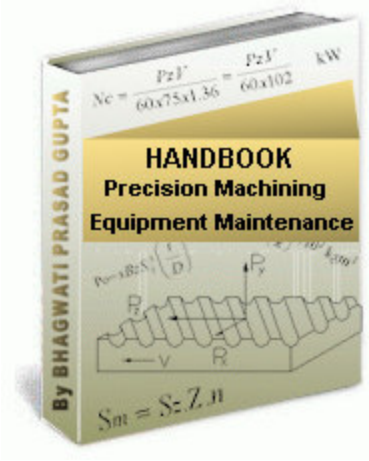
The Machinist Handbook for Precision Machining and Equipment Maintenance.



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Preface:

Today most of the countries are heading towards industrial liberalization in order to compete in the global market. The opening up of the economy has made the market of the developing countries' more attractive for international companies. It would mean increased competition. So the manufacturing companies would like to focus on certain diversification areas which would enable introduction of a steady stream of new products to meet the long term objectives of growth and profitability by maximum utilization of existing machine tools and equipment with minimum additional investment. For the success in the export front one will have to show its machining capability to meet international standards of quality which demands the maintenance of accuracy and other related parameters of the existing machining equipment.

To meet the challenge, each machinist is required to be trained in precision machining besides developing the knowledge of engineers and technologists working on the shop floor. For this, different types of books on machining and machinist handbooks need to be referred as information required are normally not available in machining manuals supplied by the manufacturers along with the machine-tools and equipment. It was therefore felt necessary to compile all such study material and the data in the form of a handy book to enable them refer during the process of learning for achieving better results while dealing with machine tools and equipment.

To start with different types of motions, required in machine tools for different types of machining processes have been described. Cutting parameters related with different types of material, have been tabulated to facilitate the calculation of cutting forces coming onto the cutting tools and the jobs being machined, for estimating the required torque and the power.

Based on the above data only, type of motor and drive could be selected and over-loading could be prevented. So various types of D.C. and A.C. variable speed drives have been described starting from the conventional Ward Leonard system, thyrister, SCR servo-drive to inverter drive, vector control and brush less drives for controlling the motions of D.C. and A.C. motors including induction, synchronous and brushless type. For regulation of speed, different types of speed and feed gearboxes along with the mode of speed change in steps have been given.

Preface: cont...

Now days stepless variable speed drives are preferred. So PIV, ball disc drives and hydraulic stepless drive like hyvari drives have also been described. Details of different types of planetary gear boxes and cyclo drive are given along with the geared-motor. Backlash-free gearing arrangement and timing belts are the essential features of CNC machines. Mechanisms for rapid traverse, reversing, periodic intermittent motion and rectilinear motion have been given along with precision rack, worm rack-pinion, lead screw and ball screw arrangements.

As regards to assemblies and systems, the design aspects of spindle unit with different types of arrangement of sliding bearings, hydrostatic and air bearing and rolling bearings have been described. Frame-housings, slide-ways, low friction guide ways including synthetic linings, hydrostatic and pneumatic guide ways, rolling ways e.g. tychoways and LM guides have been given in detail. In addition to the conventional friction clutches and rigid couplings, latest design clutches like toothed clutches, over running clutches, universal coupling, gear, compression, bellow couplings and safety clutches and protective devices have been explained in detail.

The chapter on control system includes not only the lever and pre-selection of speed but also the automatic controls like logic switching, PLC, numerical control and CNC system. Latest lubrication system like centralized automatic lubrication including metering cartridge and monitoring units have been described in addition to the conventional manual, splash and pressurized lubrication devices. In the Hydraulic system, not only the industrial circuit has been touched but its components like various types of pumps, valves and actuators etc. have been given in much detail.

Besides the details of the mechanisms illustrated by more than 175 figures, due care has been taken to indicate the maintenance aspects of all such systems, assemblies and major components. Mathematical formulae and equations have been provided along with technical data in more than thirty tables which can be used by the designers and application and maintenance engineers for verification purposes. This has made this book useful not only for students of industrial machines but also for the machinists, technologists and practicing engineers in the field of design, manufacturing and maintenance.

6.6 INSTALLATION AND MAINTENANCE OF BALL SCREW ASSEMBLY

The nut and bracket structure should be such that the ball screw is not under twisting load. For that parallelism between ball screw and linearly motion guide should also be maintained. When mounting a ball screw on a machine, care is to be taken that the nut is not separated from the screw. If this is unavoidable, use a sleeve, which is approximately 1 mm smaller than the root diameter of the ball screw, and remove the balls together with the nut without separating them. No balls should fall off and return tube is not damaged.

Incase standard ball screw are valuable and additional is required for bearing journals and end fittings, following procedure should be adopted during machining of the same. Tape up vinyl packed nut at both ends so that the nut will not be moved when the shaft is rotated. Ensure that no chips get in. Ball screw should be fixed by centre as far as possible.

6.7 CARE & MAINTENANCE

Properly applied ball screw components change very little during its operating life. As a result there is no need for adjustment. Here are a few maintenance trips to be followed for the best performance.

a) **Lubrication**: - Machine tool ball screws must be properly lubricated at all times. Either a good quality oil P.S. turbine oil of 38 to 90Cst is recommended or lithium soap based grease is preferred. Never use grease that contains graphite. It can built up within the nut and reduce internal clearance.

b) **Dirt protection**:-In an environment which can involve dirt or foreign substances, it is necessary to hermetically seal the ball screw with a bellows or cover. A labyrinth seal can protect the nut only if there is no foreign substance expert dirt in the surrounding. The easiest way to clean a ball screw is to flush it with clean oil during operation.

c) **Preventive care**: - Common problems and their and their solutions are listed below for better preventive care of ball screws.

   i) The cause of jamming is a “Key stoning" effect where one ball enters the return path improperly.

   ii) System inaccuracy and non-repeatability may be due to faulty assembly if growling or rambling noise is heard. If no noise, the problem may be in loose end bearings on the ball screw or in the control system.

   iii) Excessive drive torque may be due to faulty assembling of nut to screw ball nut to the machine to enable it to take its own alignment.

   iv) If backlash isolate the cause whether it is there due to loose end bearings or wear in the nut.

8.4 SLIDE WAYS OF MACHINE TOOLS

Tool or the job travels in a straight line or a circle together with the units on which the tool or job is mounted. To guide the travel of the unit ways are provided. Either slide ways or antifriction ways are used. The principle characteristics of the ways are given below.

1. Accuracy of the travel
2. Durability
3. Rigidity.

Types of Sideways for Rectilinear Motion

Slide ways may be encompassed type (with apex upward) or encompassing type (with apex downward) as shown in fig.8.2. Former type retains lubricants poorly than the later type. That is why encompassed types are generally used for comparatively a low traverse of a middle or a table advantages are that encompassed type are easy to manufacture and it has no tendency to accumulate type is easy to manufacture and it has no tendency to accumulate dirt and chips, so not necessary to provided shield or other protecting devices. Encompassing type slide ways are employed in M/c having units traversing at higher speed because it can retain lubricants in large quantity**.**

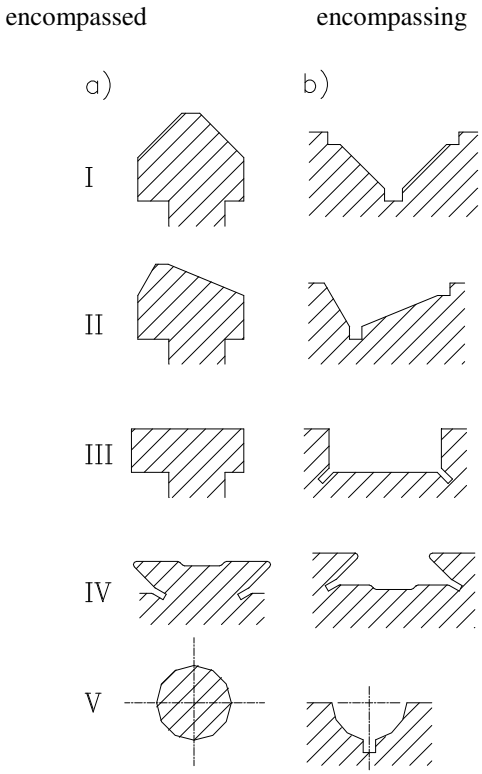

Fig. 8.2 Principal types of slideways

(i) **V ways**

V ways are difficult to manufacture but are capable of self adjustment. Clearance is automatically eliminated under the action of load. 'V' ways are made symmetrical as the load is directed vertically by the weight of the travelling unit and are more suitable for higher speed such as planners and grinding M/c. A deeper 'V' with small apex angle is preferred for precision machine-tools where loading is less.

Chapter 9: LOW FRICTION SLIDEWAYS

9.1 INTRODUCTION

Conventional guideway materials such as cast iron to steel, cast-iron to cast iron etc causes stick slip motion at low velocity because of their negative friction characteristics while seeking the solution it is concluded that-

. 1) stick slip is eliminated when the friction velocity characteristics has a positive slope.

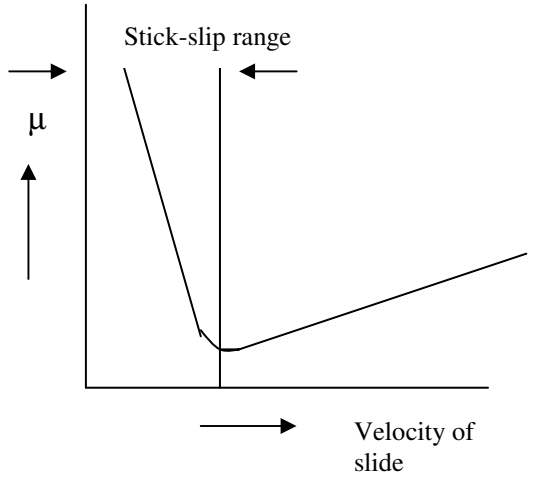

Fig.9.1 Diagram for velocity-friction relationship

2) when the difference between the kinetic and static friction is small, the elastic energy stored in the driving system will also be small and hence stick slip will be minimized.

To achieve these characteristics several methods are being followed in guideways system now a day.

9.2 NON METALLIC SLIDEWAY LININGS

As friction coefficient is higher between cast iron – cast iron as well as between cast iron –steel pair, it was thought to apply synthetic lining on one of the slide pair. Plastic like nylon, Perspex on cast iron give a frictional pair better than cast iron – cast iron pair even though their friction velocity characteristics curve has negative slope. It is because the plastic has anticorrosive and conformability properties. Plastics like phenolics and epoxies give positive slope friction velocity characteristics in a fair range of velocities. The former has that in a low velocity regime and the later has that in a high velocity regime (1.5-2 m/min). PTFE (Polytetrafluoroethylene) has a positive slope friction velocity characteristic at all the operating velocities encountered in a machine tool. PTFE has a lamellar structure from chain to chain branching. This gives important characteristics to the plastic such as-

i) Anti-sticking tendency
ii) Thermal stability
iii) Non solubility and lowest dry coefficient of friction
iv) Slide way does not wear in contact with PTFE.