Axis Identification:

In order for the part programmer to plan the sequence of positions and movements of the cutting tool relative to the workpiece, it is necessary to establish a standard axis system by which the relative positions can be specified.

Certain rules are followed for designating these axes, for applying it to different types of NC machines having relative motions of tool and work piece.

X-axis:

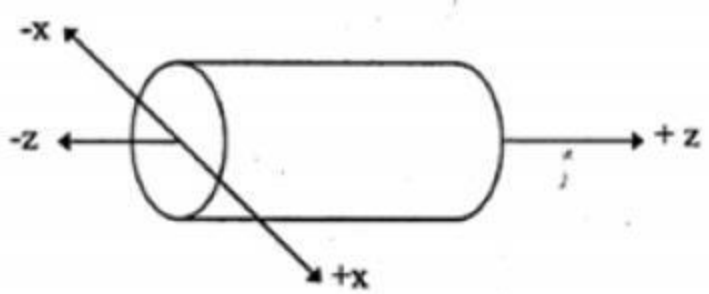
- it should be horizontal
- it is generally the longest axis of movement of wpc or tool.
- it should be perpendicular to Z-axis.
- it is always parallel to X and Z axes.

Y-axis:

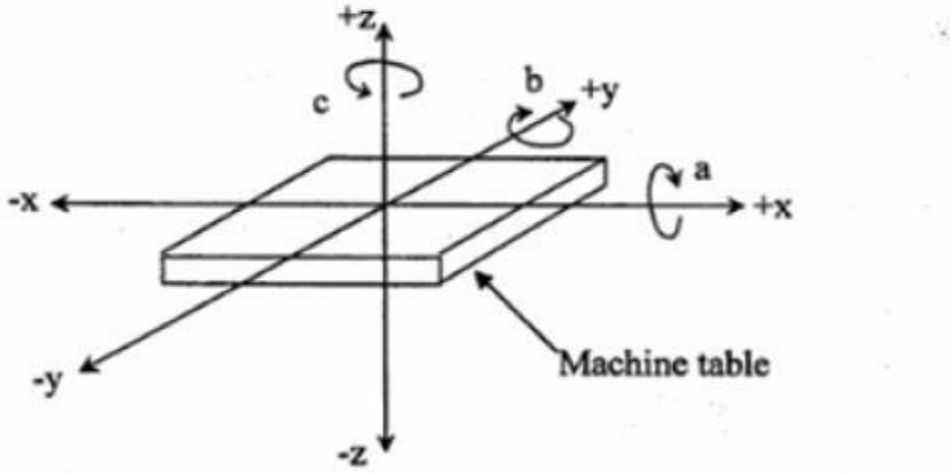
- it should be perpendicular to X and Z-axes.

Z-axis:

- it is always parallel to spindle.
- it should be perpendicular to X and Y-axes.



NC machine tool axis system for turning



NC machine tool axis system for milling and drilling

The basis of axis identification is the 3-dimensional Cartesian co-ordinate system and the three axis of movement are identified as X, Y and Z axis.

Machines with Rotating tools:

a) with Vertical Spindle

The various m/cs that come under this types are: Drilling m/c, Vertical milling, Jig boring and drafting m/c etc.

b) with Horizontal Spindle Machine

The Horizontal boring m/c, Horizontal spindle m/cing center etc.

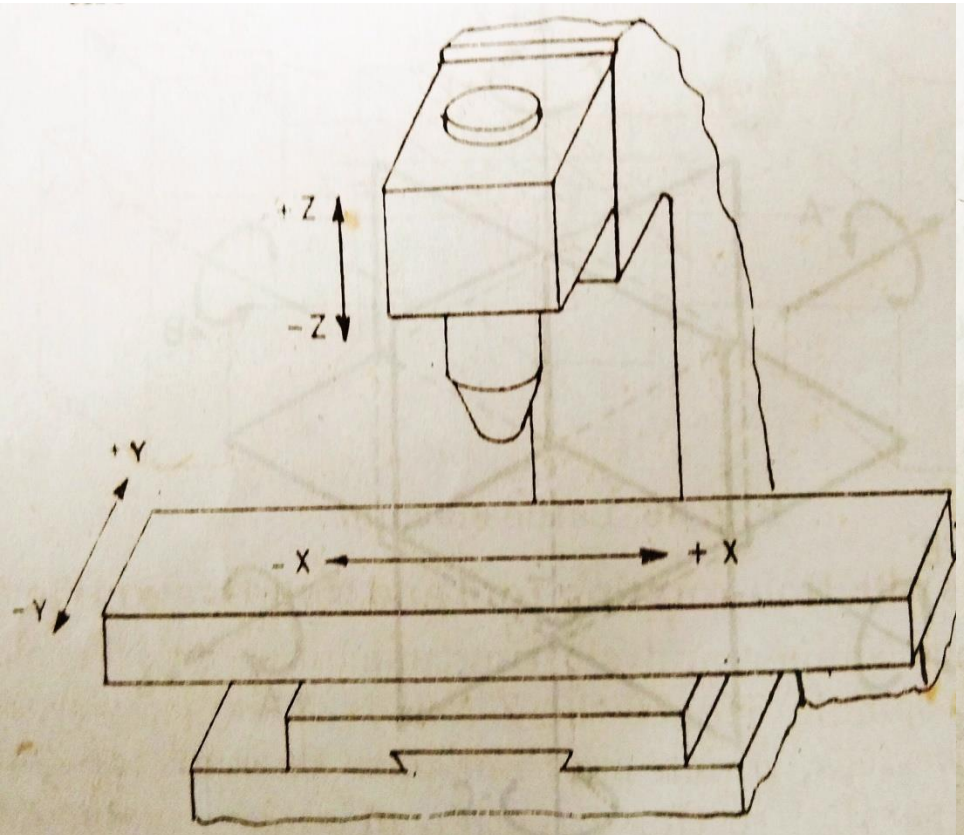


Fig. 34. Vertical milling machine.

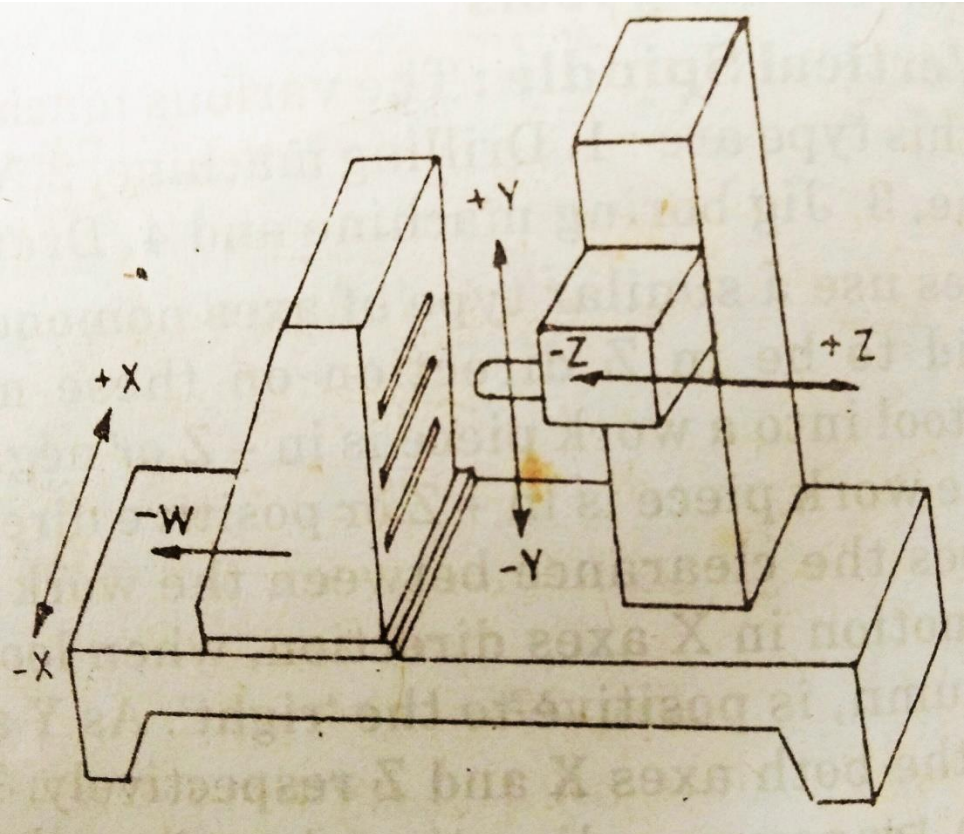


Fig. 35. Horizontal Boring Machine

Machines with Rotating work-piece: most lathes are horizontal spindle machines the z axis, for such a lathe, will be horizontal. Z is the axis of rotation of the work-piece. There is no Y axis movement in lathes.

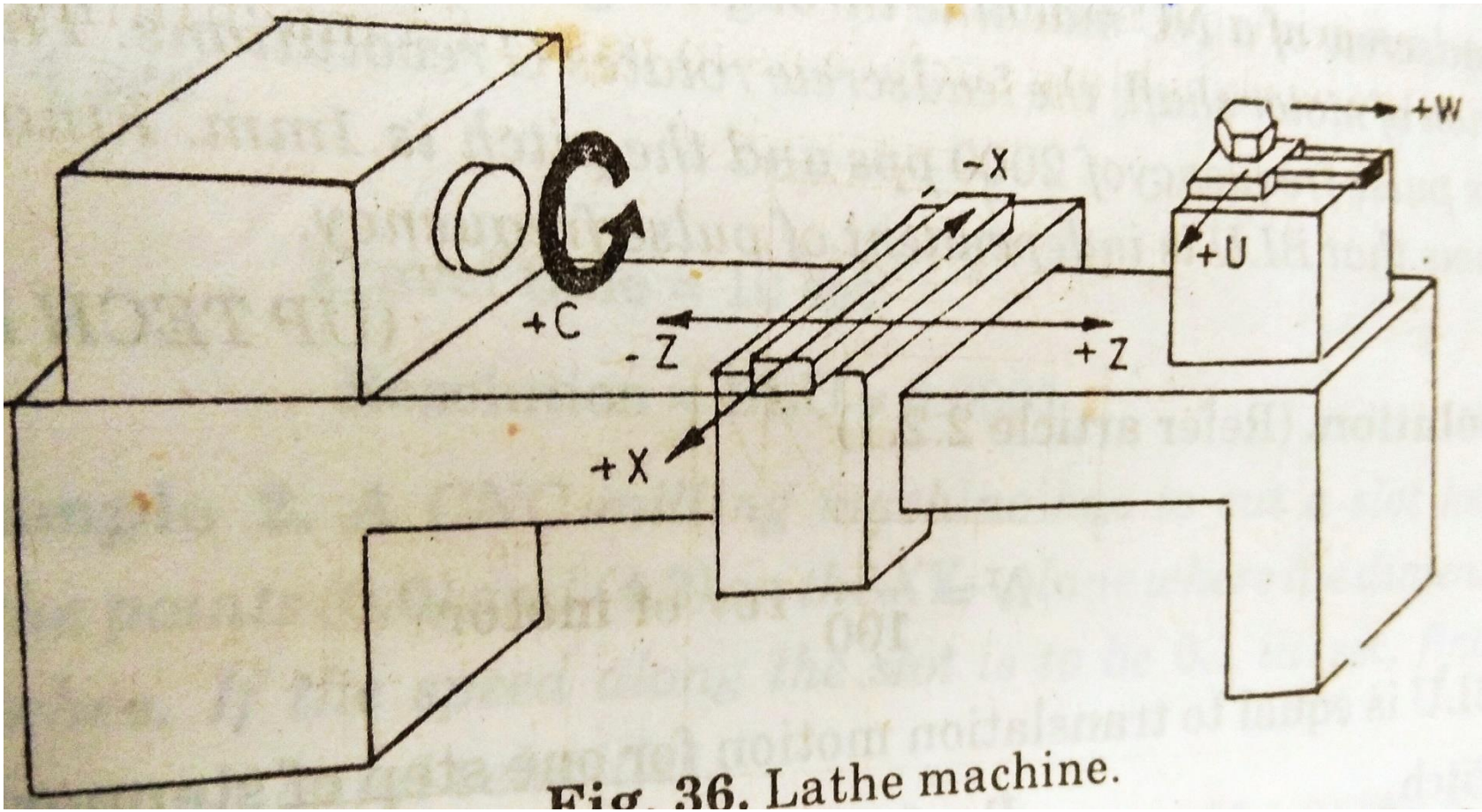


Fig. 36. Lathe machine.

Machines with Non -rotating tool and Non rotating work-piece: The planer, shaper and slotting machines are the machines which have no spindle. Hence the Z axis is taken perpendicular to work holding devices, The X axis is parallel to the direction of major movement i.e. is cutting. The Y axis is calculated as previous cases.

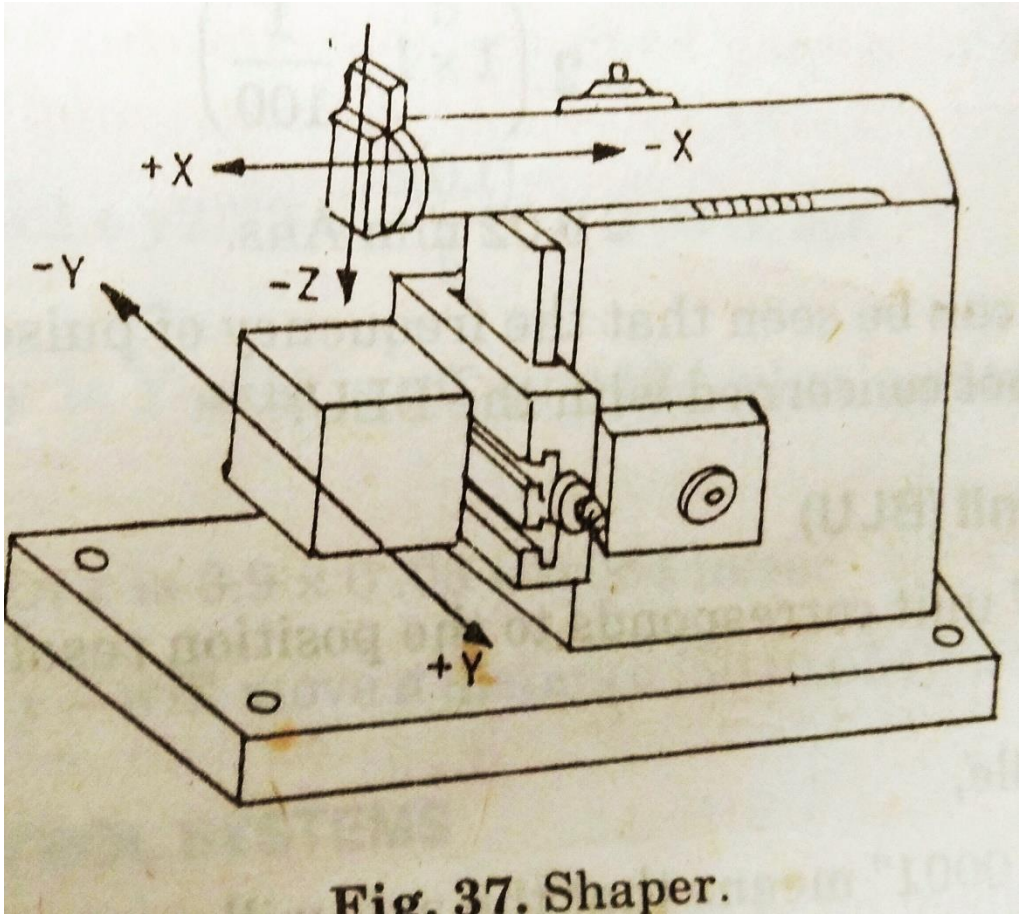


Fig. 37. Shaper.

CONSTRUCTIONAL DETAILS OF CNC MACHINES

The basic design of a conventional machine tool is not suitable for CNC machines. Many design changes are required for CNC machines as compared to the conventional machines, due to a number of additional requirements which CNC machines are expected to meet.

There is a need for special consideration to be given to the design of CNC machine tools in the following areas:

(1) Machine structure
(2) Slideways
(3) Spindle mounting
(4) Drive units
(5) Elements of transmission and positioning slides
(6) Location of transducers
(7) Tool and work holding devices
(8) Swarf removal
(9) Safety

(1) Machine structure

The design and construction of CNC machine should be such that it meets the following main objectives:

(i) High precision and repeatability, (ii) Reliability and (iii) Efficiency

To meet the requirements of high precision, repeatability and high efficiency, the numerically controlled machine tools should have a structure that is correctly designed to withstand normal weight distribution.

The machine structure should not bend due to the heavy cutting forces.

The design of machine tool structures should be such that the thermal distortion is minimum.

The machine tool should be provided with an efficient and foolproof lubrication and cooling system. Also the machine structure design should be such that removal of swarf is easy and the chips, etc. do not fall on the sideways.

(2) Slide and Slide ways :

In the conventional machine tools, there is a direct metal to metal contact between the slide way and the moving slides. The demand on slide ways is much more in CNC machines because of rapid movements and higher machine utilization. These slide ways should be rigid, accurately designed and durable. The design of slide way in a CNC machine tools should:

(a) Reduce friction
(b) Reduce Wear
(c) Satisfy the requirements of movement of the slides
(d) Improve smoothness of the drive

To meet these requirements in CNC machine tool slide ways, the techniques used include *hydrostatic slideways–oil lubricated and Air Bearing, Anti–friction type slide ways– linear bearings with balls, rollers, wear resistant slide ways– anti –stick liners, needles and surface coatings.*

(3) Spindle :At the high cutting speeds and high material removal rates, the spindle carrying the work piece or the tool are subject to deflection and thrust forces. To ensure increased stability and minimize torsional strain, the machine spindle is designed to be short and stiff and the final drive to the spindle is located as near to the front bearing as possible. The rotational accuracy of the spindle is dependent on the quality and design of bearings used. The ball or roller bearings are suitable for high speeds and high loads because of low friction, lower wear rate and lesser liability to incorrect adjustment and ease of replacement when necessary. For efficient service and accuracy the bearings should be of high quality. The vibrations and noise in the spindle can be reduced by using toothed belts and accurate and balanced gears. Adequate supply of lubricants should be ensured to the spindle bearings.