

Module 4 General Purpose Machine Tools

Lesson 22

Use of various Attachments in Machine Tools.

Instructional objectives

At the end of this lesson, the students will be able to;

- (i) Comprehend and state the use of accessories and attachments in machine tools
- (ii) Realize and Identify why and when Attachments are necessarily used
- (iii) Describe the basic construction and application principles of different attachments used in;
 - Centre lathes
 - Drilling machines
 - Shaping machines
 - Planing machines
 - Milling machines

(i) Use Of Various Accessories And Attachments In General Purpose Machine Tools.

ACCESSORIES :

A general purpose machine tool is basically comprised of power drive and kinematic system for the essential formative and auxiliary tool – work motions and a rigid body or structure to accommodate all of the above. But several additional elements or devices called accessories are also essentially required for that machines' general functioning, mainly for properly holding and supporting the workpiece and the cutting tool depending upon the type and size of the tool – work and the machining requirements.

These accessories generally include for instance, in case of;

- Centre lathes : chucks, collets, face plate, steady and follower rests, centres, tool holders etc.
- Drilling machines : vices, clamps, drill chuck and sockets etc.
- Shaping and planing machines : vices, clamps, tool holders etc.
- Milling machines : vices, clamps, parallel blocks, collets, job – support like tailstock etc.

Such accessories, inevitable for general functioning of the machine tools, are usually enlisted in the supply list and covered within the total price of the machine tools. Occasionally, some accessories are ordered separately as and when required.

ATTACHMENTS

Each general purpose conventional machine tool is designed and used for a set of specific machining work on jobs of limited range of shape and size. But often some unusual work also need to be done in a specific machine tools, e.g. milling in a lathe, tapping in a drilling machine, gear teeth cutting in shaping machine and so on. Under such conditions, some special devices or systems are additionally used being mounted in the ordinary machine tools. Such additional special devices, which augment the processing capability of any ordinary machine tool, are known as Attachments, Unlike accessories, Attachments are not that inevitable and procured separately as and when required and obviously on extra payment. Some attachments being used in the general purpose conventional machine tools are :

- **In centre lathes :**
 - Taper turning attachment
 - Copy turning attachments
 - Milling and cylindrical grinding attachments
 - Spherical turning attachments
 - Relieving attachment
- **In drilling machines :**
 - Tapping attachment
- **In shaping machines :**
 - Double cut tool head
 - Thread rolling attachment
 - Matterson's attachment (gear teeth cutting)
- **In planing machines :**
 - Contour forming attachment
 - Helical grooving attachment
 - Oil grooving attachments
 - Milling and grinding attachments
- **In Milling machines :**
 - universal milling attachment
 - indexing / dividing head
 - rotary table
 - slotting attachment

(ii) Conditions And Places Suitable For Application Of Attachments In Machine Tools.

With the rapid and vast advancement of science and technology, the manufacturing systems including machine tools are becoming more and more versatile and productive on one hand for large lot or mass production and also having flexible automation and high precision on the other hand required for production of more critical components in pieces or small batches. With the increase of versatility and precision (e.g., CNC machines) and the advent of dedicated high productive special purpose machines, the need of use of special attachments is gradually decreasing rapidly.

However, some attachments are occasionally still being used on non automatic general purpose machine tools in some small and medium scale machining industries;

- when and where machining facilities are very limited
- when production requirement is very small, may be few pieces
- product changes frequently as per job order
- repair work under maintenance, specially when spare parts are not available
- when CNC machine tools and even reasonable number of conventional machine tools cannot be afforded.

Therefore, use of aforesaid attachments is restricted to manufacture of unusual jobs in small quantities under limited facilities and at low cost.

(iii) Working Principles And Application Of Various Attachments In Different Machine Tools.

(a) Attachments used in centre lathes

- **Taper turning attachment**

Taper cylindrical surface, which is a very common feature of several engineering components, is generally produced in lathes in a number of methods, depending upon length and angle of the tapered position of the job, such as offsetting tailstock, swivelling the compound slide using form tool and combined feed motions. But jobs with wide ranges of length and angle of taper, are easily machined by using a simple attachment, called taper turning attachment. Fig. 4.6.1 schematically shows a taper turning attachment where the cross slide is delinked from the saddle and is moved crosswise by the guide block which moves along the guide bar preset at the desired taper angle. Thus, the cutting tool, which is fitted on the cross slide through the tool post and the compound slide, also moves along with the guide block in the same direction resulting the desired taper turning.

- **Copy turning attachment**

There are two common types of copy turning;

- mechanical type
- hydraulic type

- **Mechanical copying**

A simple mechanical type copy turning attachment has been schematically shown in Fig. 4.6.2. The entire attachment is mounted on the saddle after removing the cross slide from that. The template replicating the job-profile desired is clamped at a suitable position on the bed. The stylus is fitted in the spring loaded tool slide and while travelling longitudinally along with saddle moves in transverse direction according to the template profile enabling the cutting tool produce the same profile on the job as indicated in the Fig. 4.6.2

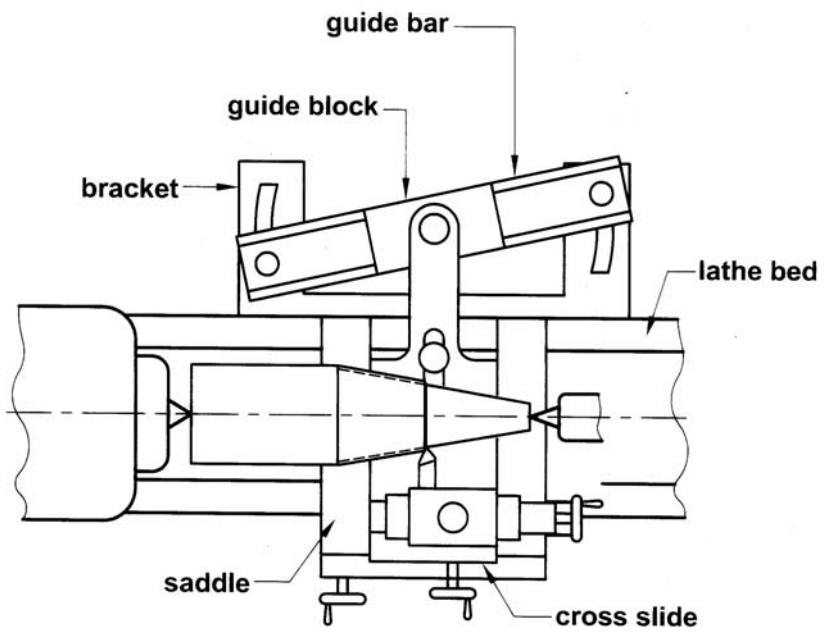


Fig. 4.6.1 *Taper turning attachment.*

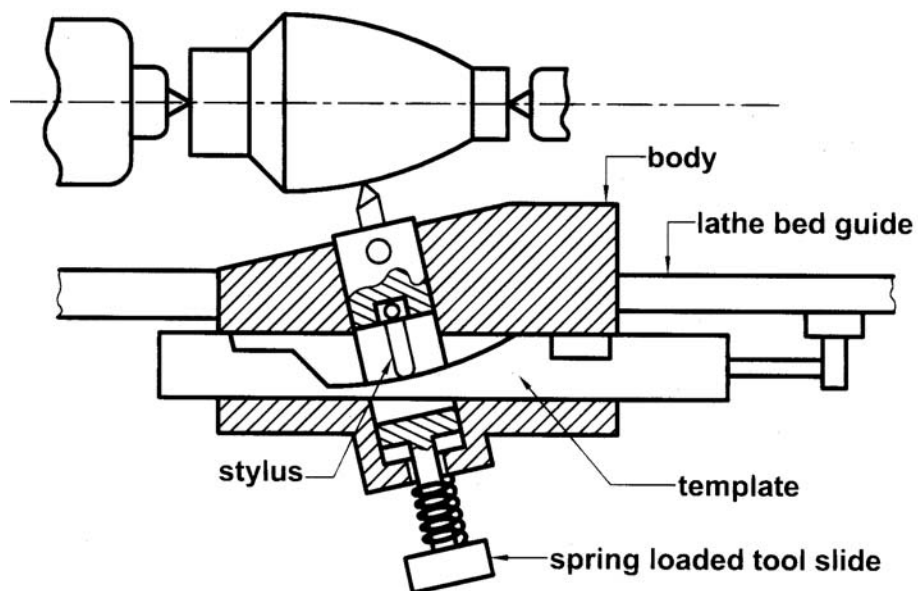


Fig. 4.6.2 *Mechanical type copying attachment.*

○ Hydraulic copying attachment

The mounting and working principle of hydraulic copying attachment for profile turning in centre lathe are schematically shown in Fig. 4.6.3. Here also, the stylus moves along the template profile to replicate it on the job. In mechanical system (Fig. 4.6.2) the heavy cutting force is transmitted at the tip of the stylus, which causes vibration, large friction and faster wear and tear. Such problems are almost absent in hydraulic copying, where the stylus works simply as a valve – spool against a light spring and is not affected by the cutting force. Hydraulic copying attachment is costlier than the mechanical type but works much smoothly and accurately. The cutting tool is rigidly fixed on the cross slide which also acts as a valve – cum – cylinder as shown. So long the stylus remains on a straight edge parallel to the lathe bed, the cylinder does not move transversely and the tool causes straight turning. As soon as the stylus starts moving along a slope or profile, i.e., in cross feed direction the ports open and the cylinder starts moving accordingly against the piston fixed on the saddle. Again the movement of the cylinder i.e., the slide holding the tool, by same amount travelled by the stylus, and closes the ports. Repeating of such quick incremental movements of the tool, Δx and Δy result in the profile with little surface roughness.

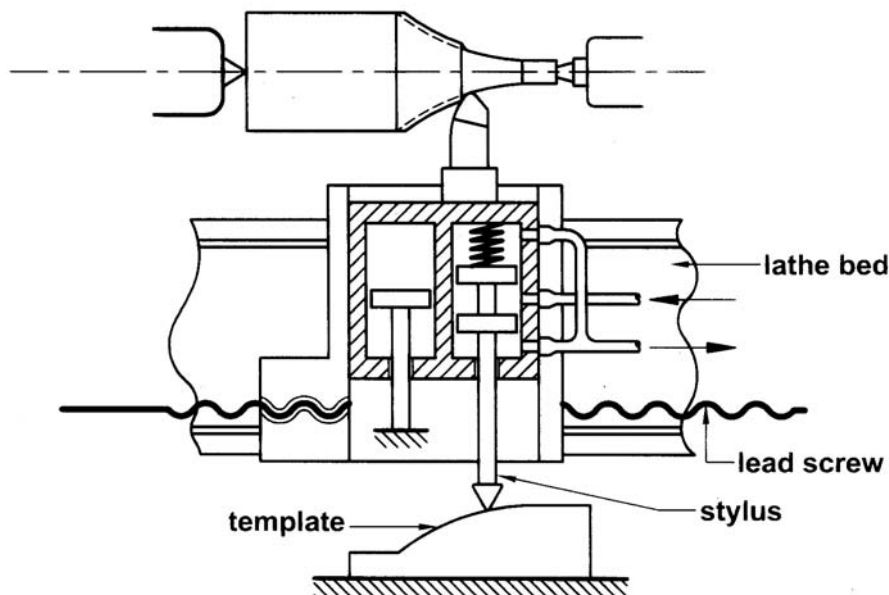


Fig. 4.6.3 Hydraulic copying attachment.

● Milling attachment

This is a milling head, comprising a motor, a small gear box and a spindle to hold the milling cutter, mounted on the saddle after removing the cross slide etc. as shown in Fig. 4.6.4. Milling attachments are generally used for making

flat surfaces, straight and helical grooves, splines, long and deep screw threads, worms etc. in centre lathes by using suitable milling cutters.

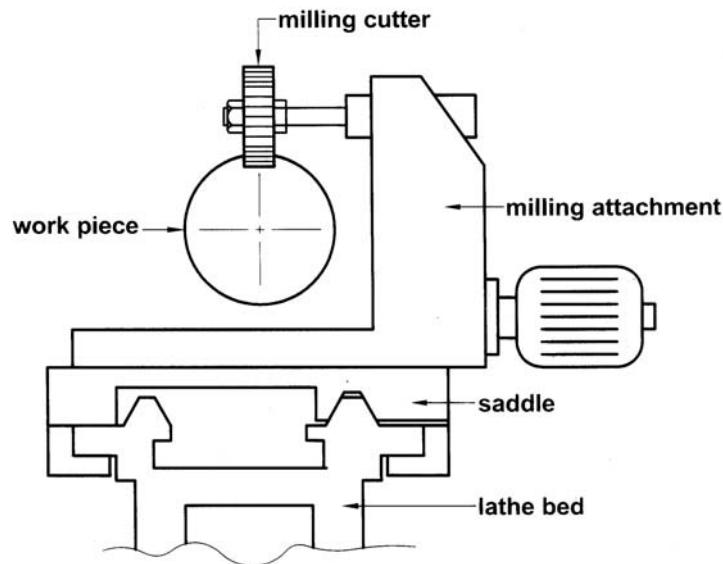


Fig. 4.6.4 *Milling attachment used in lathe.*

- **Grinding attachment**

Grinding attachment is very similar to milling attachment. But in the former, there is no gear box and the spindle speed is much higher as needed for grinding operation. Such attachments are employed for external and internal cylindrical grinding, finishing grooves, splines etc. and also for finish grinding of screw threads in centre lathe. But unlike dedicated machines, attachments cannot provide high accuracy and finish.

- **Spherical turning attachments**

These simple attachments are used in centre lathes for machining spherical; both convex and concave surfaces and similar surfaces. Fig. 4.6.5 schematically visualises the usual setting and working principle of such attachments. In Fig. 4.6.5 (b), the distance R_i can be set according to the radius of curvature desired. In the type shown in Fig. 4.6.5 (a) the desired path of the tool tip is controlled by the profile of the template which is pre-made as per the radius of curvature required. The saddle is disconnected from the feed rod and the leadscrew. So when the cross slide is moved

manually in transverse direction, the tool moves axially freely being guided by the template only.

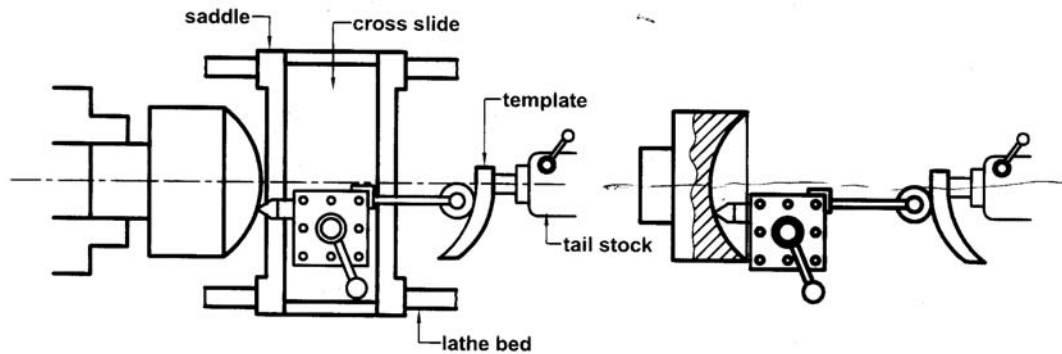


Fig. 4.6.5 (a) Spherical turning using template.

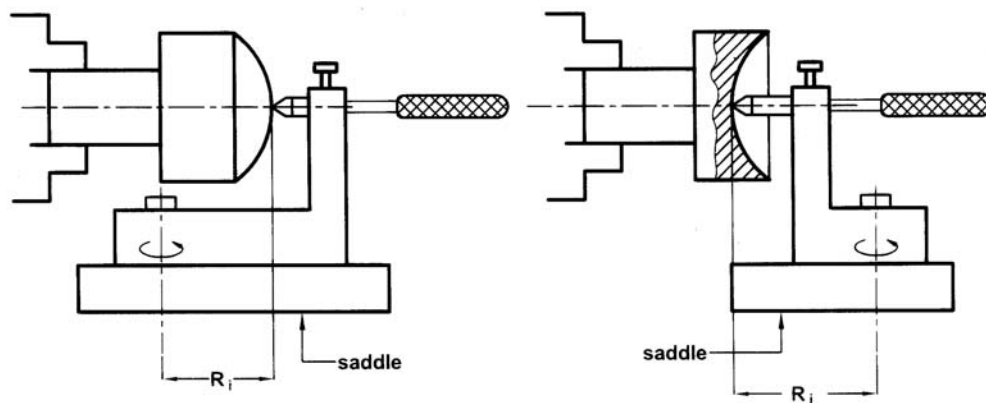


Fig. 4.6.5 (b) Spherical turning without template.

- **Relieving attachment**

The teeth of form relieved milling cutters like gear milling cutters, taps, hobs etc. are provided with flank having archimedean spiral curvature. Machining and grinding of such curved flanks of the teeth need relieving motion to the tool (or wheel) as indicated in Fig. 4.6.6 (a). The attachment schematically shown in Fig. 4.6.6 (b) is comprised of a spring loaded bracket which holds the cutting tool and is radially reciprocated on the saddle by a plate cam driven by the feed rod as indicated.

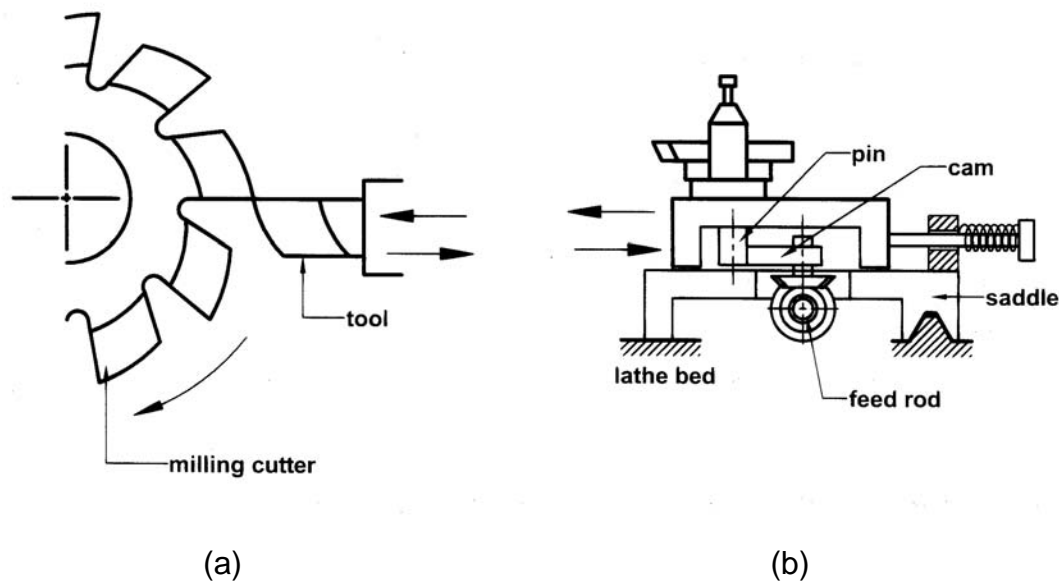


Fig. 4.6.6 Relieving attachment used in lathe.

- **Thread pitch correcting attachment**

While cutting screw thread in centre lathes by single point chasing tool, often the actual pitch, p_a deviates from the desired (or stipulated) pitch, p_s by an error (say $\pm \Delta p$) due to some kinematic error in the lathe.

Mathematically,

$$p_s - p_a = \pm \Delta p \quad (4.6.1)$$

Therefore for correct pitch, the error $\pm \Delta p$ need to be compensated and this may be done by a simple differential mechanism, namely correcting bar attachment as schematically indicated in Fig. 4.6.7.

In equation 4.6.1,

$$p_a = 1 \times U_C \times L$$

$$\pm \Delta p = p_s \tan(\pm \alpha) \cdot L / (\pi m Z) \quad (4.6.2)$$

where, U_C = transmission ratio

L = lead of the leadscrew

m, Z = module and no. of teeth of the gear fixed with the nut and is additionally rotated slightly by the movement of the rack along the bar.

Such differential mechanism of this attachment can also be used for intentionally cutting thread whose pitch will be essentially slightly more or less than the standard pitch, as it may be required for making differential screws having threads of slightly different pitch at two different locations of the screw.

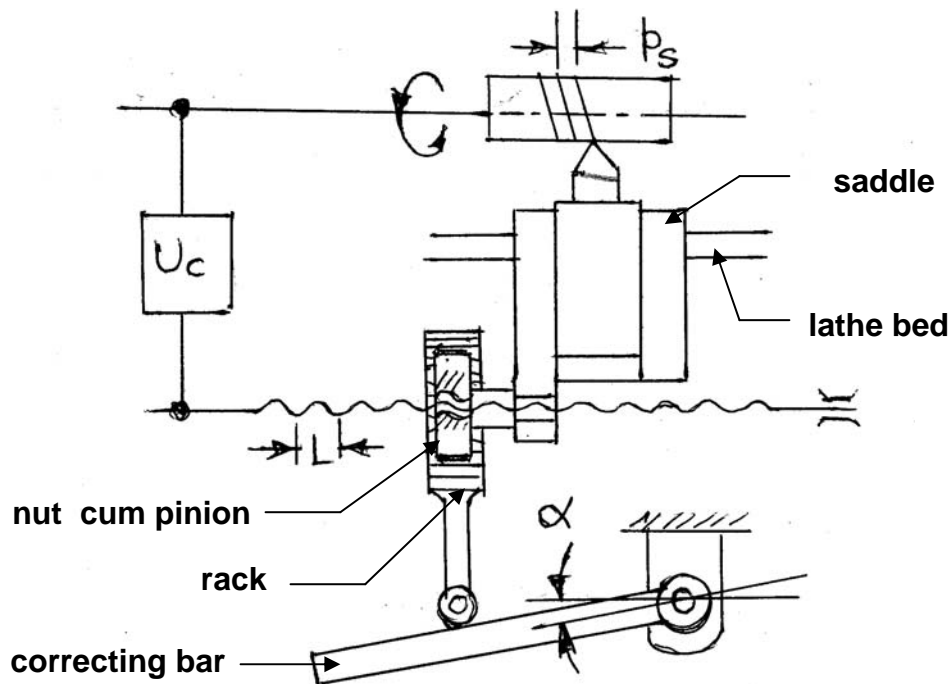


Fig. 4.6.7 Thread pitch correcting attachment.

(b) Attachments used in drilling machines

o Tapping attachment

It has been mentioned earlier in the previous lessons that several machining work other than drilling can be done in drilling machine using different types of cutting tools and job holding device. Tapping of nuts for their internal threads is also often done in a drilling machine by using tapping attachment as schematically shown in Fig. 4.6.8. Return of the tap by reverse rotation of the spindle without damage of the thread and the tap is the most critical design. Fig. 4.6.8 (a) visualises that the spring loaded sliding clutch engages with the free tapping clutch during threading. The clearance between the jaws of the two clutches and the spring action enable safe return of the tap following that of the spindle. Fig. 4.6.8 (b) shows another faster working tapping system where the hexagonal blanks are fed one by one and the tapping unit, rotating at a constant speed in the same direction moves only up and down for ejecting the threaded nuts by centrifugal force.

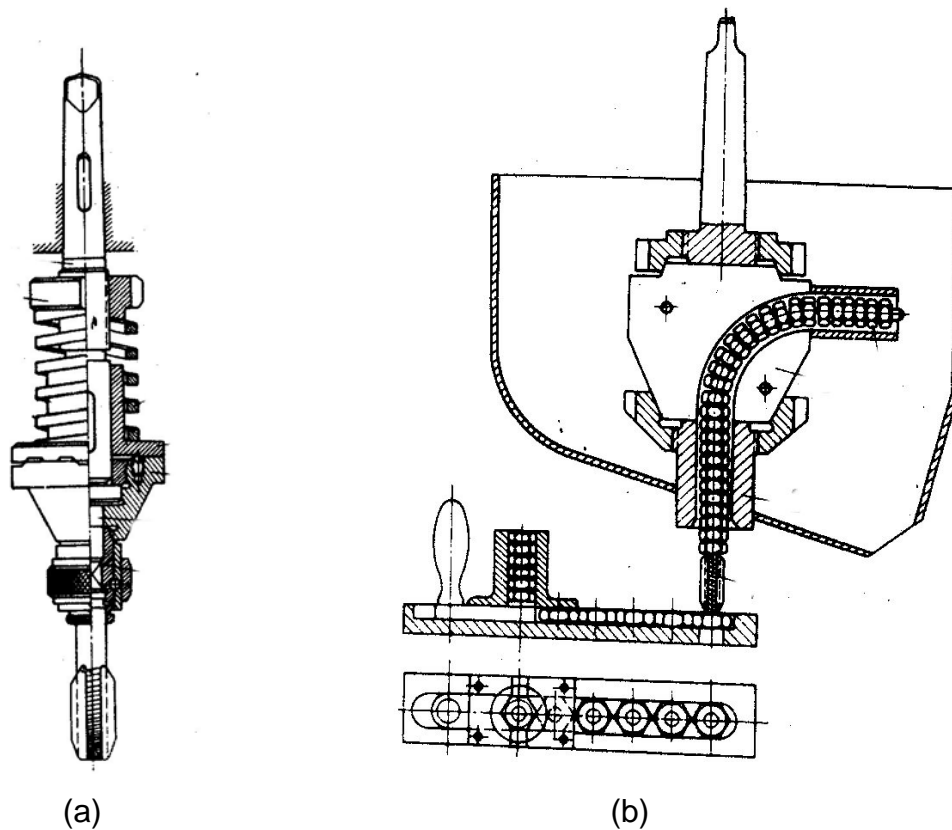


Fig. 4.6.8 Tapping attachment used in drilling machine.

(c) Attachments used in shaping machine

Some attachments are often used for extending the processing capabilities of shaping machines and also for getting some unusual work in ordinary shaping machine.

- **Attachment for double cut**

This simple attachment is rigidly mounted on the vertical face of the ram replacing the clapper box. It is comprised of a fixed body with two working flat surfaces and a swing type tool holder having two tools on either faces as can be seen in Fig. 4.6.9. The tool holder is tilted by a spring loaded lever which is moved by a trip dog at the end of its strokes.

Such attachment simply enhances the productivity by utilising both the strokes in shaping machines.

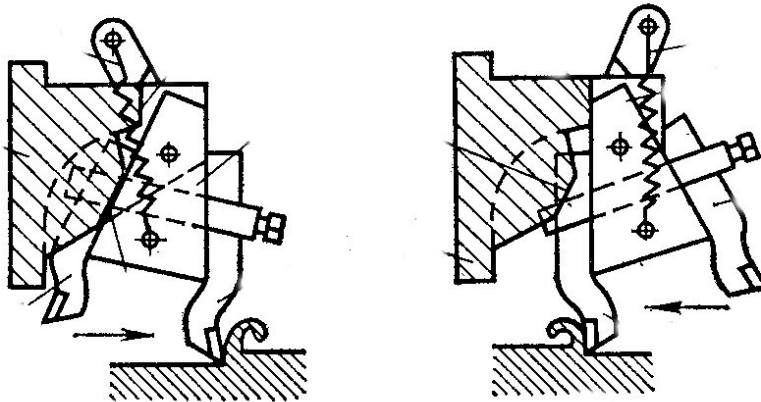


Fig. 4.6.9 Double cut attachment used in shaping machine.

- **Thread rolling attachment**

The thread of fasteners is done by mass production methods. Thread rolling is hardly done nowadays in shaping machines. However the configuration, mounting and the working principle of the thread rolling (in shaping machine) attachment are visualised in Fig. 4.6.10. In between the flat dies, one fixed and one reciprocating, the blanks are pushed and thread – rolled one by one.

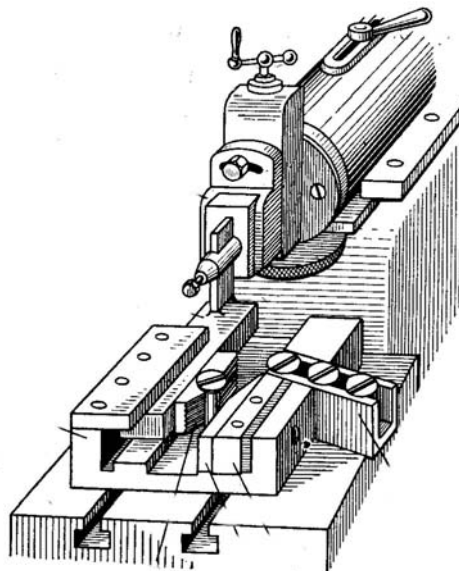


Fig. 4.6.10 Thread rolling attachment used in shaping machine.

- **Matterson's attachment**

Various machines and processes have been developed for producing gear teeth with high productivity and job quality. Gear teeth are hardly produced

nowadays in shaping machines. But, if required, it may be occasionally done by shaping machine in some small tool room or small workshop specially for repair and maintenance work. One or two, even all the teeth of a gear may be cut by forming tool in shaper using an indexing head. But such forming, specially in shaper is not only very slow process but also not at all accurate. But the Matterson's attachment can produce gear (spur) teeth even in shaping machine by generation process. The working principle of the attachment is shown in Fig. 4.6.11. For generation of the tooth by rolling the blank is rotated and the bed is travelled simultaneously at same linear speed by the synchronised kinematics as indicated in the diagram. After completing one tooth gap both the tool and blank are returned to their initial positions and then after indexing the blank for one tooth, the tool – work motions are repeated.

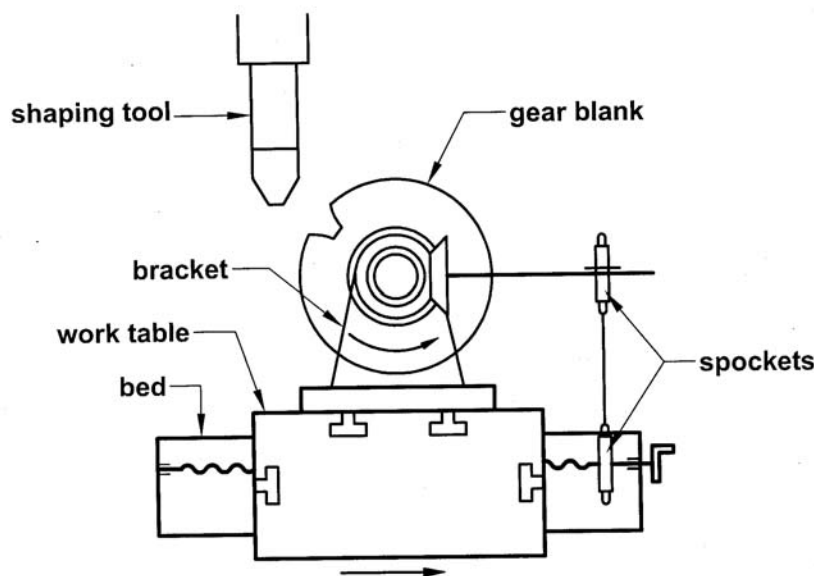
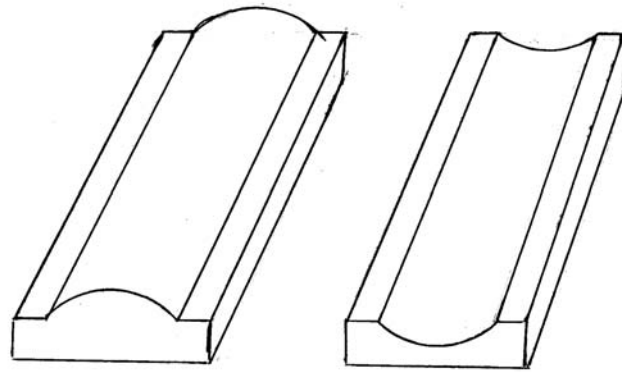


Fig. 4.6.11 *Matterson's Attachment for gear teeth generation in shaping machine.*

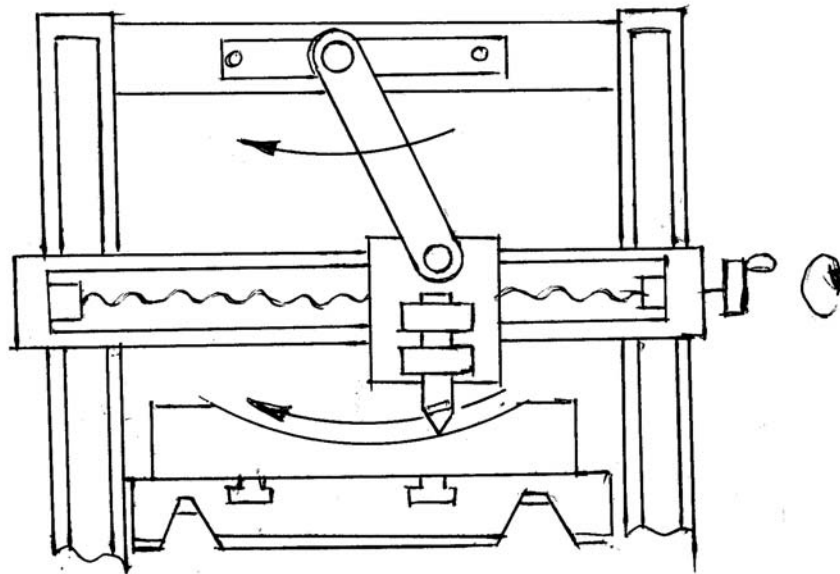
(d) Attachments used in planing machines

- **Contour forming attachment**

This simple and low cost attachment may be used in planing machine for producing 2 – D form of circular section in long heavy tables or beds as indicated in Fig. 4.6.12 (a). The basic working principle is schematically shown in Fig. 4.6.12 (b). The convex circular arc form is produced by a swinging bar hinged at the upper bracket and connected with one tool head which is manually or automatically moved axially by the horizontal leadscrew. The horizontal rail is kept delinked from the vertical leadscrews. The horizontal feed alone will move the tool – tip in circular path with the help of the swing – bar. Similarly, with slight modification the concave form can also be made.



(a)



(b)

Fig. 4.6.12 Contour forming attachment used in planing machine.

- **Helical grooving attachment**

Long lead helical grooves on large rod type jobs can be done easily and inexpensively in a planing machine, if available, by using simple attachment as shown in Fig. 4.6.13. Swinging of the bar clamping the linearly travelling rod (job) due to the prefixed inclined bar causes the required rotation of the rod. Such rotation along with linear axial travel produce the groove.

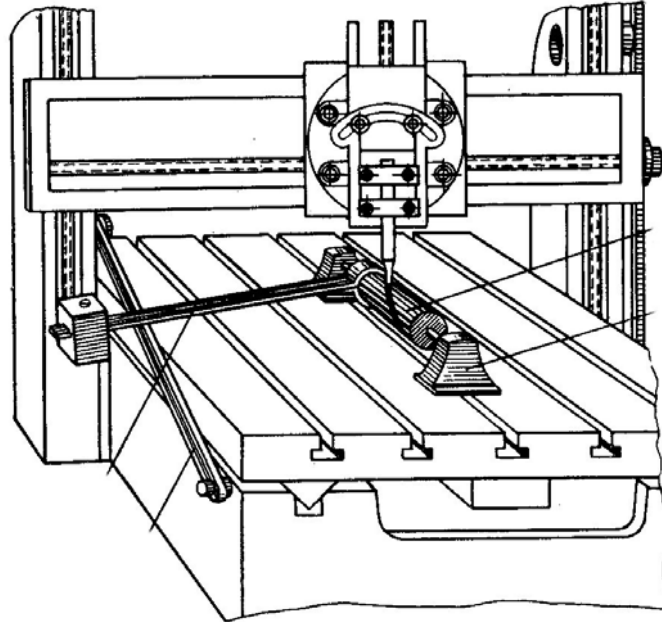


Fig. 4.6.13 Attachment in planing machine for cutting long lead helical grooves.

- **Other attachments used in planing machine**

- △ Shallow oil grooves of various patterns can be cut on the flat surfaces of large tables or beds of large machineries by replacing the stationary fixed single point tool (s) by a rotary tool driven by a separate motor.
- △ Hydraulic tracer control type attachments are often used for making complex shaped 2 – D contours on large components in planing machines. The form of the template is replicated on the product as described in case of hydraulic copying lathe.
- △ Milling and grinding attachments.
Both productivity and process capability of conventional planing machines are low for use of single point tools. Both productivity and finish are substantially increased by replacing those single point tool heads by milling and grinding heads on the horizontal and / or vertical rails. Such powered heads with rotary tools led to development of high productive plano millers and plano grinders.

(e) Attachments used in Milling machines

- **Universal milling attachment**

Amongst the knee type conventional milling machines, horizontal arbour type is very widely used, where various types and sizes of milling cutters viz. plain or slab milling cutters and disc type cutters including single and double side(s) cutter, slot cutter, form cutters, gear milling cutters, slitting cutter etc. having axial bore are mounted on the horizontal arbour. For milling by solid end mill type and face milling cutters, separate vertical axis type milling machines are available. But horizontal arbour type milling machines can also be used for those operations to be done by end milling and smaller size face milling cutters by using proper attachments. The universal milling attachment is shown in Fig. 4.6.14. The rotation of the horizontal spindle is transmitted into rotation about vertical and also in any inclined direction by this attachment which thus extends the processing capabilities and application range of the milling machine.

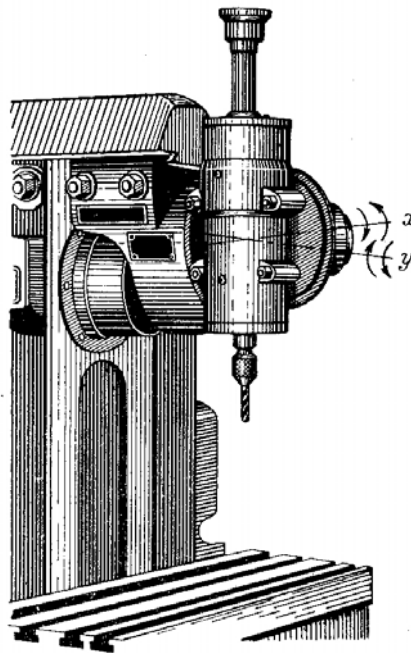


Fig. 4.6.14 Universal milling attachment.

- **Indexing or Dividing head**

This device is essentially so frequently and widely needed and used that it is also considered as an accessory. But it is taken as an attachment possibly for being procured separately. This attachment is basically used for equi-angular rotation by simple compound or differential indexing of the job while machining. Fig. 4.6.15 typically shows a universal type dividing head and its mounting and an application.

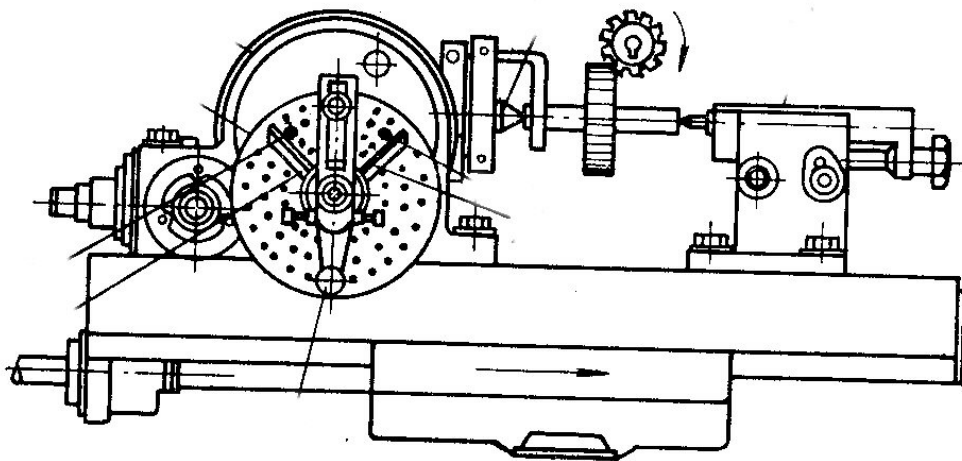


Fig. 4.6.15 A Universal type dividing head and its application.

- **Rotary table**

This device may also be considered both accessory or attachment and is generally used in milling machines for both offline and online indexing / rotation of the job, clamped on it, about vertical axis. Fig. 4.6.16 visualises such a rotary table which is clamped or mounted on the machine bed / table.

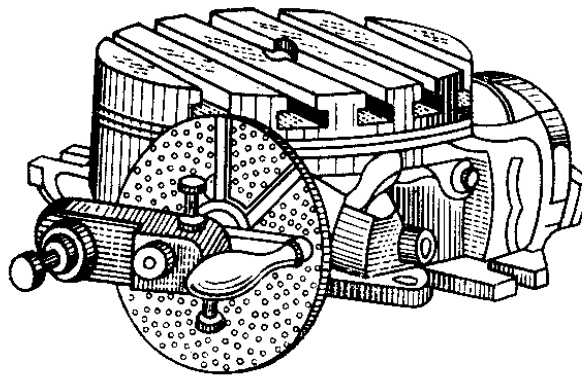


Fig. 4.6.16 A rotary table which can be clamped or mounted on the machine bed.

- **Slotting attachment**

Such simple and low cost attachment is mounted on the horizontal spindle for producing keyways and contoured surface requiring linear travel of single point tool in milling machine where slotting machine and broaching machine are not available. The configuration of such a slotting attachment and its mounting and operation can be seen in Fig. 4.6.17. The mechanism inside converts rotation of the spindle into reciprocation of the single point tool in

vertical direction. The direction of the tool path can also be tilted by swivelling the circular base of the attachment body.

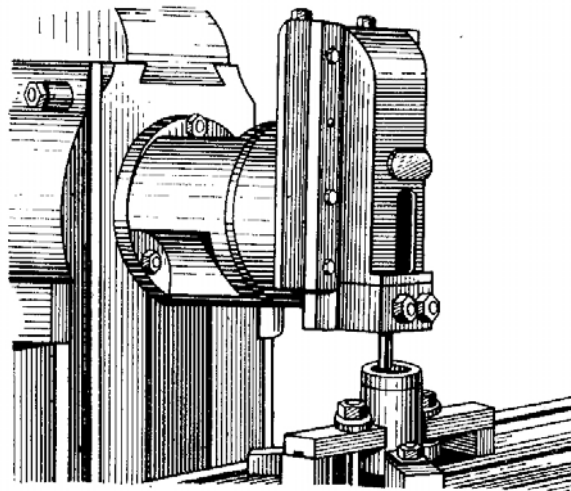


Fig. 4.6.17 *Slotting attachment*

There are several other possible attachments which can be used for some specific application not included in the basic range of a particular machine tool. New attachments can also be developed if so demanded. But need and use of attachments are gradually decreasing for rapid and vast developments in types of machine tools and more so after the advent of CNC machine tools with flexible automation.