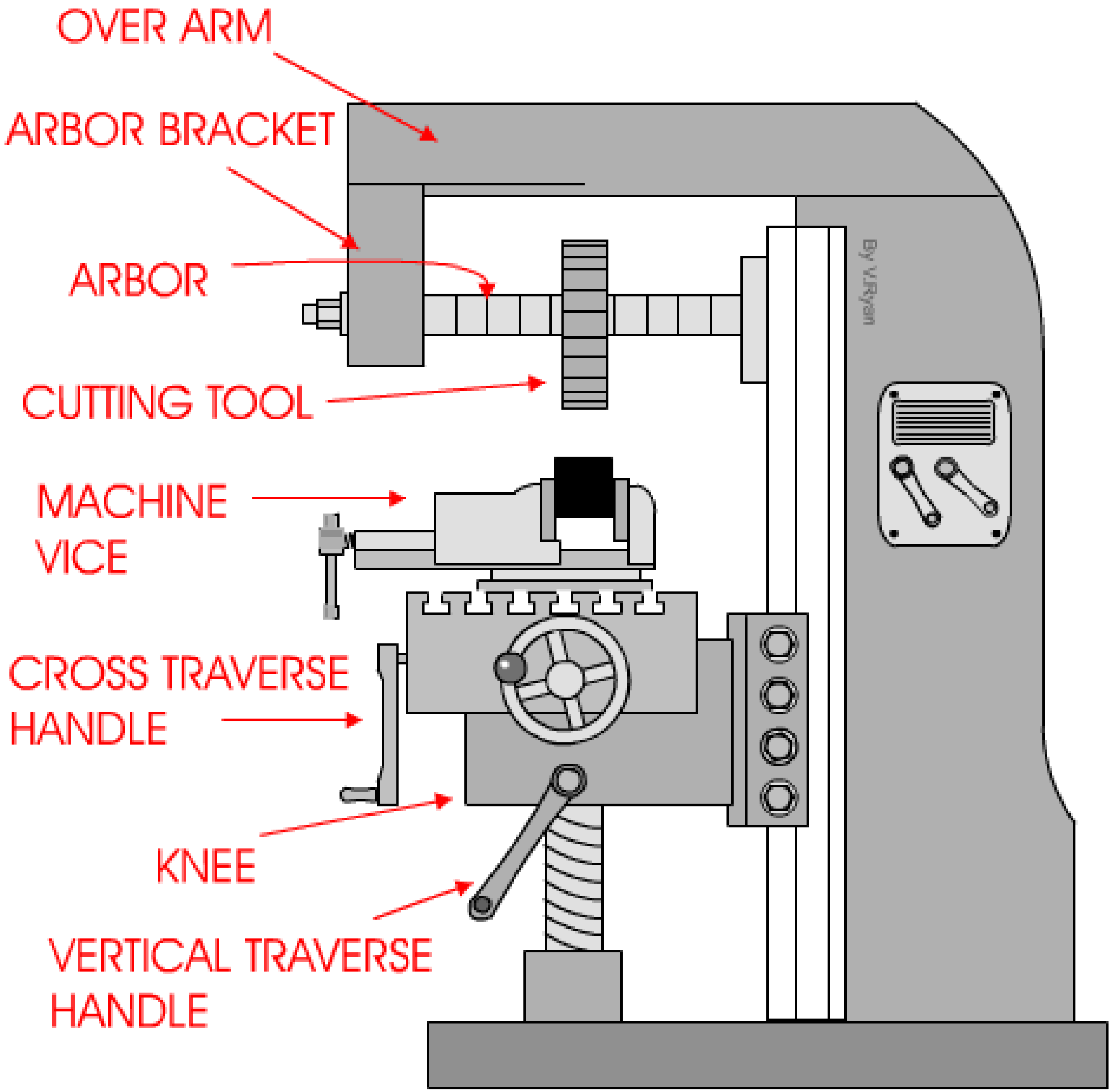
The geometrical checks made on machine tools are :

- Straightness and flatness of guide ways and slide ways of machine tool.
- Flatness of machine tables
- Parallelism, equidistance and alignment of the slide ways.
- True running and alignment of shaft and spindle.
- Lead of lead screw or error in pitch.

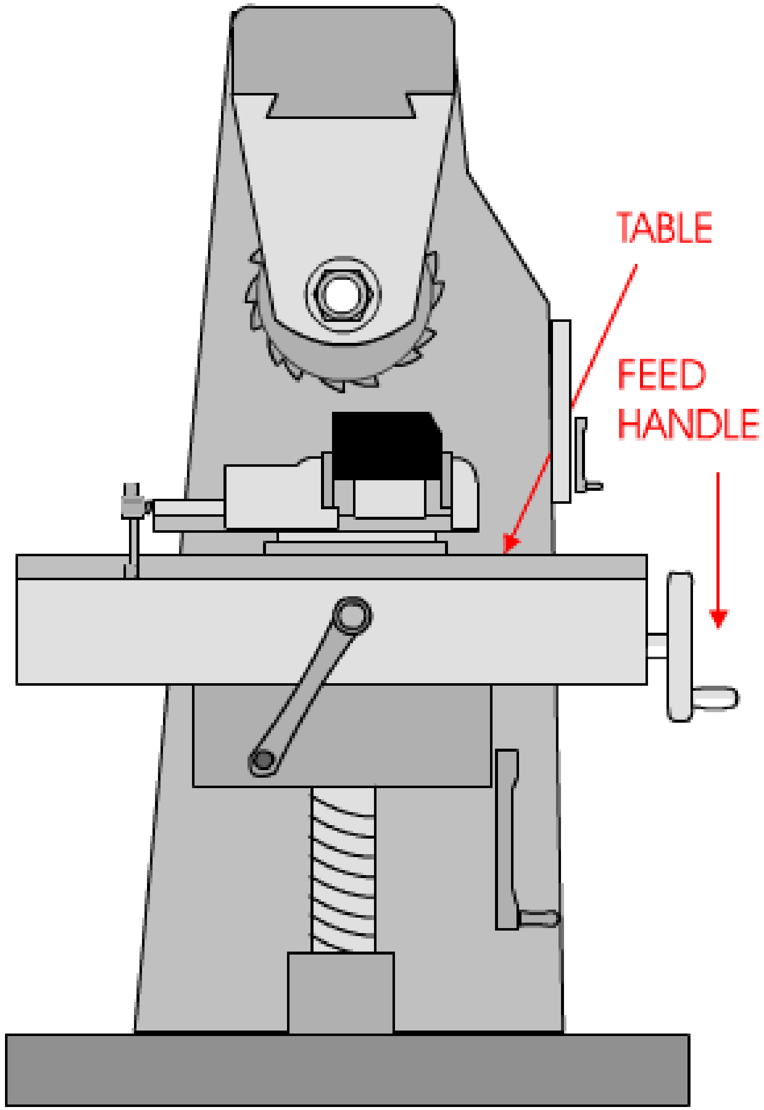
- The geometrical test is carried out to check the grade of manufacturing accuracy of the machine tool.
- Practical test is carried out to check the accuracy of the finished component.
- Geometrical test consists of checking the relationship between various machine elements when the machine tool is idle.
- Practical test consists of preparing the actual test jobs on the machine and checking the accuracy of the jobs produced.


Chuck
Tool Post
Head Stock
Spindle
Cross Slide
Tail Stock
Hand Wheel
Lead Screw
Feed Rod
KINGSTON
HJ-1700
Leg
Speed and Feed Control Levers
Hand Traversing Wheel
Carriage
Bed

CONSTRUCTIONAL FEATURES OF A LATHE

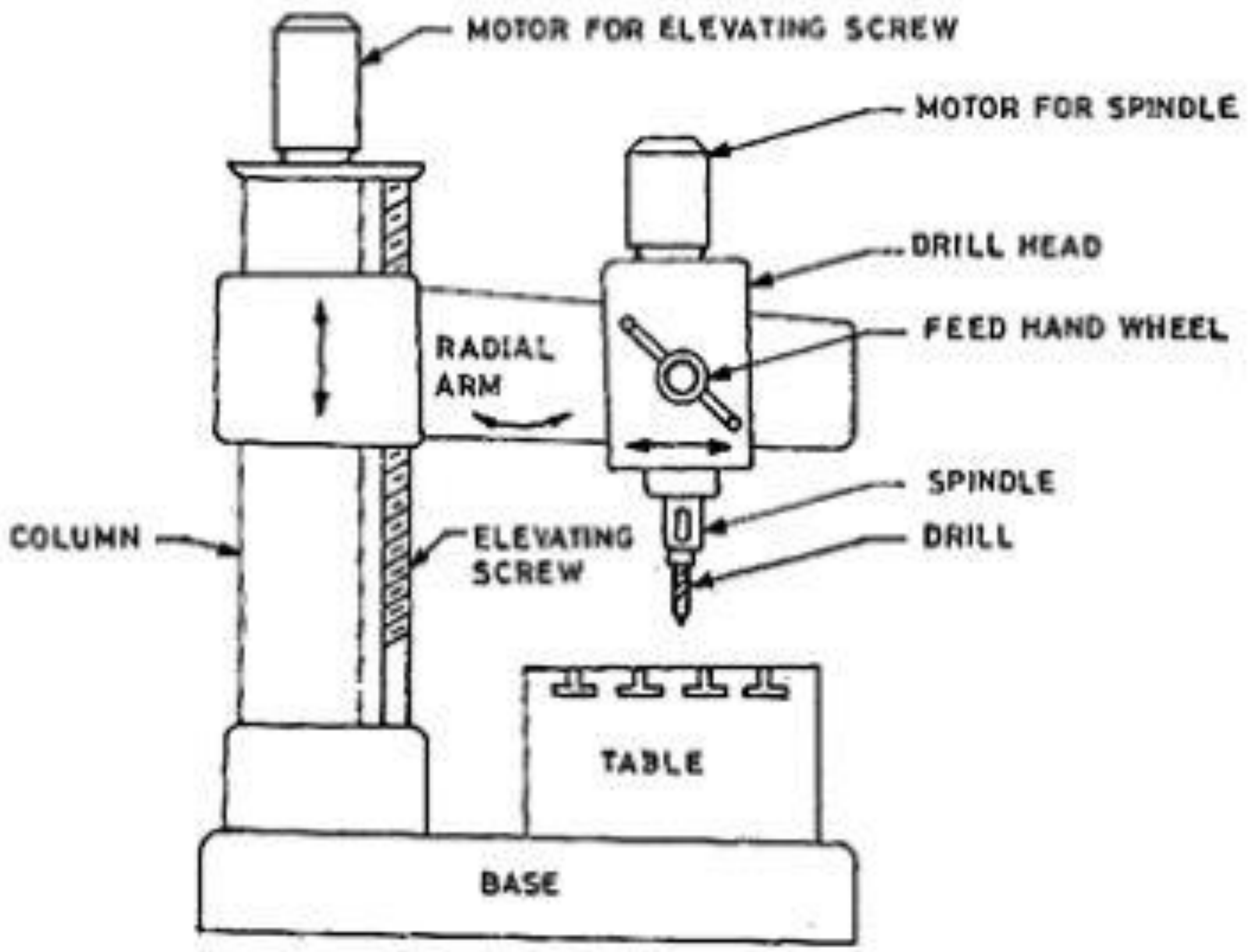


FRONT VIEW



SIDE VIEW

INTRODUCTION TO MILLING MACHINE


MOTOR FOR ELEVATING SCREW
MOTOR FOR SPINDLE
DRILL HEAD
FEED HAND WHEEL
RADIAL ARM
SPINDLE
COLUMN
ELEVATING SCREW
DRILL
TABLE
BASE

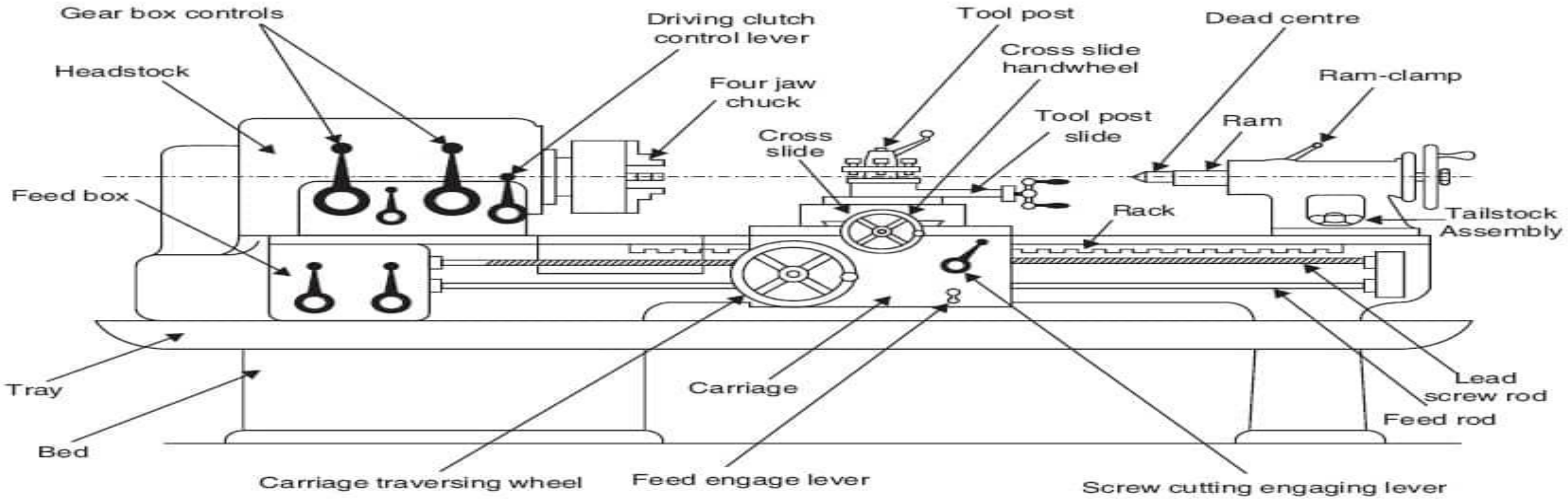

Victory
Victory
Victory

1. LATHE

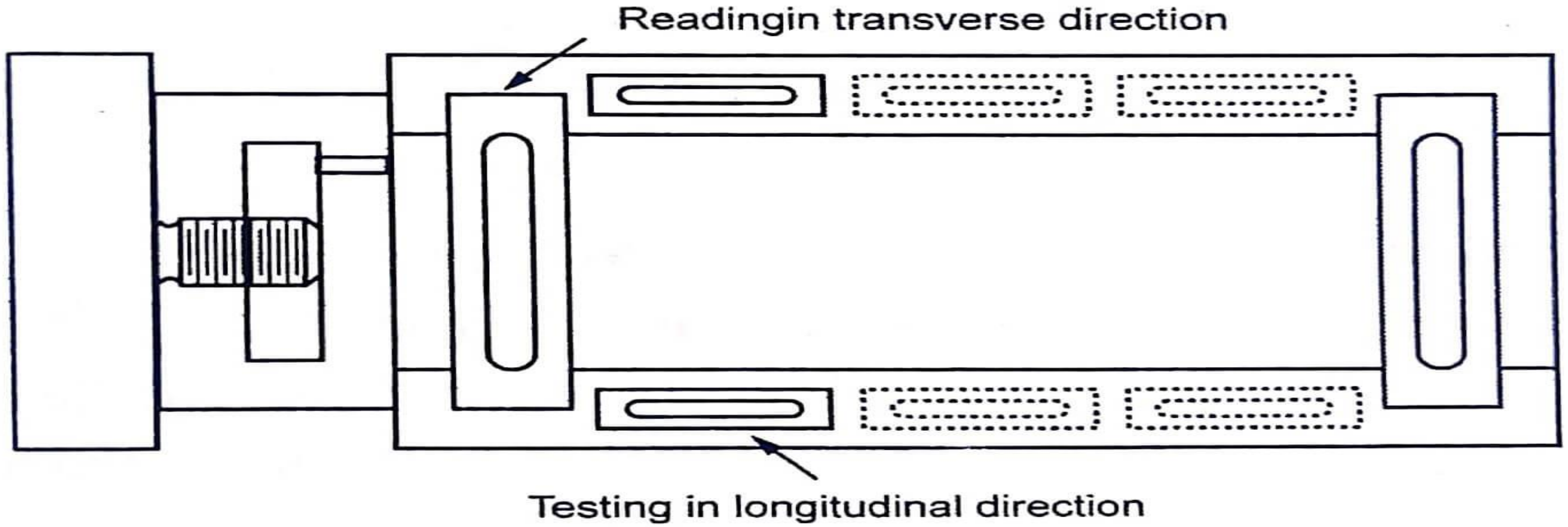
1.1 Levelling of the Machine

- Before the various tests on any machine tool are carried out, it is very essential that it should be installed in truly horizontal and vertical planes.
- In horizontal plane, both longitudinal and transverse directions are equally important. If, say, any long lathe bed is not installed truly horizontal the bed will undergo a deflection, thereby producing a **simple bend and undesirable stresses will be introduced**.
- If the bed is not installed truly horizontal in transverse direction, **twist** will be introduced. Thus the movement of the saddle can't be in a straight line and **true geometric cylinder** can't be generated.

- For proper installation and maintenance of its accuracy, a special concrete foundation of considerable depth must be prepared. Also this must be insulated from the surrounding floor by introducing some form of damping.
- The level of the machine bed in longitudinal and transverse directions is generally tested by a sensitive **spirit level.** The saddle is kept approximately in the centre of the bed support feet.
- The spirit level is then placed at a-a (Fig. 16.1), the ensure the level in the longitudinal direction. It is then traversed along the length of bed and readings at various places noted down.

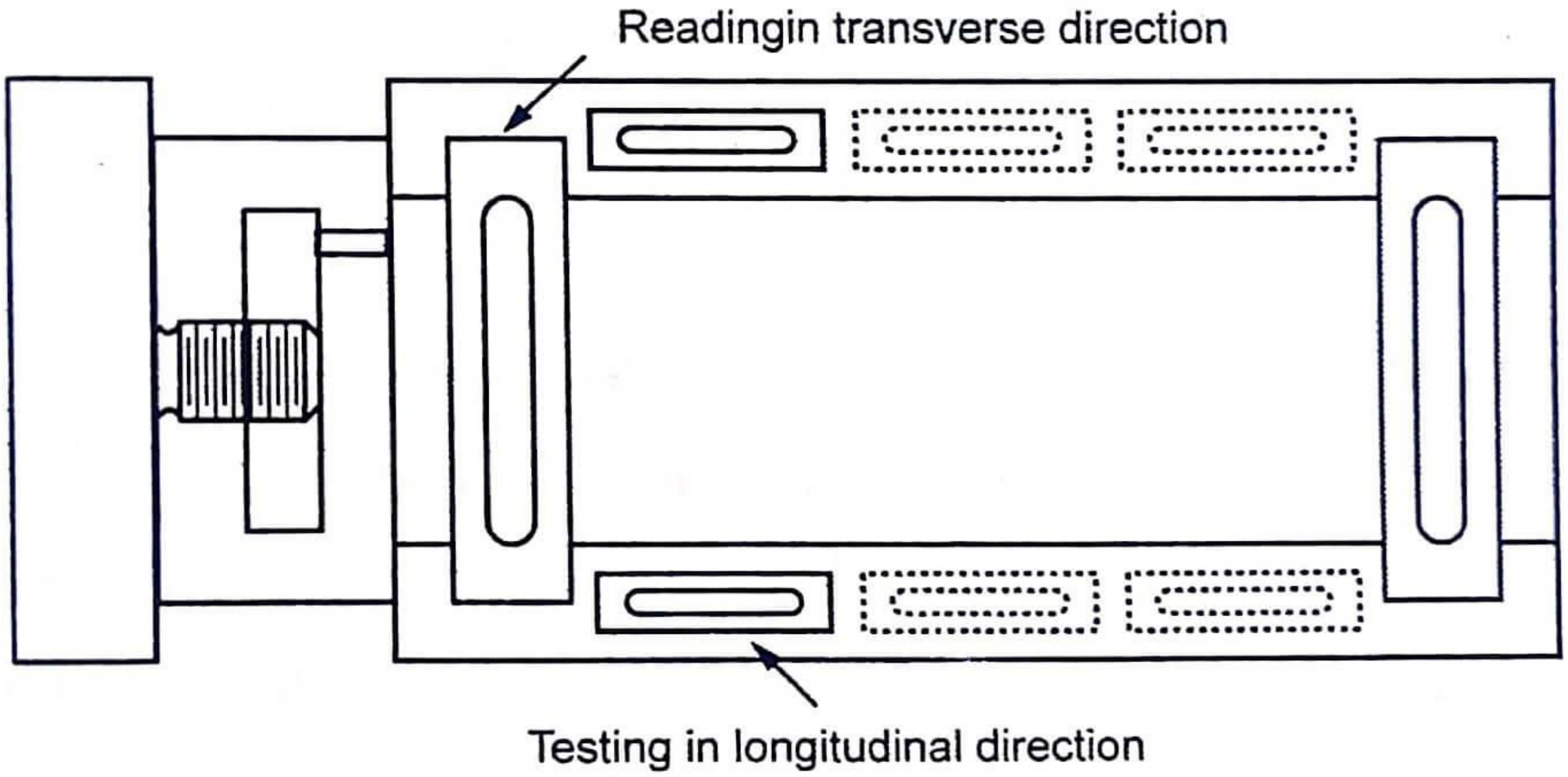


Engine lathe



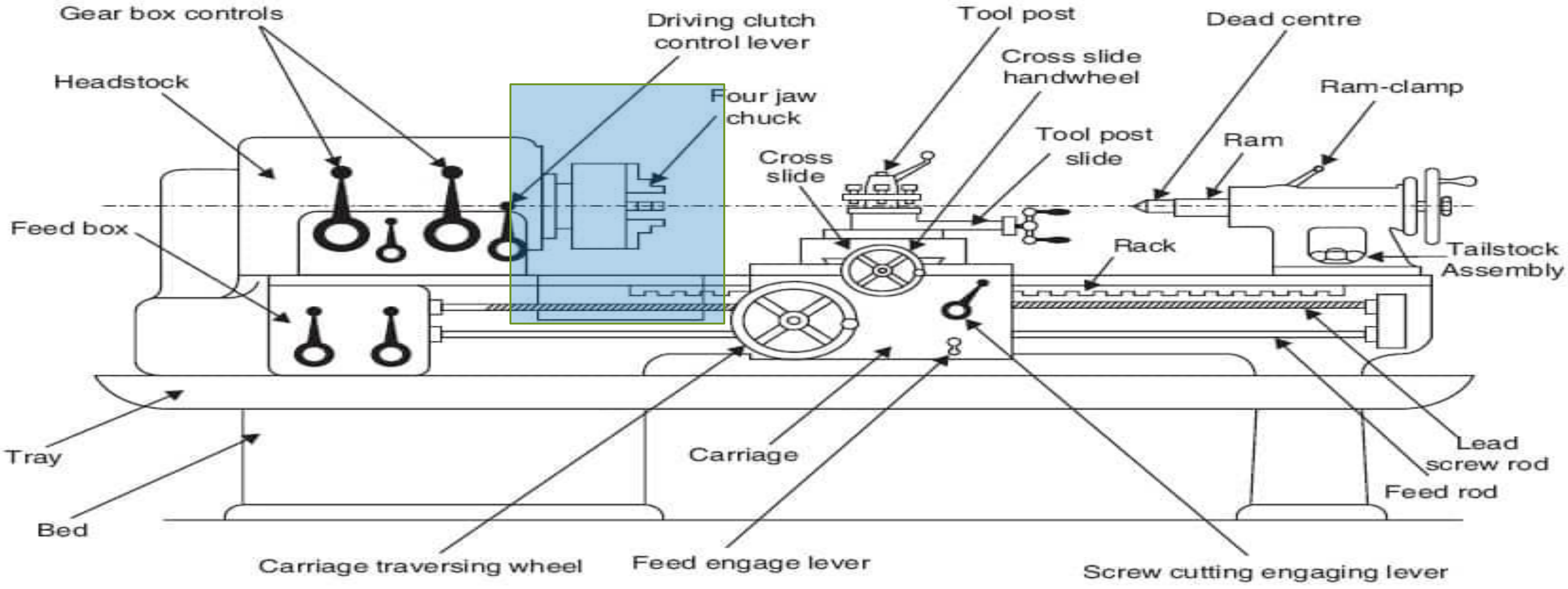
Leveling of the machines

- For test in transverse direction the level is placed on a bridge piece to span the front and rear guideways and then reading is noted.



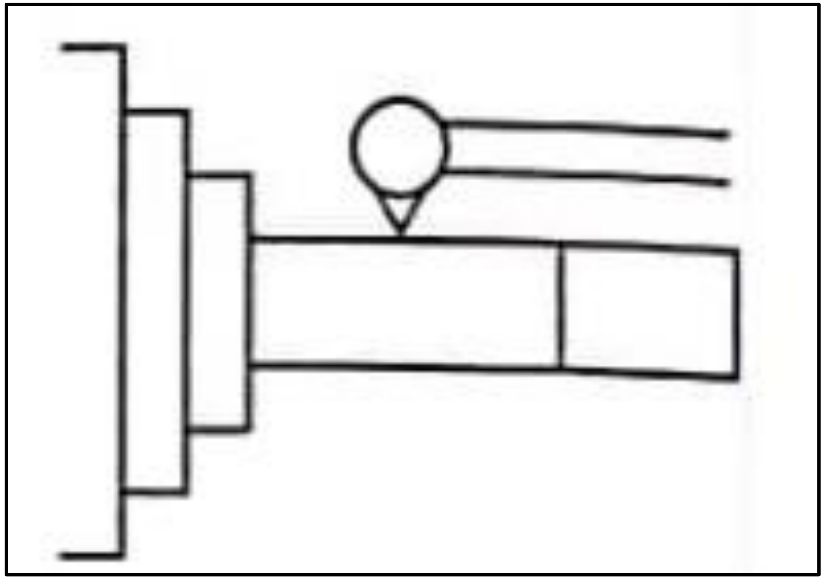
Leveling of the machines

1.2 True Running of Locating Cylinder of Main Spindle.



Engine lathe

1.2 True Running of Locating Cylinder of Main Spindle.

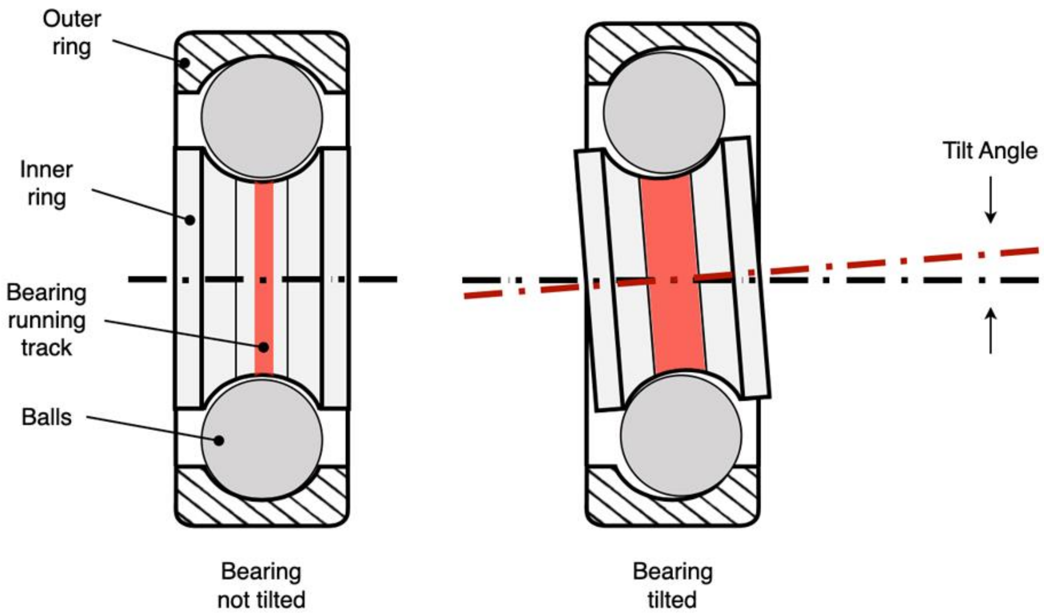


- Locating cylinder is provided to locate the chuck or face plate.
- However locating surface can't be threaded one as threads get worn out soon and thus introducing play in face plate or chuck. Thus locating surface is cylindrical and this must run truly for only then the face plate etc., can run truly.
- The dial indicator is fixed to the carriage (or any other fixed member) and the feeler of the indicator touches the locating surface.
- The surface is then rotated on its axis and indictor should not show any movement of needle.

1.3 Axial Slip of Main Spindle and True Running of Shoulder Face of Spindle Nose.

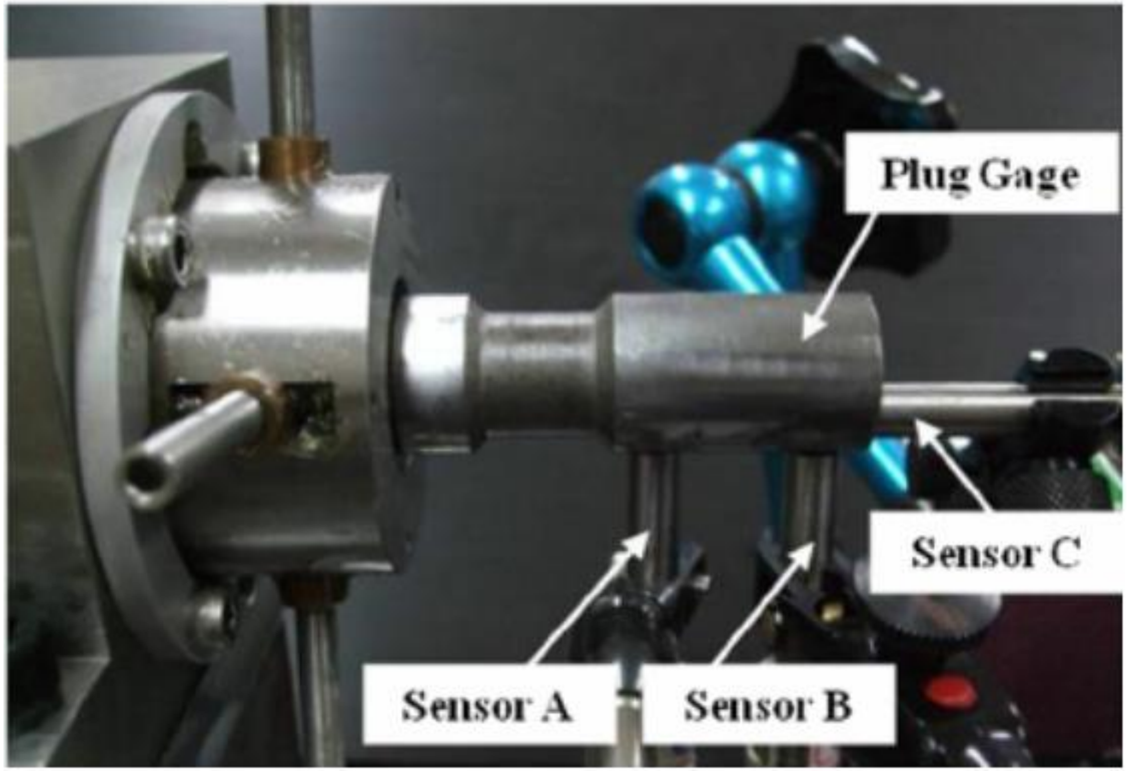
- Let us first distinguish between the axial play and the axial slip.

- Axial play means the indispensable freedom of spindle movement in axial direction to prevent it from seizing by heating.



- The spindle is supported between two bearings. Due to running of spindle, there will be a rise in temperature and thermal expansion of spindle would be there.

- If no axial play is allowed, it would try to bend. Thus there will be no adverse effect of axial play if the direction of cutting forces remains same.
- If the direction of cutting force changes, there would be some error introduced due to movement of spindle axially in either direction. Under such conditions, therefore, it is advisable to cut threads in one direction only.



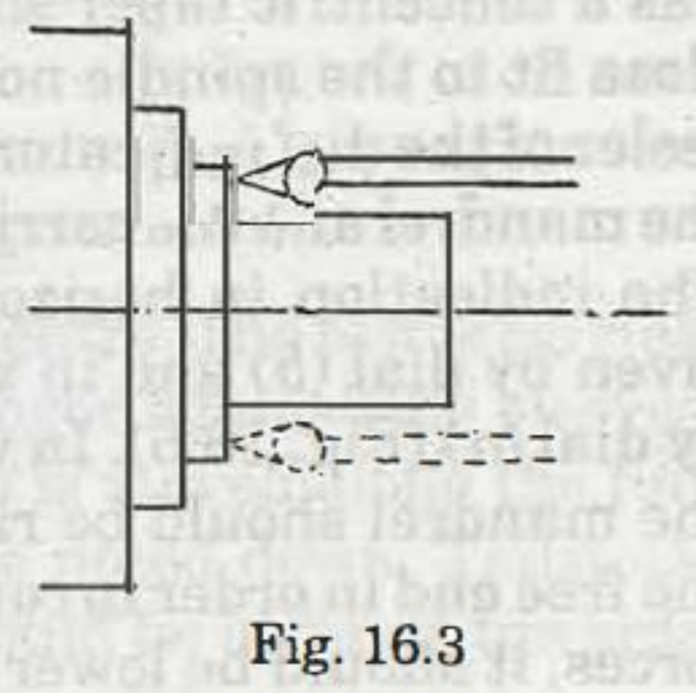


Fig. 16.3

- Axial slip is defined as the axial spindle movement which Fig. 16.3 follows the same pattern and is due to the manufacturing error. Actually this test is meant to check this error.
- To test this the feeler of the dial gauge rests on the face of the locating spindle shoulder and the dial gauge holder is clamped to the bed (Fig. 16.3).
- The locating cylinder is then rotated and the change in reading noted down. The readings are taken at two diametrically opposite points. The **total error** indicated by the movement of the pointer includes three main sources of errors.

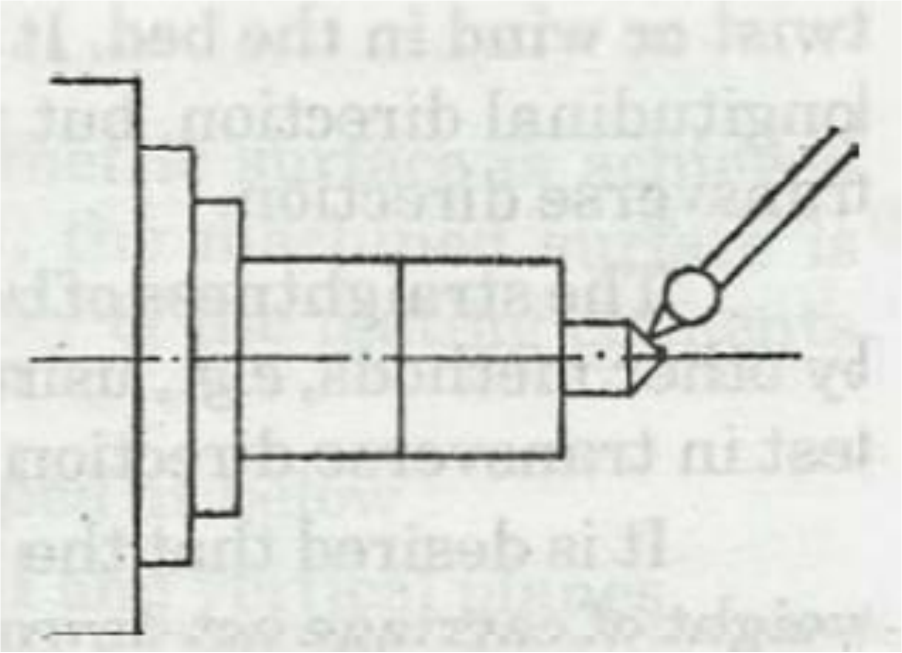
(i) Axial slip due to error in bearings supporting the locating shoulder, i.e., the bearings are not perpendicular to the axis of rotation and due to it a point on the shoulder will move axially in and out at diametrically opposite points.

(ii) Face of the locating shoulder not in a plane perpendicular to axis of rotation.

(iii) Irregularities of front face.

1.4 True Running of Headstock Centre

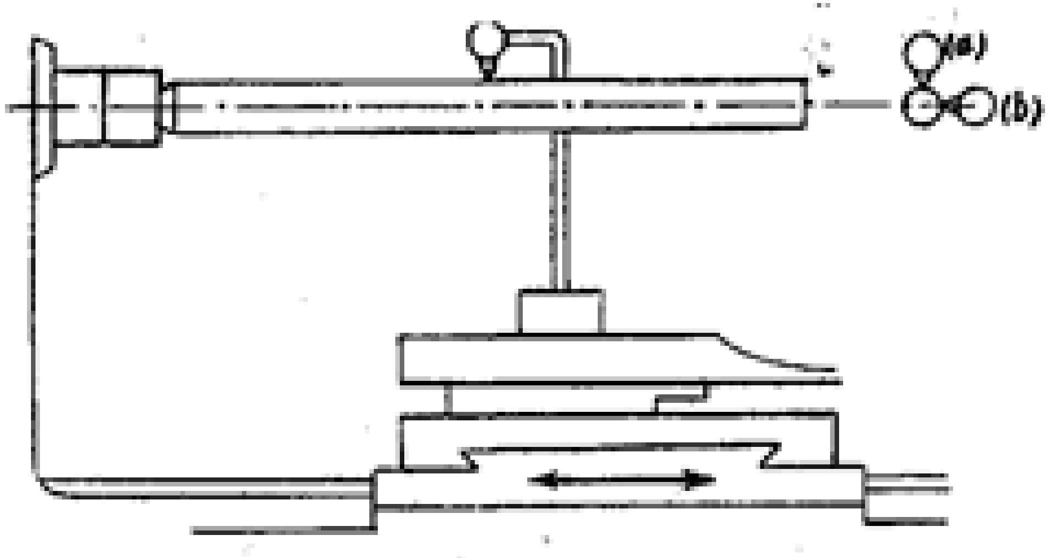
- Headstock centre is live centre and the workpiece has to rotate with this centre.



- If it is not true with the axis of movement of the spindle, eccentricity will be caused while turning a work, as the job axis would not coincide with the axis of rotation of main spindle
- For testing this error, the feeler of the dial indicator is pressed perpendicular to the taper surface of the centre (Fig. 16.4), and the spindle is rotated. The deviation indicated by the dial gauge the true nflH of the centre.

1.5 Parallelism of the Main Spindle to Saddle Movement.

- This has to be checked in both vertical and horizontal planes.
- In this we require the use of mandrel. An important precaution in the use of mandrels and dial indicator is mentioned here.



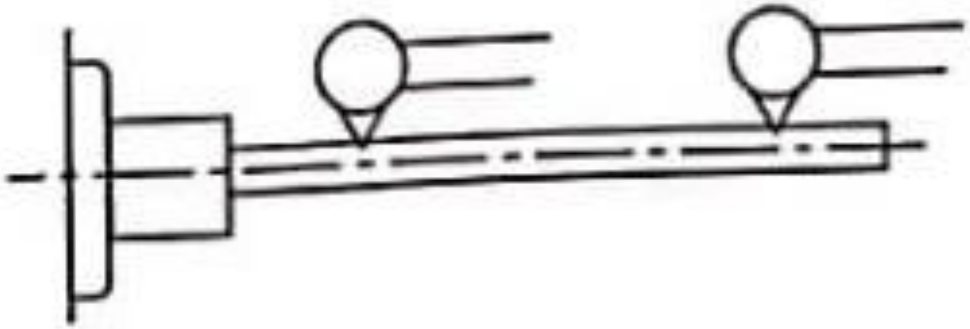
- The mandrel must be so proportioned that its overhang does not produce appreciable sag, or else the sag must be calculated and accounted for.
- The rigidity indicator set up is also very important and must be carefully watched. Otherwise variations in readings are recorded by pointer may be solely due to deflection of the indicator mounting in different positions and it becomes very difficult to detect and isolate the spurious deflection from the true variations.

- If axle of the spindle is not parallel to bed in horizontal direction, a **tapered surface** is produced
- Any deviation from parallelism of spindle axis from bed in vertical axis will produce a hyperboloid surface.
- For this test, a mandrel is fitted in the taper socket of the spindle Mandrel has a concentric taper shank which is close fit to the spindle nose taper
- The feeler of the dial indicator is pressed on the mandrel and the carriage is moved.

- The mandrel and the carriage is moved.
- The indication in horizontal plane is given by dial (b) and in vertical plane by dial (a)
- In vertical plane the mandrel should be rising towards the free end in order to counteract the weight of mandrel and job. But for counter-acting cutting forces.
- It should be lower towards free end. In horizontal plane, mandrel should be inclined in a direction opposite to the direction of tool pressure.

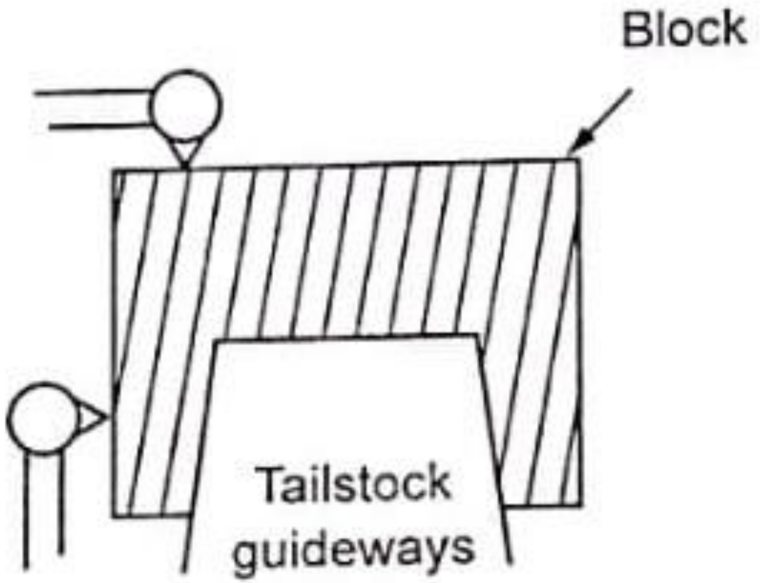
1.6 True running of taper socket in main spindle

- If the axis of tapered hole of the socket is not concentric with the main spindle axis, eccentric and tapered jobs will be produced
- To test it, a mandrel is fitted into the tapered hole and readings at two extremes of the mandrel are taken by means of a dial indicator as shown in Figure



1.7 Parallelism of tailstock guideways with the movement of carriage

- Sometimes the job is held between head-stock and tail stock centre for turning In that case the job axis must coincide with the tailstock centre
- If the tailstock guideways are not parallel with the carriage movement there will be some offset of the tailstock centre and this results in taper turning.



- To check the parallelism of tailstock guideways in both the planes i.e., horizontal and vertical, a block is placed on the guideways as shown in Figure and the feeler of the indicator is touched on the horizontal and vertical surfaces of the block
- The dial indicator is held in the carriage and carriage is moved. Any error is indicted by the pointer of dial indicator.

1.8 Parallelism of tailstock sleeve to saddle movement.

- If the tailstock sleeve is not parallel to the saddle movement, the height of dead centre would vary as varying lengths of sleeve are taken out
- For the jobs held between two centres, it is necessary that the central axis of the dead centre be coaxial with the job axis in both the planes.
- If it is not so, the job may be tilted up or down or in sideways due to the support of the dead centre.

- The test is carried out by fixing the dial indicator on the tool post and pressing the plunger against the sleeves first in vertical and then in horizontal plane figure.
- The carriage is moved along the full length of the sleeve and deviations as indicated by dial indicator are noted down.
- Tailstock sleeve should be rising towards the free end in vertical plane and should be inclined towards the tool pressure in horizontal plane.

Parallelism of tailstock sleeve taper socket to saddle movement.

A mandrel is put in the sleeve socket. The dial gauge is fixed on the tool post and plunger is pressed against the mandrel and saddle is moved from one side to the other. This test is carried out in both the horizontal and vertical planes.

Alignment of both the centers in vertical plane.

- Besides testing the parallelism of the axes individually (main spindle axis and tailstock axis) it is necessary to check the relative position of the axes also.
- Both the axes may be parallel to carriage movement but they may not be coinciding. So when a job is fitted between the centres, the axis of the job will not parallel to the carriage movement.
- This test is to be carried out in vertical plane only. A mandrel is fitted between the two centres and dial gauge on the carriage. The feeler of the dial gauge is pressed. against . the mandrel in vertical plane as Figure and the carriage is moved and the error noted down.

Pitch accuracy of lead screw

- The accuracy of the threads cut on any machine depends upon the accuracy of its lead screw. Thus it is very essential that pitch of the lead screw throughout its length be uniform
- Test for this is performed by fixing a positive stop on the lathe bed. Against the stop, the length bars and slip gauges can be located.
- An indicator is mounted on the carriage and first it makes contact against the calculated length of slip gauges.
- The initial loading of the dial gauge against the slip gauge is noted.
- The slip gauges are then removed and the carriage is connected to the lead screw and lead screw is disconnected from the gear train.

- An indexing arrangement is utilised for rotating the lead screw and lead screw is given some revolutions so that distance travelled by carriage is equal to the length of slip gauges
- The reading of the dial indicator against the stop is noted down in this position.
- It it is same as before, there is no error, otherwise it can be recorded.
- In this method, care must be taken not to disturb the datum location when changing the gauges for testing different pitch lengths.

- A suitable method for recording the progressive and periodic errors is by using a suitably divided scale, which is placed close to the line of centres.
- A microscope is rigidly mounted on the carriage in a convenient position to note the readings on the scale.

Alignment of lead screw bearings with respect to each other

The alignment of the bearings decides the position of the lead screw. Misalignment of lead screw i.e., it not being parallel to the bed in vertical plane or horizontal plane can cause additional stresses due to bending, when carriage is moved. Due to it the lead screw might get damaged and the precision of the machine is reduced

Alignment of lead screw bearing with split nut in both the planes is also essential.

Axial slip of lead screw

- The thrust face and the collars of the lead · screw (or the abuttment collar and the thrust bearing of the screw) must be exactly square to the screw axis,
- Otherwise a cyclic endwise movement is set up which is of the same nature as the axial slip in the main spindle.
- Thus a periodic pitch error will be additional to any true periodic errors in the pitch of the screw.

- For testing the axial slip in lead screw, a ball is fitted in the end of lead screw and the feeler of the dial gauge is pressed against the ball. The lead screw is rotated and deviation, if any, in any direction is noted down

ALIGNMENT TESTS ON MILLING MACHINE

Alignment Tests on Milling Machine

- Machine tools are very sensitive to impact or shock, even heavy cast iron standards are not always solid and rigid enough to withstand stresses due to falling during transportation, and deformations may be set up.
- Although the machine is always carefully adjusted and aligned when on the test stand or in the assembly department of the manufacturer, it is well known from experience that erection in the workshop of the user is not always done with sufficient care and thus inaccuracies of the work may result from the faulty erection of the machine. So the machine should be carefully levelled up by means of a spirit level before starting with the actual trial tests.

A specification for the alignment tests must comply with the following general requirements:

(1) The procedure for testing standard machine tools must not require more than 6 to 8 hours of work provided all the tooling and measuring equipment are readily available.

(2) The permissible limits of accuracy of individual measurements must be wide enough to make economical manufacture possible while on the other hand the cumulative error of number of superimposed details should not be excessive.

Cutter Spindle Axial Slip or Float.

Axial play means the indispensable freedom of a spindle moving in the axial direction to prevent it from seizing by heating. This end play is specially important on high speed machines and it should be within the prescribed limits.

Axial slip is defined as the axial spindle movement which may repeat positively with each revolution as a consequence of manufacturing errors. It is only this axial sliding movement which is to be tested, and the specified tolerance applies only to this movement.

When testing the **axial slip** of a spindle the feeler of the dial gauge rests on the face of the locating spindle shoulder and dial gauge holder is clamped to the table. The locating spindle shoulder is rotated and change in reading is noted. This is done at the two spots diametrically. opposite to each other.

The total error indicated by the movement of the pointer includes three main sources of errors.

(i) Axial slip due to error in bearing supporting the locating shoulder.

(ii) Face of the locating shoulder not in a plane perpendicular to axis of rotation.

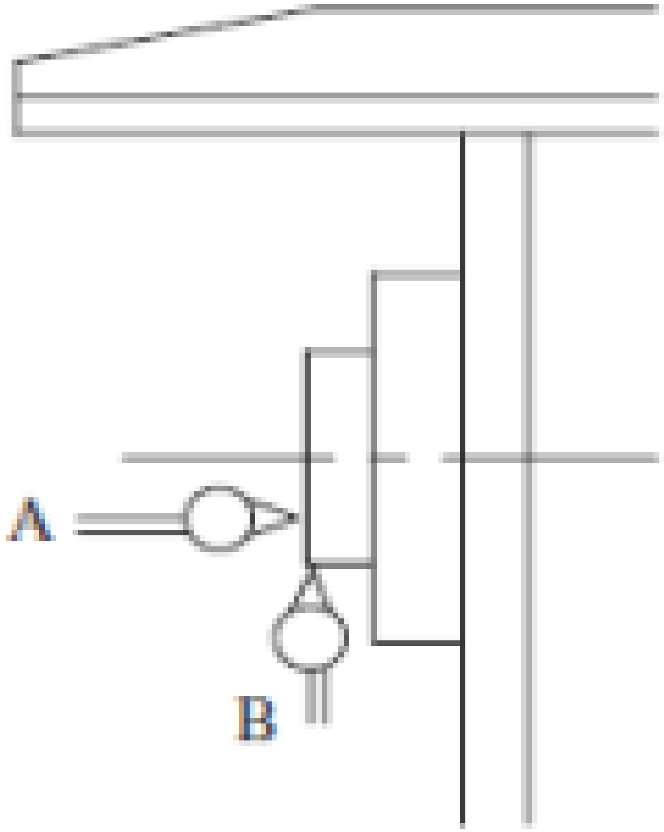
(iii) Irregularities of front face.

ALIGNMENT TESTS ON MILLING MACHINE

Axial slip of spindle: A spindle may have an axial slip, which is the axial movement of the spindle during its rotation.

Axial slip may occur due to the following reasons:

Errors due to worn-out spindle bearings, face of the locating shoulder of the spindle not being in a plane perpendicular to the axis of the spindle, and irregularities in the front face of the spindle.

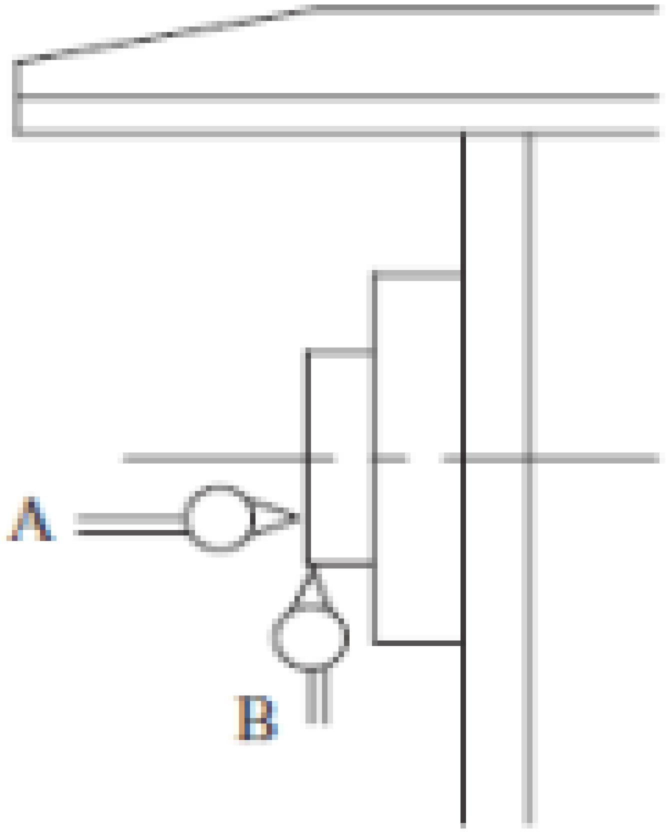


Measuring axial slip of a spindle

The **feeler of the dial gauge** is held against the front face of the spindle and the base is mounted on the table. The position of the dial gauge (in order to measure axial slip) is denoted by **A** in the figure.

The spindle is gently rotated by hand and the dial gauge reading is noted down.

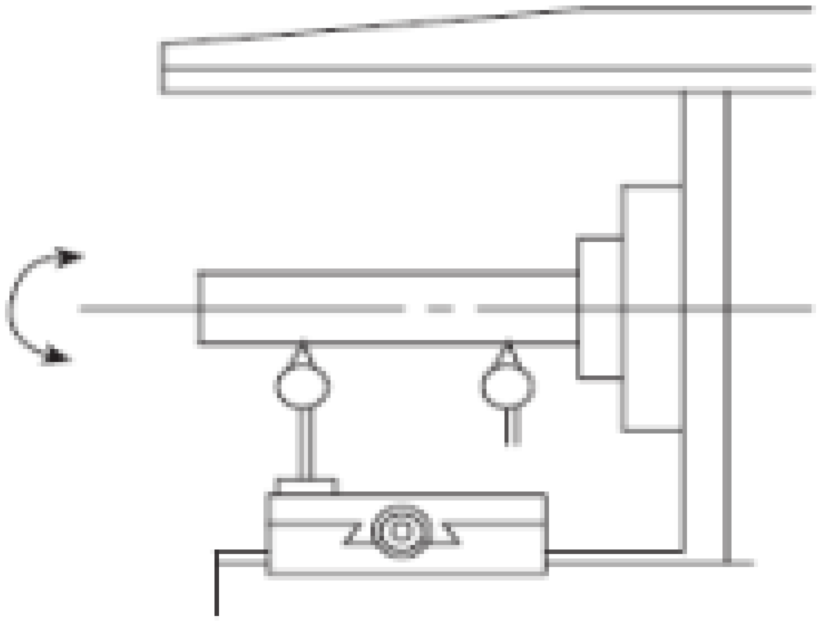
The test is repeated at a diametrically opposite spot. The maximum deflection should be well within the prescribed limits.



Measuring axial slip of a spindle

Eccentricity of external diameter of spindle:

- **Position B** of the dial gauge shown in the left side Fig. is used to determine the eccentricity of the external diameter of the spindle.
- The feeler is made to contact the spindle face radially, and the dial gauge base is mounted on the machine table. The spindle is gently rotated by hand and the dial gauge deviation is noted down.
- The maximum deviation gives the eccentricity of the external diameter of the spindle, and it should be well within specified limits.



True running of a spindle taper

Cutter Spindle Axial Slip or Float:

- Axial slip is defined as, "**an axial movement of spindle, which may repeat positively with each revolution**". Clamp the dial gauge stand to table, such that, the plunger or feeler of dial gauge indicator is touching the face of locating spindle shoulder.

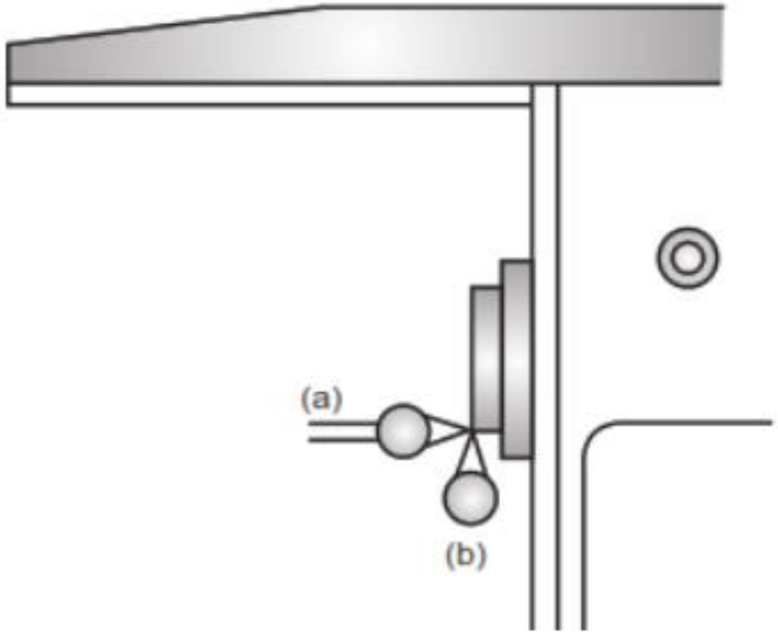


Fig. 3.27 Cutter Spindle Axial Slip or Float

- Now rotate the spindle about its centre and note down the variations observed in the readings shown on dial gauge indicator.

- This is to be tested at two points 180° apart from each other. It is expected that, the value of maximum variation in dial gauge readings should not be more than specified permissible range.

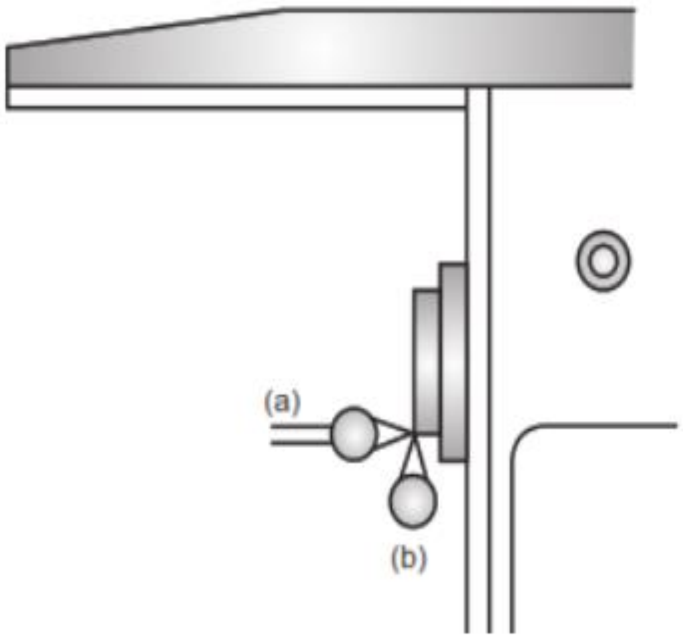
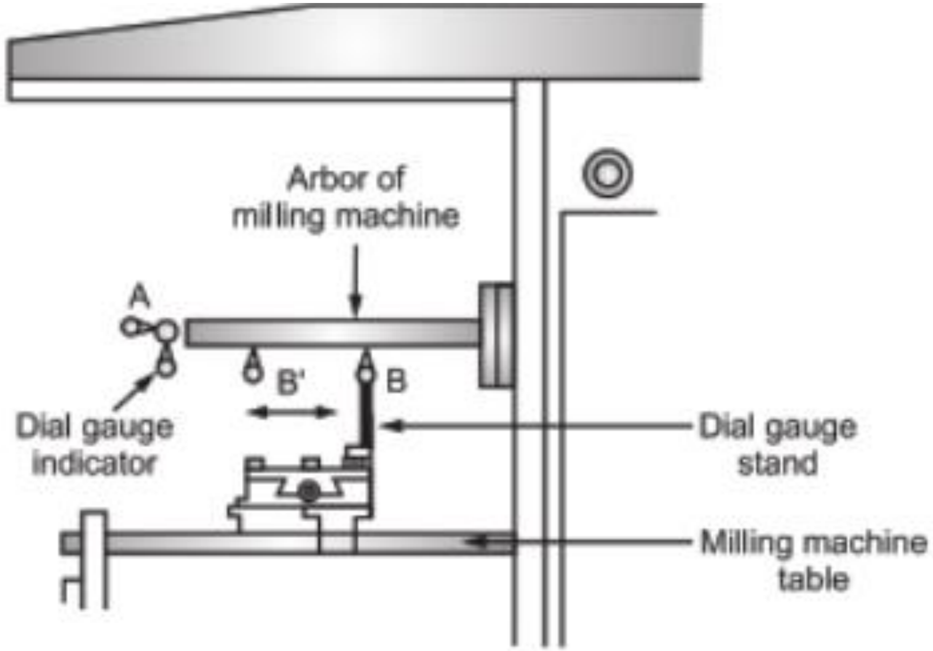


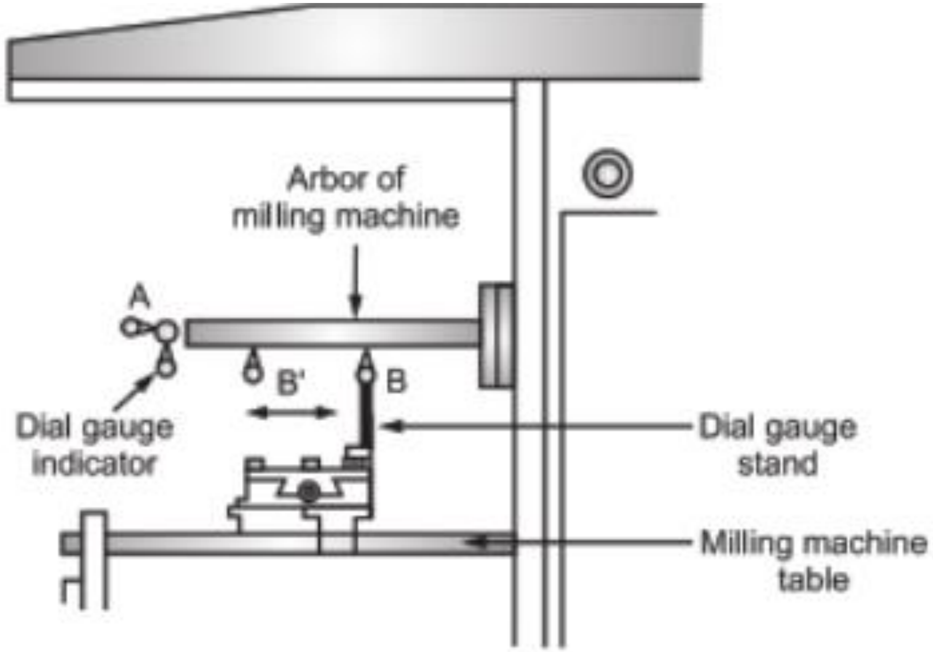
Fig. 3.27 Cutter Spindle Axial Slip or Float

Transverse Movement Parallelism with Spindle Axis:

- Fig. shows the arrangement required to carry out test, using a dial gauge indicator along with its mounting stand arrangement.
- Mount and fix the dial gauge indicator with the help of its stand, on the table of milling machine.
- Use Arbor of milling machine as shown in Fig. A stationery mandrel can also be used instead of Arbor.



- Initially, place the plunger (or feeler) of dial gauge indicator touching the Arbor at point 'B' to check along vertical plane. Note down the reading of dial gauge indicator (1st reading).
- Now move the dial gauge indicator along with its stand in transverse direction up to point B' and note down the second reading of dial gauge indicator (2nd reading).



- If no variation is found in first (1st) and second (2nd) reading, then transverse movement is parallel with spindle axis.

True Running of Internal Taper:

- Fix a mandrel as shown in Fig
- It is ensured that, plunger remains in contact with mandrel, while carrying the test.
- This test is carried out at two places, given below:
  - (i) Near to spindle nose, refer position (1).
  - (ii) At a distance of 300 mm from spindle nose, refer position (2).

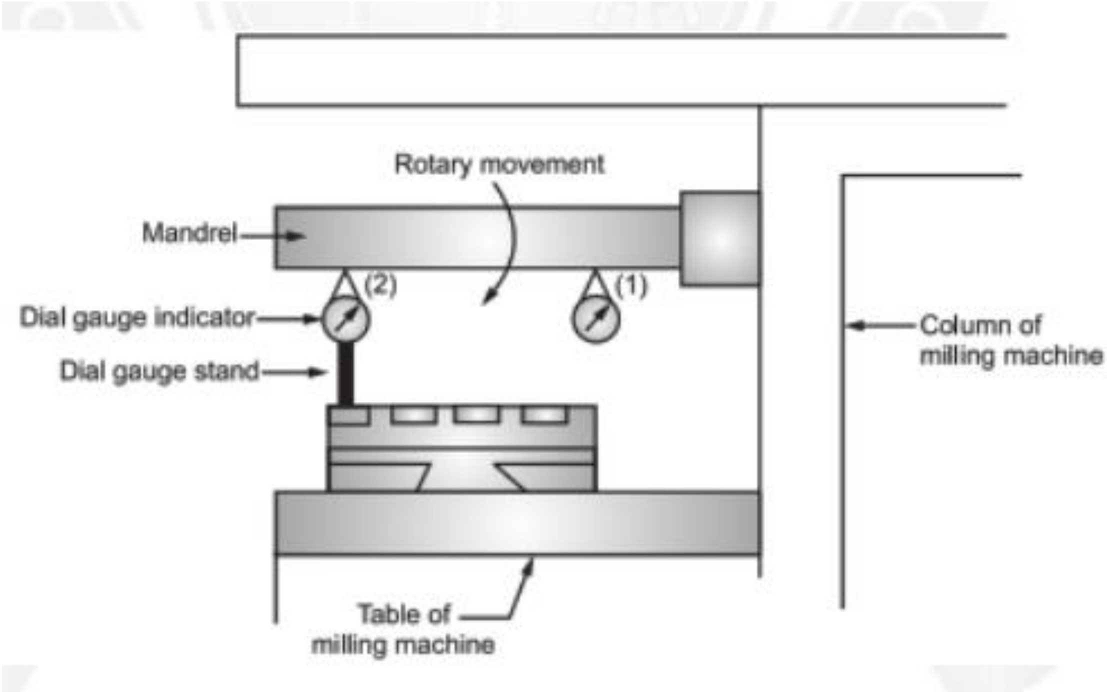


Fig. 3.29 Transverse Movement Parallelism with Spindle Axis

- Consider that plunger of dial gauge indicator is at position (1). Now, rotate the mandrel and observe the readings shown on dial indicator, to find out the value of maximum variation (if present) is noted down as 1st reading.
- Now, dial gauge indicator is mounted with the help of its stand at position (2), which is 300 mm away from position (1). Repeat the same procedure and note down 2nd reading.

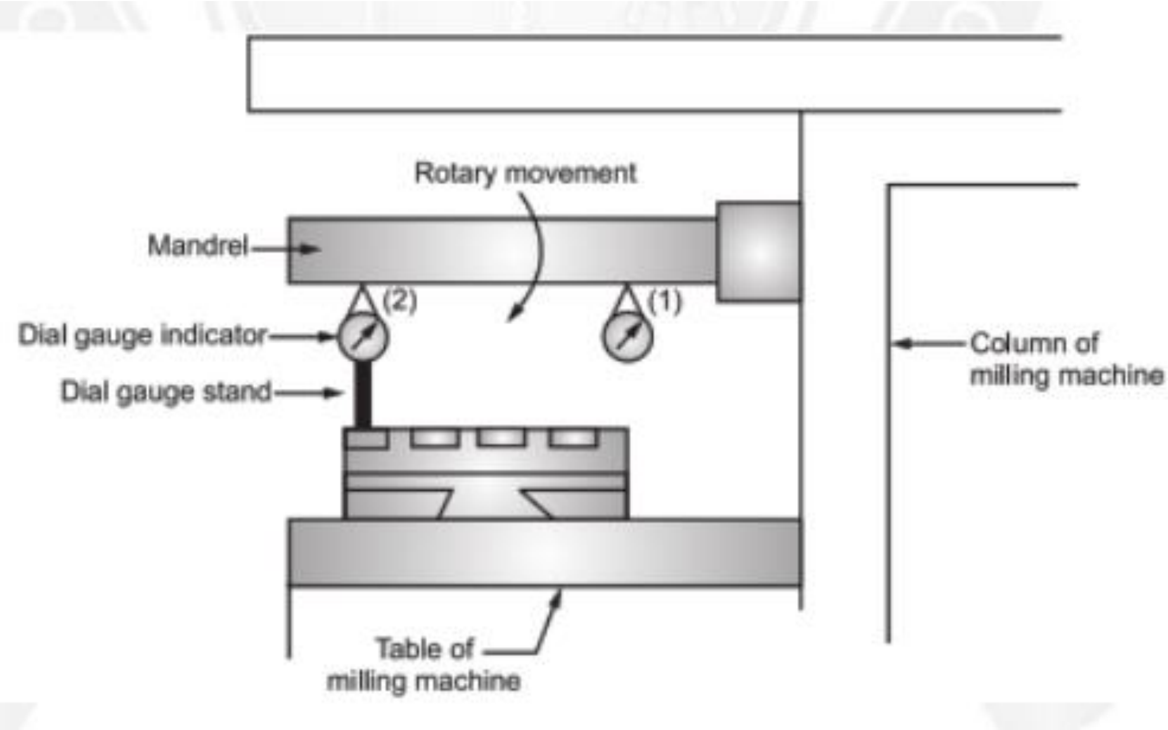


Fig. 3.29 Transverse Movement Parallelism with Spindle Axis

- Difference between 1st and 2nd readings indicates an error in true running of internal taper.

- This error should not exceed the specified permissible value.

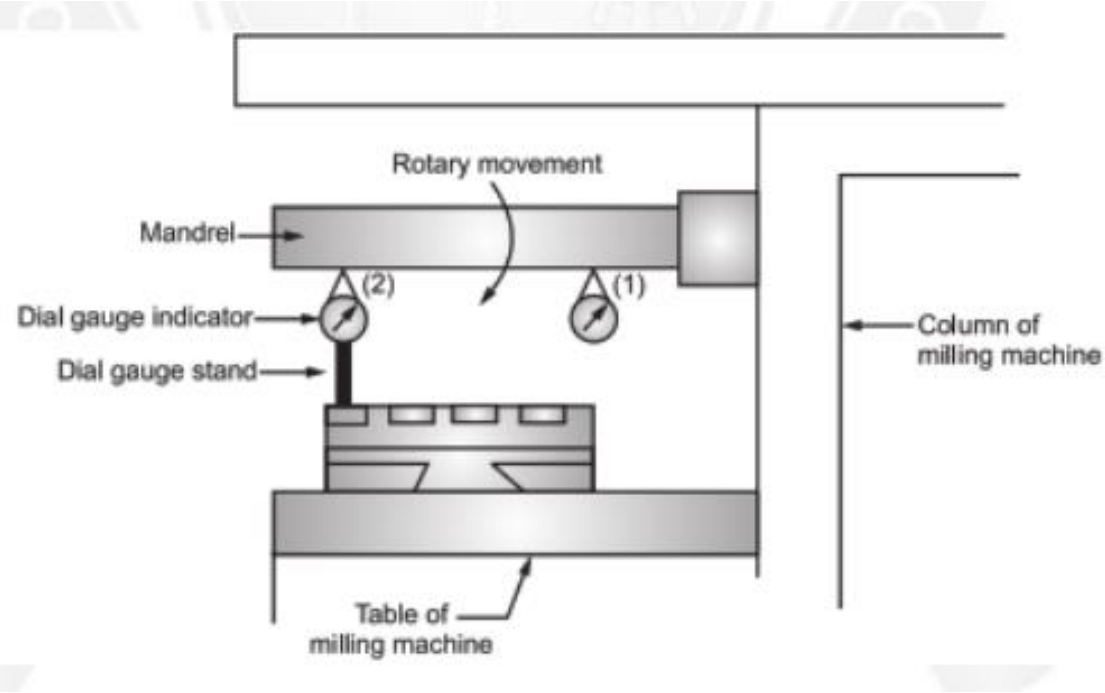
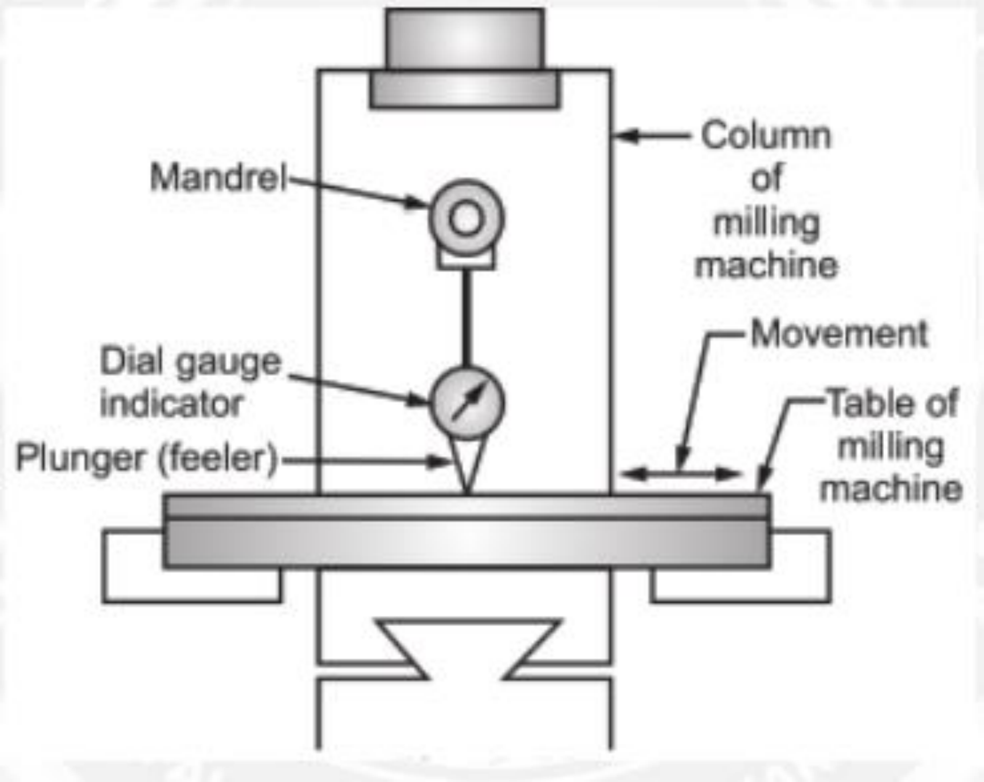


Fig. 3.29 Transverse Movement Parallelism with Spindle Axis

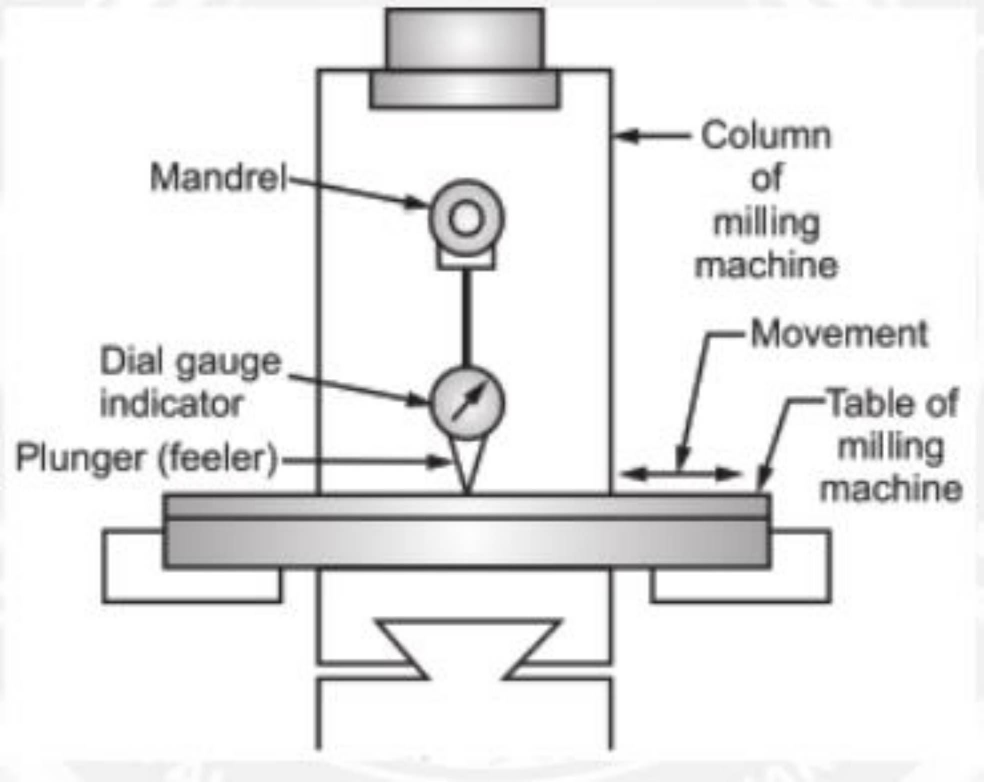
Surface Parallelism with Longitudinal Movement:

- Fix a mandrel and a dial gauge indicator in such a way that, the plunger of dial gauge indicator will touch the table surface. Also, plunger is slightly pressed against the table surface, so that, it will be always in contact with table surface throughout the test. Refer Fig.
- Test the table surface for maximum travel.



Transverse Movement Parallelism with Spindle Axis

- Readings shown by dial gauge indicator are observed to find out maximum variation, i.e., error in parallelism of surface during horizontal movement. This error should not exceed more than the specified permissible value.



Transverse Movement Parallelism with Spindle Axis

ALIGNMENT TESTS ON DRILLING MACHINE

Introduction

The alignment test on a drilling machine is carried out to check the grade of manufacturing accuracy of the machine tool.

The geometrical checks made on the machine are:

- Straightness and flatness of guide ways and sideways of machine tool
- Flatness of machine tool
- Parallelism equidistance and alignment of sideways
- True running and alignment of shaft and spindle
- Error in pitch

The instruments used for the alignment test are

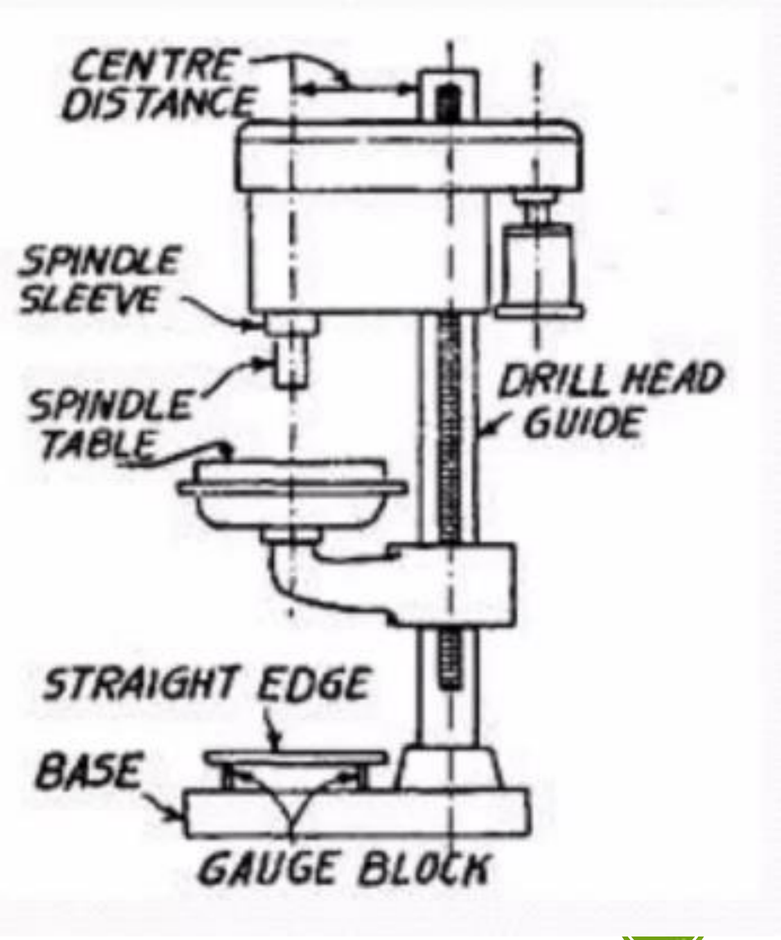
- Dial gauge
- Test Mandrels
- Straight edges
- Spirit levels
- Frame levels

Testing Procedure

Before carrying out the alignment tests, the machine is properly levelled in accordance with the manufacturer’s instructions. The various tests performed are :

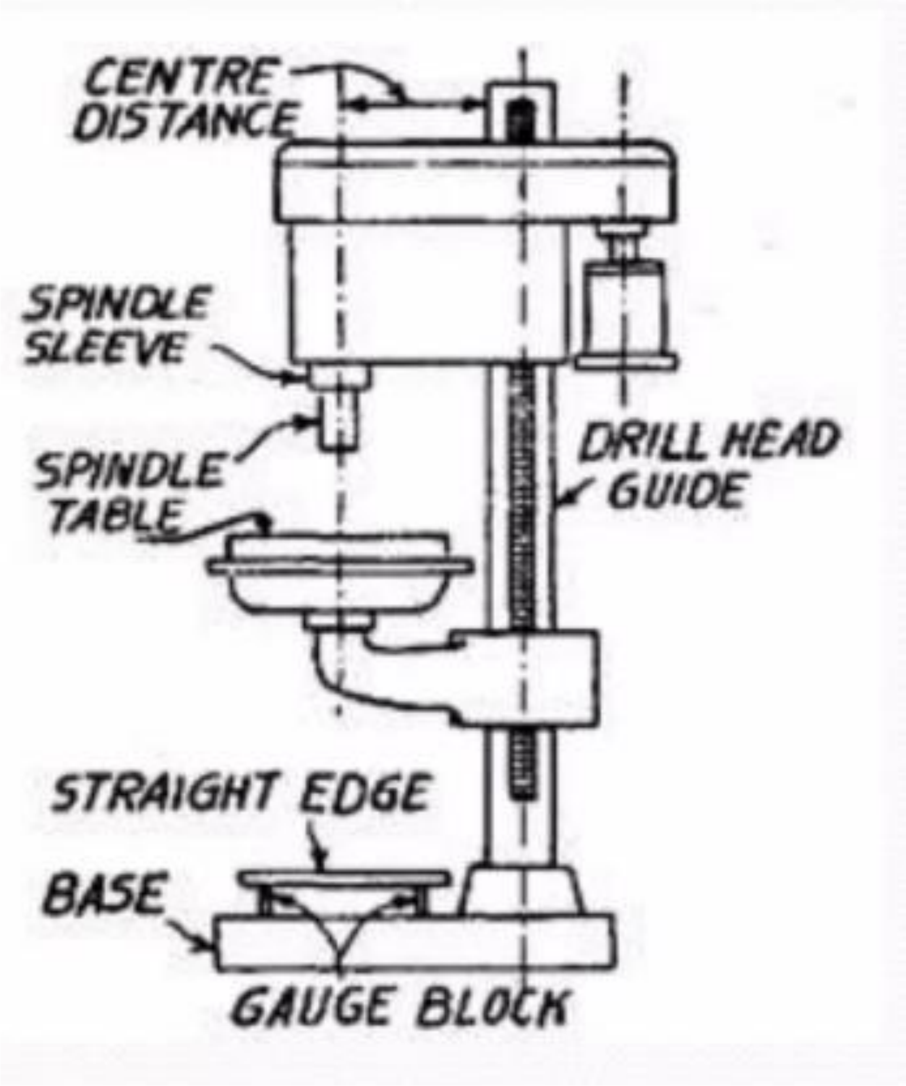
1. Flatness of clamping surface of base.

- The test is performed by placing a straight edge on two gauge blocks on the base plate in various positions and the error is noted down by inserting the feeler gauges.
- This error should not exceed 0.1/1000 mm clamping surface and the surface should be concave only.



2. Flatness of clamping surface of table.

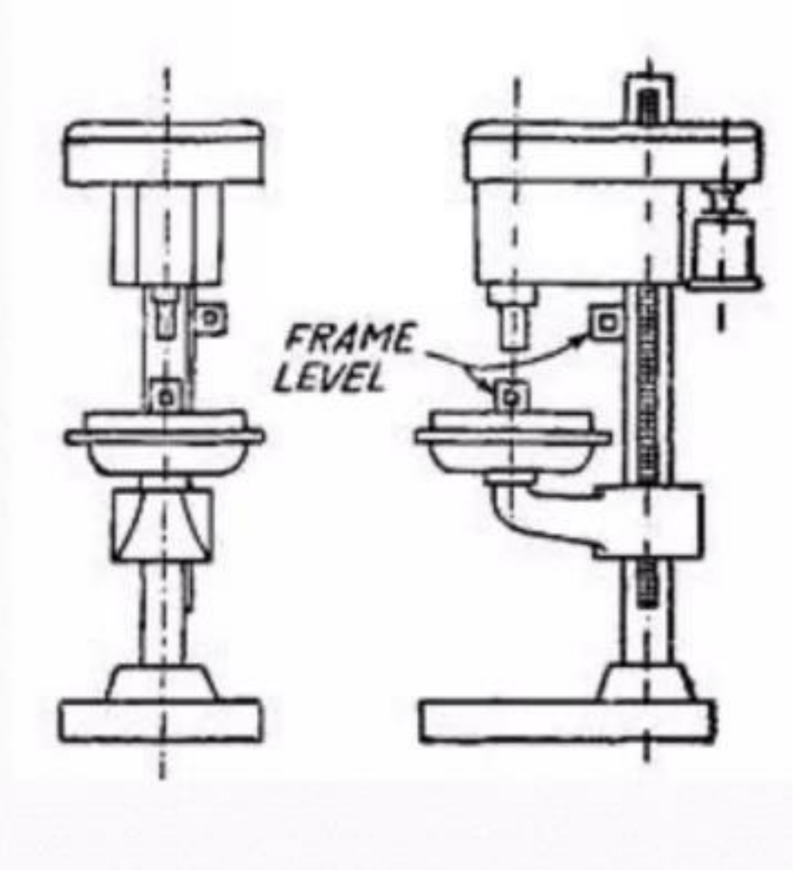
This test is performed in the same manner as above test of flatness but on the table. The permissible error is also same.



3. Perpendicularity of drill head guide to the base plate.

The perpendicularity of drill head guide to the base plate tested

(a) in a vertical plane passing through the axes of both spindle and column, and (b) in a plane at 90° to the plane at (a).

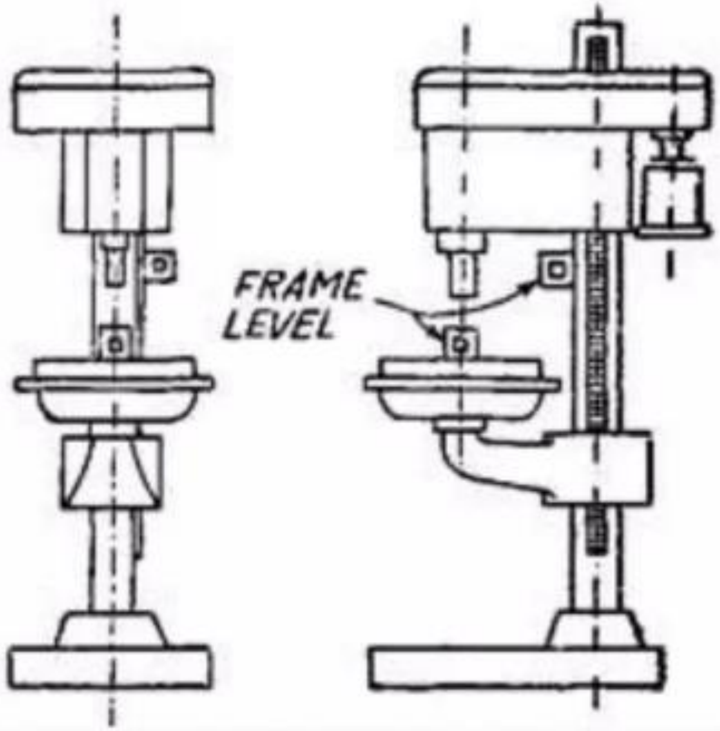


- The test is performed by placing the frame level (with graduations from 0.03 to 0.05 mm/m) on guide column and base plate and the error is noted by noting the difference between the readings of the two levels.
- This error should not exceed 0.25/1000 mm guide column for (a) and the guide column should be inclined at the upper end towards the front only, and 0.15/1000 mm for (b).

4.Perpendicularity of drill head guide with table: This test is performed exactly in the same way as (b). (Refer Figure in above slide) and the permissible error is also same.

5. Perpendicularity of spindle sleeve with base plate:

This test is performed in both the planes specified in test (3) and in the similar manner with the difference that the frame levels are to be placed on spindle sleeve and base plate. The error (i.e., the difference between the readings of the two levels) should not exceed 0.25/1000 mm for plane (a) and the sleeve should be inclined toward column only and 0.15/1000 mm for plane (b).



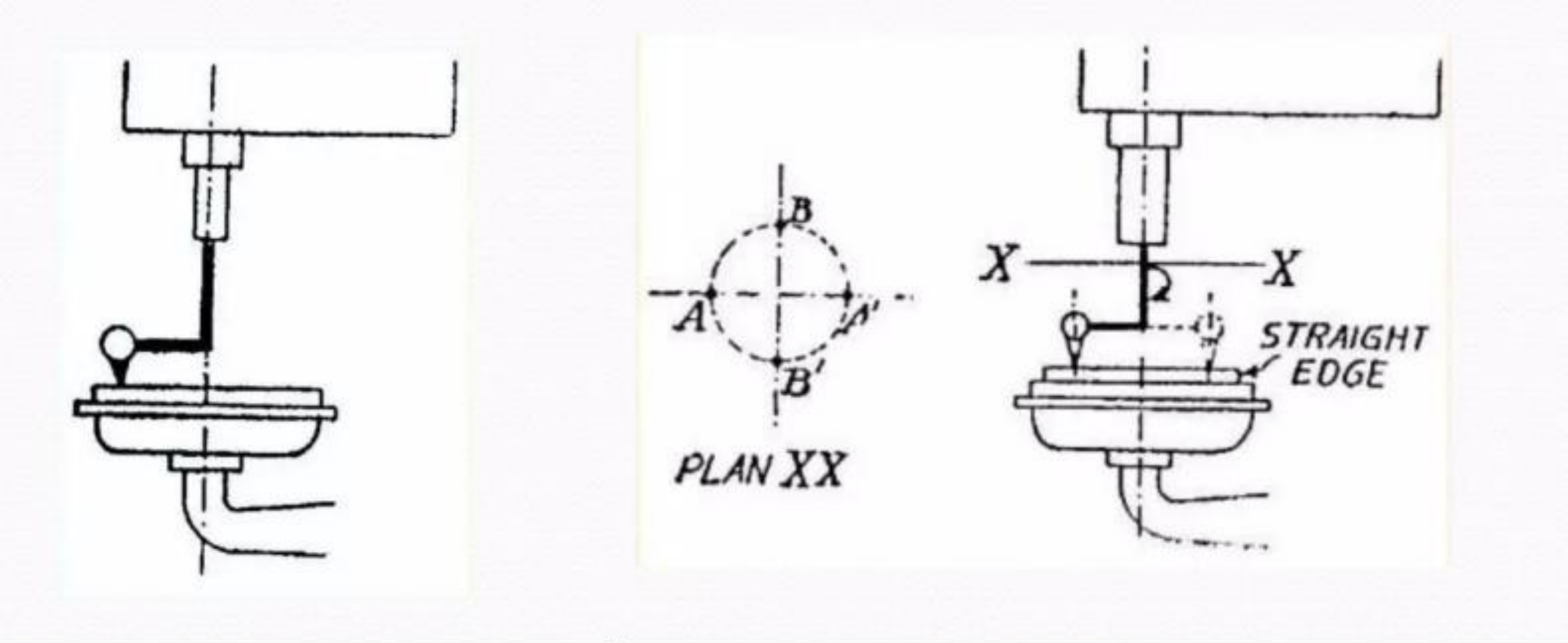
6. True running of spindle taper: For this test, the test mandrel is placed in the tapered hole of spindle and a dial indicator is fixed on the table and its feeler made to scan the mandrel. The spindle is rotated slowly and readings of indicator noted down. The error should not exceed 0.03/100 mm for machines with taper up to Morse No. 2 and 0.04/300 mm for machines with taper larger than Morse No. 2.

7. Parallelism of the spindle axis with its vertical movement.

This test is performed into two planes and at right angles to each other. The test mandrel is fitted in the tapered hole of the spindle and the dial indicator is fixed on the table with its feeler touching the mandrel. The spindle is adjusted in the middle position of its travel. The readings of the dial indicator are noted when the spindle is moved in upper and lower directions of the middle position with slow vertical feed mechanism.

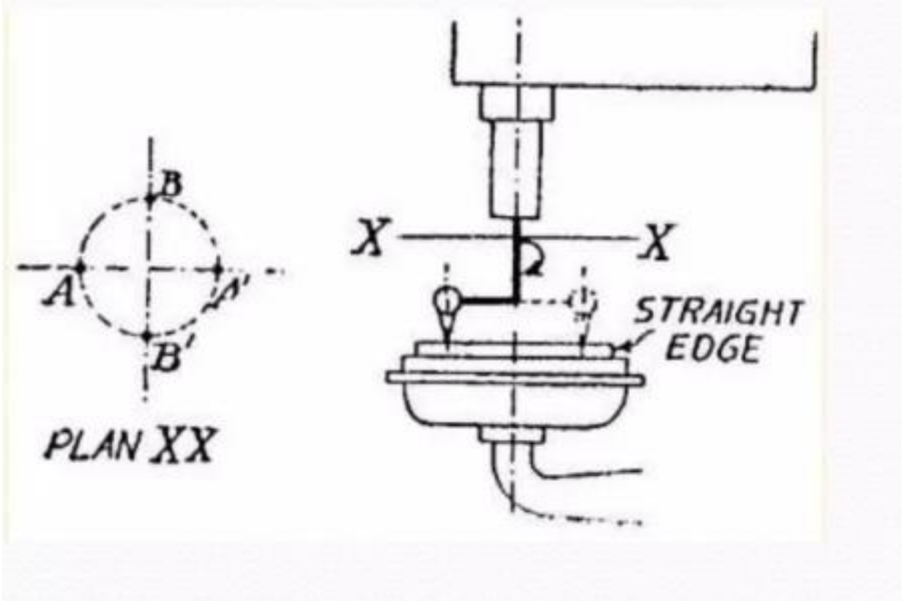
8. Squareness of clamping surface of table to its axis

For performing this test, the dial indicator is mounted in the tapered hole of the spindle and its feeler is made to touch the surface of table (Refer Figure). Table is slowly rotated and the readings of dial gauge noted down, which should not exceed 0.05/300 mm diameter.

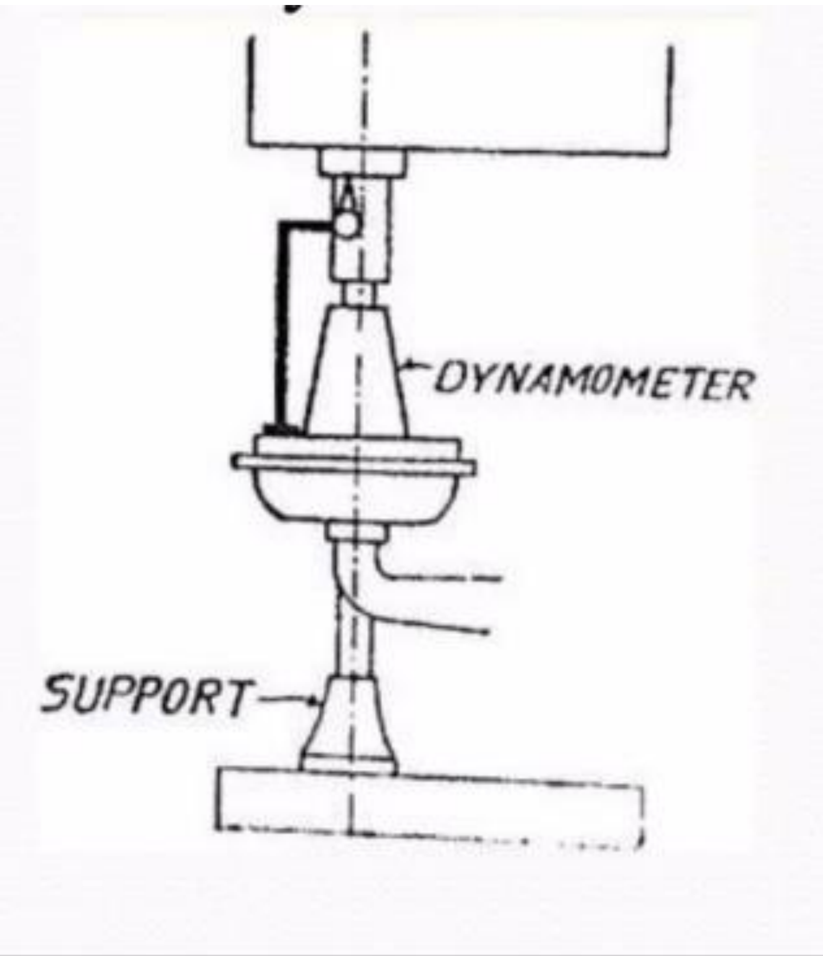


9. Squareness of spindle axis with table

For this test a straight edge is placed in positions AA' and BB'. Work table is arranged in the middle position of its vertical travel. The dial indicator is mounted in the spindle tapered hole and its feeler made to touch the straight edge first say at A and reading noted down. The spindle is rotated by 180° so that the feeler touches at point A' and again reading is noted down. The difference of two readings gives the error in squareness of spindle axis with table. Similar readings are noted down by placing the straight edge in position BB'.



10.Total deflection: For this test, the drill head and table are arranged in their middle position. Dial indicator is mounted on table with its feeler touching the lower machined surface part and spindle stock as shown in Fig. 16.23.Drill spindle is loaded with the dynamometer (load gauge) placed on table and the deflection of dial indicator noted down. The drill spindle pressure is set in accordance with the table on sideways.



COORDINATE MEASURING MACHINES (CMM)


CMM
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COORDINATE MEASURING MACHINES (CMM)

- Coordinate measuring machine refers to the instrument/machine that is capable of measuring in all three orthogonal axes.
- A CMM enables the location of point coordinates in a three-dimensional (3D) space. It simultaneously captures both dimensions and orthogonal relationships.
- CMM is integrated with a computer which provides additional power to generate 3D objects as well as to carry out complex mathematical calculations.
- Complex objects can be dimensionally evaluated with precision and speed.

CMM can be used in situations that require:

Multiple features : The more the number of features (both dimensional and geometric) that are to be controlled, the greater the value of CMM.

Flexibility: It offers flexibility in measurement, without the necessity to use accessories such as jigs and fixtures.

Automated inspection : Whenever inspection needs to be carried out in a fully automated environment, CMM can meet the requirements quite easily.

High unit cost: If rework or scrapping is costly, the reduced risk resulting from the use of a CMM becomes a significant factor.

Structure

- The basic version of a CMM has three axes, along three mutually perpendicular directions. Thus, the work volume is cubical.
- A carriage is provided for each axis, which is driven by a separate motor.
- While the straight line motion of the second axis is guided by the first axis, the third axis in turn is guided by the second axis.
- Each axis is fitted with a precision measuring system, which continuously records the displacement of the carriage from a fixed reference.

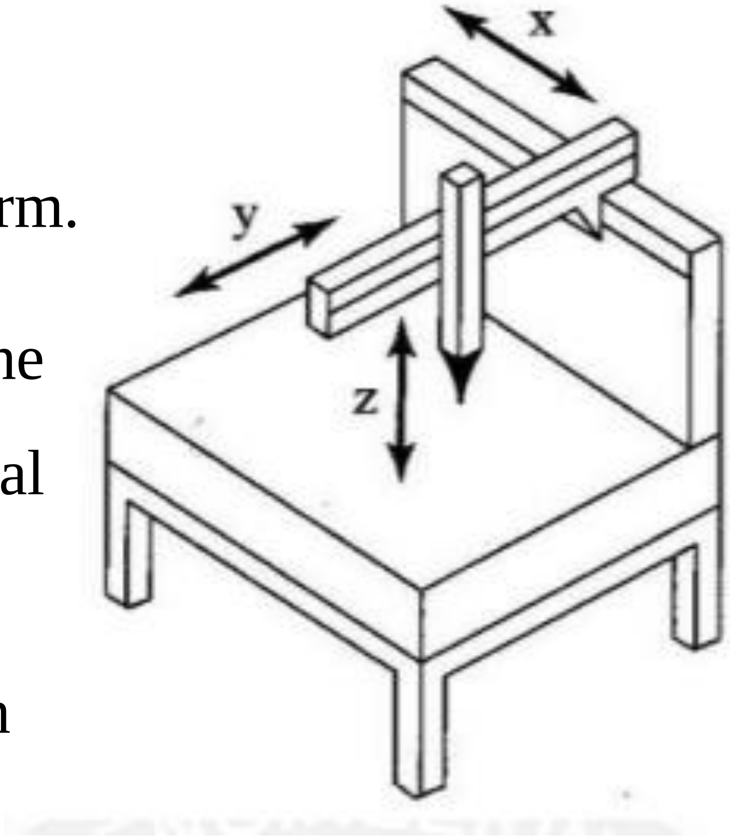
- The third axis carries a probe. When the probe makes contact with the workpiece, the computer captures the displacement of all the three axes.
- Depending on the geometry of the workpiece being measured, the user can choose any one among the five popular physical configurations. Figure below illustrates the five basic configuration types:

a) cantilever,
b) bridge,
c) column,
d) horizontal arm, and
e) Gantry.

TYPES OF CO-ORDINATE MEASUREMENT MACHINES (CMM)

a) Cantilever type CMM

- The vertically positioned probe is carried by a cantilevered arm.
- The probe moves up and down along the Z-axis, whereas the cantilever arm moves in and out along the Y-axis (lateral movement).
- The longitudinal movement is provided by the X-axis, which is basically the work table.
- This configuration provides easy access to the workpiece and a relatively large work volume for a small floor space.



Cantilever type CMM

b) Bridge type CMM

- A bridge-type configuration is a good choice if better rigidity in the structure is required.
- The probe unit is mounted on a horizontal moving bridge, whose supports rest on the machine table.

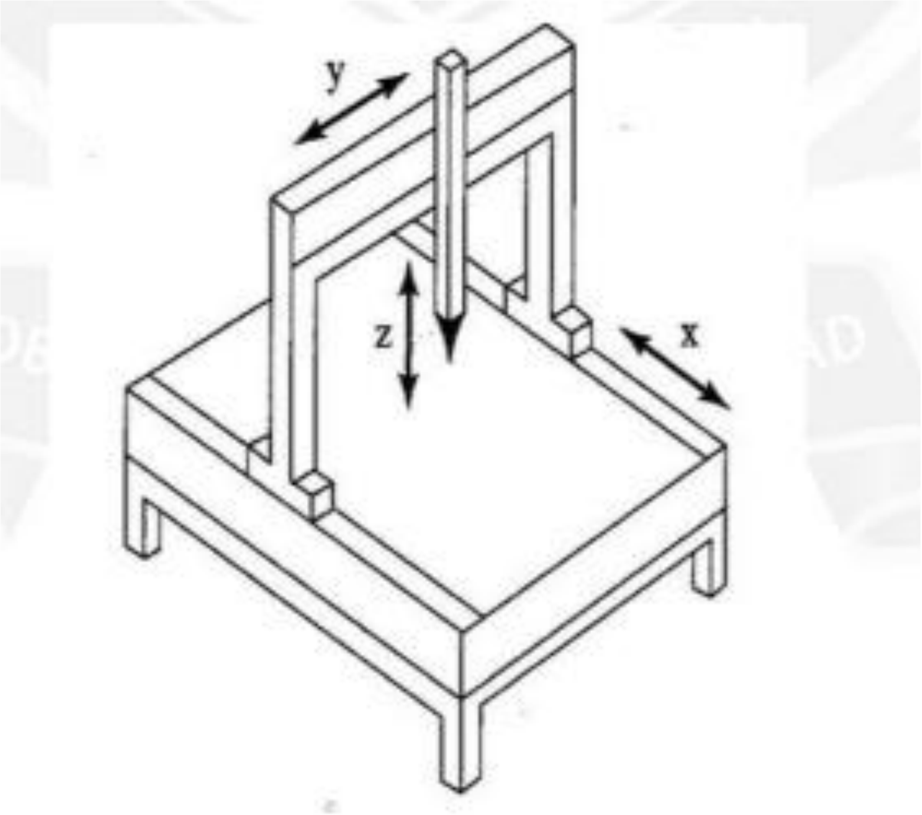
i. Moving Bridge type CMM
ii. Fixed Bridge type CMM

i. Moving Bridge type CMM

- Most widely used
- Has stationary table to support work piece to be measured and a moving bridge

Disadvantage- with this design, the phenomenon of yawing (sometimes called walking) can occur- affect the accuracy

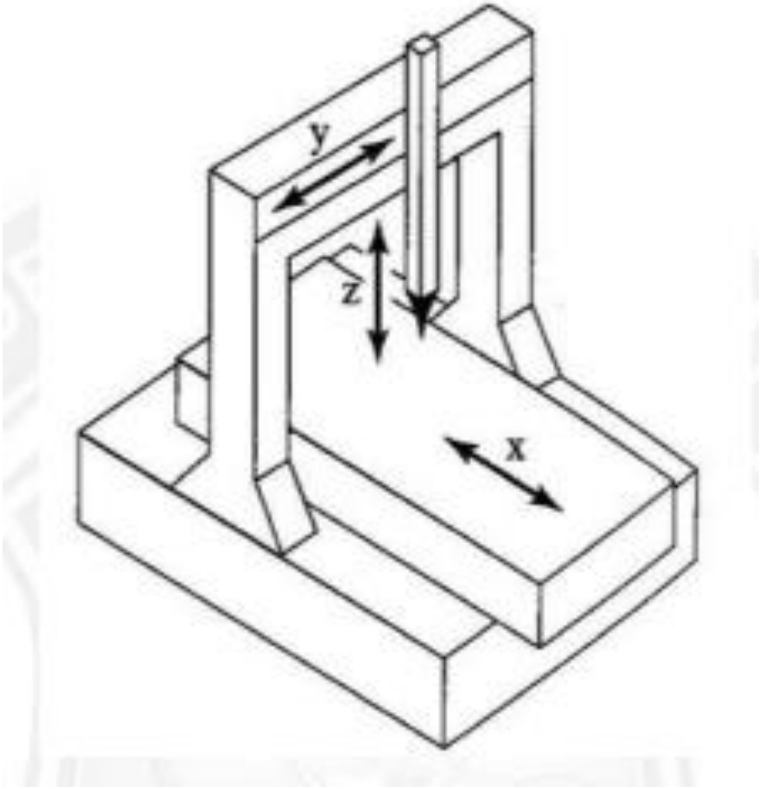
Advantage- reduce bending effect



Moving Bridge type CMM

ii) Fixed Bridge type CMM

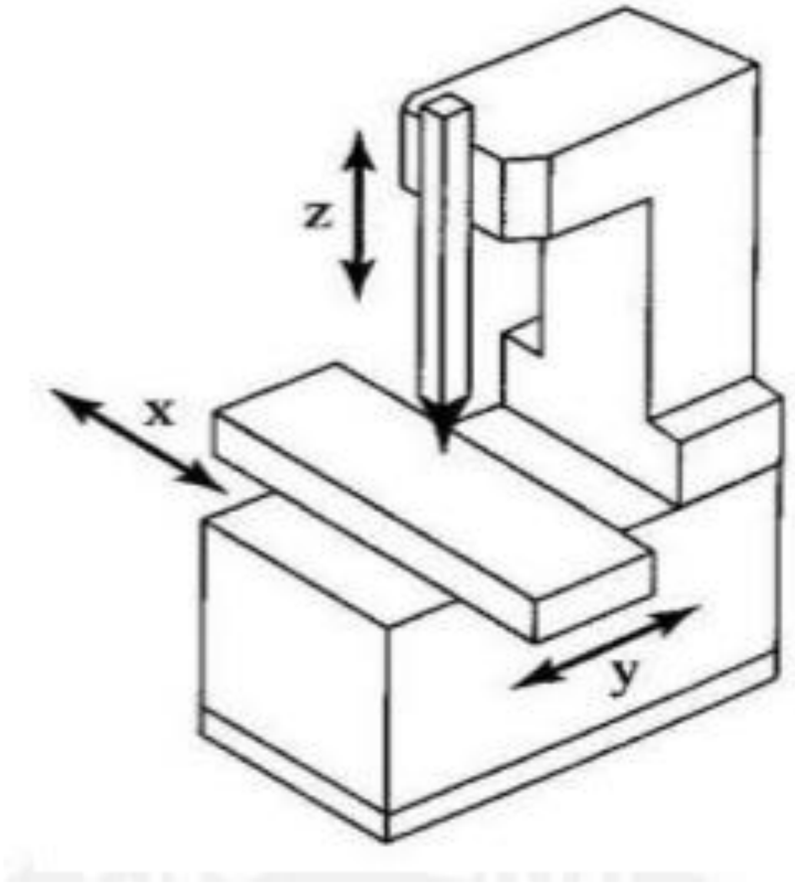
- In the fixed bridge configuration, the bridge is rigidly attached to the machine bed
- This design eliminates the phenomenon of walking and provides high rigidity



Fixed Bridge type CMM

c) Column type CMM

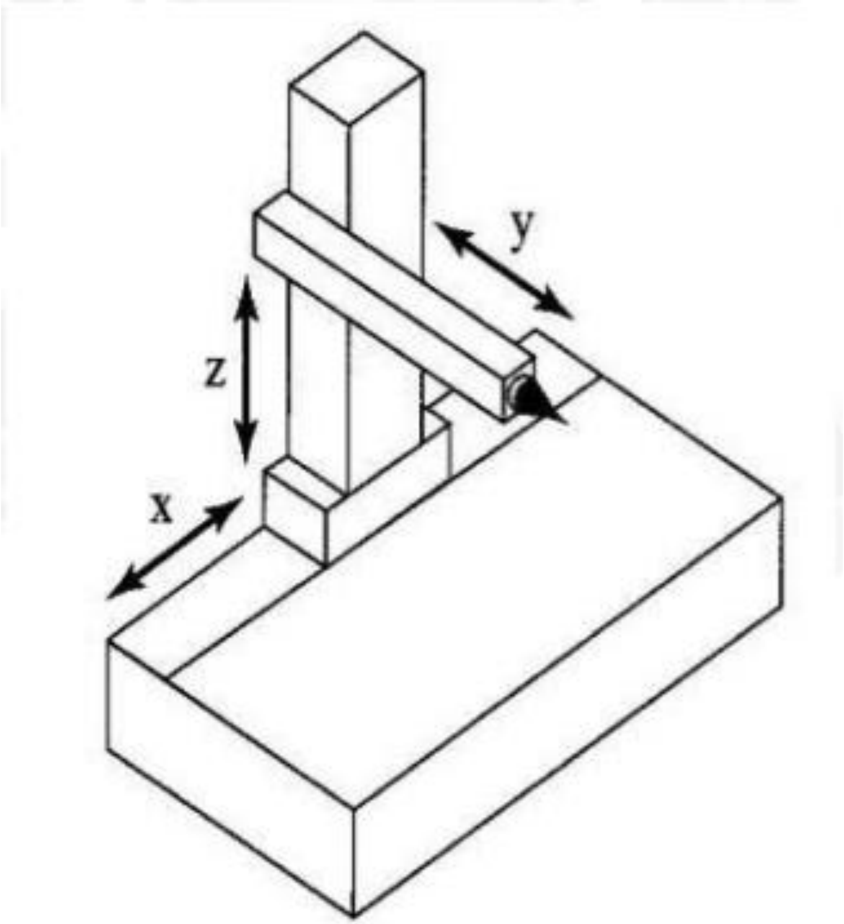
- This configuration provides exceptional rigidity and accuracy.
- It is quite similar in construction to a jig boring machine.
- Machines with such a configuration are often referred to as universal measuring machines.



Column type CMM

d) Horizontal arm type CMM

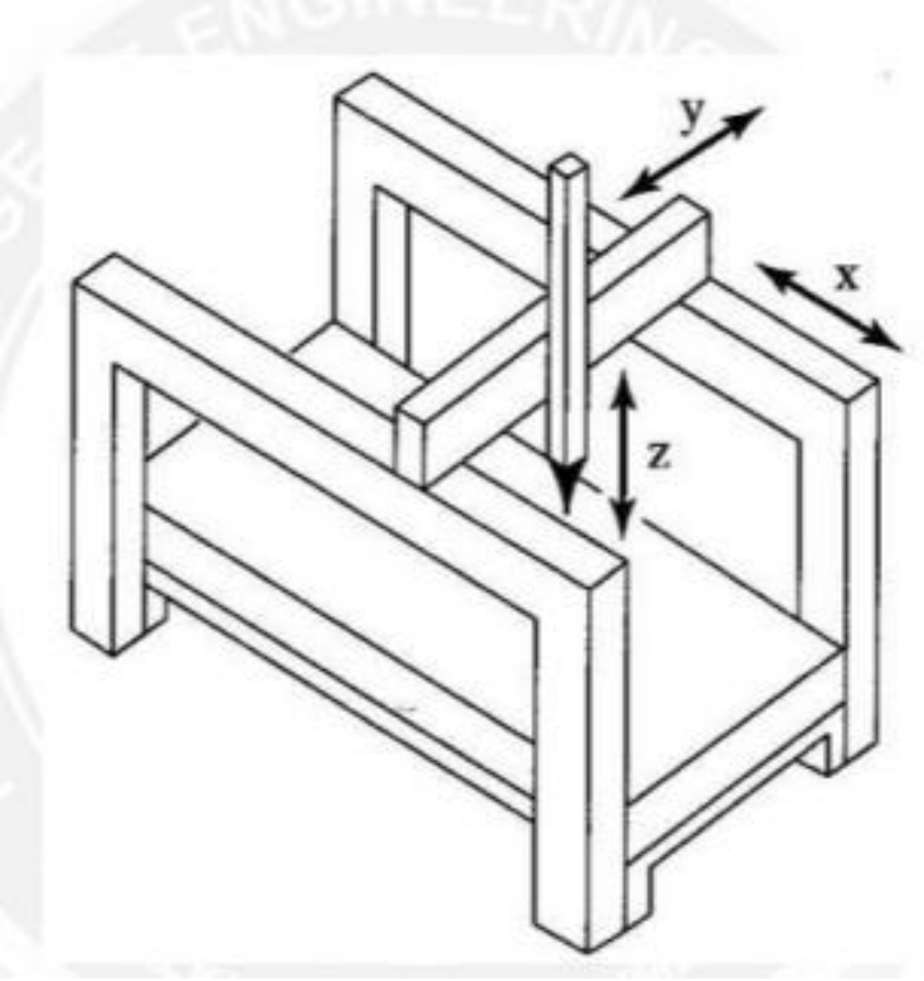
- In this type of configuration, the probe is carried by the horizontal axis.
- The probe assembly can also move up and down along a vertical axis.
- It can be used for gauging larger workpieces since it has a large work volume.
- It is often referred to as a layout.



Horizontal arm type CMM

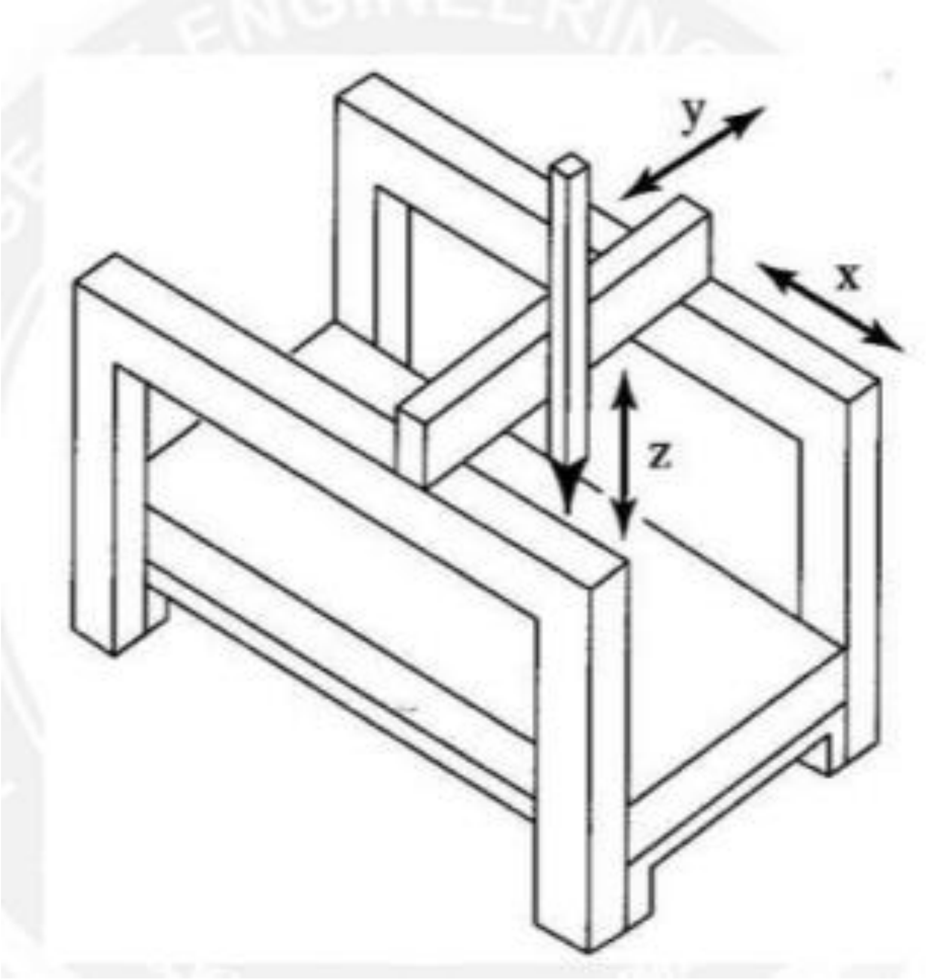
e) Gantry type CMM

- In this configuration, the support of the workpiece is independent of the X- and Y-axis.
- Both these axes are overhead and supported by four vertical columns from the floor.
- The operator can walk along with the probe, which is desirable for large workpieces.



Gantry type CMM

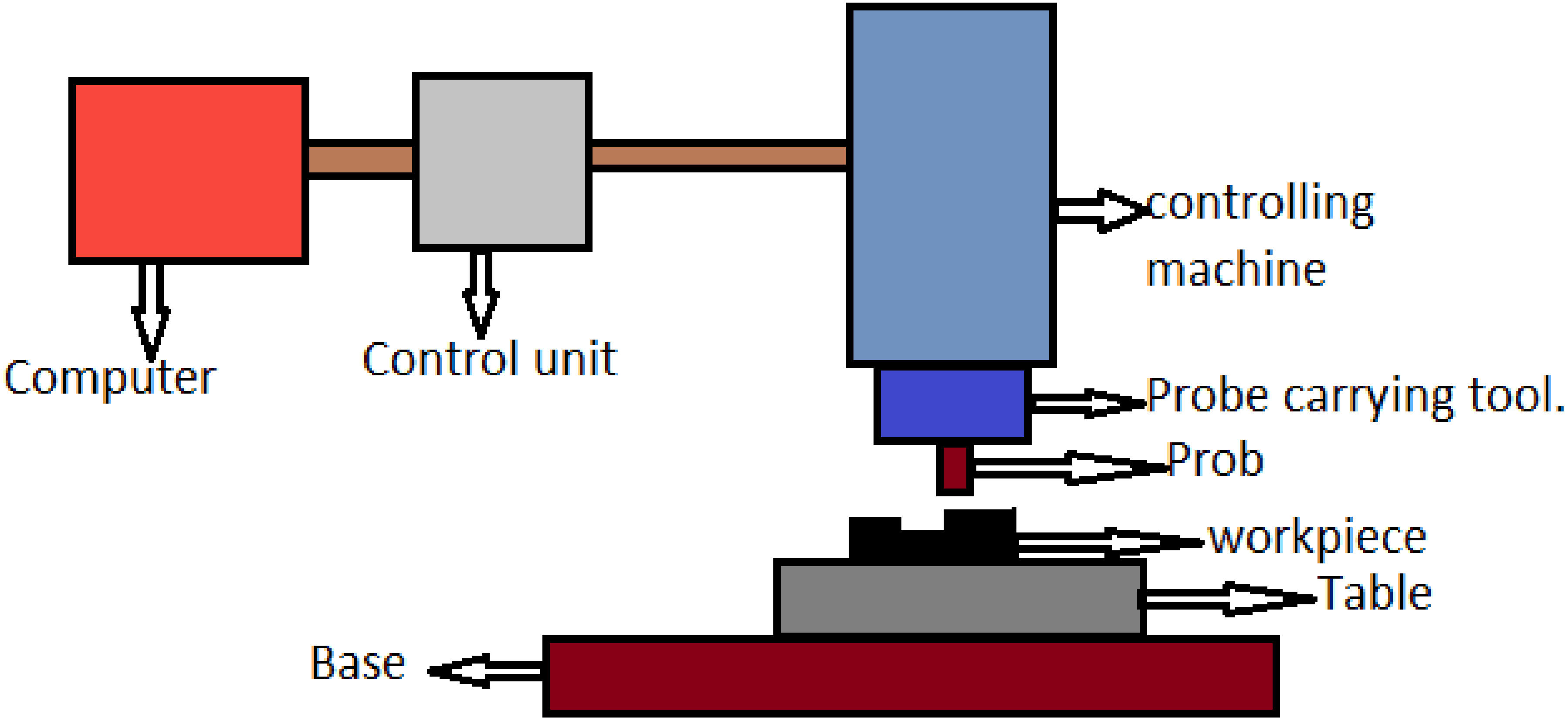
- Some of the machines may have rotary tables or probe spindles, which will enhance the versatility of the machines.
- The work space that is bounded by the limits of travel in all the axes is known as the work envelop.
- Laser interferometers are provided for each of the axes if a very precise measurement is necessary



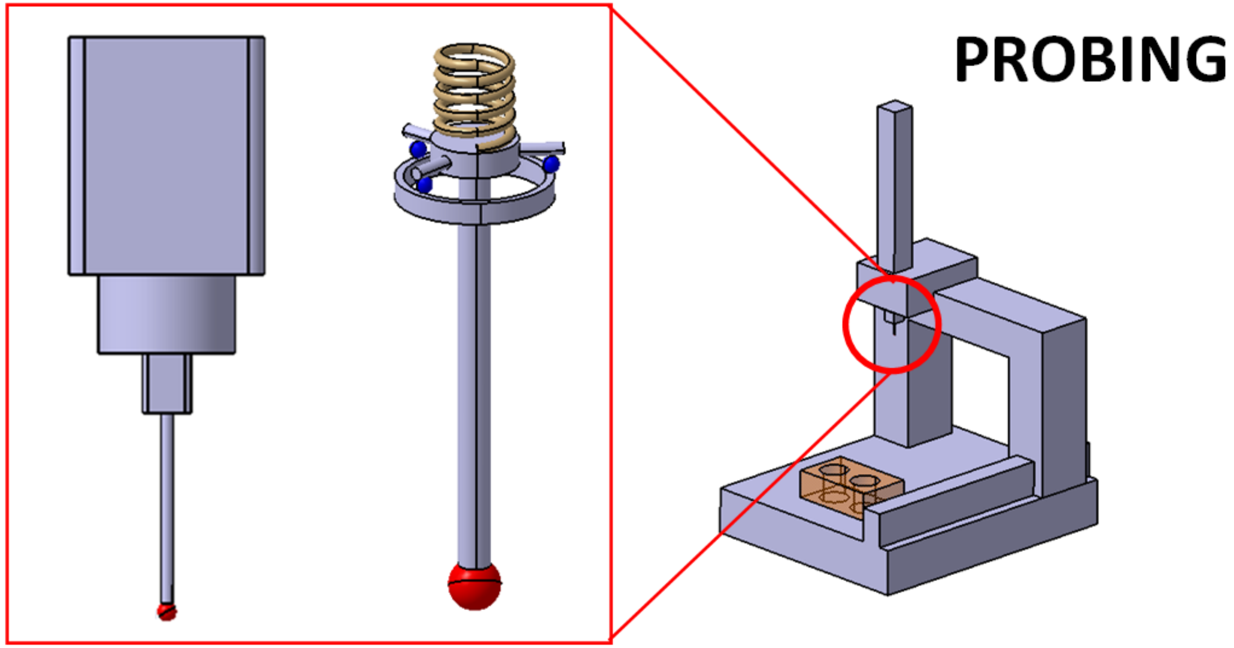
Gantry type CMM

CMM Machine Components

1) Probe
2) Granite Table
3) Fixtures
4) Air Compressors and Dryers
5) Software
6) Computer system
7) Control unit



1)Probe



- Probes are the most popular and important component of a traditional CMM machine responsible for measuring action. Other CMM machines use optical light, cameras, lasers, etc.
- Due to their nature, the probes’ tip comes from a rigid and stable material. It must also be temperature resistant such that the size won’t change when there is temperature alteration. Common materials used are ruby and zirconia. The tip can also be spherical or needle-like.

2) Granite Table

A granite table is an important component of the CMM machine because it is very stable. It is also not affected by temperature, and when compared to other materials, the rate of wear and tear is lower. Granite is ideal for highly accurate measurement because its shape stays the same over time.

3)Fixtures

Fixtures are also very important tools used as agents of stability and support in most manufacturing operations. They are components of the CMM machine and functions in fixing the parts into place.

Fixing the part is required since a moving part can lead to errors in measurement. Other fixing tools available for use are the fixture plates, clamps, and magnets.

4) Air Compressors and Dryers

Air compressors and dryers are common components of CMM machines such as the standard bridge or gantry-type CMMs.

5) Software:

There are roughly two types of software for coordinate measuring machines.

The first is software for our own measuring machines that we independently developed for each measuring machine maker.

The second is software developed by a third-party that can be used by measuring instruments from multiple manufacturers.

6) Computer system:

A computer is used to store the programs in it and send it to the control unit, we can change the program directly in the computer if required.

7) Control unit:

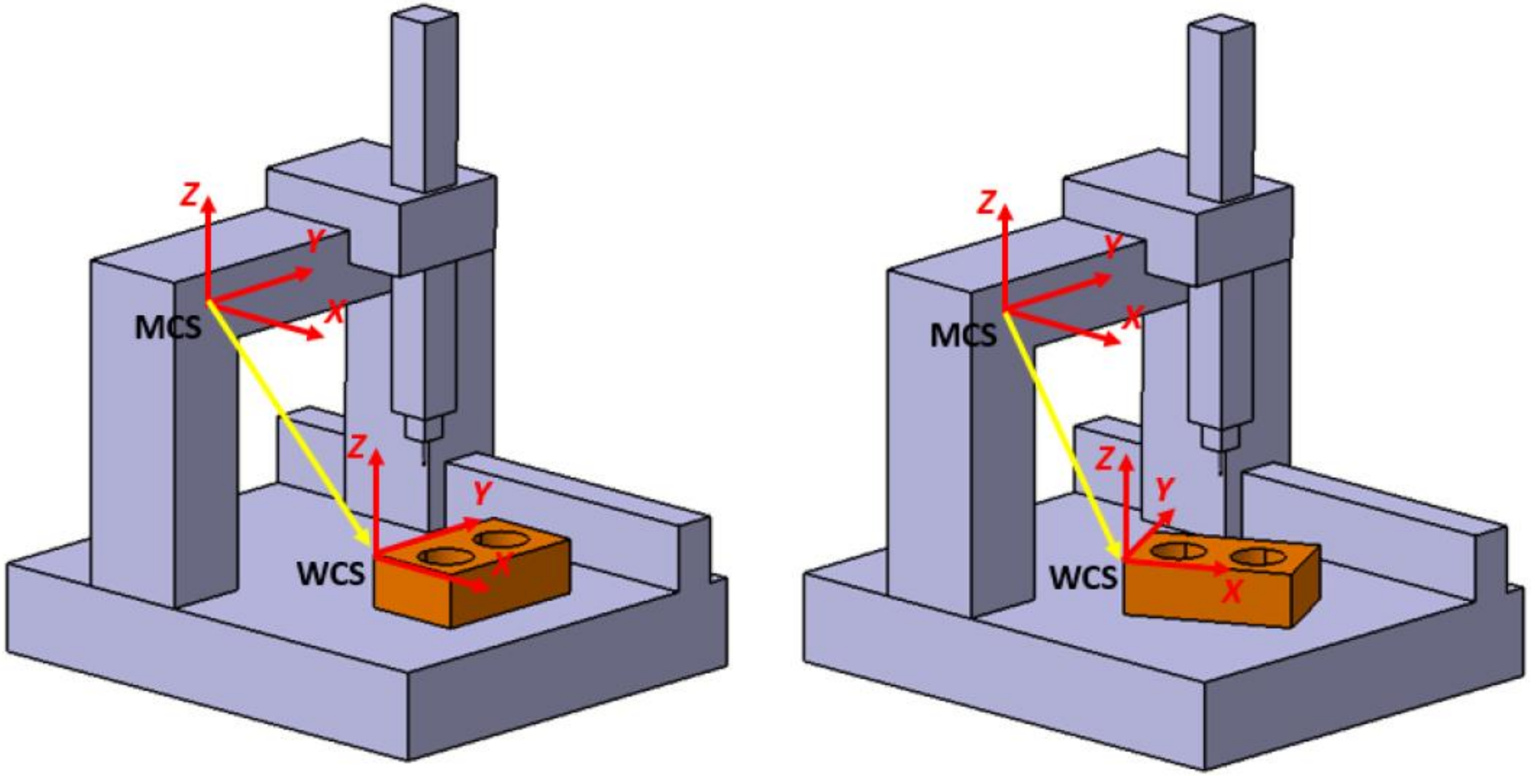
This controls the machine according to the programmes designed.

Modes of Operation

Modes of operation are quite varied in terms of type of construction and degree of automation. Accordingly, CMMs can be classified into the following three types based on their modes of operation:

1. Manual
2. Semi-automated
3. Computer controlled

The manual CMM has a free-floating probe that the operator moves along the machine’s three axes to establish contact with part features.



- The differences in the contact positions are the measurements.
- A semi-automatic machine is provided with an electronic digital display for measurement
- Many functions such as setting the datum, change of sign, and conversion of dimensions from one unit to another are done electronically.
- A computer-controlled CMM has an on-board computer, which increases versatility, convenience, and reliability.

Computer assistance is utilized for three major functions.

Firstly, a programming software directs the probe to the data collection points. **Secondly,** measurement commands enable comparison of the distance traversed to the standard built into the machine for that axis.

Thirdly, computational capability enables processing of the data and generation of the required results.

a) CMM Operation and Programming

Positioning the probe relative to the part can be accomplished in several ways, ranging from manual operation to direct computer control.

Computer-controlled CMMs operate much like CNC machine tools, and these machines must be programmed.

CMM Operation

This section explains the operation or the measurement process using a CMM. Most modern CMMs invariably employ computer control.

A computer offers a high degree of versatility, convenience, and reliability.

A modern CMM is very similar in operation to a computer numerical control (CNC) machine, because both control and measurement cycles are under the control of the computer.

A user-friendly software provides the required functional features. The software comprises the following three components:

1. Move commands, which direct the probe to the data collection points

2. Measurement commands, which result in the comparison of the distance traversed to the standard built into the machine for that axis

3.Formatting commands, which translate the data into the form desired for display or printout.

Thank you!

Revision classes :

1)Topics given in class

2) Exam need to written or assignment

3)Submitted candidate eligible for attendance

4)White Notes Needed during class