Machine Tool Technology

With the industrial revolution in the mid-18th century, early machine tools were developed and were continually improved. The development of machine tools and related technologies advanced rapidly during and immediately after World Wars I and II. Since World War II processes such as numerical control, electro-machining, computer-aided design (CAD), computer-aided manufacturing (CAM), and flexible manufacturing systems (FMS) greatly altered manufacturing methods.

Machines can mass produce parts to millionths of an inch accuracy. The fields of measurement, machining, and metallurgy have become very sophisticated. All these factors have produced a high standard of living for us. All of us, regardless of our occupation or status, are dependent on machines and/or their products. Through constant improvement, modern machine tools have become more accurate and efficient. Improved production and accuracy have been made possible through the application of hydraulics, pneumatics, fluidics, and electronic devices such as numerical control to basic machine tools.

Machine tools are generally power-driven metal-cutting or forming machines used to shape metals by:

- The removal of chips.
- Pressing, drawing, or shearing.
- Controlled electrical machining processes.

Any machine tool generally has the capability of:

- Holding and supporting the workpiece.
- Holding and supporting a cutting tool.
- Imparting a suitable movement (rotating or reciprocating) to the cutting tool or the work.
- Feeding the cutting tool or the work so that the desired cutting action and accuracy will be achieved.

The machine tool industry is divided into several different categories, such as the general machine shop, the tool room, and the production shop. The machine tools in the metal trade fall into three broad categories:

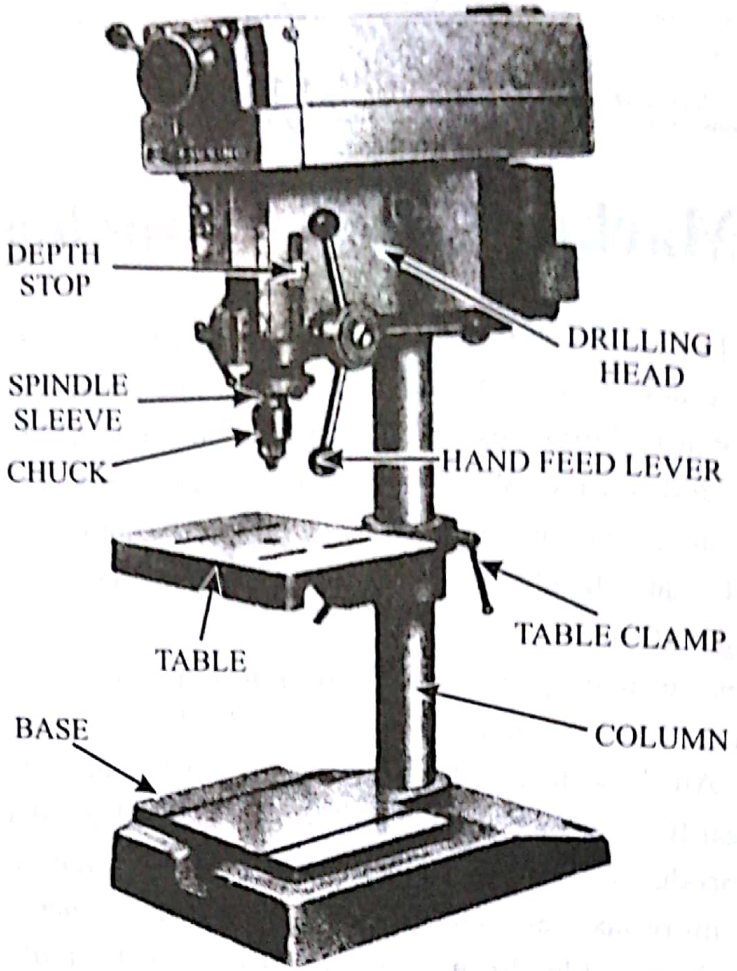

Figure 9-1. A Bench-Type Sensitive Drill Press.

1. Chip-Producing machines, which form metal to size and shape by cutting away the unwanted sections. These machine tools generally alter the shape of steel products by casting, forging, or rolling in a steel mill.
2. Non-Chip-Producing machines, which form metal to size and shape by pressing, drawing, punching, or shearing. These machine tools generally alter the shape of sheet steel products and also produce parts which need little or no machining by compressing granular or powdered metallic materials.
3. New-Generation machines, which were developed to perform operations would be very difficult, if not impossible, to perform on chip or non-chip-producing machines. Electro-Discharge and electro-chemical and laser machines, for example, use either electrical or chemical energy to form metal to size and shape.

A general machine shop contains a number of standard machine tools that are basic to the production of a variety of metal components. Operations such as turning, boring, threading, drilling, reaming, sawing, milling, filing,

and grinding are most commonly performed in a machine shop. Machines such as the drill press, engine lathe, power saw, shaper, milling machine, and grinder are usually considered the basic machine tools in a machine shop.

The drill press or drilling machine (Figures 9-1 & 9-2) probably the first mechanical device developed prehistorically, is used primarily to produce round holes. Drill presses range from the simple hobby type to the more complex automatic and numerical control machines used for production purposes. The function of a drill press is to grip and revolve the cutting tool (generally a twist drill) so that a hole can be produced in a piece of metal or other material. Operations such as drilling, reaming, spot facing, counter sinking, counterboring, and tapping are commonly performed on a drill press.

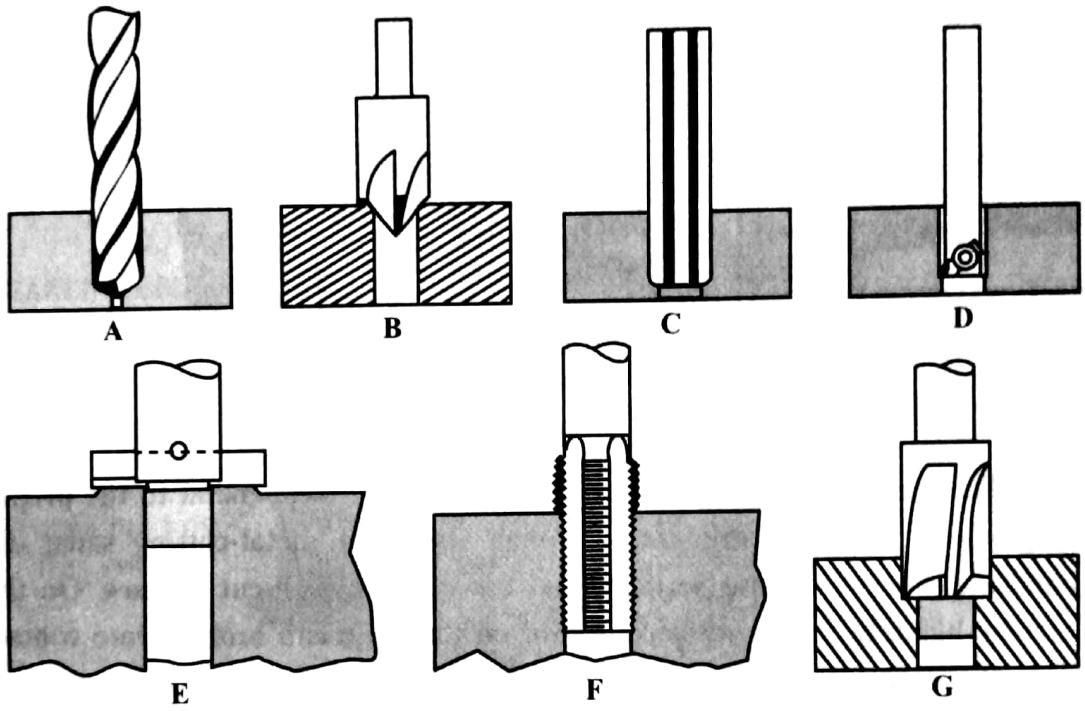

Figure 9-2. (A) Drilling produces a straight hole; (B) countersinking produces a cone-shaped hole; (C) reaming is used to finish a hole; (D) boring is used to true and enlarge a hole; (E) spot-facing produces a square surface; (F) tapping produces internal threads; (G) counterboring produces square shoulders in a hole.

The engine lathe (Figure 9-3) is used to produce round work. The workpiece, held by a work-holding device mounted on the lathe spindle, is revolved against a cutting tool, which produces a cylindrical form. Straight turning, tapering, facing, drilling, boring, reaming, and thread cutting are some of the common operations performed on a lathe.

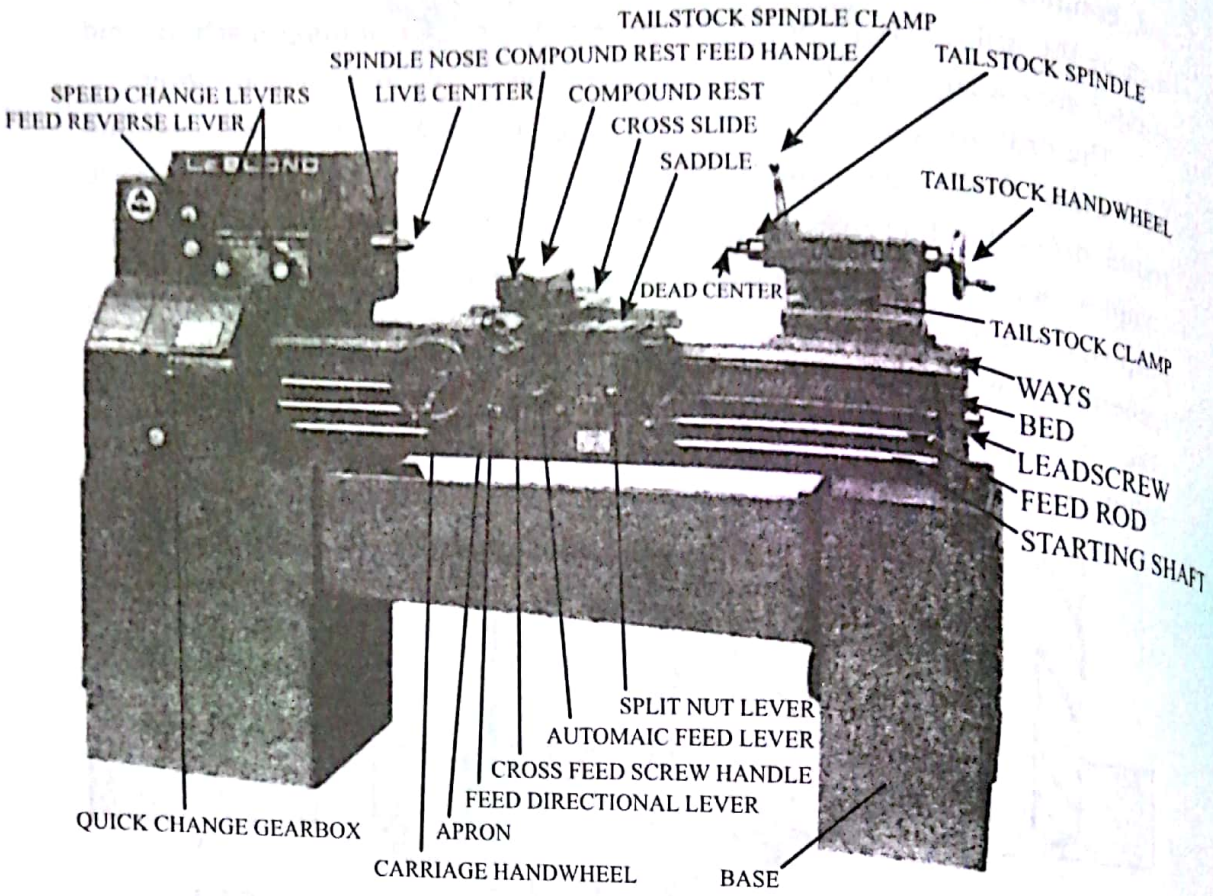

Figure 9-3. The Parts of an Engine Lathe.

The metal-cutting saws (Figure 9-4) are used to cut metal to the proper length and shape. There are two main types of metal-cutting saws: the bandsaw (horizontal and vertical) and the reciprocating cut off saw. On the vertical bandsaw, the workpiece is held on the table and brought into contact with the continuous-cutting saw and blade. It can be used to cut work to length and shape. The horizontal bandsaw and the reciprocating saw are used to cut work to length only. The material is held in a vise and saw blade is brought into contact with the work.

The horizontal milling machine (Figure 9-5) and the vertical milling machine are two of the most useful and versatile machine tools. Both machines use one or more rotating milling cutters having single or multiple cutting edges. The workpiece, which may be held in a vise, fixture, accessory, or fastened to the table, is fed into the revolving cutter. Equipped with proper accessories, milling machines are capable of performing a wide variety of operations such as drilling, reaming, boring, counterboring, and spot facing, and of producing flat and contour surfaces, grooves, gear teeth, and helical forms.

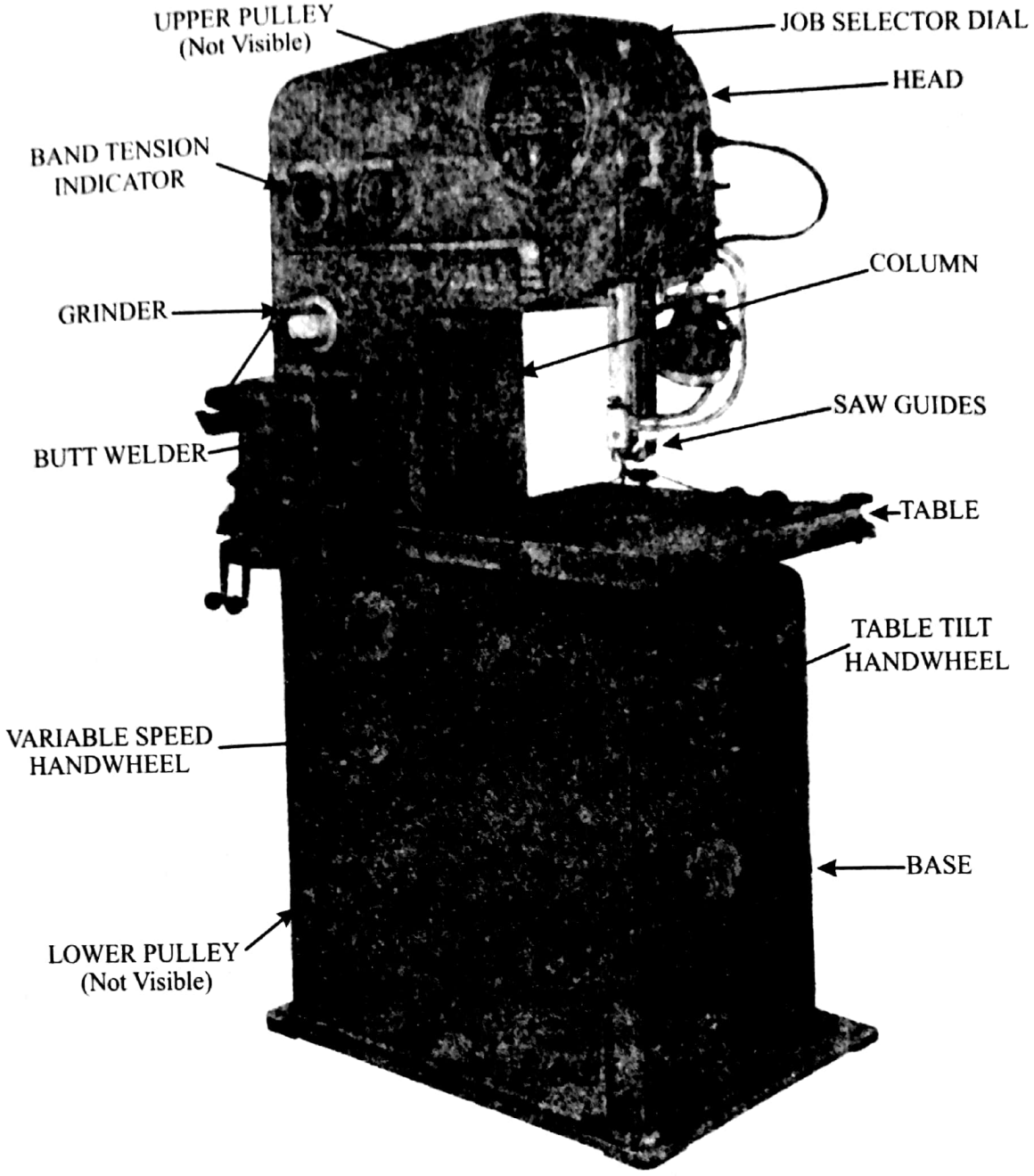

Figure 9-4. A Contour Bandsaw Provides an Economical Means of Cutting Metals to Shape.

Grinders (Figure 9-6) use an abrasive cutting tool to bring a workpiece to an accurate size and produce a high surface finish. In the grinding process, the surface of the work is brought into contact with the revolving grinding wheel. The most common types of grinders are the surface, cylindrical, cutter and tool, and bench or pedestal. Surface grinders are used to produce flat, angular, or contoured surfaces on a workpiece. Cylindrical grinders are used to produce internal and external diameters, which may be straight, tapered, or

contoured. Cutter and tool grinders are generally used to sharpen milling machine cutters. Bench or pedestal grinders are used for offhand grinding and the sharpening of cutting tools such as chisels, punches, drills, and lathe and shaper tools.

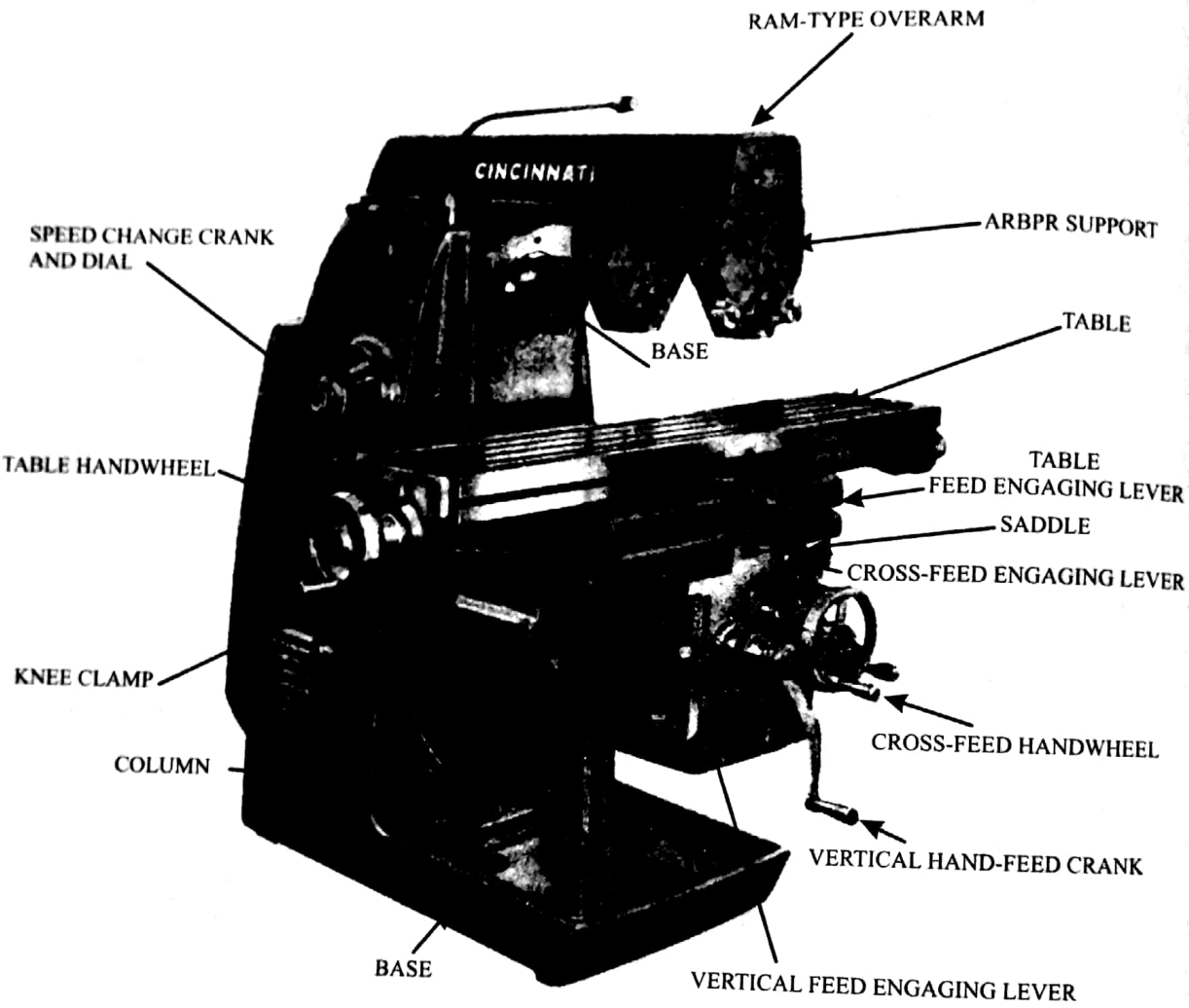

Figure 9-5. Universal Horizontal Milling Machine.

Special machine tools are designed to perform all the operations necessary to produce a single component. Special-Purpose machine tools include gear-generating machines; centerless, cam, and thread grinders; turret lathes; and automatic screw machines. Numerical control and computer-numerically controlled (CNC) machines, more recent additions to the array of machine tools, have greatly increased production and improved the quality of finished products. Consistent accuracy over many hundreds of parts is one of the features of these machines. The numerical control principle has also been

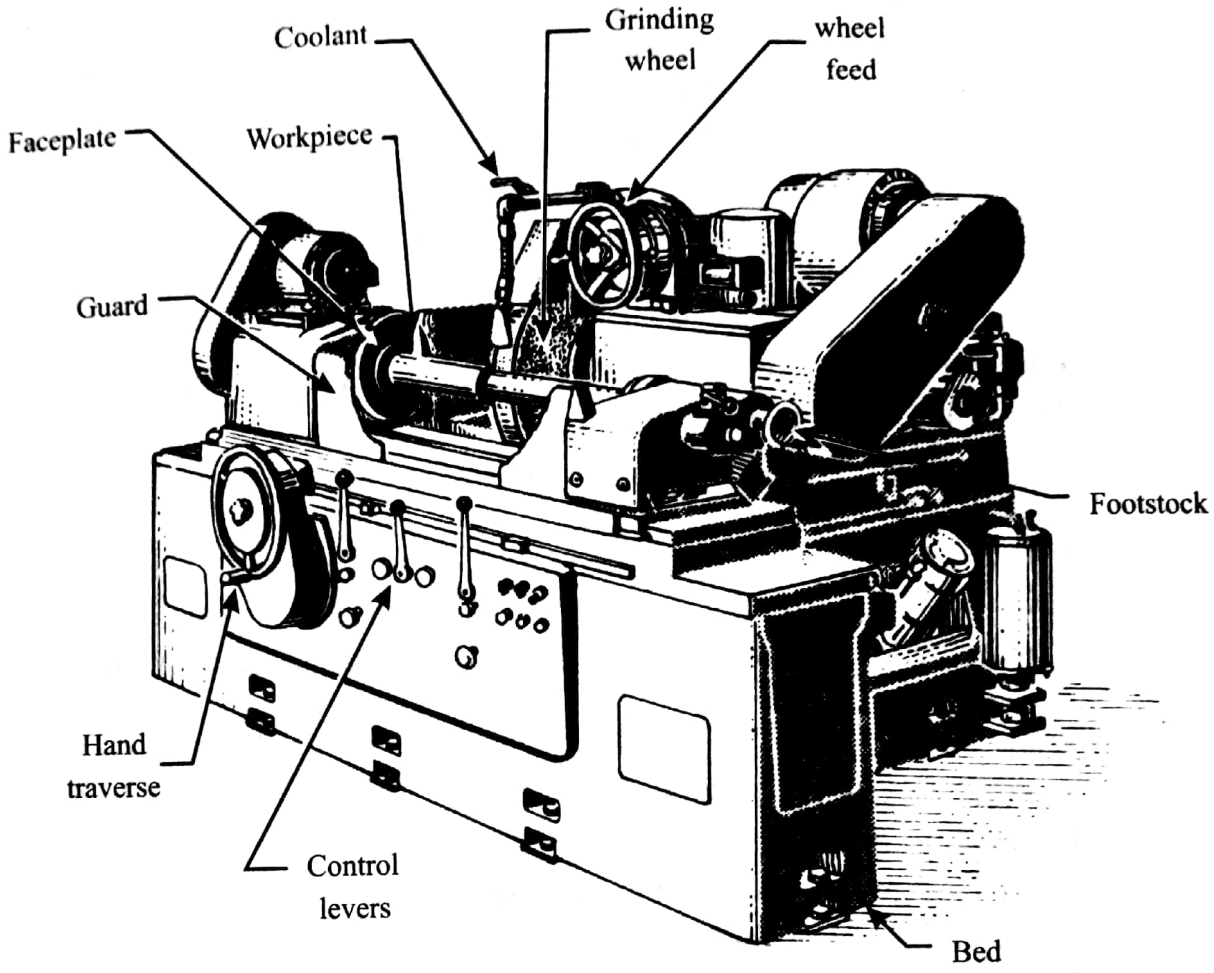

Figure 9-6. A Universal Cutter and Tool Grinder.

applied to robots, which are now capable of handling materials and changing machine tool accessories as easily and probably more efficiently than a person can. Robotics has become the fastest-growing phase of the manufacturing industry.

Part I. Comprehension Exercises

A. Put "T" for true and "F" for false statements. Justify your answers.

..... 1. According to the text, machine tools are used for both material-removal and forming metals in industry.