

Manufacturing Tooling 5. Jig Design

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Fixture

- ◆ A fixture is a means through which a part is securely fastened to the machine tool table to accurately locate, support and hold the part during the machining operation.

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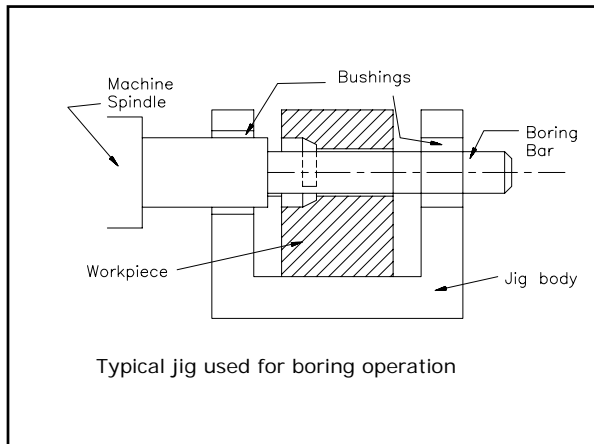
Jig

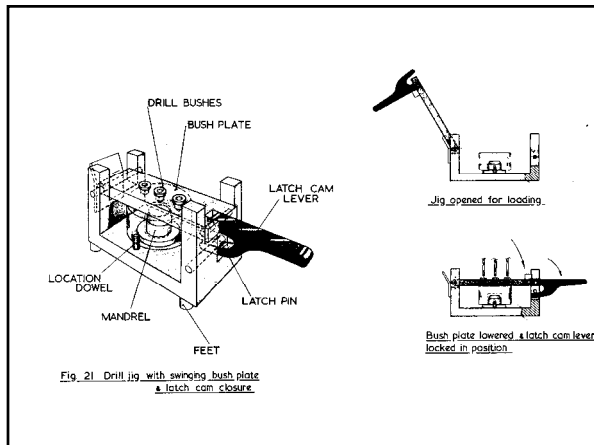
- ◆ A jig is a special class of fixture, which in addition to provide all the functions as above, also guides the cutting tool during machining.
- ◆ This is generally used for the operations such as drilling, boring, reaming, tapping, counter boring, etc.

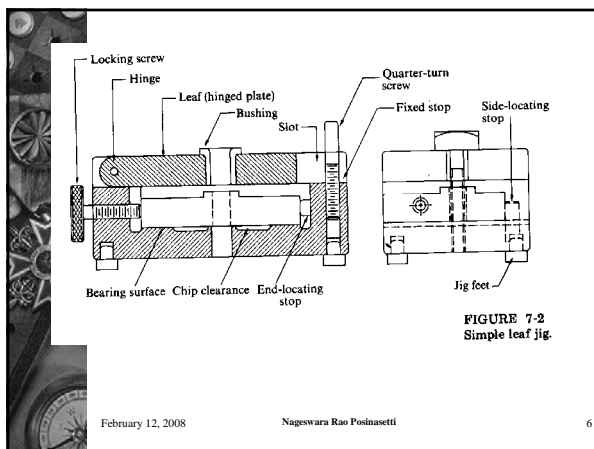
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Drill Jigs

- ◆ Provide methods for
 - Correctly locate the workpiece with respect to the tool
 - Securely clamp and rigidly support the workpiece during the operation
 - Guide the tool
 - Position and/or fasten the jig on a machine


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Drill Jigs

- ◆ Advantages
 - Minimize tool breakage
 - Minimize the possibility of human error
 - Permit the use of less skilled labor
 - Reduce manufacturing time
 - Eliminate retooling for repeat orders


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Machine Considerations

- ◆ Horsepower
- ◆ Size limitations
- ◆ Weight limitations
- ◆ Cutting Tools
- ◆ Special Machinery


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Process Considerations

- ◆ Type of Operations (drilling, reaming, other)
- ◆ Number of Operations
 - Similar vs. different
 - Sequential vs. simultaneous
- ◆ Sequence
- ◆ Inspection Requirements


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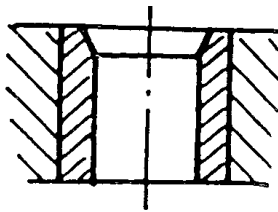
Jig Bushes

- ◆ To position and guide the cutting tool for cutting.
- ◆ Materials
 - Hardened steel
 - Carbide
 - Bronze
 - Stainless steel

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Headless Bush



Most popular and least expensive
Light axial load is expected

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Clearance between Bush and Part

No clearance (maximum precision drilling only)
Normal chip clearance
Excessive chip clearance

Equal to:
1/2 ID (small chips)
1 to 1 1/2 ID (Long, stringy chips)

Cutting tool with normal back taper
Guiding effect of bushing reduced

Jig
Workpiece
ID
Workpiece

Figure 5-40. Recommended clearance between workpiece and bushing. (Courtesy, American Drill Bushing Co.)

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Headed Drill Bush

WORKPIECE

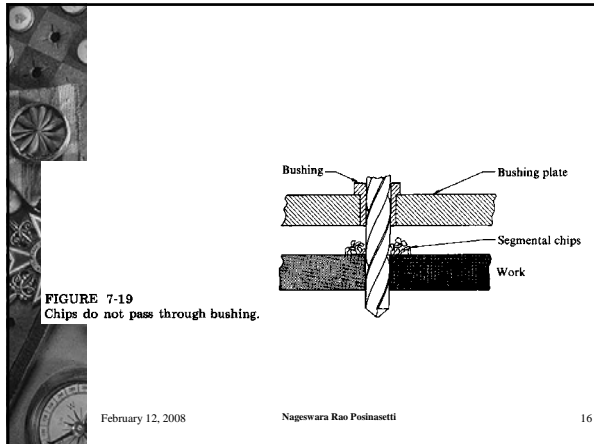
Jig plate can be thinner

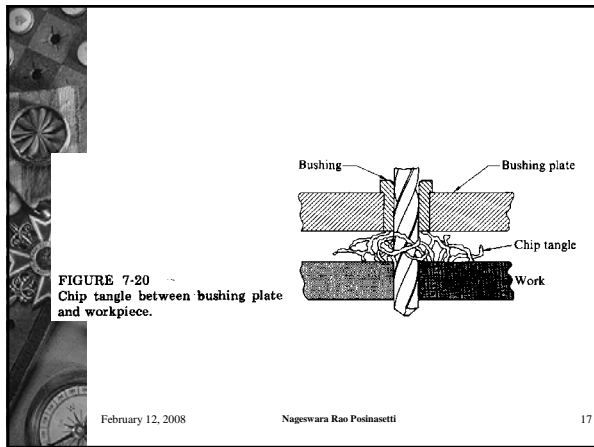
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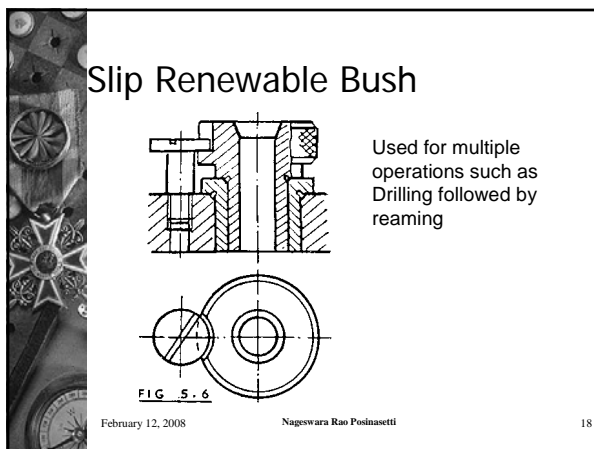
Jig Burr clearance
Workpiece
Secondary burr

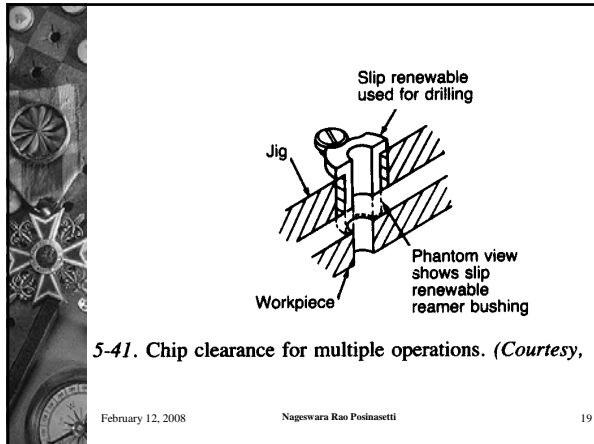
5-42. Burr clearance. (Courtesy, American Drill Bus)

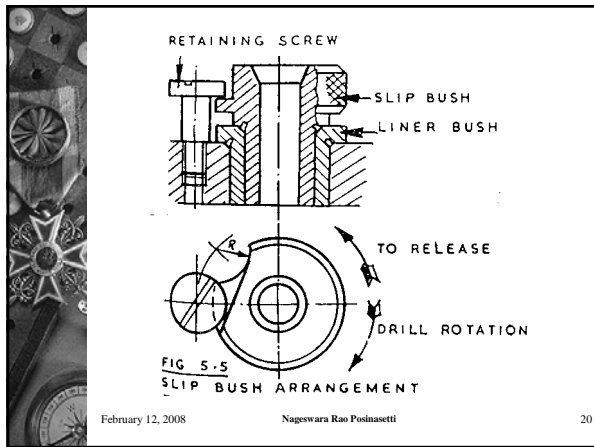
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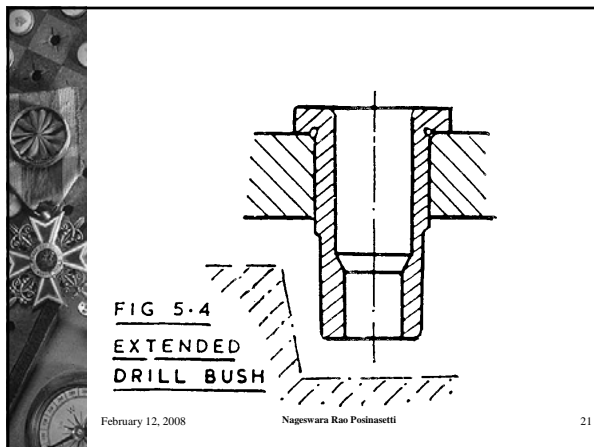


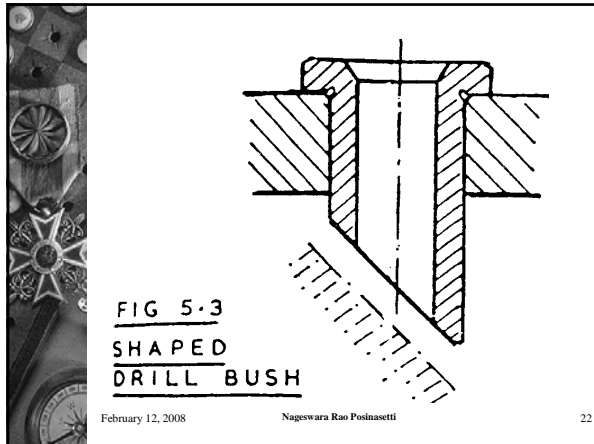


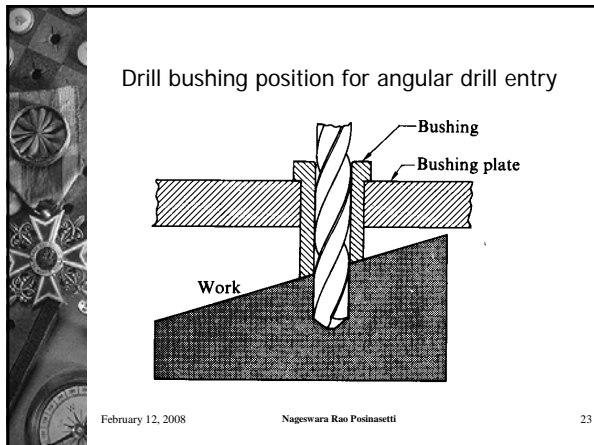


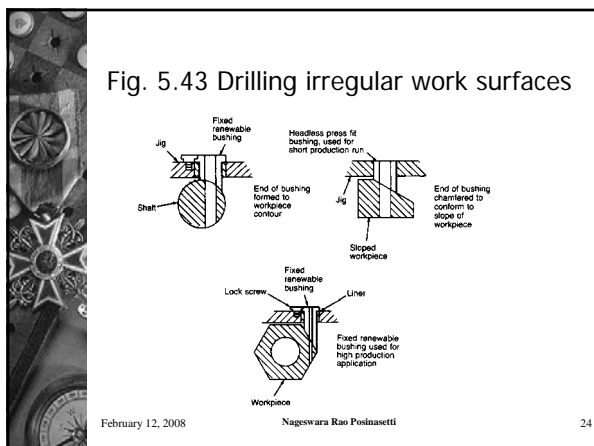


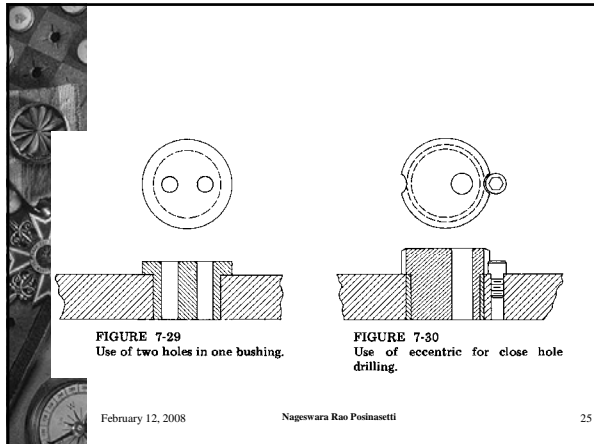


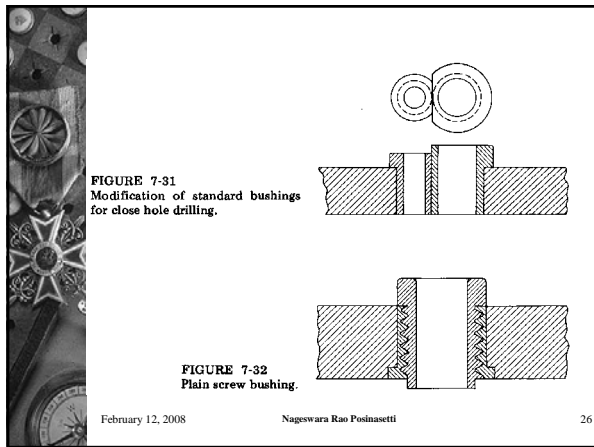


















Jig Components

- ◆ Locators
- ◆ Clamps
- ◆ Jig plate with bushes
- ◆ Jig body
- ◆ Other elements as required
 - Supports
 - Jig feet


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Types of Jigs

- ◆ Template jigs
- ◆ Plate jigs
- ◆ Universal jigs
- ◆ Leaf jigs
- ◆ Channel and tumble jigs
- ◆ Indexing jigs
- ◆ Miscellaneous jigs

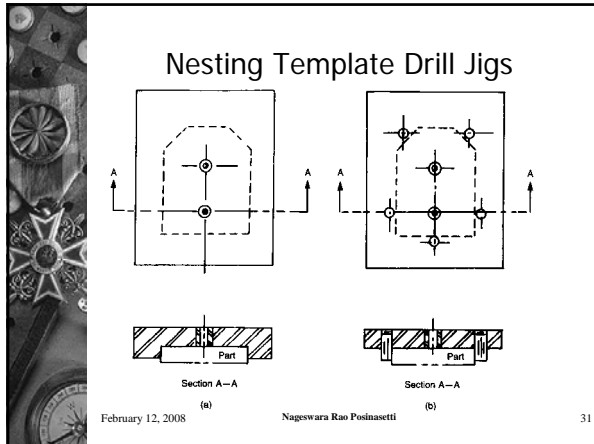
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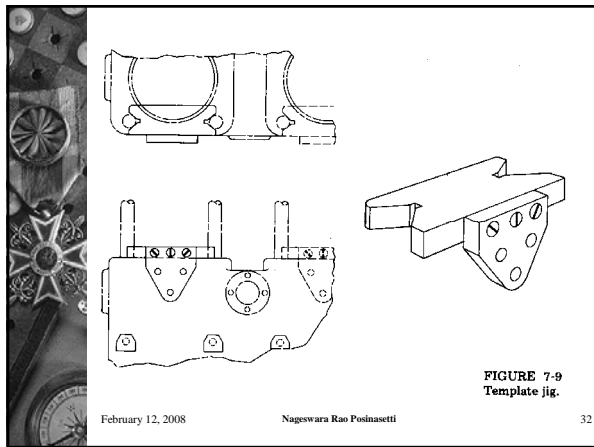


Template jigs

- ◆ No clamping arrangement
- ◆ Plates with bushing to guide the tool
- ◆ Directly placed on the part
- ◆ Simple
- ◆ Least expensive

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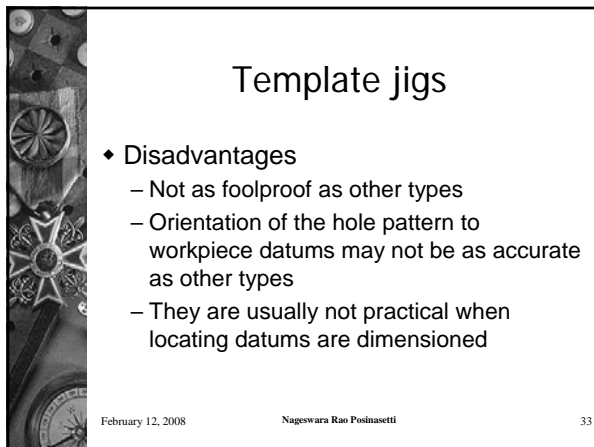


Plate jigs

- ◆ A template jig with workpiece clamping system

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Plate Jig

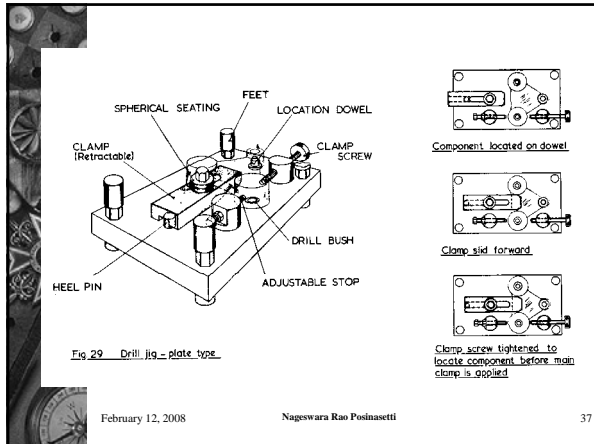
WORKPIECE

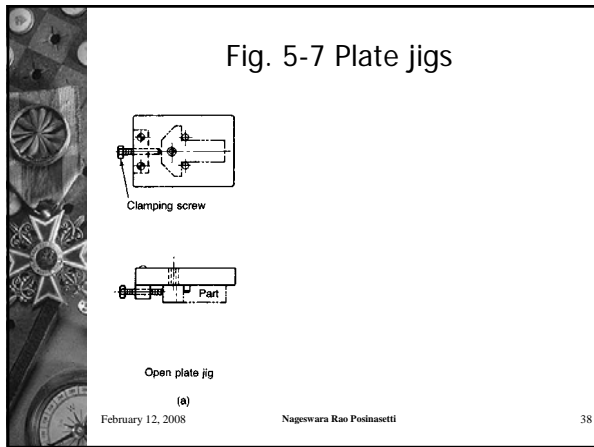
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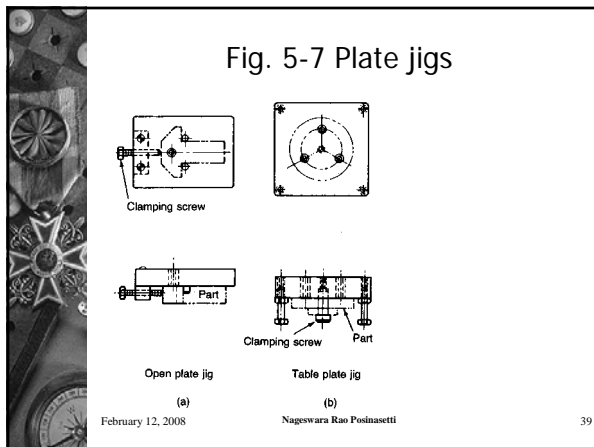
Plate Drill Jig

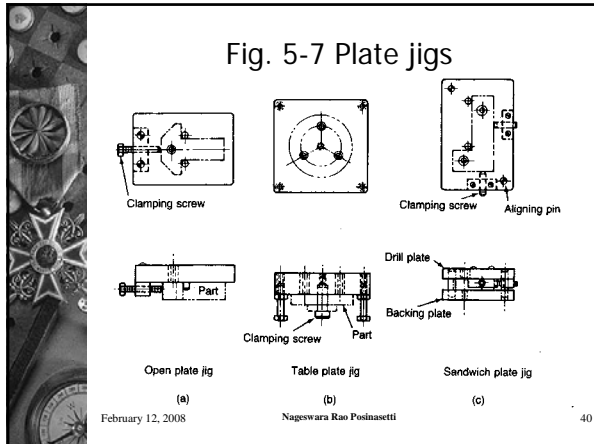
THUMB NUTS
DRILL BUSHES
RUSH PLATE
ALIGNMENT DOWELS
BASE
SWING BOLTS
COMPONENT LOCATION

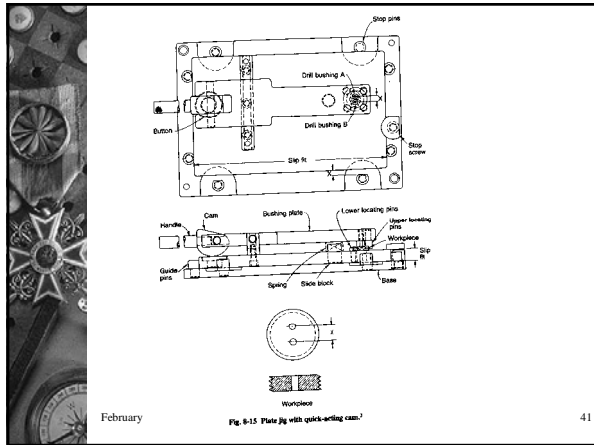
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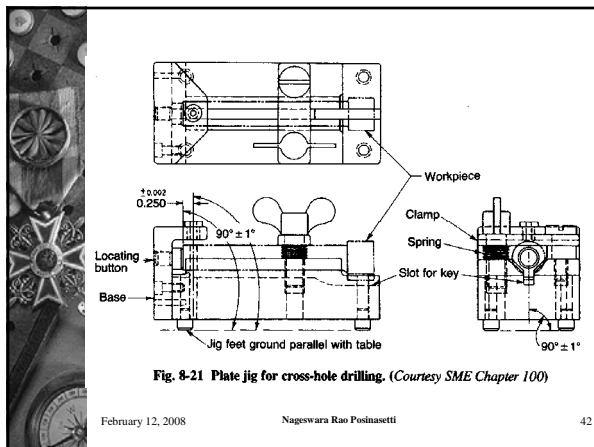


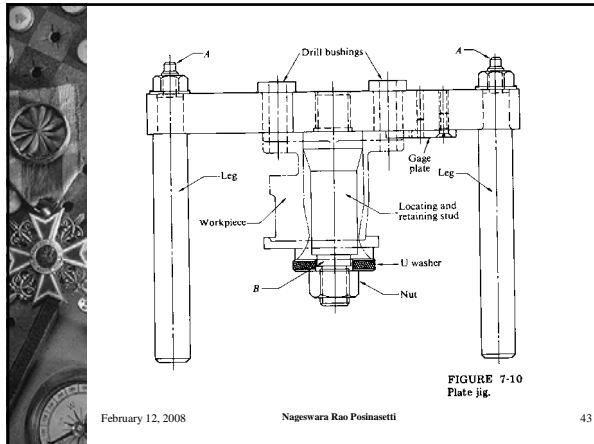


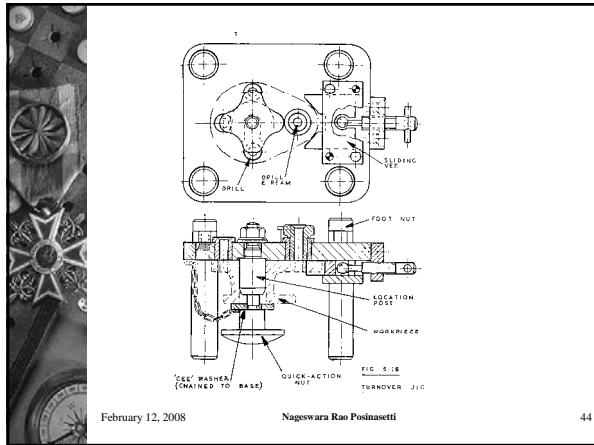


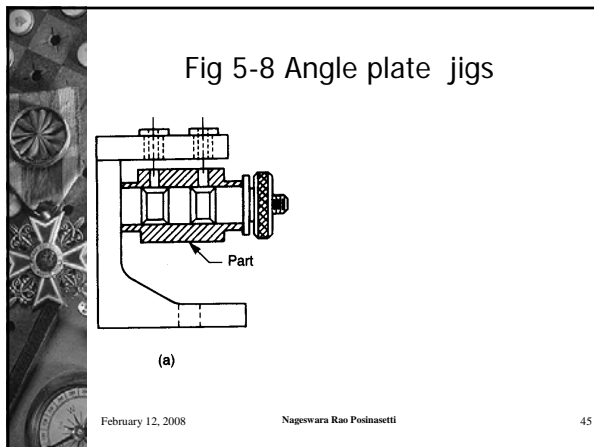


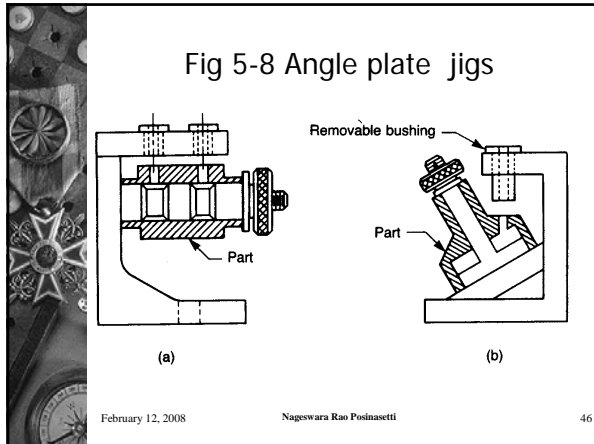


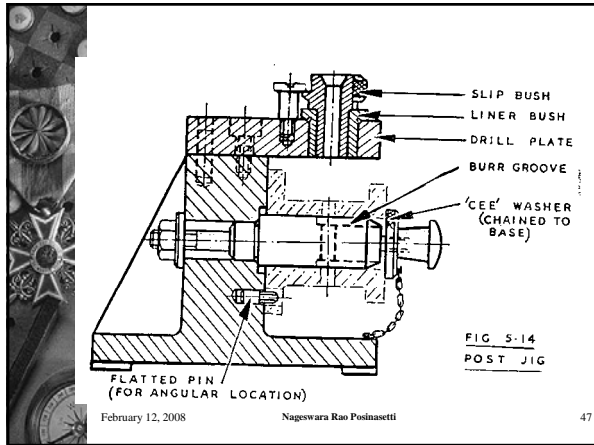


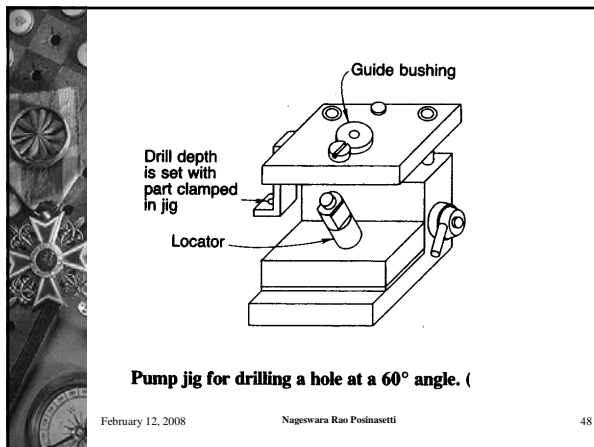


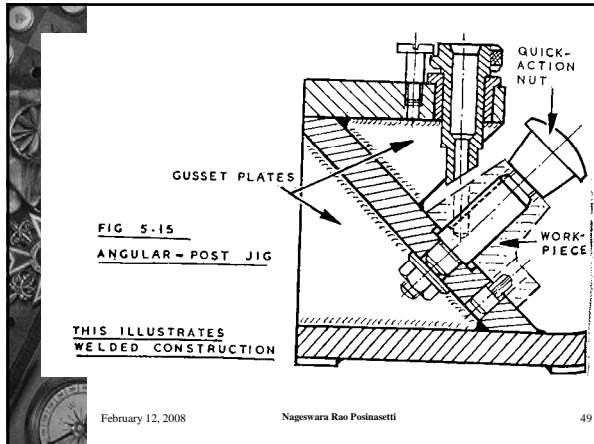


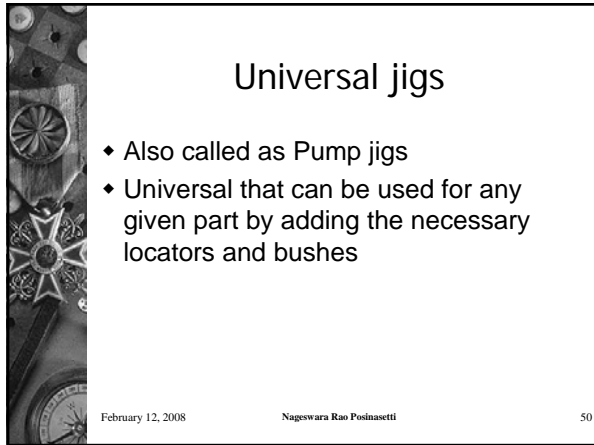


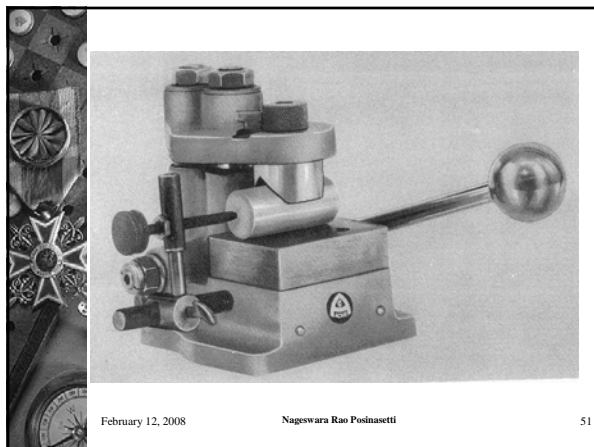


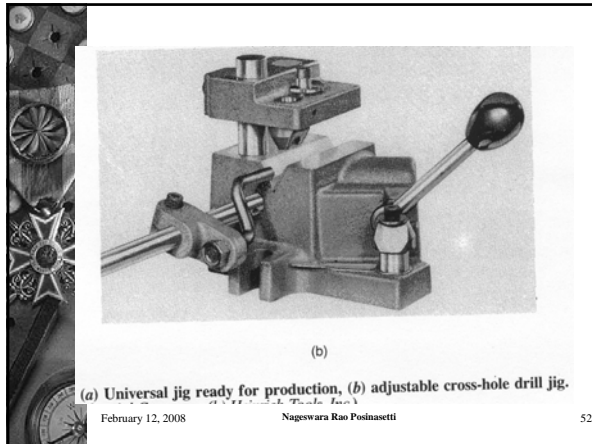


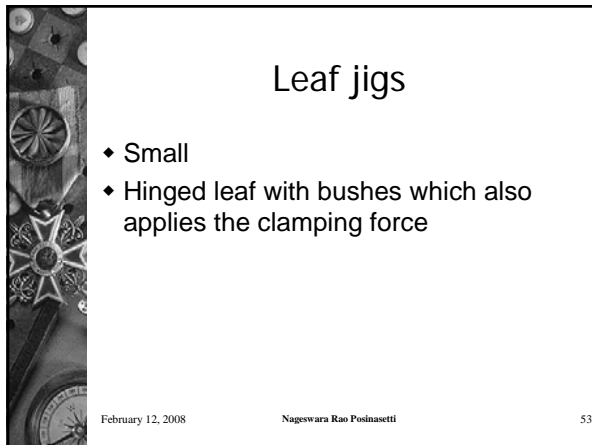


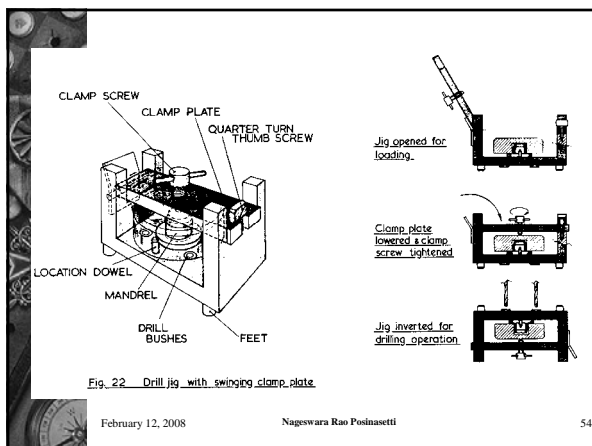


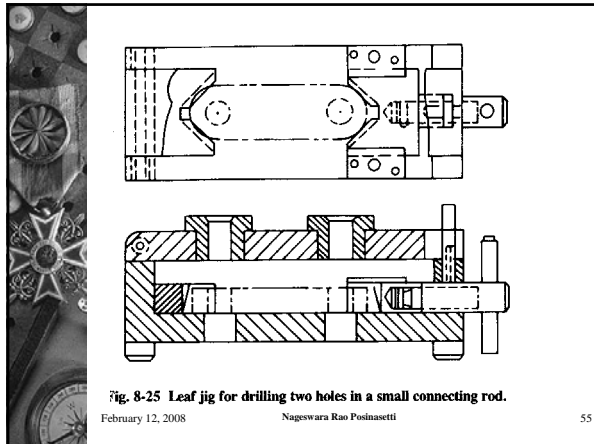


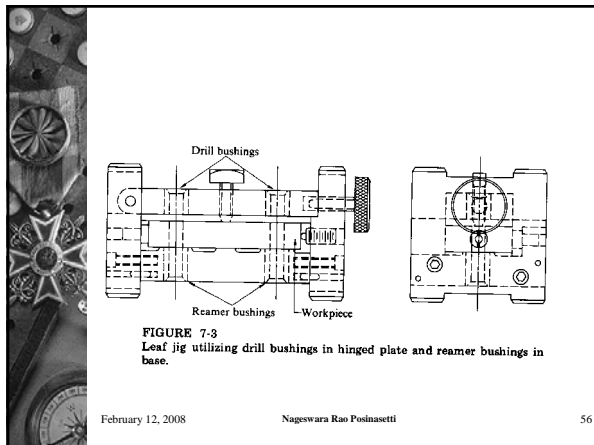


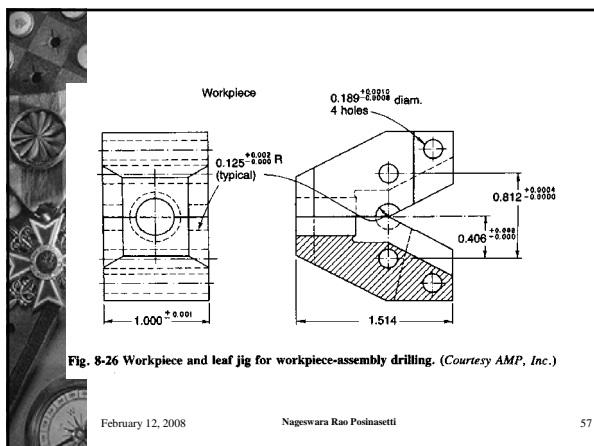


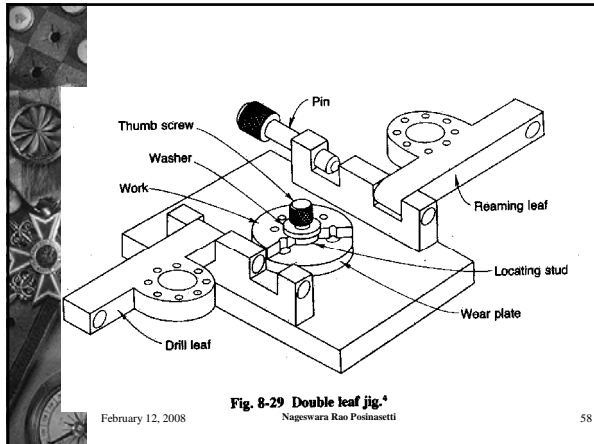


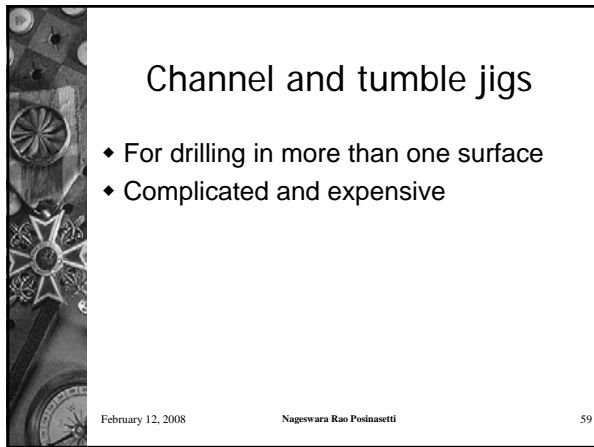


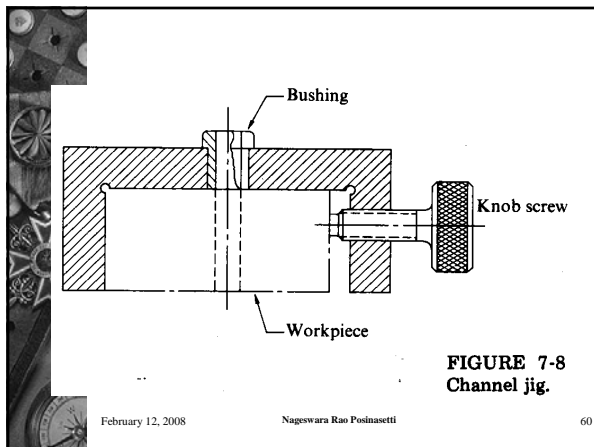


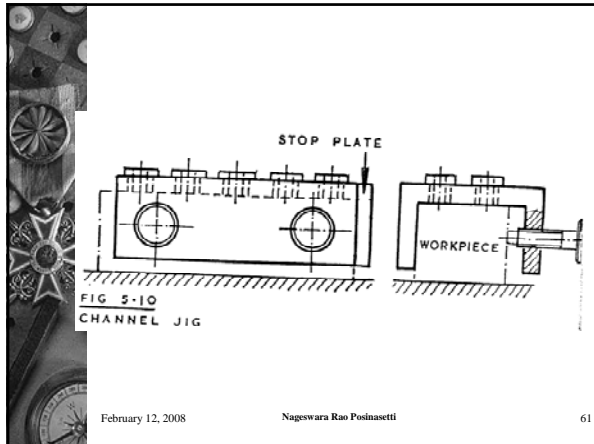


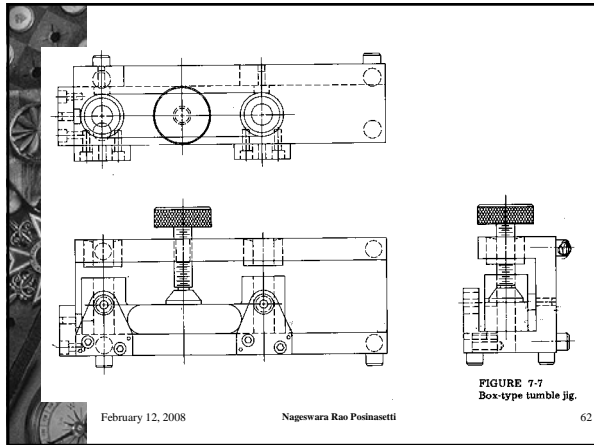


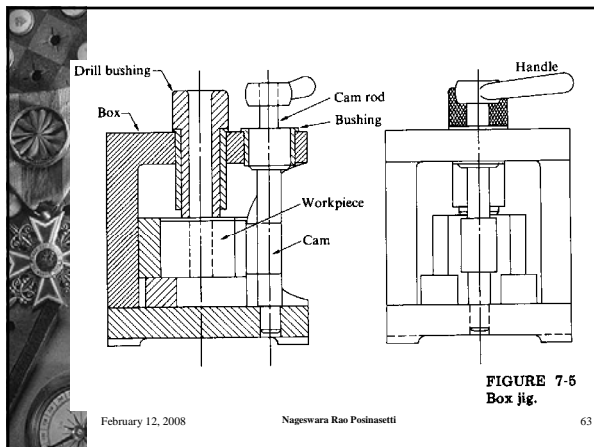


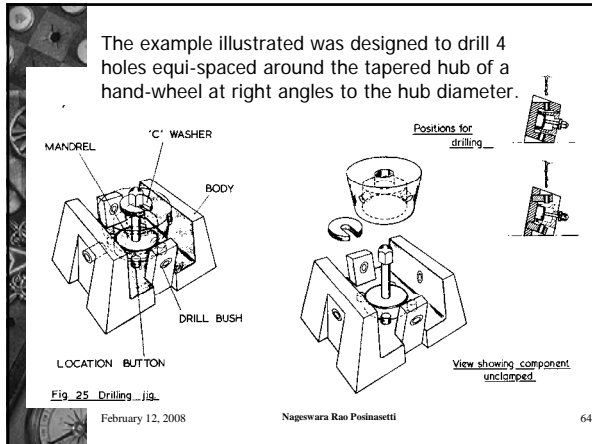


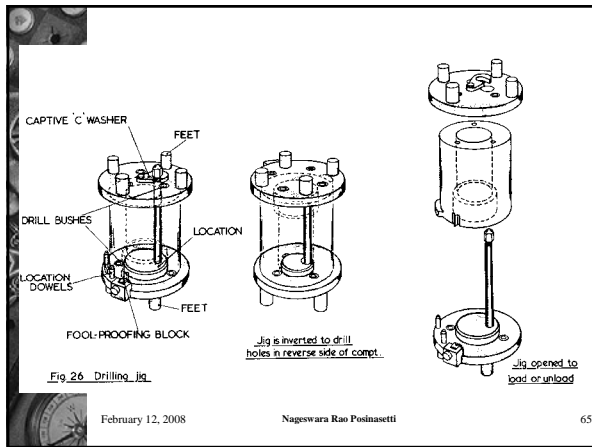


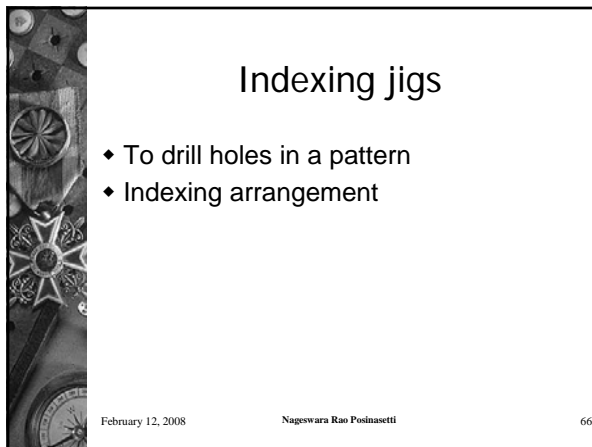


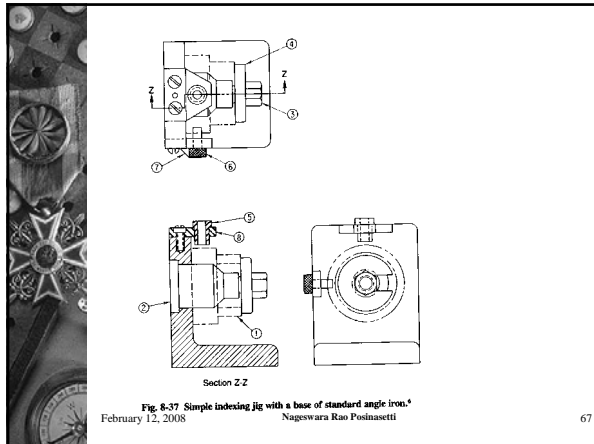


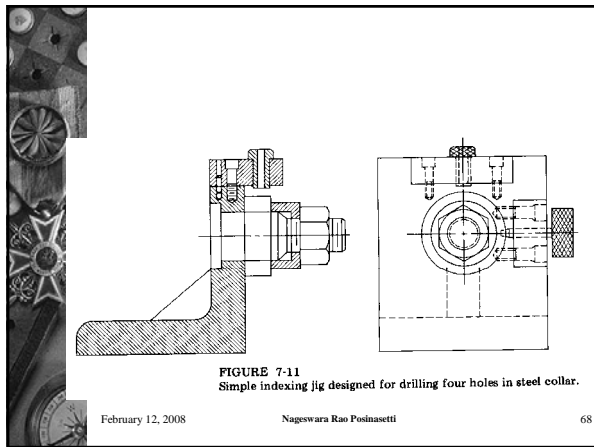


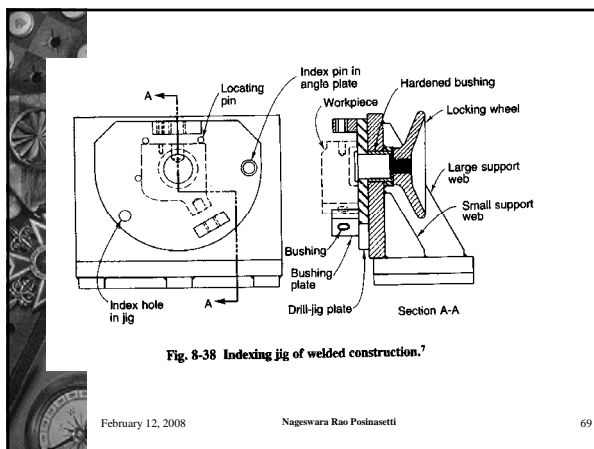










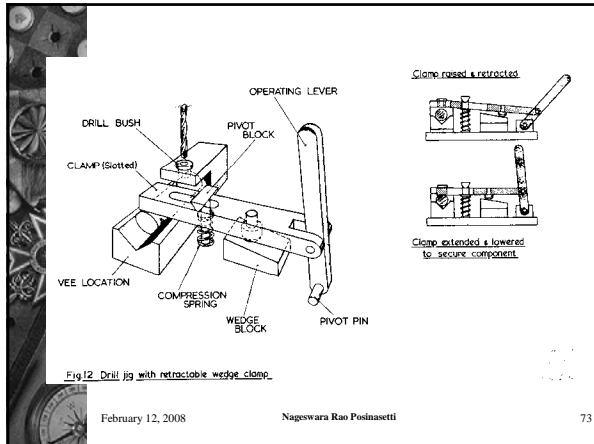


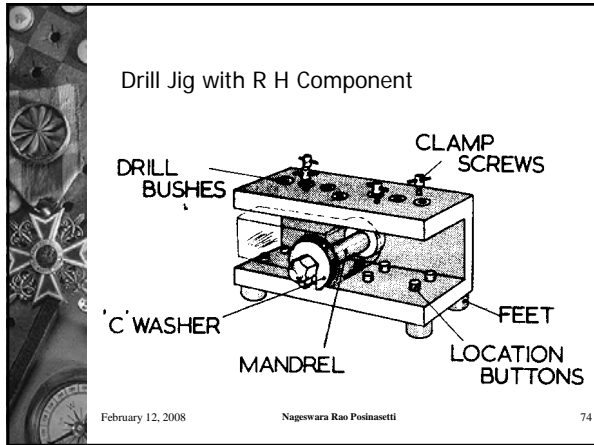
Miscellaneous jigs

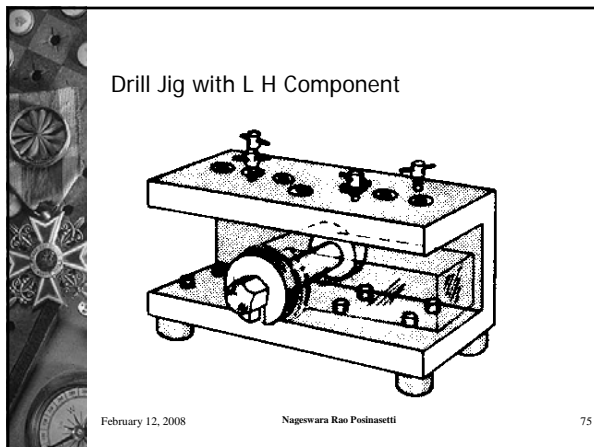
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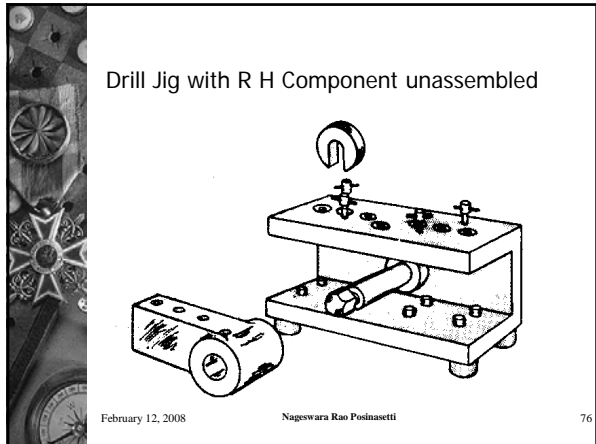
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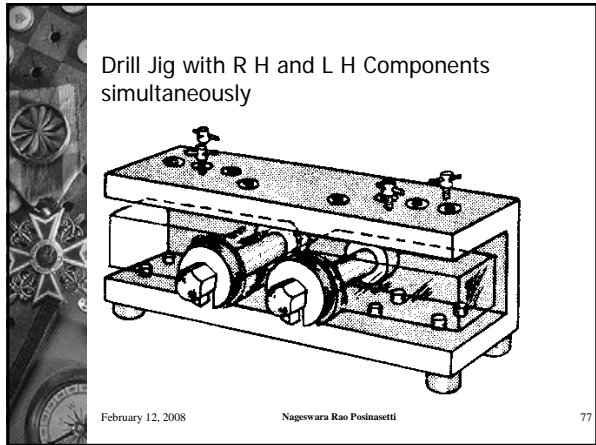
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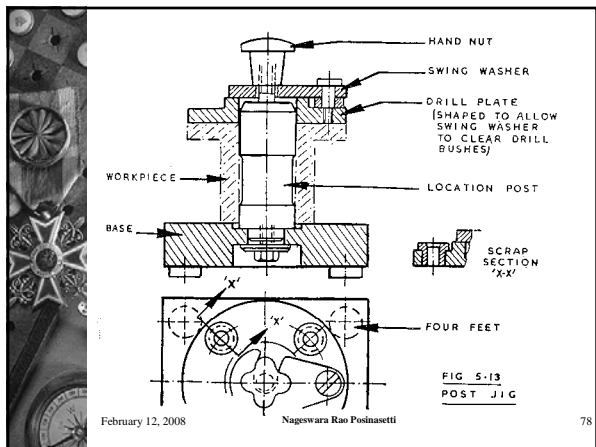


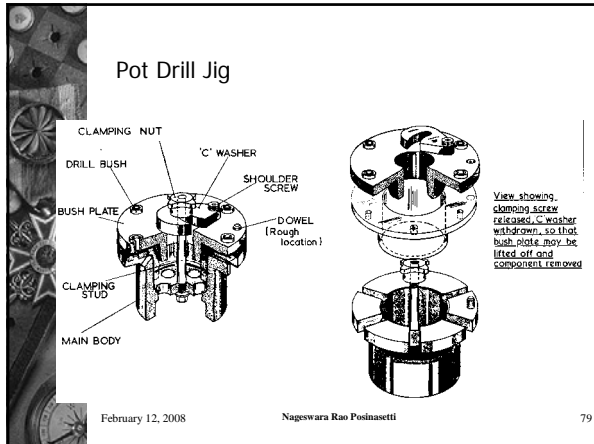


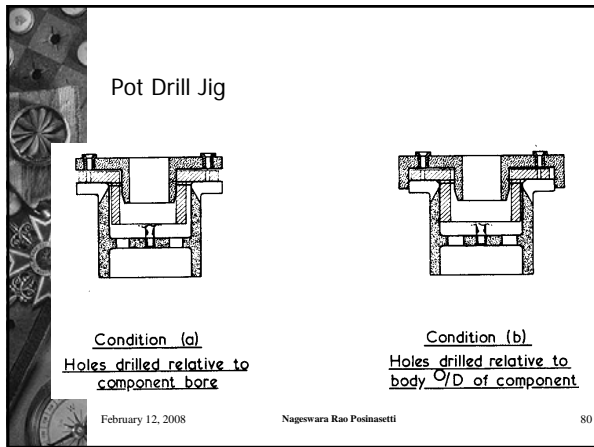


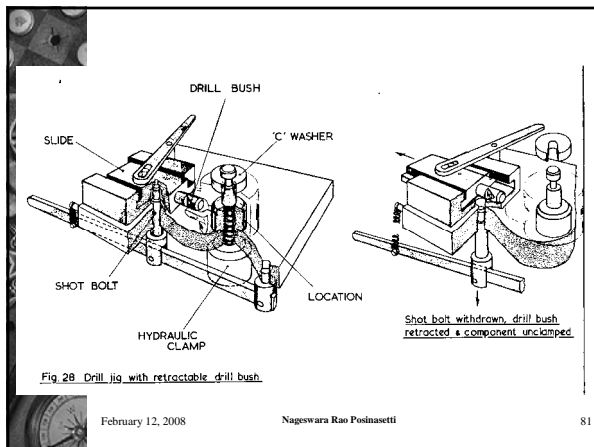


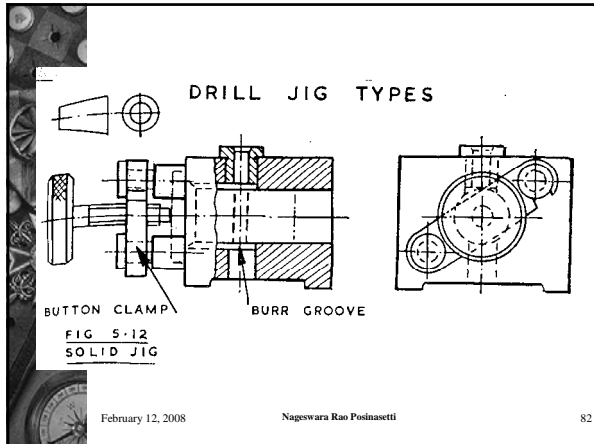


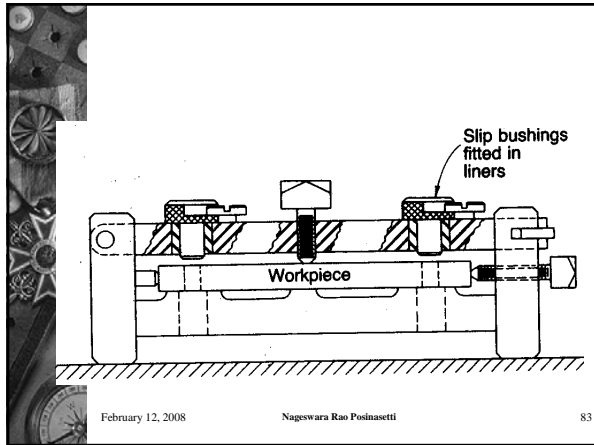


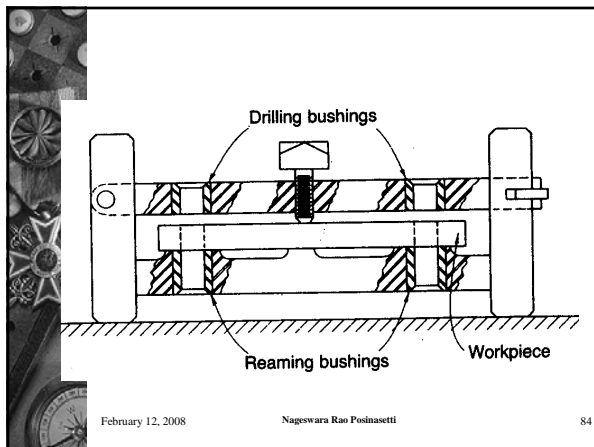














Jig Design Guidelines

- ◆ Drill Jigs should be of light construction, consistent with rigidity to facilitate handling, especially when jigs have to be turned over so that holes can be drilled from more than one side.
- ◆ All unnecessary metal should be cored out of the jig body.

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Jig Design Guidelines

- ◆ A jig which is not bolted to the machine table should be provided with feet, preferably four, opposite all surfaces containing guide bushings, so that it will 'rock' if not standing square on the table and so warn the operator.
- ◆ Clearance holes or burr slots should be provided in the jig to allow for the burr formed when the drill breaks through the component and for swarf clearance, particularly from locating faces.

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Jig Design Guidelines

- ◆ Make all component clamping devices as quick acting as possible.
- ◆ Design the jig fool-proof by the use of foul pins and similar devices, that is arrange it so that the component, tools or bushes cannot be inserted except in the correct way.
- ◆ Make some locating points adjustable when the component is a rough casting and may be out of alignment.

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Jig Design Guidelines

- ◆ Locate clamps so that they will be in the best position to resist the pressure of the cutting tool when at work.
- ◆ If possible, make all clamps integral parts of the jig and avoid the use of loose parts.
- ◆ Avoid complicated clamping and locating arrangements which are liable to wear or need constant attention.

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Jig Design Guidelines

- ◆ Place all clamps as nearly as possible opposite some bearing point of the component to avoid springing the component and in accessible positions.
- ◆ All sharp edges should be removed from the various detail parts of the jig.
- ◆ Provide handles or other devices wherever these will make the handling of the jig more convenient.

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Jig Design Guidelines

- ◆ If possible, place all tool guide bushings inside the geometrical figure formed by connecting the points of location of the feet.
- ◆ Make, if possible, all locating points visible to the operator when placing the component in position in the jig so that the component can be seen to be correctly located. The operator should also be able to have an unobstructed view of the clamps.

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Jig Design Guidelines

- ◆ Before using the jig in the machine shop for commercial purposes, test all jigs as soon as they are made.
- ◆ The location points, which are hardened if necessary, are established with considerations to machining operations, if any, to follow and that any mating parts are located from the same datum surface.

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Jig Design Guidelines

- ◆ Locating and clamping arrangements are designed to reduce idle time to a minimum by using simple clamps which are easy and quick to operate and also operate without damaging the component.
- ◆ Springs should be used whenever possible to elevate the clamps clear of the component whilst being loaded or unloaded.

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Jig Design Guidelines

- ◆ Clamps should be positioned above the points supporting the component, in order to avoid distortion and should be strong enough to hold the component without bending.
- ◆ Generally clamps should not be relied upon for holding the work against the pressure exerted by the cutting tool.

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Jig Design Guidelines

- ◆ Locating and supporting surfaces should, whenever possible, be renewable.
 - Such surfaces should be of hard material.


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Jig Design Guidelines

- ◆ The process of inserting and withdrawing the component from the jig should be as easy as possible.
 - Ample space should be left between the jig body and the component for hand movements.
 - Some means of ejection should exist to release the component if it sticks in the jig.


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Jig Design Guidelines

- ◆ The design of the jig must be safe.
 - Handles or levers should be large enough to clear adjacent parts so that pinched fingers are avoided.


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Jig Design Guidelines

- ◆ If necessary, make provision for the use of coolant.
- ◆ Position locations at places where there is no flash or burr on the component.


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Jig Design Guidelines

- ◆ If possible, eliminate spanners by the use of levers.
 - If spanners have to be used, make one spanner fit all the clamp operating bolts and nuts.
- ◆ Consideration should be given at the design stage to the use of standardised jig components.

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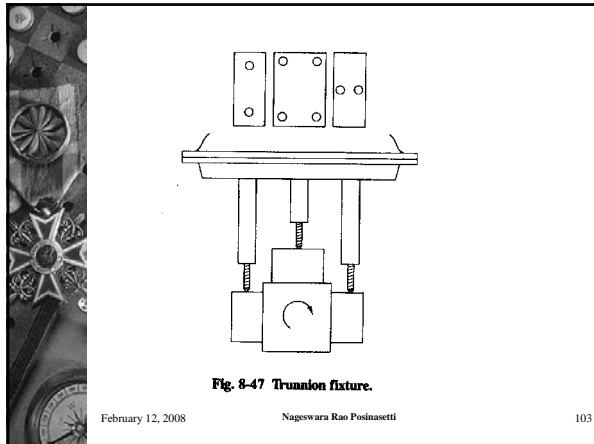
Power requirement for Drilling

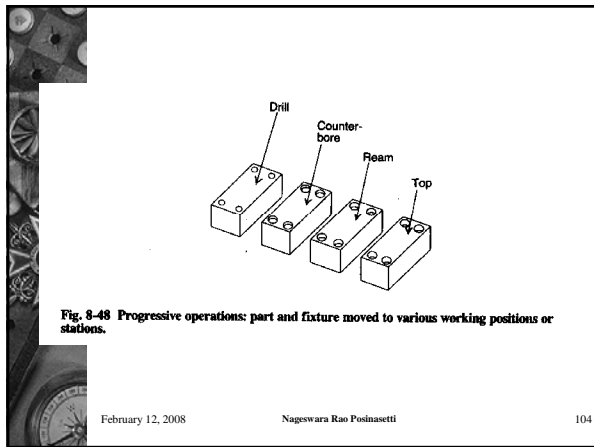
Torque, $M = K A f^{0.8} d^{1.8}$

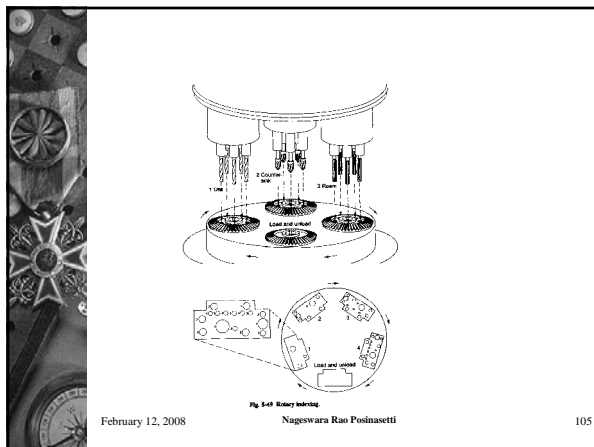
Thrust, $T = 2 K B f^{0.8} d^{0.8} + K E d^2$


- d = drill diameter, in
- K, A, B, E - Constants

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Basic Design Steps

- ◆ 1. Method of locating the part – identify the standard components required for locating purpose.
- ◆ 2. Design the clamping method. Make a proper choice of clamps – C-washer, swing washer, nut, strap clamp, toggle clamp, etc.
- ◆ 3. Design any supports required
- ◆ 4. Design the jig bushes required.
- ◆ 5. Design the jig body.

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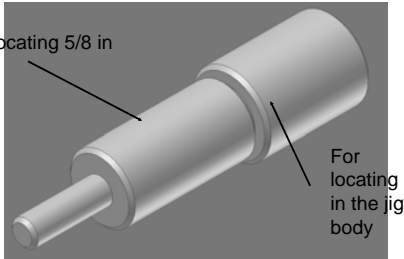


Design Study – Drill Jig



- ◆ 1. Method of locating the part – The central hole which helps in locating as well as indexing for the hole.
- ◆ 2. Clamping can be done with a nut and a C-washer
- ◆ Indexing will have to be done with a plunger type retracting.

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