

Computer Aided Manufacturing



**Dr.S.RAMABALAN,
PRINCIPAL,
E.G.S. PILLAY ENGINEERING COLLEGE,
NAGAPATTINAM.**



Topic :

Linear motion and Re-circulating ball bearings

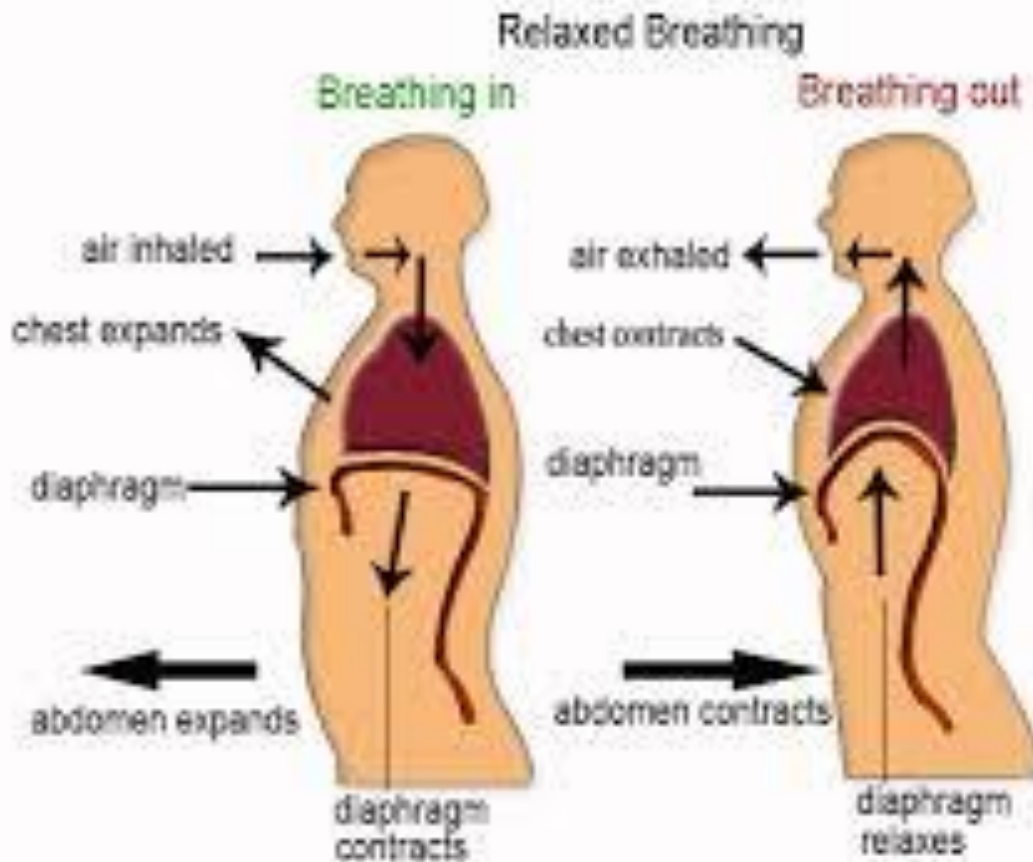
Prerequisites Knowledge

- Mechanisms
- Dynamics

Relaxed Breathing



Belly breathing



Recap and review of previous class

Let's
Recap



5 mins

Evocation



General Objective (GO)

- Students will be able to understand the two types of anti-frictional bearings and evaluate the appropriate bearing for CNC machines.

Specific Objectives

- *Students will be able to*
 - List the four types of guide ways in CNC machine. (R / F) (E)
 - Explain the recirculating ball bearings in CNC machine. (U / C) (E)
 - Select the suitable linear ball / roller bearing for 5 axis CNC machines. (Ap / C) (E)
 - Determine the suitable type of bearing for table movement of CNC machines. (Ev / C) (E)

TYPES OF SLIDE WAYS OR GUIDE WAYS

1. Friction slide ways
2. Antifriction slide ways
3. Hydrostatic slide ways
4. Aerostatic slide ways

Anti-friction Guide ways - TYPES

1. Recirculating Ball Bushings
2. Recirculating ball bearing/screws
3. Recirculating linear bearing with Balls and Rollers
(Linear Motion Bearings – LM Bearings)

2. ANTI-FRICTION GUIDEWAYS

Antifriction linear motion guideways are used on CNC machine tools to:

- (a) Reduce the amount of wear
- (b) Improve the smoothness of the movement
- (c) Reduce friction
- (d) Reduce heat generation

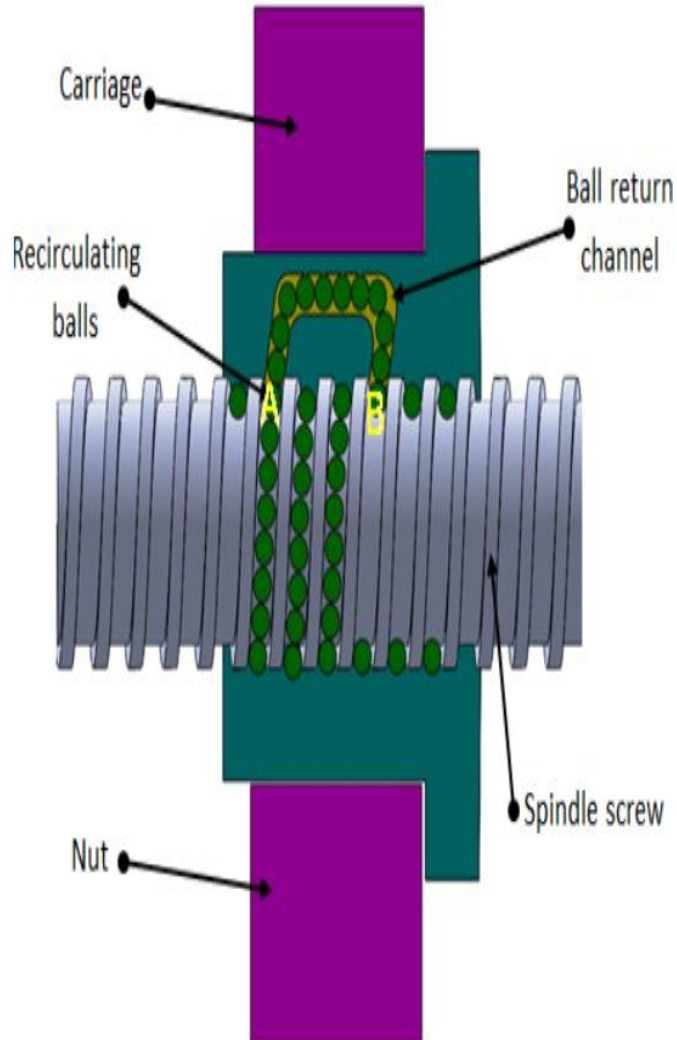
Antifriction guide ways are used to over-come the relatively high coefficient of friction in **metal-to-metal contacts and the resulting limitations addressed in the above list**. They use rolling elements in between the moving and the stationary elements of the Machine.

They provide the following **advantages** when compared with friction guides.

- (a) Low frictional resistance
- (b) No stick-slip
- (c) Ease of assembly
- (d) Commercially available in ready-to-fit condition
- (e) High load carrying capacity
- (f) Heavier preloading possibility
- (g) High traverse speeds

The main **disadvantage** of these guide ways as compared to friction guide ways is their **lower damping capacity**.

RECIRCULATING BALL BEARINGS



- The rotary motion from the motor have to be converted into the linear motion to move the various axes of the machine tool.
- In conventional machines lead screw and nut (or) the rack and pinion systems are used for this purpose.
- But in case of CNC machines, the recirculating ball screw-nut system is used to convert the rotary motion into linear motion.
- It is similar to replacement of simple journal bearing by ball bearings.
- In recirculating ball screws, the nut is replaced by a series of balls. These balls circulate in the channel in the form of threads.
- So a highly efficient rolling motion of balls in the space between the screw shaft and nut is obtained.



Fig.1-11(a) Ball Screw in a CNC machine

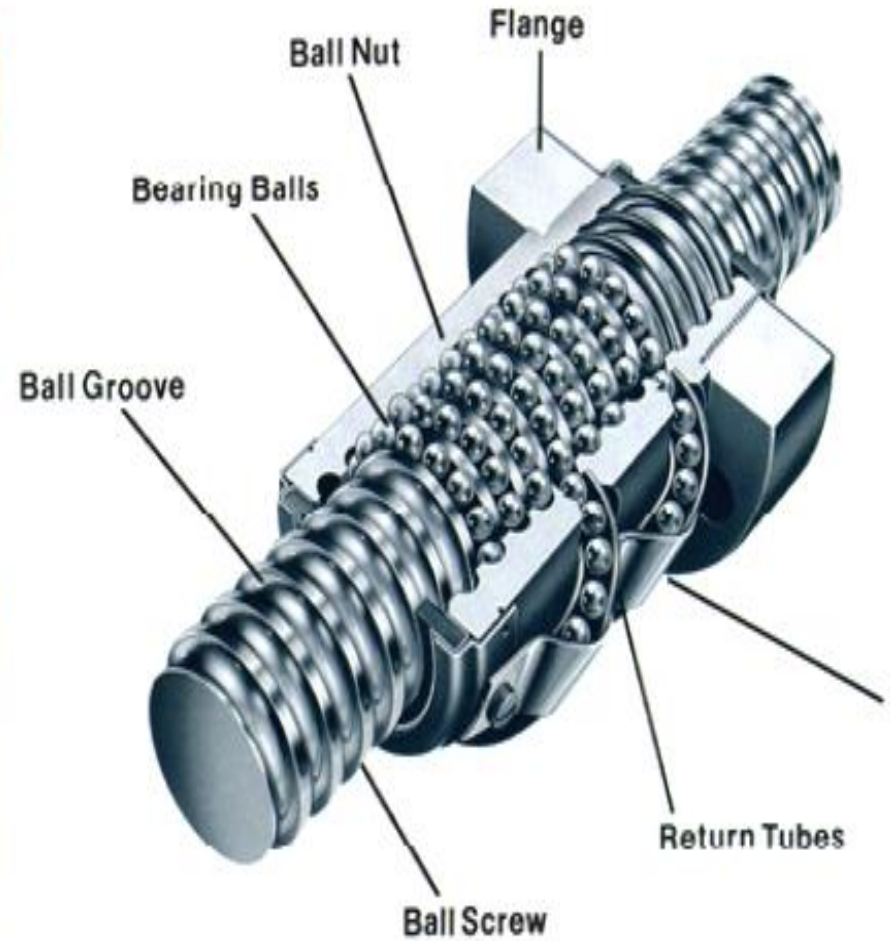
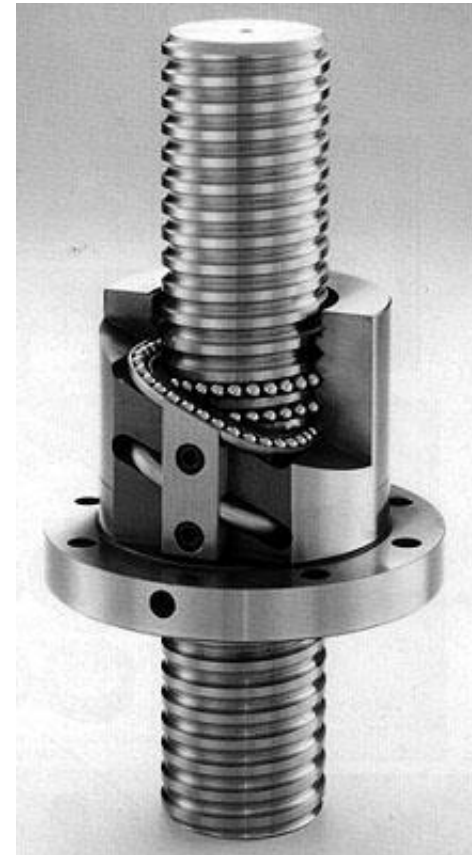


Fig.1-11(b) Ball screw structure

COMPONENTS OF RECIRCULATING BALL SCREWS

- Ball screw
- Ball nut (anti-backlash)
- Ways
- Linear bearings



Features

- Accuracy of CNC machines depends on their rigid construction, care in manufacturing, and the use of ball screws to almost eliminate slop in the screws used to move portions of the machine.



Photo courtesy Thompson Ball Screw.



Graphic courtesy BSA Co.

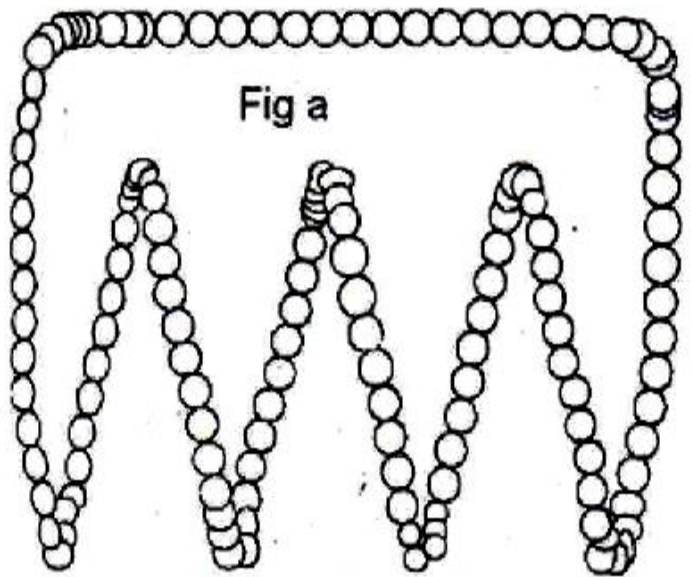


Fig a

Recirculation through an external tube

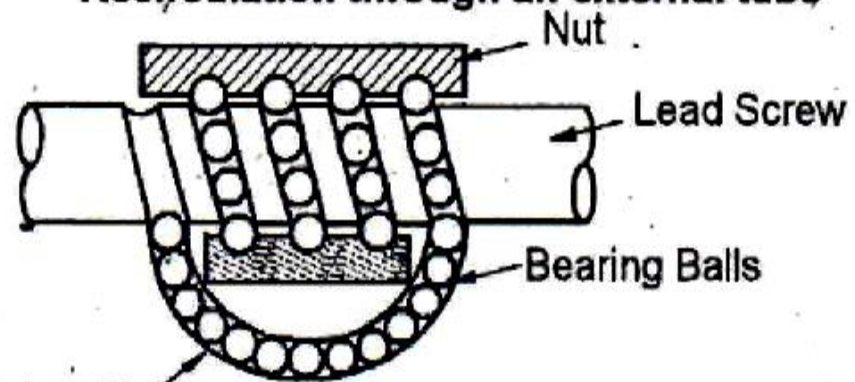


Fig a

Return Tubes

Nut

Lead Screw

Bearing Balls

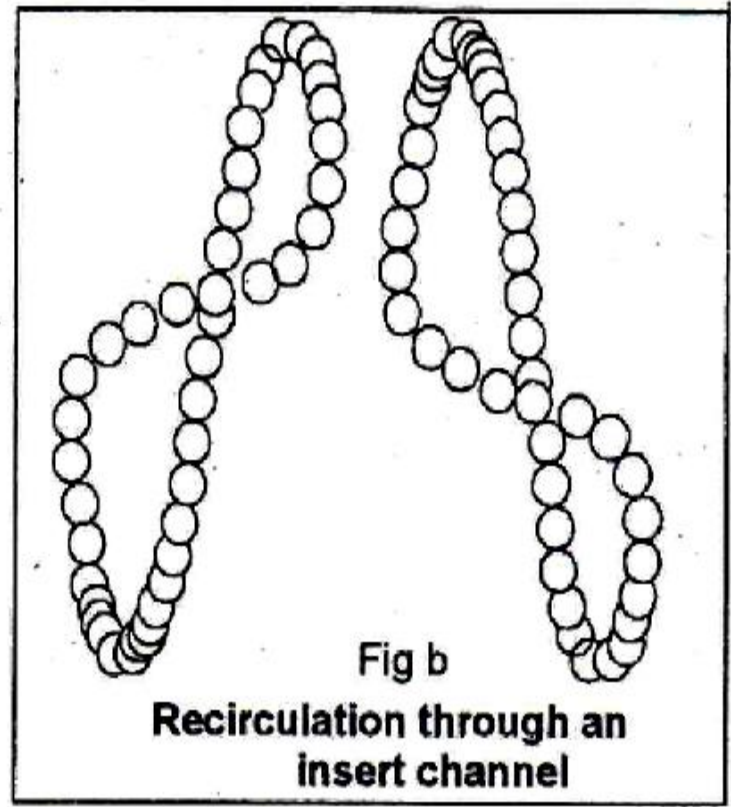
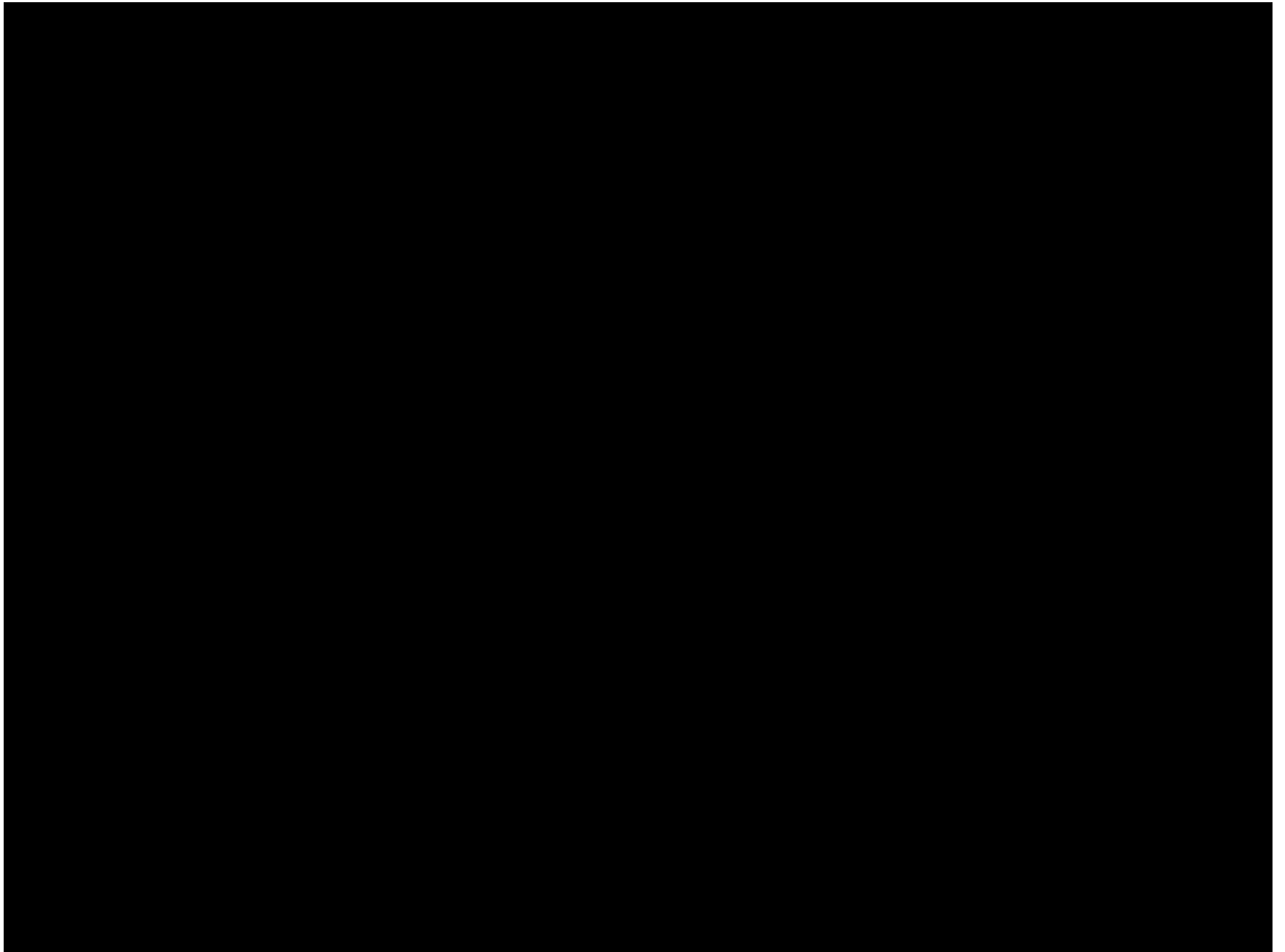


Fig b

Recirculation through an insert channel

Ball Screw Arrangement



Recirculating Ball Bushings

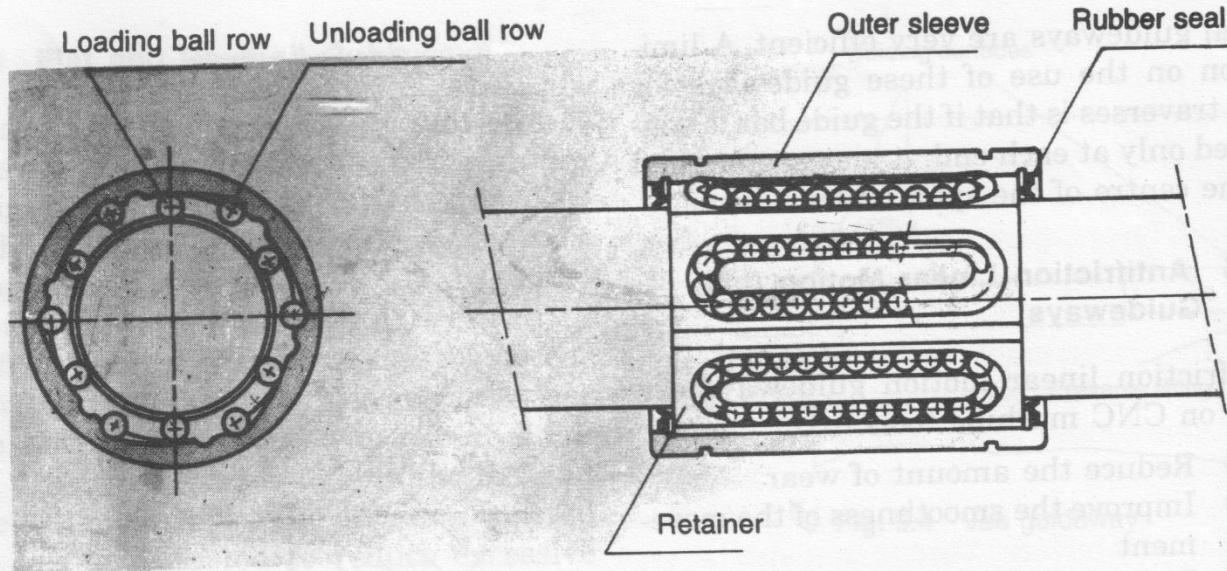


Fig. 5.8 Details of inner construction of ball bushing

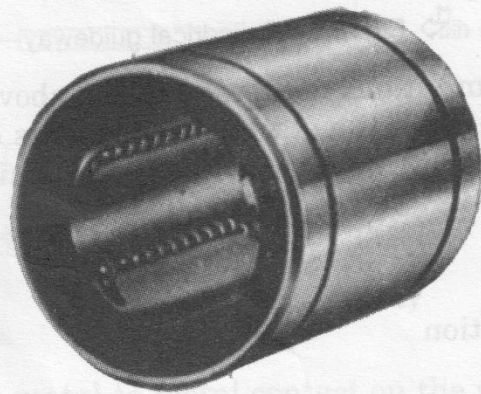


Fig. 5.9 Closed type ball bushing

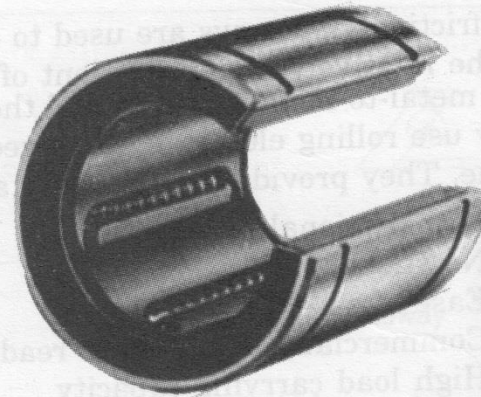
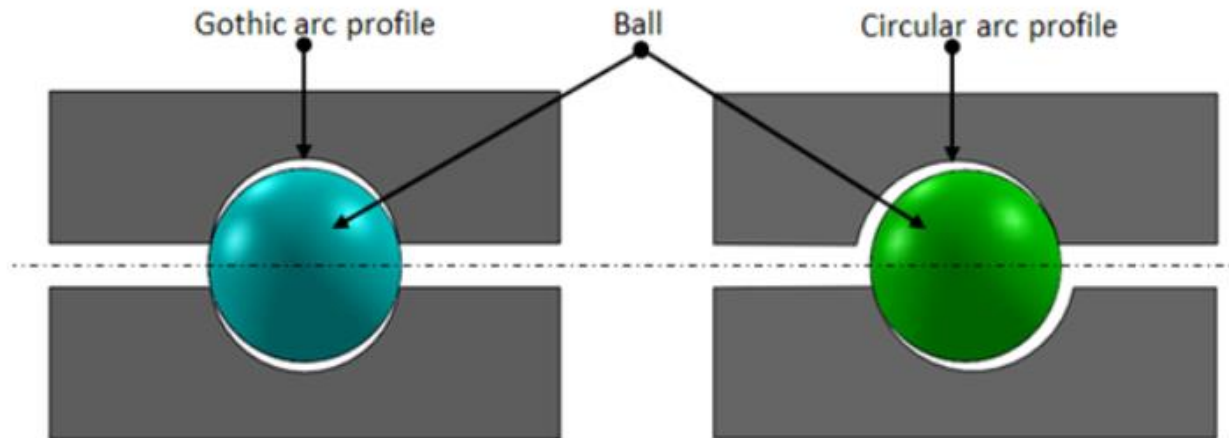


Fig. 5.10 Open type ball bushing

CHARACTERISTICS OF BALL SCREWS

- High mechanical efficiency
- Low in wear
- Thread Form



PRE – LOADING OF BALL SCREW

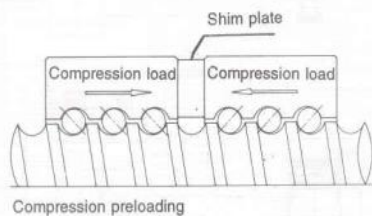
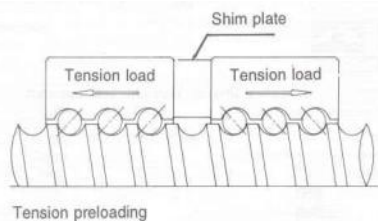


Fig. 5.28 Types of nut preloading

- One of the distinctive features of a ball screw is the ability to have increase rigidity by preloading.
- In order to increase the rigidity of a ball screw, "preloading" must be applied to reduce an axial clearance between a ball nut and the screw shaft.
- Precise positioning can be achieved by the application of preloading.
- However, it is of great importance to apply only the proper amount of preloading in order to prevent excessive heat-generation and premature termination of ball screw's expected life.

EFFECT`S OF PRELOAD

- Zero backlash: It eliminates axial play between a screw shaft and a ball nut.
- It minimizes elastic deformation caused by external force, thus the rigidity enhances.
- In case mounting errors, misalignment between the screw shaft and the nut may occur this further generates distortion forces.
- This could lead to the problems such as, Shortened service life Adverse effect on smooth operation Reduced positioning accuracy Generation of noise or vibration Breakage of screw shaft

ADVANTAGES OF RECIRCULATING BALL SCREWS

1. They have long life
2. Minimum wear in the screw. So more accuracy is obtained
3. Less frictional resistance.
4. Heavier loads can be carried and moved at faster speeds.
5. Less power is needed to drive the screw due to less frictional resistance.
- 6 The efficiency of the recirculating ball screw is of the order of 90%.

LINEAR BEARINGS WITH BALLS AND ROLLERS

- A number of machines use rollers to provide for a **rolling motion rather than a sliding motion**.
- The **rollers** are in contact with the **guide way machined on a casting of the machine**.
- These are very effective in providing **smooth and easy movement**, but still require an accurate form to be machined on castings.
- The **surfaces in contact** with the rollers have to be hardened and should have a smooth texture.
- To reduce the problem of machining, an accurate form on the bed of a machine, hardened steel rails with special guide forms may be fastened to the castings the machine.
- Special blocks, a pair along each guide rail, with recirculating balls can move rails.
- The balls provide the rolling motion and since the contact form on the rail is a mating form of the balls, there is a line contact between the balls and the rails, a pair along each guide rail.
- The coefficient of friction is reduced and there is no stick- slip in this arrangement.
- These guide way sets are precision elements

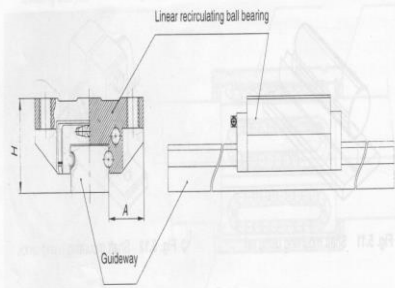


Fig. 5.16 Linear bearing with balls

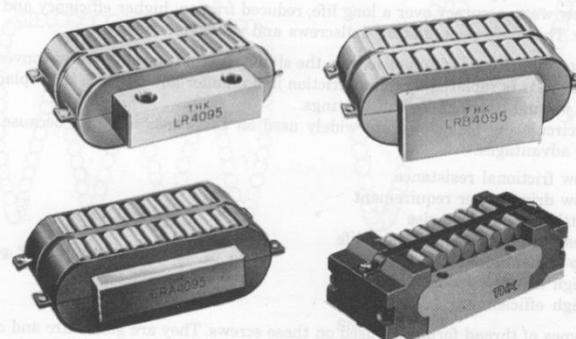


Fig. 5.23 Types of linear bearings with rollers

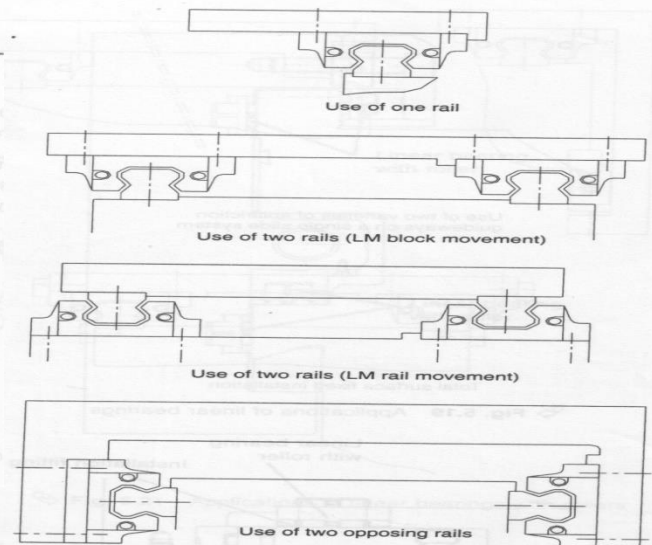
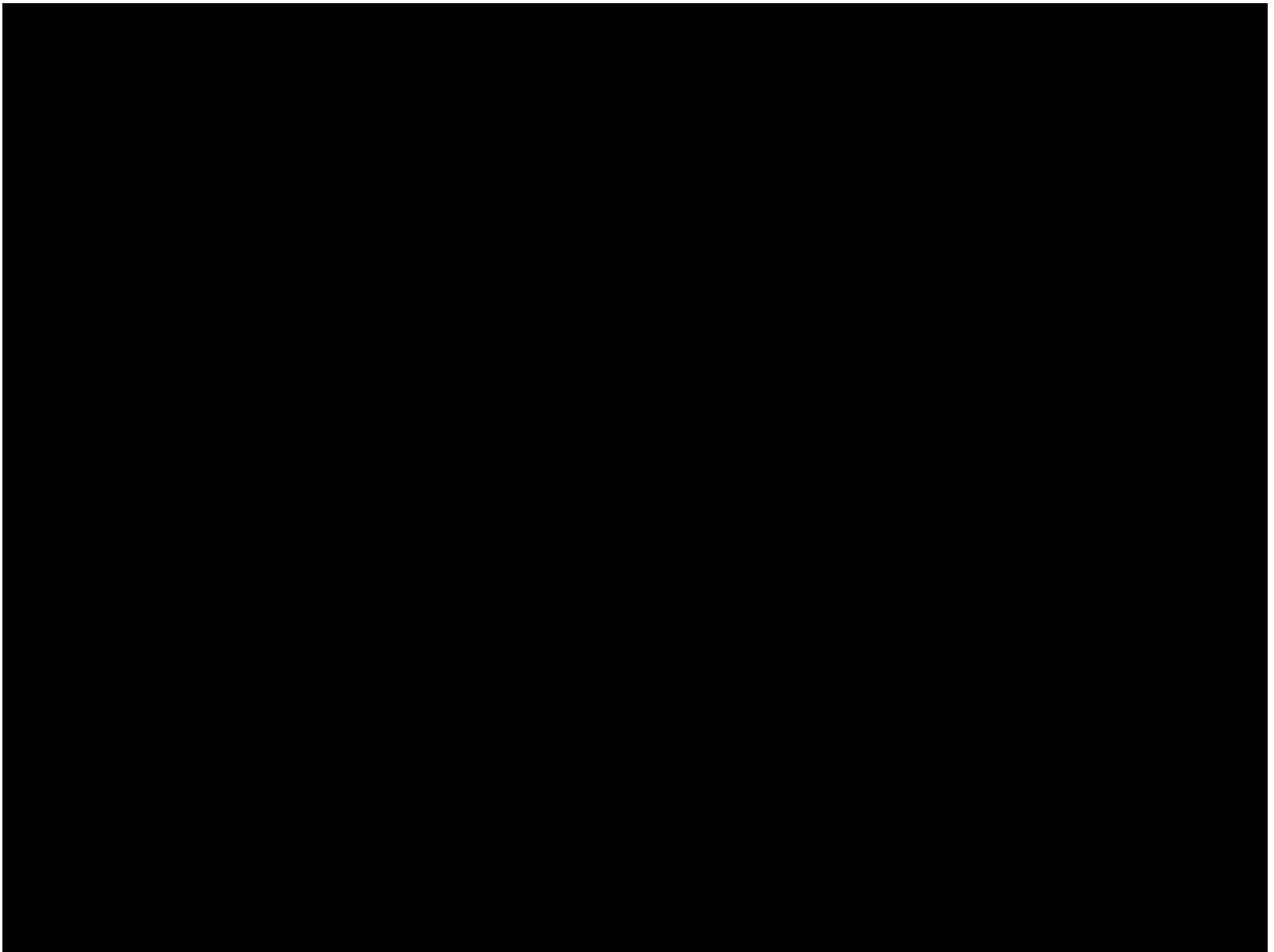
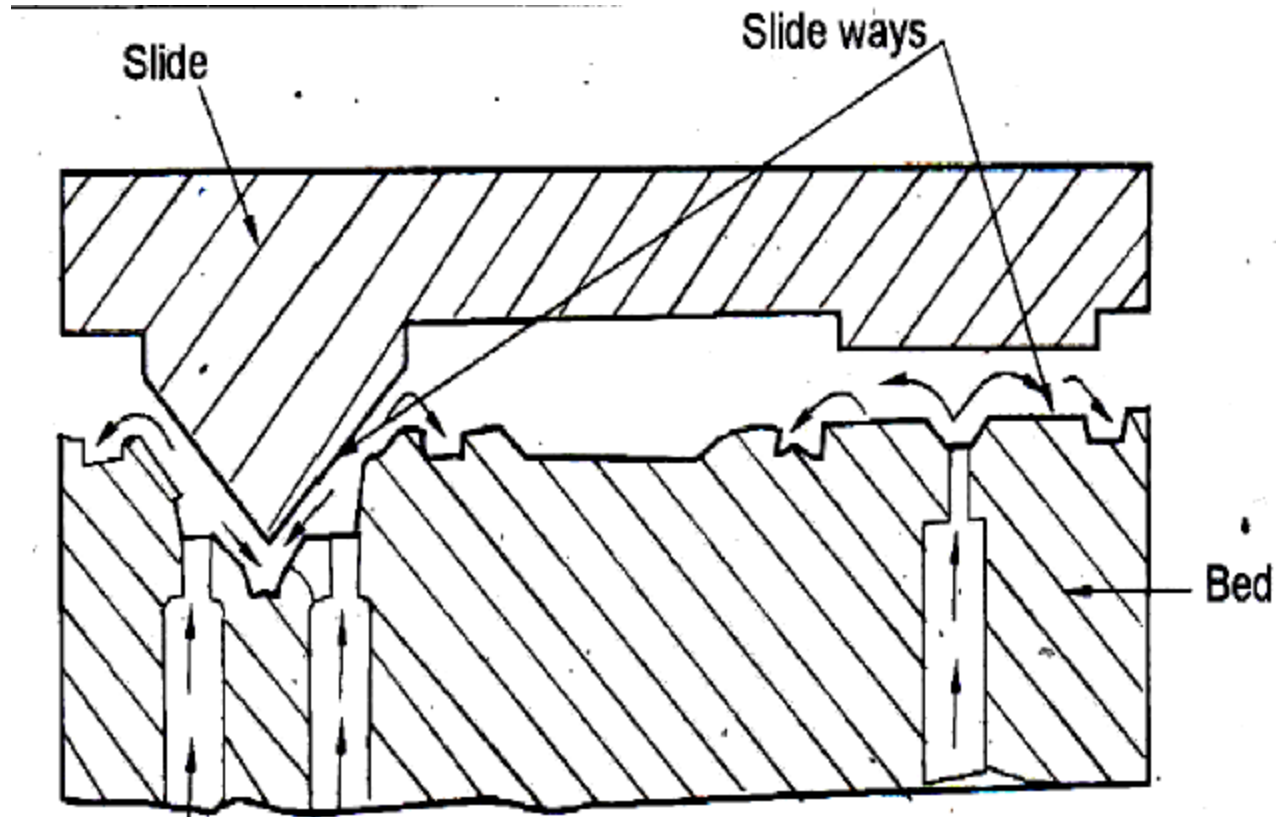


Fig. 5.18 Applications of linear bearings with balls



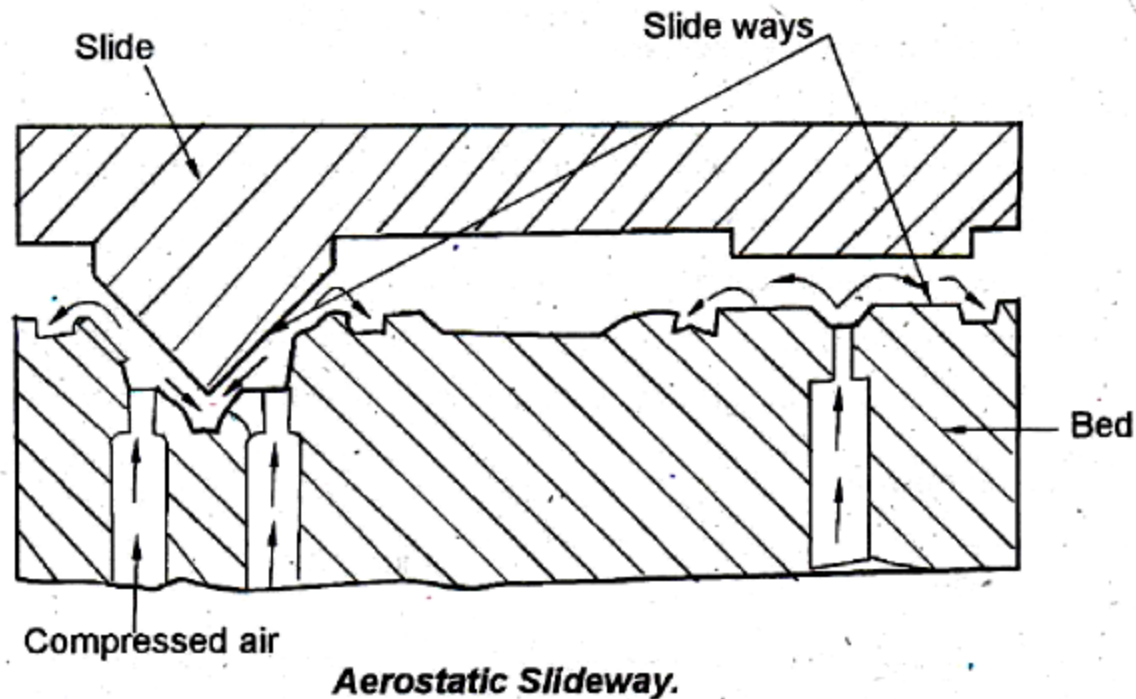
3. HYDROSTATIC TYPE SLIDE WAYS



Pressurized oil

Hydrostatically Lubricated Slideway.

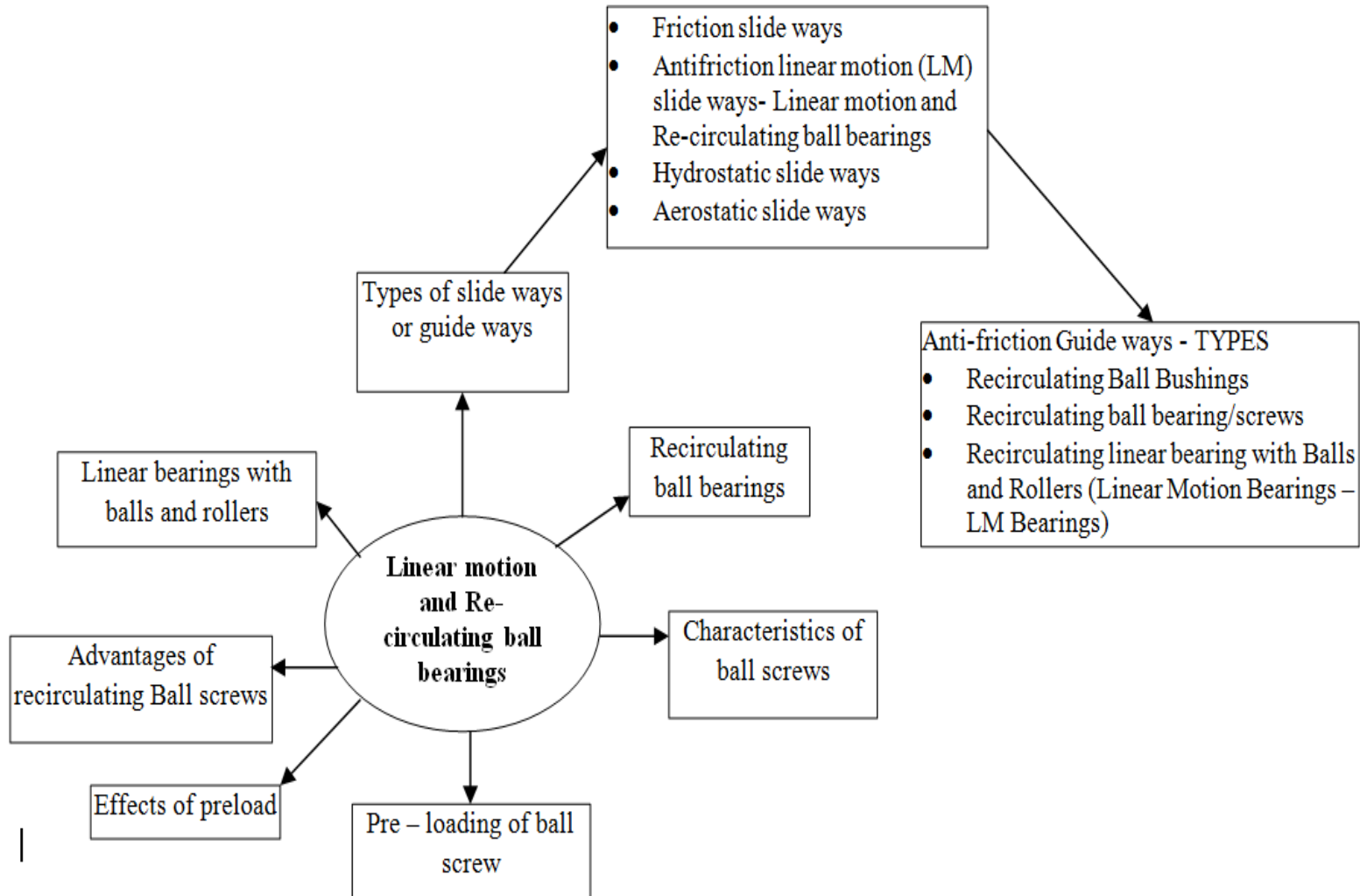
4. AEROSTATIC SLIDE WAYS



But this type is only used for positioning work such as Drilling, boring, and reaming because of its lower stiffness..

Also, this type has drawback that there may be misalignment due to lifting of slides, when uneven load is situated on the work table.

Concept Map



Discussion



10 mins