

Milling Machines and Milling Operations

Unit 3

Page 1

2 classes of milling machines: Vertical and Horizontal. The one in this lab is a vertical.

I. Vertical Milling Machines

A. Types of Vertical Mills

- 1. Standard Milling Machine-The cutter head and spindle are mounted in the vertical position. Used for all types of cutting and drilling applications.**
- 2. Ram Type Milling Machine-Used for lightweight and small applications.**
- 3. Numerically Controlled Milling Machine-Uses a computer to control cutter movement.**
- 4. Tracer Controlled Mills-uses a master object to duplicate other pieces.**
- 5. Optical Scanner Mill-uses a print to transfer cuts onto an object.**

B. Vertical Mill Parts

- 1. Base-Made out of Cast iron and may contain coolant.**
- 2. Column-Attached to the base and provides a place for the knee to move on.**
- 3. Overarm-On top of the mill and can be adjusted in or out to increase milling capacity.**
- 4. Head-Attached to the end of the overarm, the motor is mounted here.**
- 5. Quill-Holds the spindle and is mounted on the opposite end of the motor.**
- 6. Knee-Moves up and down on the column and supports the saddle.**
- 7. Saddle-Holds the table.**
- 8. Table-Where all work is mounted and all milling operations take place.**

C. Milling Cutters and Collets

- 1. End Mills-Have cutting teeth on the end as well as the sides.**

Milling Machines and Milling Operations

Unit 3

Page 2

2. **Two-Fluted End Mills-Can drill shallow holes as well as do face milling.**
3. **4-Fluted End Mills-Require a starting hole and is used for finer detail work.**
4. **Fly-Cutter-Used to machine larger work, a cutter head holds 3 or more replaceable diamond shaped cutters.**
5. **Collets-Provide a means of gripping and holding the end mills.**

D. Cutting Speeds

1. **Determined in feet per minute**
2. **Factors to be considered**
 - a. **material to be machined**
 - b. **type of the cutter**
 - c. **finish required**
 - d. **depth of cut**
 - e. **clamping of the work piece**
3. **The speed of the cutter head**

E. Cutting Feeds

1. **Feed is the rate at which work moves into the cutter.**
2. **Chip Per Tooth-the maximum size of chip a cutter can make before it becomes clogged, important is softer metals.**

F. Vertical Milling Operations

1. **Drilling**
2. **Boring**
3. **Reaming**
4. **Cutting Slots**
5. **Keyways**
6. **Dovetails**
7. **Side and face milling**

Milling Machines and Milling Operations

Unit 3

Page 3

G. Climb and Conventional Milling

1. Climb milling

- a. Also called “down” milling**
- b. The milling cutter cuts in the downward position.**
- c. If the mill is not equipped with a backlash eliminator it can cause the cutter to climb up on the stock and throw it from the vise.**
- d. Used for light finish cuts**
- e. Not very safe**

2. Conventional Milling

- a. Also called “up” milling.**
- b. Milling cutter is fed into the work rotating in an upward manner.**
- c. Most widely used form of cutting and is the safest**

II. Horizontal Milling Machines

A. Types

1. Manufacturing Type

- a. used for quantity production**
- b. either automatic or semi-automatic**
- c. large massive machines**

2. Knee and Column Type

- a. used for single parts**
- b. used by school and machine shops**
- c. Two types of Knee and Column Mills**
 - 1. Plain Horizontal-has a fixed table**
 - 2. Universal Horizontal-has a table that can be swung 360 degrees in any direction, this makes it more versatile.**

***No more discussion on horizontal mills since this lab does not have one.**

Milling Machines and Milling Operations

Unit 3

Page 4

III. Holding Devices

A. Vises

1. Bolted to the table
2. Usually very heavy duty
3. Types
 - a. Plain vise-fixed in one position
 - b. Swivel vise-can move side to side X and Y axis
 - c. Universal vise-can move in all axis X,Y,Z

B. V-Blocks-a "V" groove is cut into a piece of steel and is used to hold round work pieces.

C. Angle Plates-90 degree plates of steel that large work can be bolted to and then the angle plates are bolted to the table.

D. Clamps and T-Bolts-Used for holding large work and used for holding irregular work.

IV. Milling Cutters

A. Two Categories

1. Solid Cutters-The teeth and the cutter are the same piece of metal.
2. Inserted Tooth Cutters-These have removable teeth that are interchangeable and can be replaced when dull.

B. Plain Milling Cutters

1. Light Duty-Less than $\frac{3}{4}$ " wide.
2. Heavy Duty-Large cutters with deep gullets for chip removal.
3. Side Milling Cutters-have teeth on the side for cutting slots and grooves.
4. Face Milling Cutters-are usually over 6 inches and are used for milling large surfaces.
5. Angular Cutters-used for milling angled surfaces without tilting the mill table or vise.
6. Formed cutters-specialized cutters that are used to cut special shapes into work pieces.

Milling Machines and Milling Operations

Unit 3

Page 5

- 7. T-Slot Cutter-Used for making wide grooves in machine tables, similar to the wide groove on top of the table saws for the miter gage.**
- 8. Flycutters-house interchangeable cutting teeth to perform roughing and finishing cuts in one pass.**

V. Milling Safety.

A. Precautions

- 1. Always brush away chips with as brush.**
- 2. Always securely clamp the work using a dead blow hammer.**
- 3. Always hold parts that have been milled in a cloth or rag to prevent burs.**
- 4. Move the table as far out as possible to avoid slipping into the cutter.**
- 5. Keep the floor free of grease, oil, and chips.**
- 6. Allow the cutter to stop completely before making adjustments.**
- 7. Never remove more metal than the cutter is capable of removing. For the cutters in this class .010 is the maximum per pass.**
- 8. Hold the cutters in a rage when installing or removing.**
- 9. Safety Glasses**