A Design of Lathe Boring Tool with Rotating Cutter Principle

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***Abstract*—Boring process is the machining process to enlarge an internal diameter of cylindrical tubes and is considered one of the most important processes in rocket motor manufacturing. In general, vertical boring is used over horizontal boring in order to control dimensional accuracy and concentric of bored tubes. However, vertical boring process required a specific machine which can be a burden to manufacturer. In this study, the lathe boring tool is developed to reduce the cost of acquiring new machine. In a typical boring process using horizontal lathe, the ratio between workpiece internal diameter and length is restricted to 1:3. If the length is too long, defects such as uneven roughness can be observed due to vibration of cutting insert. The new horizontal boring tool is designed based on rotating cutter principle. The designed is simulated using finite element method and tested on S40C cylindrical tubes. The surface finished of tested workpiece is within tolerance and acceptable.**

Keywords—Machine design; Boring process; Rotating cutter principle; Rocket motor tube;

I. INTRODUCTION

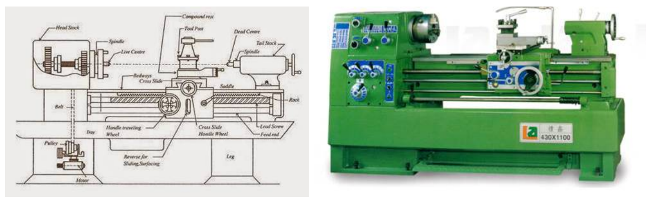
A. Horizontal Turning Process

Turning is a machining process in which a single point cutting tool removes material from the surface of a rotating workpiece. The cutting insert is fed linearly in a direction parallel to the axis of rotation to generate a cylindrical geometry. Turning is traditionally carried out on a machine called lathe or turning machine, which provides power to turn the part at controlled rotational speed, feed rate and depth of cut. Turning machine is a versatile machine tool which can be manually operated or computer controlled, and is widely used in various productions such as automotive parts, machine parts or household equipment. Fig. 1 depicts a sketch of a turning machine showing its principal components. The head stock contains a drive unit to rotate machine spindle and a workpiece. On the opposite side of the head stock is the tail stock, in which a center of the workpiece is mounted in order to support the rotating workpiece during the process.

The cutting insert, held in a tool post and fastened to the cross slide, is assembled to the carriage. The carriage is designed to slide along the sliding way of turning machine in order to feed the cutting tool parallel to the axis of rotation. In order to achieve a high degree of parallelism relative to the spindle axis, the sliding way is made with great precision and is built into the bed of the machine, providing a rigid frame for the machine tool. The carriage is driven by a lead screw that rotates at the proper speed to obtain the desired feed rate. The cross-slide is designed to feed in a cutting tool in the direction perpendicular to the carriage movement. Thus, by moving the carriage, the cutting tool can be fed parallel to the workpiece axis to perform the straight turning; or by moving the cross-slide, the cutting tool can be fed radially into the work to perform facing, from turning, or cutoff operation.

Turning operation can be characterized into two categories regarding the direction of sliding cutting tool. One is called horizontal turning, in which the cutting tool slides horizontally along the spinning workpiece. This method is appropriate for a majority of turning job whereas the workpiece length is greater than its diameter. For a job where the workpiece diameter is larger in relative to its length or is too heavy, it is more convenient to orient the machine spindle so that it rotates about a vertical axis, thus, so called a vertical turning operation.

The size of a turning machine is designated by its swing distance and a maximum distance between its centers. The swing distance is a maximum workpiece diameter that can be rotated on the spindle which can be determined as twice the distance of a center line of the spindle and a sliding ways of the machine. However, the actual maximum size of a cylindrical workpiece that can be accommodated on the machine is normally smaller than the swing distance because the carriage and cross-slide assembly are mounted on the sliding ways. The distance between the machine centers indicates the maximum length of a workpiece that can be mounted between a head stock and a tail stock. For example, a 350 mm x 1.2 m turning machine designates that the swing distance is 350 mm and the maximum distance between its centers is 1.2 m.



(a) (b)

Fig. 1. Turning machine configuration