CONVENTIONAL

MILL

UNIT

CONVENTIONAL MILL

For Quiz Purposes:

See Assignments under CONVENTIONAL ENGINE LATHE UNIT along with these notes and demonstration information.

Definition:

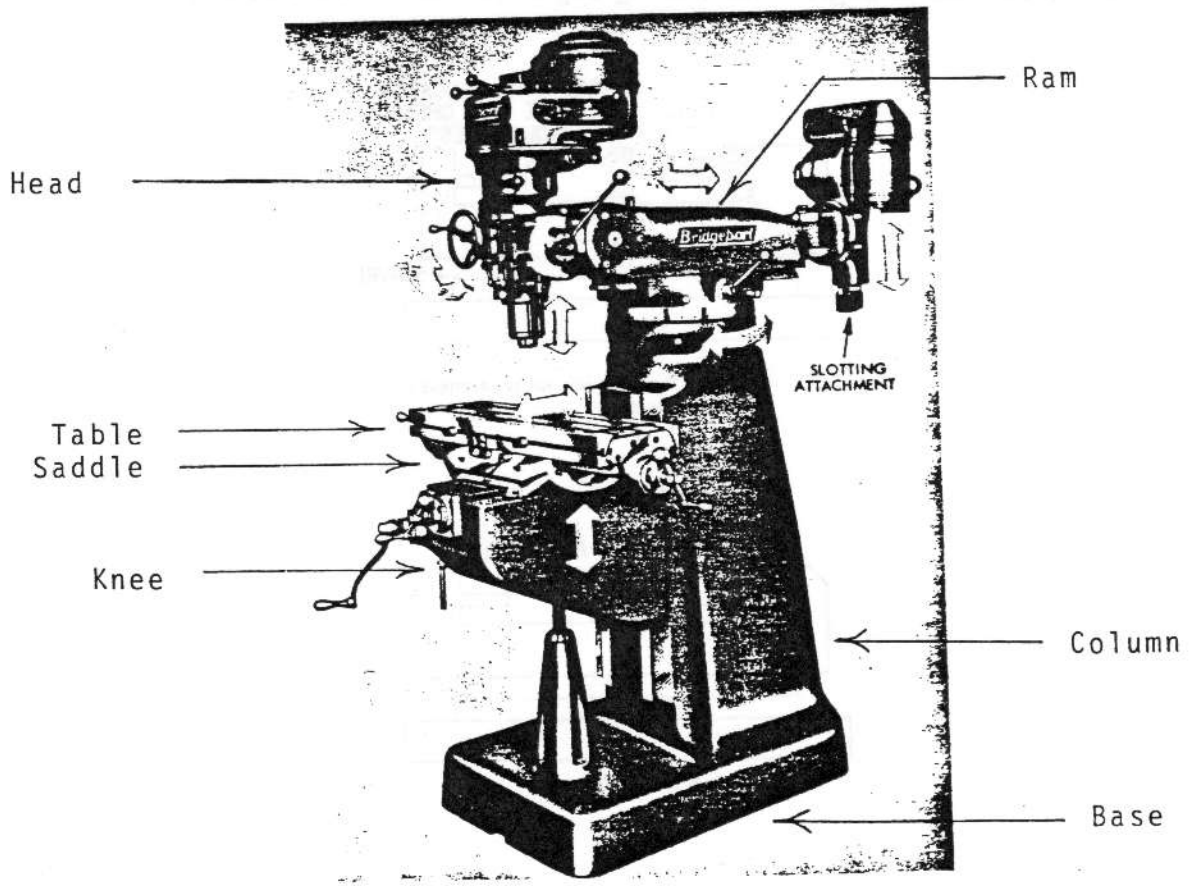
- Function of a Mill: A stationery workpiece is fed against a revolving cutter.

Background:

The mill was first designed and developed by Eli Whitney in 1818. Prior to this time, engine lathes were employed to do milling operations by securing a cutter to the headstock spindle and mounting the workpiece on the carriage section of the lathe.

There are primarily two different types of conventional mills:
- horizontal mill - cutter is held horizontally
- vertical mill - cutter is held vertically

In most facilities today, the primary type of mill is similar to this vertical mill.



PARTS DEFINED:

- Base-column - often a single casting - base sometimes houses a coolant system.

- Knee - fastened to upright column by a dovetail - responsible for "Z" axis vertical movement.

- Saddle - supported by knee - allows for horizontal movement.

- Table - supported by saddle - responsible for "X" axis movement to left and right of operator, and "Y" axis movement toward and away from operator.

- Head - houses spindle, has vertical movement, mounted on ram.

- Ram - swivels on top of column, supports head, provides for swivel adjustment of head.

Holding the Workpiece: - There are several ways to securely hold a workpiece for machining.

- Vise - a vise that generally needs to be indicated for squareness - also has swivel base graduated in degrees for milling angles (see illustration below)

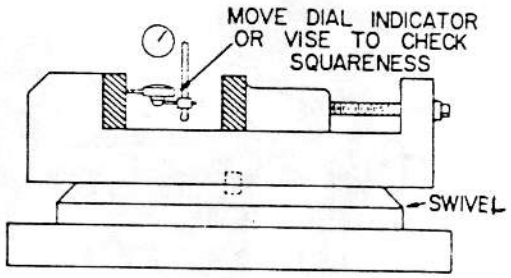
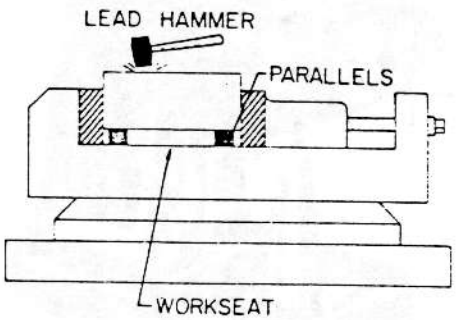


Fig. 5-70. Checking the solid jaw for squareness by us the dial indicator.



Holding the Workpiece: (Con't.)

- Plain Bar Clamp - the use of a plain bar clamp, a step block, T-slot nut, stud bolt, and washered hex nut to grip a workpiece from its top surface. The back end of the clamp must be equally high or higher than the front end.

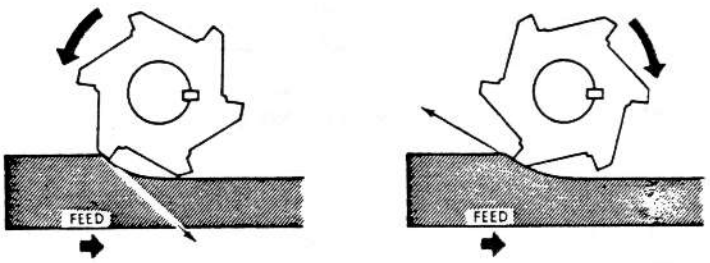
- Toe Clamps - clamps that grip the edge of the workpiece leaving the entire top surface free for machining.

- Rotary Table - provides rotary motion to workpiece - used for cutting circular grooves, slots and bolt hole circle patterns.

- Indexing Head - supports work on horizontal axis from one end or between centers - used for indexing operations like squares, hexagons, gear teeth and keyways.

Conventional Vs. Climb Milling:

There are two methods of milling according to the movement of the workpiece and the rotation of the cutter at their point of contact.

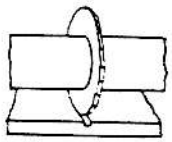


CLIMB CONVENTIONAL

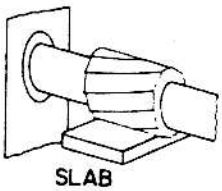
Approximately 95 percent of the time conventional milling is preferred for general purpose metal removal. The remainder of the time, climb milling is used for finish cuts.

Mill Cutters:

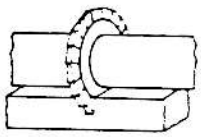
There are many different cutters to perform the milling tasks. The illustration that follows on the next page shows primarily horizontal cutters at work; however, there are vertical cutters that perform many of the equivalent tasks.



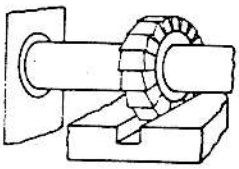
SAW-SLITTING



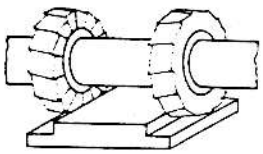
SLAB



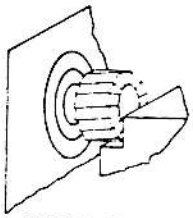
SAW-SLOTTING



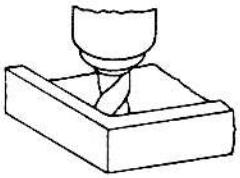
SIDE MILL-SLOTTING



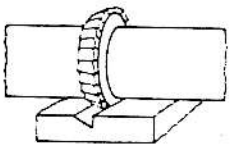
HALF SIDE STRADDLE



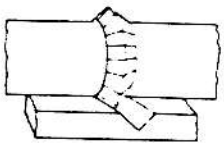
SHELL END



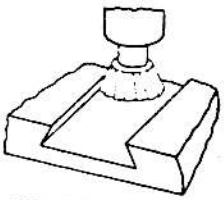
END



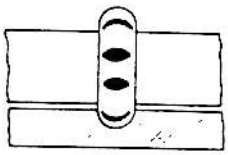
SINGLE-ANGLE



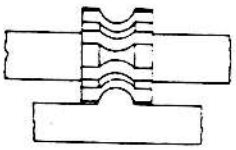
DOUBLE-ANGLE



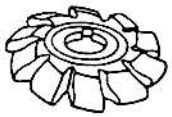
DOVETAIL ANGLE



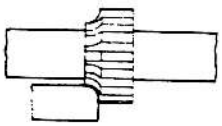
CONVEX



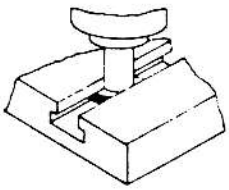
CONCAVE



GEAR

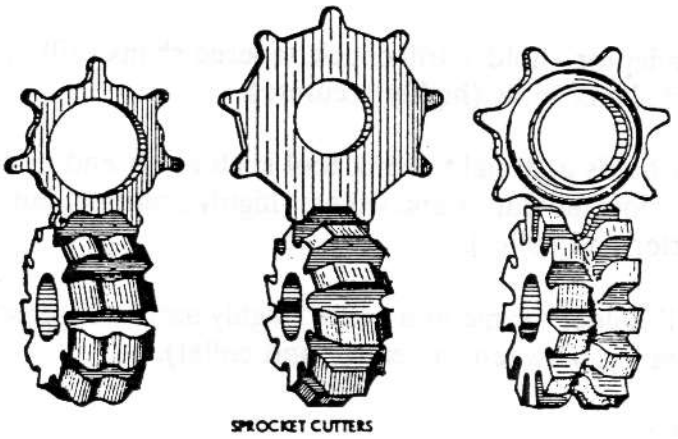


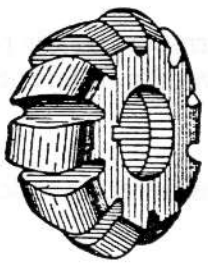
CORNER ROUNDING

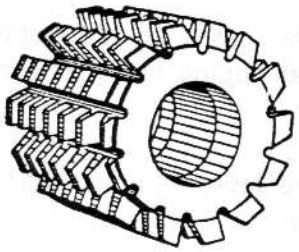


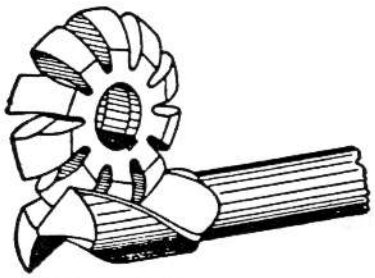
T-SLOT

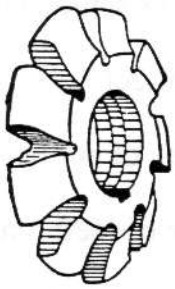
Form Cutters - Some of the special shapes in which mill cutters are produced are shown below. This illustration answers some questions as how things are produced. The person involved with tool grinding must be able to produce some of these special shapes.


SPROCKET CUTTERS


TAP AND REAMER CUTTER


WORM GEAR HOB


TWIST DRILL CUTTER


GEAR TOOTH CUTTER

Holding The Cutter:

Cutters with a hole in the middle are generally, but not always, mounted horizontally. The devices to hold these cutters are:

- stub arbor - often used to hold a shell type mill cutter - supported only from one end.

- arbor - often used with slitter, stagger toothed cutter, gear and other formed cutters - supported on both ends.

Cutters with a shank on one end are generally, but not always, mounted vertically. The devices to hold these cutters are:

- sleeve adaptor - hold a drill chuck, tapered shank drill, ream, boring head, and other tapered shank tools (highly accurate).

- collet - holds a straight shank tool such as an end mill, T-slot cutter, some form cutters, dovetail cutter and others (highly accurate, but slipping can occur between the cutter and collet).

- end mill holder - same as a collet (highly accurate, set screw secures cutter to avoid any slipping between the cutter and collet).

Speeds & Feeds:

RPM's can easily be determined by the formula already presented in association with the conventional engine lathe presentation. The only difference is the cutter becomes the diameter factor.

There are several factors that must be considered in order to determine the feed rate for a mill cutter.

- rigidity of setup and machine

- depth of cut

- diameter of cutter

- number of teeth on the cutter

- type of material to be cut

- and the list goes on.

It is usually safe to allow each tooth on the cutter to remove a chip of .002 to .004 of an inch. Therefore, if a cutter has 4 cutting teeth it should at least be able to remove .008 per revolution. To extend this calculation a little further, if the diameter of the cutter were .375 cutting in steel, then it could be said that 4 x 100 divided by .375 equals 1067 RPM's. The final calculation for determining the inches per minute feed rate would be .008 x 1067 RPM's equals 8.536 inches per minute.

DEMONSTRATION NOTES AND THOUGHTS