Lathe

Lathe is considered as one of the oldest machine tools and is widely used in industries

The primary task of a machine is to generate cylindrical work-pieces.

The process of machining a work piece to the required shape and size by moving the cutting tool either parallel or perpendicular to the axis of rotation of the work piece is known as turning.

Lathe parts

1.2.1 Bed

Bed is mounted on the legs of the lathe which are bolted to the floor. It forms the base of the machine.

1.2.2 Headstock

The head stock is permanently mounted

The headstock houses the hollow spindle and the mechanism for driving the spindle at multiple speeds

Headstock driving arrangements

1. Stepped cone pulley drive
2. Back gear drive
3. All gear drive

1.2.3 Spindle

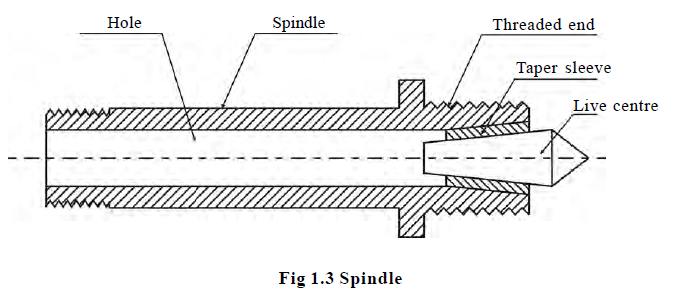
The spindle rotates on two bearings housed in the headstock

The spindle “shaft” is hollow to allow stock to pass through

The front end of the spindle is threaded on which the chuck, faceplate, driving plate and catch plate are screwed.

The front end of the spindle is tapered which receives the live centre that supports the work

On the other end of the spindle, a gear known as spindle gear is fitted.



Bearings

Bearings are machine elements that allow components to move with respect to each other.

There are two types of bearings, contact and non-contact,

Contact type have mechanical contact between elements, and they include sliding, rolling and flexural bearings.

Mechanical contact means stiffness normal to motion can be very high, but wear and fatigue can limit their life.

Non-contact bearings include externally pressurised and hydrodynamic fluid-film and magnetic bearings. The lack of contact means that the static friction can be eliminated, although viscous drag occurs when fluids are present.

Contact bearings : sliding contact

Bearings allow for relative motion between two surfaces

Lubrication can range from non on perfectly clean surfaces, which can results in a high coefficient of friction, to forced lubrication.

The latter is used in higher speed or with higher precision.

In general sliding contact bearings do the best when the material in contact are dissimilar.

Contact bearings : sliding contact

\*sliding contact bearings are commonly used for low modest speed application

\*boundry lubrication reduces wear and friction

\*Polmers ,brass and ceramics are commonly used

\*hard materials slide on soft materials

Sliding contact : Rotary motion

A sliding contact radial bearing element used to support a shaft is called a bushing ,and they sometimes have integral flanges to support the axial loads.

Sliding contact bearings have coefficients of friction on the order of 0.05-0.1 as compared to rolling elements bearings with up to two orders of magnitude lower coefficient of friction.

Sliding contact bearings have more friction and less accurate than rolling elements bearings.

Heat generated in a bearing must be dissipated by conduction to other parts of the machine.

*Sliding contact: rotary motion*

\*modular sliding contact bearings are found in many catalogs

\*molded polymer and sintered bronze bearings can be impregnated with lubricants

\*flat washers support thrust loads

Sliding contact: linear motion

Sliding contact linear bearing systems are comprised of a moving structure, often referred to as the carriage or slide and the bearing elements and the surface on which they slide are called rails, ways or guides.

It is more complex to make the inner surface of the carriage match the outer surface of the rails than it is to bore a hole in a structure for a rotary bearing

If a snug fit is required for accurate motion, an adjustable plate, a gib can be used to take out clearances.

Sliding contact linear bearings are essentially just sliding bearings with a very large radius of curvature.

Portion of the linear bearings will be uncovered during some portion of motion and the exposed region is more likely to pick up dirt which then leads to wear of linear bearings.

For this reason it is particularly important to not use too much lubrication and to use wipers of bellows cover to help keep the system clean.

Machine\_tool\_spindle\_baering\_selection\_and\_mounting\_guide

1. introduction

* Most cases the motor defines the maximum power and torque specs of the spindle,unless there is a transmission system without 1:1 ratio.
* Calculations of the cutting forces and required motor power for the spindle will help to select the integral motor with correct specifications
* The demanded machine capability from the lathe and spindle should also correlate and compete with the competitor machines in the market. Thus the sample case parameters will be estimated and improvised through a benchmarking activity that investigates the cutting performances and sample cases tested on similar spindles.

1. Frame of reference

Functions of the spindle

* Rotate cutting tool or workpiece with a certain precision
* Provide the necessary power and speed to the tool or workpiece for cutting operation
* Resisting against the cutting forces generated during cutting operation

Basic spindle structure

* Majority of machine tools spindles sold are internal driven type
* Their performance and efficiency make them preferred over external driven spindles.
* Spindles with bearing inner diameter bigger than 150mm are usually external driven, due to cost and dimensional reasons.



Major components of the spindle

1. Spindle housing

The primary function of the spindle housing is to locate the spindle bearings and support them.it must be stiff enough ,as all the forces generated on the spindle during machining are transferred to machine body through the housing

1. Spindle bearings

Spindle usually consist of at least two sets of bearing sets to hold the spindle and carry the necessary loads ,one in the front and one at the back.

The bearings act as transition elements between the spindle and its housing which acts as machine operation itself.

Bearing have the greatest influence on the life of a spindle due to the heat and stresses generated due to friction and loading during cutting operation. The internal motor is assembled onto the spindle shaft and positioned between the two bearing sets

1. Spindle motor

Transmission of power between the motor and spindle can be achieved with different methods.

*External motor*

The spindle is run by external drive motor and the motor is completely independent from the spindle system. The transmission between the motor and spindle is attained by either a direct coupling system or belt or gear system.

Spindles with external drive motors have been widely used in the past due to their reasonable cost and flexible structure which allows different power/torque outputs for different manufacturing processes.

However, low permissible speeds, extra loads on spindle bearing due to gear/belt/chain systems and low efficiency create limitations for this type of arrangement.

*Internal (built-in) motor*

Technological advancement has led to the development of internal motors specific for machine tool spindles for the last two decades. Internal motors are assembled into the spindle housing on the spindle shaft.

Internal motors are widely used because result in compact designs. Also no load on the bearings and no physical contact with the spindle as an integral part of the spindle allow higher rotational speeds to be achieved.

*Asynchronous motors*

Are produced mostly as squirrel cage type and consist of a stator and rotor made of metal laminations. The magnetic field through the stator induces a magnetic flux in the rotor and enables rotation of the shaft. However by the nature of the induction process, the speed of the rotor is different than the rotating magnetic field, which is why these motors are called asynchronous.

*Synchronous motors*

Have their rotor made of permanent magnets; therefore synchronous motors do not experience the phase difference in its rotation. These types of motors provide less heat generation and thermal drift in the spindle due to less magnetic friction, higher efficiency and smaller dimensions with similar power/torque characteristics compared to the asynchronous motors. However the relative higher cost of synchronous motors than the asynchronous ones made them less common for machine tool until the last decade. Currently the price difference is significantly lower that the advantage of synchronous motors makes them widely preferred.

1. Spindle shaft

A spindle shaft, similar to the housing, holds the components together and locates the spindle bearings.

Spindle shaft is the main rotating component of the system and one of the first components to withstand the loads during cutting, its stiffness and robustness greatly affects both static and dynamic behaviour of the spindle system, and ultimately the performance of the machine.

* 1. ***spindle design and optimization***

Spindle predefined requirements and constraints

* Desired spindle power
* maximum spindle loads
* maximum spindle speed
* spindle type
* tooling style
* dimensional constraints
* availability of the components
* cost

1. *Analysis and preliminary design*



Motor selection