Automation is incorporated into a machine tool or machining system as a whole to achieve greater productivity with a consistent quality target to meet the great requirements and the overall economy. This automation allows rapid and precise auxiliary movements, i.e. handling operations such as the assembly of tools, the feeding of bars, the indexing of tools, etc., Repeatable with the minimum human intervention but with the help of special mechanisms or additional and control systems. These systems can be mechanical, electromechanical, hydraulic or electronic or their combination. It has already been mentioned that, according to the degree of automation, machine tools are classified as,

- Non-automatic, where most of the handling operations, independently of the processing operations, are performed manually, such as central lathes, etc.
- Semi-automatic
- Automatic in which all operations or auxiliary operations, as well as processing operations, are performed automatically.

General purpose machine tools can have both fixed automation and flexible automation, in which the latter is characterized by computerized numerical control (CNC). Among machine tools, lathes are more versatile and widely used. Only the automation of lathes was discussed here. Conventional automatic lathes of general use can be classified as,

Semiautomatic:

- Capstan lathe (ram type turret lathe)
- Turret lathe
- Multiple spindle turret lathes
- copying (hydraulic) lathe

Automatic:

- Automatic cutting off lathe
- Single spindle automatic lathe
- Swiss type automatic lathe
- Multiple spindle automatic lathes

The other categories of semiautomatic and automatic lathes are: o Vertical turret lathe o Special purpose lathes o Non-conventional type, i.e., flexibly automatic CNC lathes, turning Centre etc.

Semiautomatic lathes

The characteristic features of such lathes are;

- some major auxiliary motions and handling operations like bar feeding, speed change, tool change etc. are done quickly and consistently with lesser human involvement
- The operators need lesser skill and putting lesser effort and attention
- Suitable for batch or small lot production
- Costlier than center lathes of same capacity.

Capstan and Turret lathes

The semiautomatic lathes, capstan lathe and turret lathe are very similar in construction, operation and application. Fig.1 Schematically shows the basic configuration of capstan lathe and turret lathe.

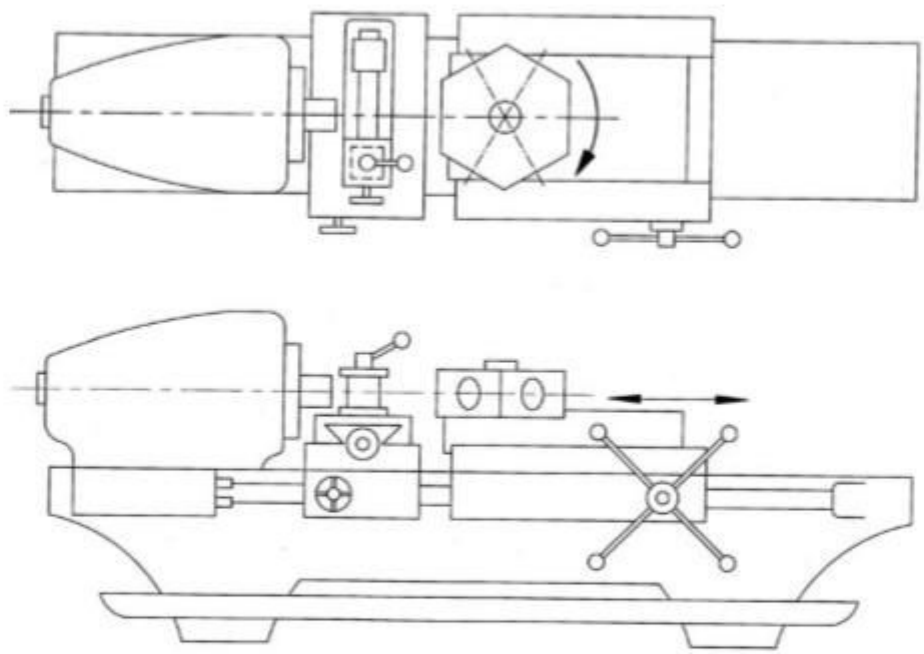

Fig. 1

In contrast to center lathes, capstan and turret lathes

- are semiautomatic
- possess an axially movable index able turret (mostly hexagonal) in place of tailstock
- holds large number of cutting tools; up to four in index able tool post on the front slide, one in the rear slide and up to six in the turret (if hexagonal) as indicated in the schematic diagrams.
- are more productive for quick engagement and overlapped functioning of the tools in addition to faster mounting and feeding of the job and rapid speed change.
- enable repetitive production of same job requiring less involvement, effort and attention of the operator for pre-setting of work–speed and feed rate and length of travel of the cutting tools
- are relatively costlier
- are suitable and economically viable for batch production or small lot production.

There are some differences in between capstan and turret lathes such as,

- Turret lathes are relatively more robust and heavy-duty machines
- Capstan lathes generally deal with short or long rod type blanks held in collet, whereas turret lathes mostly work on chucking type jobs held in the quick acting chucks
- In capstan lathe, the turret travels with limited stroke length within a saddle type guide block, called auxiliary bed, which is clamped on the main bed as indicated in Fig, whereas in turret lathe, the heavy turret being mounted on the saddle which directly slides with larger stroke length on the main bed as indicated in Fig.1
- External screw threads are cut in capstan lathe, if required, using a self-opening die being mounted in one face of the turret, whereas in turret lathes external threads are generally cut, if required, by a single point or multipoint chasing tool being mounted on the front slide and moved by a short lead screw and a swing type half nut.

Fig.1 below is showing the pictorial views of a typical capstan lathe, Ram type turret lathes, i.e., capstan lathes are usually single spindle and horizontal axis type. Turret lathes are also mostly single spindle and horizontal type but it may be also

- Vertical type and
- Multi spindle type some more productive turret lathes are provided with preemptive drive which enables on-line presetting and engaging the next work-speed and thus help in reducing the cycle time.

Multiple spindles Vertical Turret lathe

Turret lathes are mostly horizontal axis single spindle type. The multiple spindle vertical turret lathes are characterized by:

- Suitably used for large lot or mass production of jobs of generally; Δ chucking type Δ relatively large size Δ requiring limited number of machining operations
- Machine axis – vertical for Δ lesser floor space occupied Δ easy loading and unloading of blanks and finished jobs Δ relieving the spindles of bending loads due to job – weight.
- Number of spindle – four to eight.

Fig. visualize the basic configuration of multiple spindle vertical turret lathes which are comprised mainly of a large disc type spindle carrier and a tool holding vertical ram as shown.

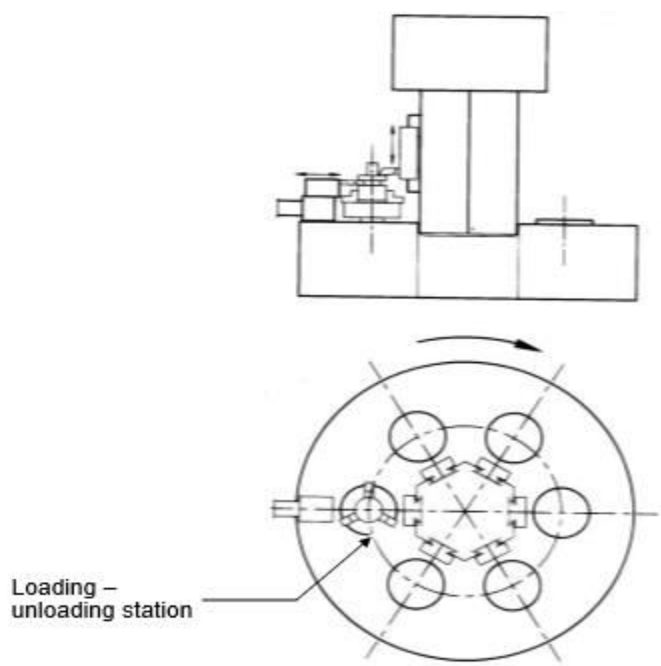

Fig. 2

Progressively processing type:

The spindle carrier with the blanks fitted in the chucks on the rotating spindle is indexed at regular interval by a Geneva mechanism. At each station the job undergoes a few preset machining works by the axially and / or radically fed cutting tools. The blank getting all the different machining operations progressively at the different work stations is unloaded at a particular station where the finished job is replaced by another fresh blank. This type of lathes is suitable for jobs requiring large number of operations.

(a) Continuously working type:

Like in parallel processing type, here also each job is finished in the respective station where it was loaded. The set of cutting tools, mostly fed only axially along a face of the ram continuously work on the same blank throughout its one cycle of rotation along with the spindle carrier. The tool ram having same tool sets on its faces also rotate simultaneously along with the spindle carrier which after each rotation halts for a while for unloading the finished job and loading a fresh blank at a particular location. Such system is also suitable for jobs requiring very few and simple machining operations.

Hydraulic copying (tracer controlled) lathes Jobs having steps, tapers and / or curved profiles, as typically shown in Fig.3, are conveniently and economically produced in batch or lot in semi automatically operated tracer controlled hydraulic copying lathe. The movement of the stylus along the template provided with the same desired job-profile) is hydraulically transmitted to the cutting tool tip which replicates the template profile.

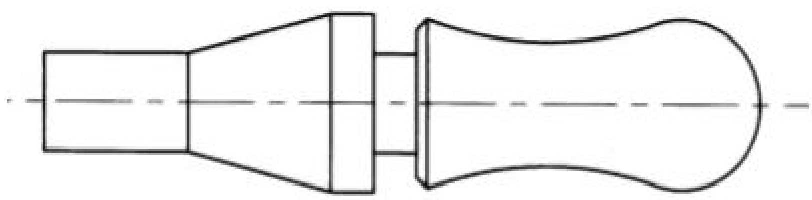

Fig.3

(b) General Purpose Automatic lathes

Automatic lathes are essentially used for large lot or mass production of small rod type of jobs. Automatic lathes are also classified into some distinguished categories based on constructional features, operational characteristics, number of spindles and applications are as follows

Automatic cutting off lathe

These simple but automatic lathes are used for producing short work pieces of simple form by using few cross-feeding tools. In addition to parting some simple operations like short turning, facing, chamfering etc. are also done.

Single spindle automatic lathe

The general purpose single spindle automatic lathes are widely used for quantity or mass production (by machining) of high quality fasteners; bolts, screws, studs etc., bushings, pins, shafts, rollers, handles and similar small metallic parts from long bars or tubes of regular section and also often from separate small blanks. Fig.4 Show a typical single spindle automatic lathe. Unlike the semiautomatic lathes, single spindle automats are:

- Preferably and essentially used for larger volume of production i.e., large lot production and mass production
- used always for producing jobs of rod, tubular or ring type and of relatively smaller size.

- run fully automatically, including bar feeding and tool indexing, and continuously over a long duration repeating the same machining cycle for each product
- provided with up to five radial tool slides which are moved by cams mounted on a cam shaft of relatively smaller size and power but have higher spindle speeds

Swiss type automatic lathe

The characteristics and applications of these single spindle automatic lathes are:

- In respect of application: Used for lot or mass production of thin slender rod or tubular jobs, like components of small clocks and wrist watches, by precision machining; o Job size (approximately) – Diameter range – 2 to 12 mm – Length range – 3 to 30 mm Dimensional accuracy and surface finish – almost as good as provided by grinding
- In respect of configuration and operation o The headstock travels enabling axial feed of the bar stock against the cutting tools as indicated in Fig., There is no tailstock or turret o High spindle speed (2000 – 10,000 rpm) for small job diameter o The cutting tools (up to five in number including two on the rocker arm) are fed radically o Drilling and threading tools, if required, are moved axially using swiveling device(s) o The cylindrical blanks are prefinished by grinding and are moved through a carbide guide bush as shown.

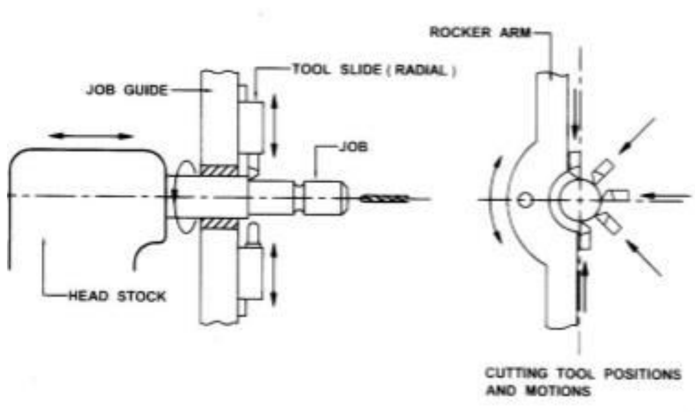

Fig.4

Multi spindle automatic lathes

For further increase in rate of production of jobs usually of smaller size and simpler geometry. Multi spindle automatic lathes having four to eight parallel spindles are preferably used. Unlike multi spindle turret lathes, multi spindle automatic lathes are horizontal (for working on long bar stocks) o work mostly on long bar type or tubular blanks Multiple spindle automats also may be parallel action or progressively working type. Machining of the inner and outer races in mass production of ball bearings are, for instance, machined in multi spindle automatic lathes.

(ii) Kinematic Systems and Working Principles of Semi-Automatic and Automatic Lathes

The kinematic systems and basic principles of working of the following general purpose semi-automatic and automatic lathes of common use have been visualized and briefly discussed here:

(a) Semi-automatic lathes:

- Capstan and single spindle turret lathe
- Hydraulic copying lathe

(b) Automatic lathes

- Single spindle automatic (screw cutting) lathe
- Swiss type automatic lathe

Kinematic system and working principle of capstan lathe

Like general configurations and applications, the basic kinematic systems are also very similar in capstan lathes and turret lathes (particularly single spindle bar and horizontal types) in respect of their major functions, i.e., bar feeding mechanism of turret moving and indexing o speed and feed drives

Bar feeding mechanism of capstan lathe Fig. typically shows the kinematic arrangement of feeding and clamping of bar stock in capstan lathes. The bar stock is held and tightly clamped in the push type spring collets which is pushed by a push tube with the help of a pair of bell-crank levers actuated by a taper ring as shown in Fig. Bar feeding is accomplished by four elementary operations; o unclamping of the job – by opening the collets o bar feed by pushing it forward o clamping of the bar by closing the collets of free return of the bar-pushing element after a job is complete and part off, the collets are opened by moving the lever manually rightward to withdraw the push force on the collets. Further moving of the lever in the same direction causes forward push of the bar with help of ratchet Pawl system. After the projection of the bar from the collets face to the desired length controlled by a pre-set stop – stock generally held in one face of the turret or in a separate swing stop, the lever is moved leftward resulting closing of the collets by clamping of the bar stock. Just before clamping of the collets, the leftward movement of the lever pushes the bar feeder (ratchet) back freely against the Paul.

Turret indexing mechanism in capstan and turret lathes Turret indexing mechanism of capstan and single spindle turret lathe is typically shown schematically in Fig. The turret (generally hexagonal) holding the axially moving cutting tools have the following motions to be controlled mechanically and manually of forward axial traverse comprising;

- quick approach – manually done by rotating the pinion as shown
- slow working feed – automatically by engaging the clutch
  stop at preset position depending upon the desired length of travel of the individual tools o quick return – manually done by disengaging the clutch and moving the turret back o indexing of the turret by 60o (or multiple of it) – done manually by further moving the turret slide back.

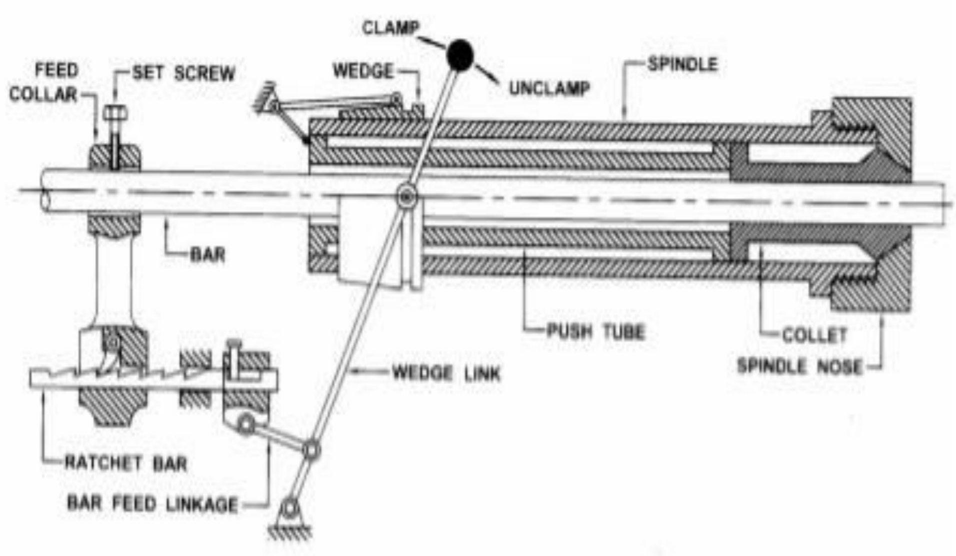

Fig 5

Just before indexing at the end of the return stroke, the locking pin is withdrawn by the lever which is lifted at its other end by gradually riding against the hinged wedge as indicated in Fig. and lever as indicated in Fig.(b). Rotation of the turret head by exact angle is accomplished by insertion of the locking pin in the next hole of the six equal spaced holes. After indexing and locking, the turret head is moved forward with the next cutting tool at its front face when the roller of the lever returns through the wider slot of the wedge without disturbing the locking pin as indicated in the figure. The forward motion of the turret head is automatically stopped when the set-screw corresponding to the working tool is arrested by the mechanical stop. The end position and hence length of travel of the tool is governed by presetting the screw. There are six such screws; each one corresponds with particular face or tool of the turret. The drum holding those equal spaced six screws with different projection length is rotated along with the indexing (rotation) of the turret head by a pair of bevel gears (1:1) as indicated in Fig.4 (a). The bottom most screw, which corresponds with the tool on the front face of the turret, when hits or touches the stop, the turret movement is stopped either manually by feeling or automatically by disengaging the clutch between the feed rod and the turret slide.

(iii) Process Planning and Tool Layout for Machining a Product in Semi-Automatic and Automatic Lathes

The procedural steps to be followed in sequence for batch or lot production of a job by machining in semi-automatic and automatic general-purpose machine tools are:

(a) Thorough study of the job to be produced: in respect of:

- Volume of production, i.e., number of pieces of the specific job to
- Material and its properties
- Size and shape
- Surfaces to be machined
- required dimensions with tolerances and surface finish
- End use of the product

(b) Selection of machine tool (after studying the job): in respect of;

- Type
- Size
- Precision
- Kind and degree of automation

(c) Selection of blank (based on job and machine selected): in respect of;

- bar chucking or housing type
- performed by; casting, forging, rolling etc.
- If bar type; cross section (circular, tubular, square, hexagon etc.)
- Nominal size based on largest dimensions and availability
- performed by hot working or cold working

(d) Identification and listing of the elementary machining operations required, depending upon the product configuration

(e) Combine elementary machining operations as much as possible for saving time

(f) Sequence the operations (after combining)

(g) Select cutting tools: in respect of;

- Type
- Material
- Size
- Geometry

Depending upon the machining operations (after combining) and work material chart giving column-wise:

- speed and feed for each operation
- cutting fluid application;
- The cutting tools and their location and mounting.
- Availability

(h) Work scheduling or preparation of the instruction sheet or operation

- Description of the machining work to be done in sequence
- cutting tools: type and location
- Length of travel of the tools Yes or not required type of cutting fluid of

(i) Tool layout: schematically showing the type and configuration of A typical tool layout for a particular job being machined in a single spindle automatic lathe is schematically shown in Fig.6-

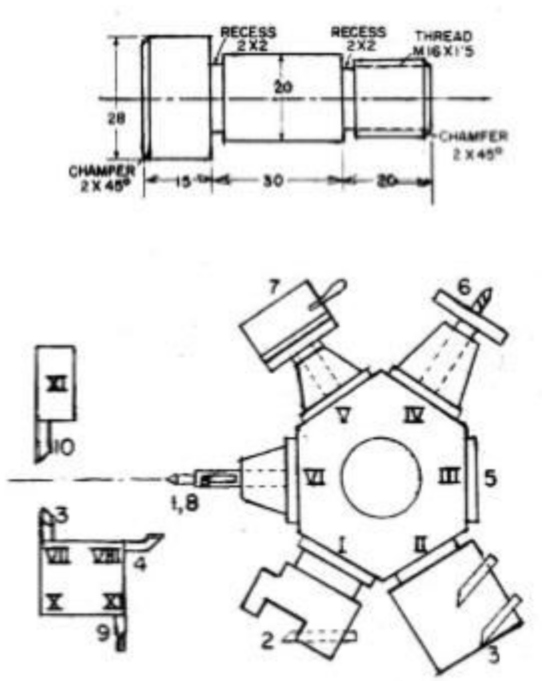

Fig.6

****