TYPES OF SHAPER:- (UNIT-4)

Shapers are classified under the following headings.

1.) According to the type of mechanism used for giving reciprocating motion to the ram.

(a) Crank type (b) Geared Type.

(d) Hydralic type.

2) According to the position and travel of ram:-

(a) Horizontal type (b) Vertical type (c) Traveling head type.

3) According to the type of design of the table

(a) Standard Shaper (b) Universal shaper.

4) According to the type of cutting stroke

(a) push type (b) Draw type.

1.(a) CRANK TYPE:- This is most common type of shaper in which a single point cutting tool is given a reciprocating motion equal to the length of the stroke desired while the work is clamped in position on an adjustable table. In construction the crank shaper employs a crank mechanish to change circular motion of large gear called "bull gear" incorporated in the machine to reciprocating motion of the ram. The bull gear receives power either from an individual motor or from an overhead line shaft if it is a belt driven shaper.

(b) GEARED TYPE:- The reciprocating motion of the ram is some type of shaper is effected by means of rack & pinion. The rack teeth which are cut directly below the ram mesh with spur gear. The pinon meshing with the rack is driven by a gear train. The speed and direction in which the machine will traverse depends on the number of gears in the gear train. This type of shaper is not very widely used.

(c) HYDRALIC SHAPER:- In the hydralic shaper the reciprocating movement of the ram is obtained by hydralic power. oil under high pressure is pumped into the operating cylinder (2) fitted with a piston. The end of the piston rod is connected to the ram. The high pressure oil first acts on one side of the piston and then on the other causing the piston to reciprocate and the motion is transmitted to the ram. The piston speed is changed by varying the amount of liquid delivered by the pump. One of the most important advantage of this type of shaper is that the cutting speed and force of the ram drive are constant from the very begining the the end of the cut. It also offers great flexibility of speed and feed control, eliminates shock and permits slip or slowing up of motion when the cutting tool is overhead, protecting the parts or the tools for breakage. Another advantage is that the machine does not make any noise and operates very quietly.

2(a) HORIZONTAL SHAPER:-
In a horizonal shaper, the ram holding the tool reciprocates in a horizontal axis. Horizontal shaper are mainly used to produce that surfaces.

(b) VERTICAL SHAPER:- In a vertical shaper, the ram holding the tool reciprocates in a vertical axis. Vertical shapers may be crank driven, rack driven, screw driven or hydraulic power driven. The work table of a vertical shaper can be given longitudinal, & rotary movement. The tool used on a vertical shaper is entirely different from that used on a horizontal shaper. The vertical shaper are very convenient for maching internal & external surfaces, keyways, slots or grooves. Large internal & external gears may also be machined by indexing arrangement of the rotary table. There are vertical shaper which are specially designed for maching internal keyways. They are known as "key eaters"

(c) TRAVELLING HEAD SHAPER:- In a travelling head shaper, the ram carrying the tool while it reciprocates moves crosswise to give the required feed. Heavy & unwidly

Jobs which are very difficult to hold on the table of a standard shaper and fed past the tool are held static on the basement of the machine while the ram reciprocates and supplies the feeding movements. (3)

3(a) STANDARD OR PLAIN SHAPER:—

A shaper is termed as standard or plain when the table has only two movements, vertical and horizontal, to give the feed. The table may or may not be supported at other end.

(b) UNIVERSAL SHAPER:—

In a universal shaper, in addition to the two movements provided on the table of a standard shaper, the table can be swiveled about an axis parallel to the ram ways, and the upper portion of the table can be tilted about a second horizontal axis perpendicular to the first axis. As the work mounted on the table can be adjusted in different planes, the machine is most suitable for different types of work and is given the name "universal". A universal shaper is mostly used in tool room.

4(a) PUSH TYPE SHAPER:-

This is most general type of shaper used in common practise. The metal is removed when the ram moves away from the column, i.e pushes the work.

(b) DRAW TYPE SHAPER:—

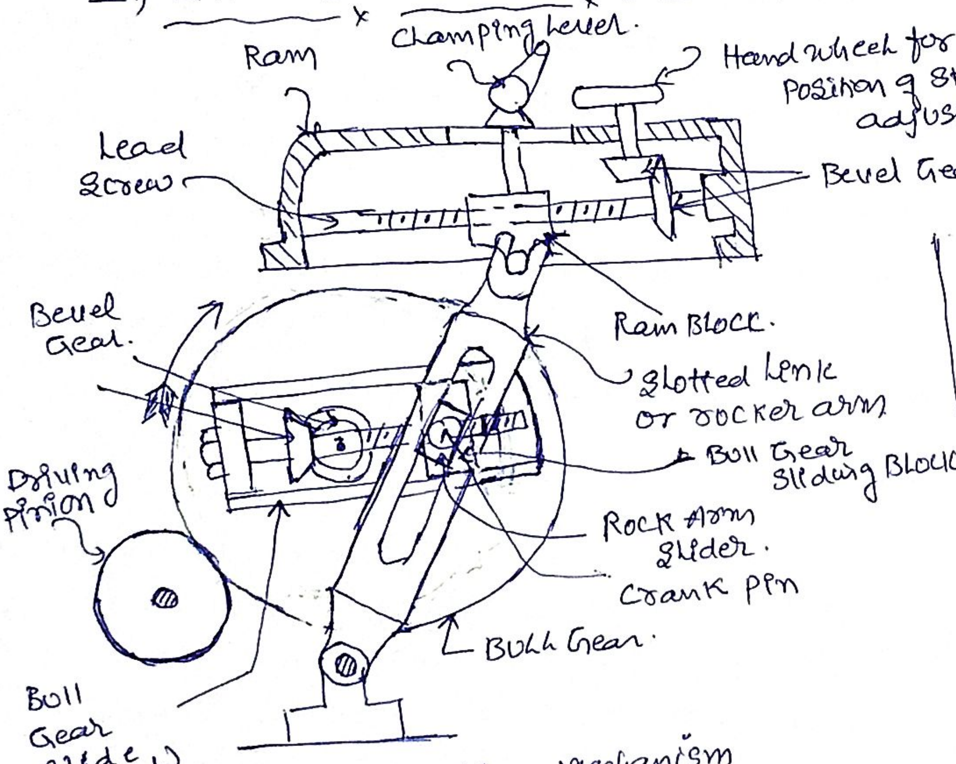
In a draw shaper, the metal is removed when the ram moves towards the column of the machine, i.e, draws the work towards the machine. The tool is set in a reversed direction to that of a standard shaper. The ram is generally supported by an over head arm which ensure rigidity and eliminates deflection of the tool. In this shaper the cutting pressure acts towards the column which relieves the cross rail and other bearings from excessive loading and allows to take deep cuts. Vibrations in these M/CS is practicaly eliminated.

SHAPER MECHANISM

In a Shaper, rotary movement of the drive is converted into reciprocating movement by the mechanism contained within the column of the machine. The ram holding the tool gets the reciprocating movement. In the Shaper metal is removed in the forward cutting stroke, while the return stroke gets idle and no metal is removed during this period. To reduce the total cycling time it is necessary to reduce the time taken by the return stroke. This mechanism is known as quick return mechanism. The reciprocating movement of the ram and quick return mechanism of the m/c are usually obtained by one one of the following methods.

1) crank & slotted link mechanism
2) whitworth quick return mechanism.
3) Hydraulic shaper mechanism.

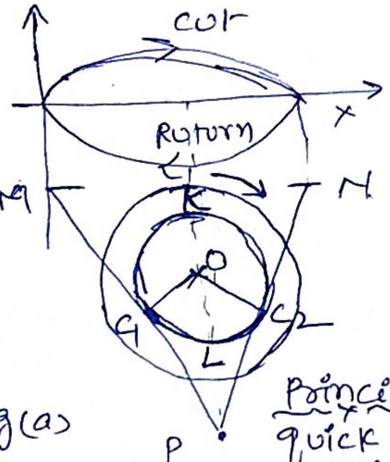
1.) CRANK & SLOTTED LINK MECHANISM :-



Crank & Slotted Link Mechanism

The crank & slotted link mechanism is shown in fig. The motion or power is transmitted to the bull gear through a pinion which receives its motion from an individual motor or over head line shaft through speed control mechanism. Speed of the bull gear may be changed by different combination of gearing or by simply shifting the belt on the step cone pulley. Bull gear is a large gear mounted within the

column. Bolted to the centre of the bull gear is a radial (5)
slide which carries a sliding block into which the crank pin is
fitted. Rotation of the bull gear will cause the crank pin to revolve
at a uniform speed. Sliding block which is mounted upon the
crank pin is fitted within the slotted ~~pi~~ link. The slotted
link which is also known as the rocker arm is pivoted at
its bottom end attached to the frame of the column. The upper
end of the rocker arm is forked and connected to the ram
block by a pin. As the bull gear rotates causing the crank
pin to rotate, the sliding block fastened to the crank pin
will rotate on the crank pin circle, and at the same time
will move up & down the slot in the slotted link
giving it a rocking movement which is communicated to
the ram. Thus the rotary motion of the bull gear is
converted to the reciprocating movement of the ram.



Fig(a)

Principle of quick return

The principle of quick return motion is illustrated in fig (a) when the link is in the position PM, the ram will be at the extreme backward position of its stroke, and when it is at PN, the extreme forward position of the ram will have reached. PM & PN are shown tangent to the crank pin circle. The forward cutting stroke, therefore, takes place when the crank rotates through the angle C_1KC_2 and the return strokes takes place when the crank rotates through the angle C_2LC_1. It is evident that the angle C_1KC_2 made by the forward or cutti stroke is greater than the angle C_2LC_1 described by the return stroke. The angular velocity of the crank pin being constant the return strok is therefore, completed with in a shoter time for which it is known as quick return motion.

The ratio betn the cutting time and return time may be determined from the formula:-

$$\frac{\text{Cutting time}}{\text{Return time}} = \frac{\widehat{C_1KC_2}}{\widehat{C_2LC_1}} \longrightarrow (1)$$

Cutting time to return time usually varies betn 2:1 and practical limit 3:2. The only disadvantages lies with this mechanism is that the cutting speed and return speed is not constant throughout the stroke. It is minimum when the rocker arm is at the two extremities and the speed is maximum when the rocker arm is vertical.

1) ADJUSTMENT OF the length of STROKE

2) ADJUSTING the POSITION of STROKE

2. WHITWORTH QUICK RETURN MECHANISM:-

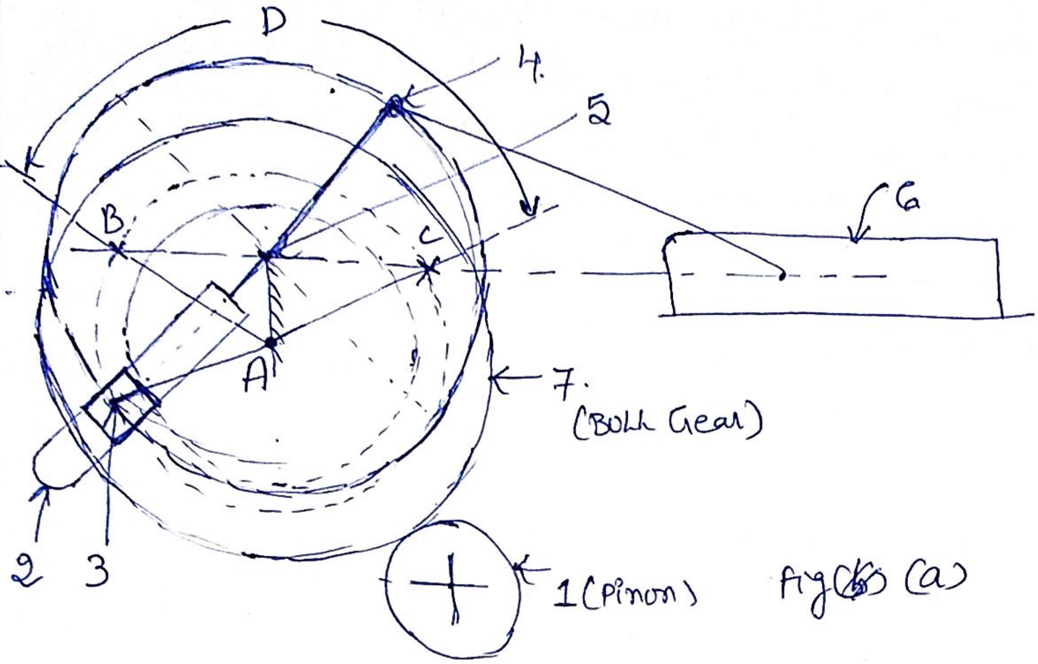


fig (a)

LINE DIAGRAM OF QUICK RETURN MECHANISM

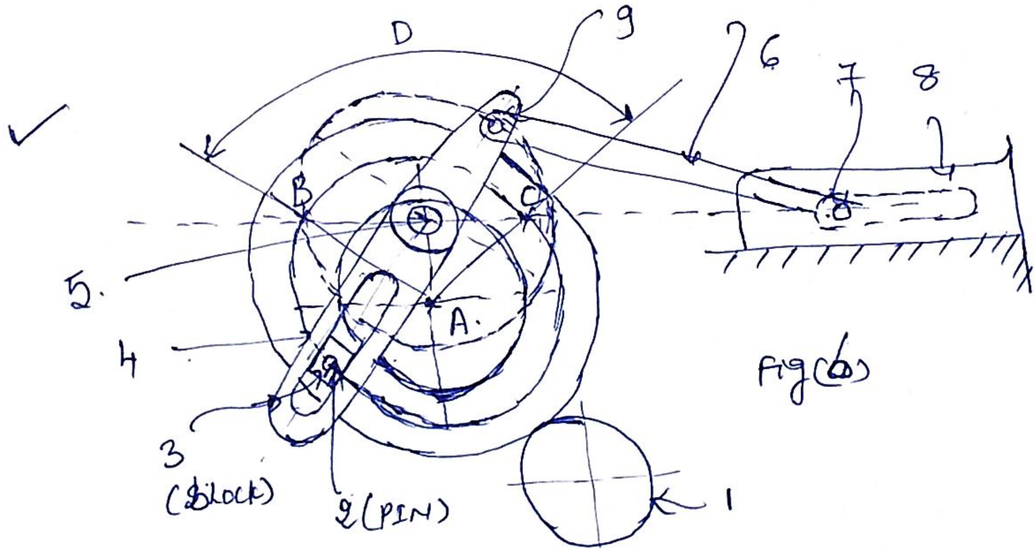


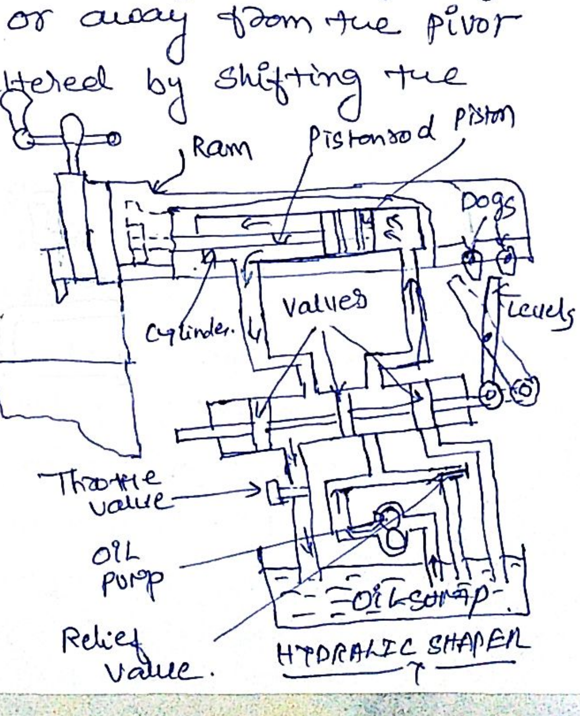
fig (b)

The whitworth quick return mechanism is shown in fig (b) and a simple line diagram of the mechanism is shown in fig (a). The bull gear is mounted on a large fixed pin A. upto which it is free to rotate. The crank plate A upto which it is free to rotate. The crank plate A. is pivoted eccentrically upto a fixed pin at 5. Fitted on the face of the bull gear is the crank pin 2 on the top of which is mounted the sliding block 3. fits into the slot provided in crank plate 4. At the other end of the crank plate A, a connecting rod 6. connects the crank plate by a pin 9. and a ram 8. by a pin 7. when bull gear will rotate at a constant speed the crank pin 2. with the sliding block 2 will rotate on a crank circle of radius A2 and the sliding block 3 will cause the crank plate to rotate about the point 5 with a variable angular velocity. pin 9 fitted on the other end of the crank plate 4. will rotate in a circle and the rotary motion of the pin 9 will be converted into reciprocating movement of ram similar to the crank and connecting rod mechanism. The axis of reciprocating of the ram passes through the pin 5. and is normal to the pin A5.

when the pin 2 is at the position 'C' the ram will be at the extreme backward position when the pin is at the position 'B', the extreme forward position of the ram will have been reached. when the pin 2 travels from C to B the crank pin 9 passes through the backward position to the forward position in the cutting stroke, and the return stroke is completed when the pin 2 travels from B to C or the pin 'g' passes from the forward position to the backward position. As the angular velocity of the crank pin is uniform, the time taken by the crank pin 2 to travel through an arc covering CEB is greater than the time taken to move through an arc covering BDC. Thus a quick return motion is obtained by the mechanisms

The length of stroke of the ram may be changed by shifting the position of pin '9' closer or away from the pivot 5. The position of stroke may be altered by shifting the position of pin 7 on the Ram.

HYDRALIC SHAPER MECHANISM:-



HYDRALIC SHAPER

In a hydraulic shaper the ram is moved forward & backward by a piston moving in a cylinder placed under the ram. The M/c mainly consists of constant discharge oil pump, a value chamber, a cylinder, & a piston

The piston rod is bolted to the ram body. As shown in the figure the oil under high pressure is pumped from the reservior and is made pass through the valve chamber to the right side of the oil cylinder exerting pressure on the piston This causes the ram connected to the piston to perform forward stroke, and any oil present on left side of the cylinder is discharged to the reservoir through the throttle valve. At the end of extreme forward stroke the shaper dog hits against the reversing leve & causing the valves to alter their positions with in the valve chamber. Oil under high pressure is now pumped to the left side of the piston causing the ram to perform return stroke. Oil present on the right hand side of the piston is now discharged to the reservoir. At the end of the return stroke another shaper dog hits against the reversing lever altering the direction of the stroke of the piston and thus the cycle is repeated.

The quick return motion is effected due to the difference in stroke volume of the cylinder at both ends, the left hand end being smaller due to the presence piston rod. As the pump is a constant discharge one, with in a fixed period, the same amount of oil will be pump into the right or to the left hand side of the cylinder. This will mean that the same amount of oil will be packed within the smaller stroke volume causing the oil pressure to rise automatically and increase the speed during the return stroke.

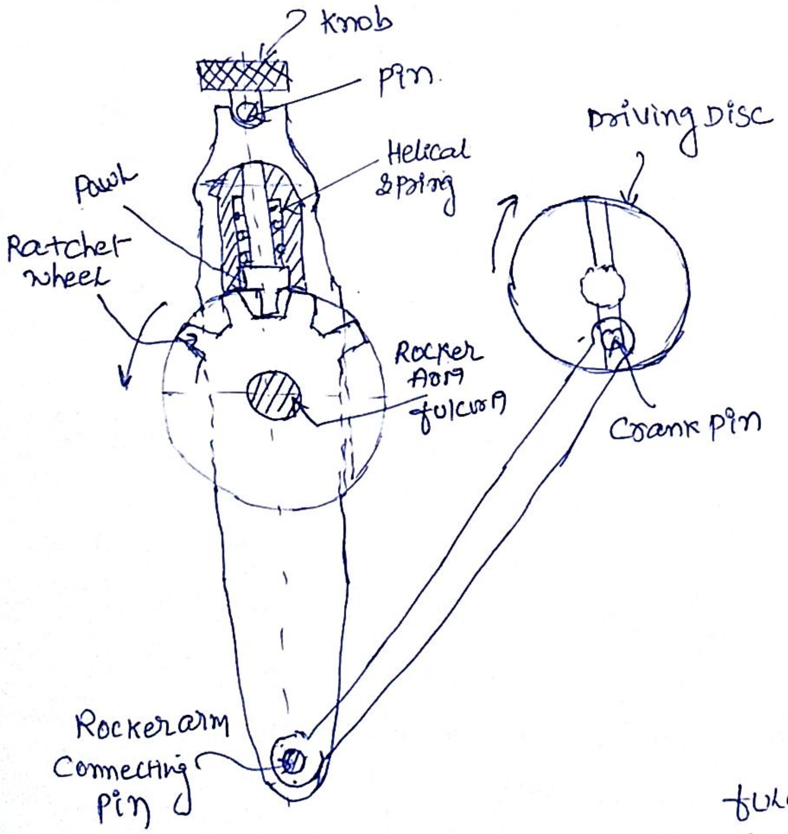
NOTE:- i) The length and position of stroke is adjusted by shifting the position of reversing dogs.

ii) The cutting speed may be changed by controlling the throttle valve which regulates the flow of oil. When the throttle valve is partially closed the excess oil flows out through the relief valve to the reservoir maintaining uniform pressure during cutting stroke.

A hydraulic is widly used for having many advantages! -

1. The cutting & return speeds are practically constant throughout the stroke. This permits the cutting tool to work uniformly during cutting stroke.
2. The reversal of the ram is obtained quickly without any shock as the oil on the other end of the cylender provides cushioning effect.
3. Infinite number of cutting speeds may be obtained from zero to the max. value and the control is easier.
4. With a higher rate of return speed, the greater number of cutting strokes may be available within the range of cutting speed.
5. The relief valve ensures safety to the tool and the machine when the machine is overloaded.

FEED MECHANISM :-



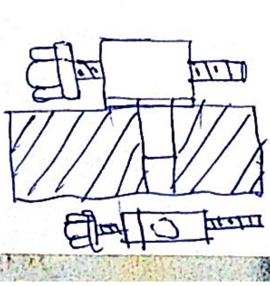
AUTOMATIC FEED MECHANISM OF A SHAPER

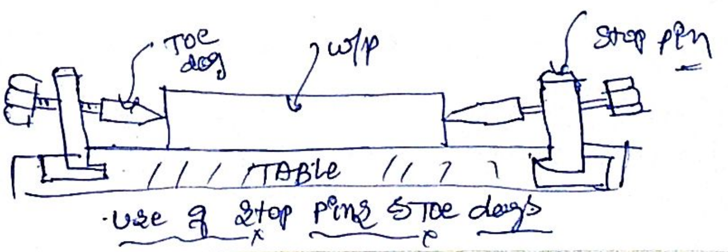
Fig illustrate the automatic cross feed mechanism of a shaper. The rotation of bull gear causes the driving disc to rotate in a particular direction. The driving disc is T-slotted and position of crank pin attached to the connecting rod may be altered to give different throw of eccentricity. The other end of the connecting rod ~~may be~~ is attached to the rocking arm by a pin. The rocking arm is fulcrumed at the centre of the ratchet wheel. The ratched wheel is keyed keyed to the crossfeed screw. The rocking arm houses a spring a spring loaded pawl which is straight on one side and bevel on the other side. As the driving disc rotates, the connecting rod ~~starts~~ starts reciprocating and the rocking arm rocks on the fulcrum. When the driving disc rotates through half of the revolution in the clock wise direction, top part of the rocking moves in clockwise direction and the pawl being slant on one side slips over the teeth of the ratchet wheel imparting it no movement. As the driving disc rotates through the other half, the top of the rocking arm now moves in the anticlock wise direction and the straight side of pawl engages with the teeth of the ratchet wheel causing the wheel to move in anticlock wise direction only. As the driving disc is connected to the bull gear the table feed movement is effected when the bull gear or the driving disc rotates through half of the revolution, i.e during return stroke only. Rotation through other half imparts no movement. To reverse the direction of rotation of ratchet wheel and consequently the feed, a knob on top of the pawl After removing the pin with respect to the centre. Greater the throw of essentricity, more will be the rocking movement of the arm and the pawl will pass through three or four teeth on the rachet wheel at the time imparting greater feed movement.

WORK HOLDING DEVICES :-

The work may be supported on the table by the following methods depending on the nature of the work piece.

1. clamped in vise. ⟶ a) Plain vise, swivel vise, universal vise.
2. clamped on table ⟶ a) T-bolts and clamps, stop pins, stop pins & toe dogs, strip & stop pins. Pallets
3. clamped to the angle plate ⟶
4. clamped on a V-block ⟶
5. Held betn shaper index centre ⟶





Use of stop pins & Toe dogs

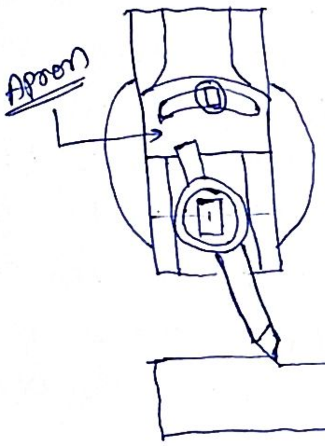
SHAPER OPERATIONS :-

A Shaper is a versatile M/c tool primarily designed to generate a flat surface by a single point cutting tool. But it may also be used to perform many other operations. The different operations which a Shaper can perform are as follows.

1. Machining Horizontal Surfaces.
2. Machining Vertical Surfaces.
3. Machining Angular Surfaces.
4) Cutting Slots, grooves & keyways
5) Machining irregular Surfaces
6) Machining Splines or cutting Gears.

1. Machining Horizontal Surfaces :-

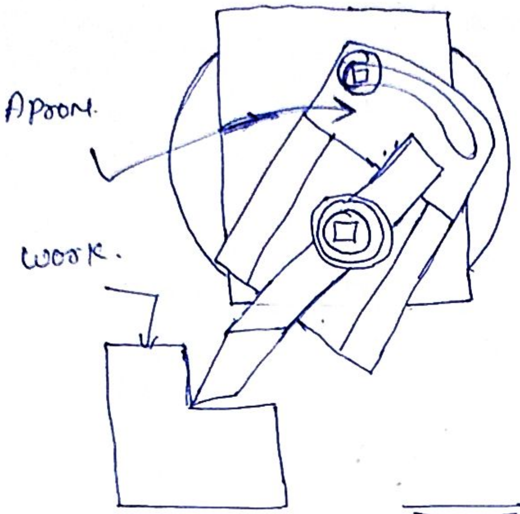
Fig illustrates machining horizontal surface on a work piece. A shaper is mostly used for machine a flat, true surface on a work piece held in a vise or other holding devices. After the work is properly held on the table, a planning tool is set in the tool post with minimum overhang. The table is raised till there is a clearance of 25 to 30mm betn tool and work piece. The length and the position of the stroke are then adjusted. The length of the stroke should be nearly 20mm



Machining Horizontal Surfaces

longer than the work and the position of the stroke is so adjusted that the tool begins to move from a distance of 12 to 15 mm before the begining of the cut and continues to move 5 to 8mm after the end of the cut. Proper cutting speed and feed is then adjusted. Short stroke should be taken with high speed while long strokes should be taken with slow speed. Both roughing & finishing cuts are performed to complete the job. For roughing cut speed is decreased but feed and depth of cut is increased. Depth of the cut is adjusted by rotating the down feed screw of the tool head. The amount of depth of cut is adjusted by a micrometer dial. The depth of cut for roughing work usually is 1.5 to 3mm, while the finishing work, it ranges from 0.075 to 0.900 mm

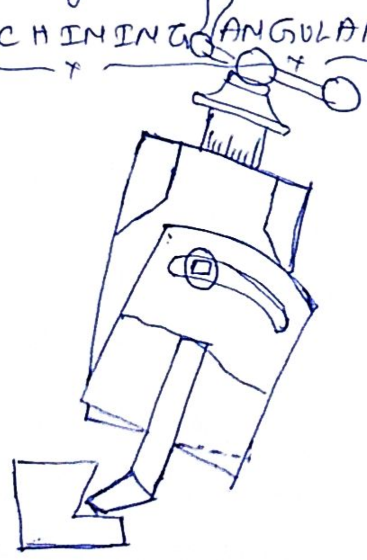
MACHINING VERTICAL SURFACES :- Fig illustrates machining vertical surfaces on a work piece. A vertical cut is made while machining the end of a work piece, squaring up a block or cutting shoulder. The work is mounted in the vise or directly on the table and the surface to be machined is carefully aligned with the axis of the ram. A side cutting tool is set on the tool post and



Machining vertical surfaces

the position the position and length of the stroke is adjusted. The vertical slide is set exactly at zero position and the apron is swiveled in the direction away from the surface being cut. This is necessary to enable the tool to move upwards and aways and away from the work during return stroke. This prevents the side of the tool from dragging on the planned vertical surface during return stroke. The downfeed is given by rotating the down feed screw by hand. The feed is about 0.25 mm given at the end of ~~each~~ each return stroke. Bour roughing & finishing cuts are performed to complete the Job.

MACHINING ANGULAR SURFACE :- Fig illustrates machining of an angular surface on a work piece. An angular cut is made at any angle other than a right angle to the horizontal or to the vertical plane. The work is set on the table and the vertical slide of the tool head is swiveled to the required angle either toward left or right from the vertical position. The apron is further

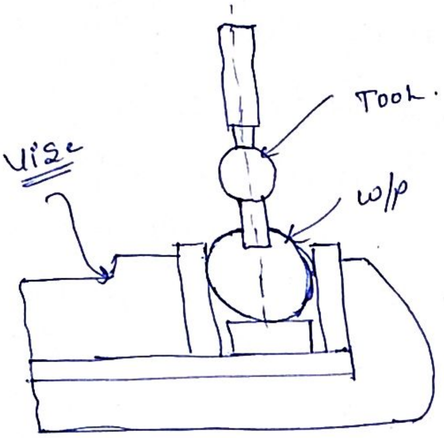


Machining Angular Surface

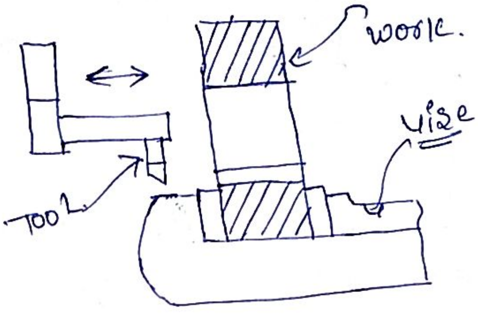
swiveled away from the work so that the tool will clear the work during return stroke. The downfeed is given by

rotating the downfeed screw. Angular surface can also (14)
be machined in a universal shaper or by using a universal
vise without swiveling the tool head.

CUTTING SLOTS AND KEYWAYS:-



(a) Cutting external Keyway



(b) Cutting Internal Keyways

With suitable tools a shaper can very conveniently machine slots or grooves on a work or cut external keyways on shafts and internal keyways on pulleys or gears. For cutting slots or keyways a square nose tool similar to the parting tool is selected. Fig (a) & (b) shows cutting of external keyways & internal keyways. External keyways are cut on a shaft by first drilling a hole at the blind end of the keyways. The diameter of the holes should be 0.5 to 0.8 mm oversize than the width of the keyway and the depth should be about 1.5 mm larger than the depth of the keyway. This is necessary to leave a clearance on the tool at the end of the stroke. The length and the position of the stroke is carefully adjusted so that the stroke will terminate exactly at the clearance hole. The speed is reduced while cutting a keyway. Internal keyways are cut by holding the tool on a special tool holder so that the tool post will not hit against the work at the end of the stroke. The clapper block is locked in the clapper box to prevent the tool from lifting during return stroke. Lubrication is necessary on the work to prevent the cutting edge of the tool from wear due to dragging.

MACHINING IRREGULAR SURFACE:- A Shaper can also produce a contoured surface, i.e a convex or concave surface or a combination of any of the above surfaces. To produc a small contoured surface a forming tool is used. If the curve is sufficiently Large, power-crossfeed in conjunction with manual downfeed is so adjusted that the tool will trace the required contour. If the contour has too many ups & downs both the feeds are operated by hand. A round nose tool is selected for machining irregular surfaces. for a shallow cut the apron may be set vertical but if the curve is quite sharp, the apron is swiveled toward left or right away from the cut.

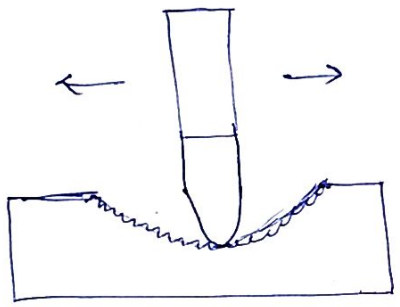
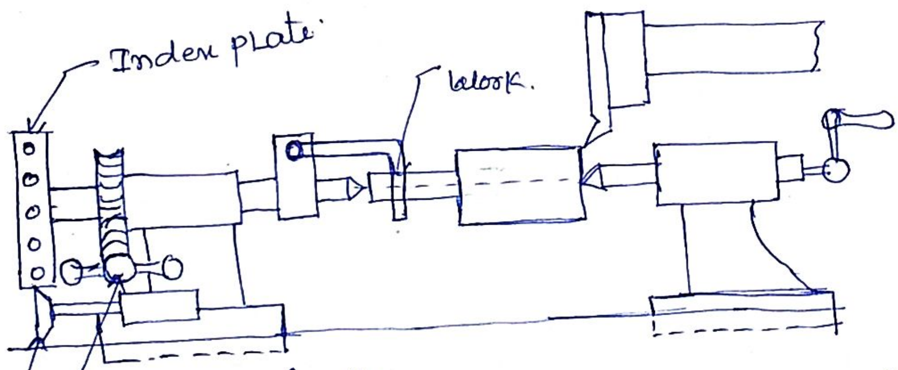


fig shows m/cing of concave surface using round nose tool.

Maching irregular surfaces.

MACHINING SPLINES OR CUTTING GEARS:-



By using an index centre, Illustrated in fig. a gear or equally spaced spline may be cut. The work is mounted betn two centres and a spline is cut similar to the cutting of a keyway. After the first spline is cut, the work is rotated through a predetermined amount by using the index plate and index pin. The periphery of a gear blank is divided, and equally spaced grooves are cut by using an index plate having proper hole circles. while cutting gear a formed tool is used.

CUTTING SPEED, FEED AND DEPTH OF CUT

CUTTING SPEED:- In a shaper, the cutting speed is the rate at which the metal is removed by the cutting tool. This is expressed in metre per minute. In a lathe the cutting action is continuous the cutting speed is expressed by the peripheral speed of the work. But in the shaper the cutting action is intermittent. In the shaper the cutting speed is considered only during the forward cutting stroke.

CUTTING SPEED CALCULATIONS:-

The cutting speed in a shaper is expressed by the formula:-

$$\text{Cutting speed} = \frac{\text{length of the cutting stroke}}{\text{time required by the cutting stroke}}$$

Let L = the length of the stroke in mm.

m = the ratio betn return time to cutting time.

n = the no. of double strokes of the ram per minute or r.p.m of the bull wheel.

v = the cutting speed expressed in m/min.

$$\text{time taken by cutting stroke} = \frac{\text{length of the cutting stroke}}{\text{cutting speed in m/min}}$$

$$= \frac{L}{1000 \times v} \quad \& \quad m = \frac{\text{Return stroke time}}{\text{cutting stroke time}}$$

or $\text{return stroke time} = \dfrac{m \times L}{1000 \times v}$

Time taken to complete one double stroke

$$= \frac{L}{1000 \times v} + \frac{m \times L}{1000 \times v}$$

$$= \frac{L}{1000 \times v}(1+m) \longrightarrow (1)$$

Number of double strokes per minute.

or r.p.m of the bull wheel

$$n = \frac{1}{\frac{L(1+m)}{1000 \times v}}$$

No. of strokes per min

$$\boxed{n = \frac{1000 \times v}{L(1+m)}} \quad \& \quad \boxed{v = \frac{n L (1+m)}{1000}}$$

cutting speed.

The cutting speed so, calculated is the average cutting speed as it has been assumed that the cutting ~~speed~~ stroke is completed at a uniform speed. But in reality in crane driven shaper cutting speed and return speed is not uniform.

FEED:- Feed (s) is the relative movement of tool or work in a direction ⊥le to the axis of reciprocation of the ram per double stroke & is expressed in mm. The feed is always given at the end of the return stroke when the tool is not cutting the metal. The selection of feed depends ~~on~~ upon the kind of metal, type of Job, etc.

DEPTH OF CUT:- Depth of cut (t) is the thickness of metal that is removed in one cut. It is the ⊥le distance measured between machined surface and non-machined surface of the work piece.

MACHINING TIME:-

If the length of cutting stroke, breadth of the Job, feed & cutting speed are known, the time required to complete the Job may be calculated as.

Let
L = the length of stroke in mm.
B = the breadth of work in mm
s = the feed expressed in mm/double stroke.
m = the ratio of return to forward stroke (cutting)
v = cutting speed in m/min.

The time taken to complete one double stroke

$$= \frac{L}{1000 \times v}(1+m)$$

Total no. of double strokes required to complete the job $= \frac{B}{s}$

$\therefore$ Total Time taken to complete the cut $= \dfrac{L \times B(1+m)}{1000 \times v \times s}$

Problems:-

In a shaper work, the length of stroke is 200 mm, no. of double strokes per minute is 30 and the ratio of return time to cutting time is 2:3. Find the cutting speed.

Sol) Cutting speed $= \dfrac{NL(1+m)}{1000}$

$$= \frac{30 \times 200(1+\frac{2}{3})}{1000} = \frac{30 \times 200 \times 5}{1000 \times 3}$$

$$v = 10\ m/min$$

Prob: Find the time required for taking a complete cut on a plate 600 x 900 mm, if the cutting speed is 9 m/min. The return time to cutting ratio is 1:4 and the feed is 3 mm. The clearance at each end is 75 mm.

In a shaper a stroke length of more than 900 mm is not ordinarily available so the work is placed on the table to take a cut of 600 mm plus the clearances.

Sol) Total stroke $L = 600 + 75 + 75 = 750$ mm.

$$\text{cutting time} = \frac{750 \times 60}{1000 \times 9} = 5\ sec.$$

$$m = \frac{\text{Return stroke time}}{\text{cutting stroke time}} = \frac{1}{4}.$$

$$\text{Return time} = \frac{1}{4} \times 5 = \frac{5}{4}\ sec.$$

$\therefore$ Total time for one complete double stroke

$$= 5 + \frac{5}{4} = \frac{25}{4}\ sec.$$

total time of double strokes necessary to complete cut $= \frac{900}{3} = 300$

$\therefore$ Total time require to complete the cut

$$= \frac{25}{4} \times \frac{300}{60} = 31.25\ min$$

PLANING MACHINES (UNIT-4)

Introduction:-

The planer like a shaper is a machine tool primarily intended to produce plane and flat surfaces by a single point cutting tool. A planer is very large and massive compared to a shaper and capable of machining heavy work pieces which cannot be accommodated on a shaper table. The fundamental difference betn the shaper and planer is that in a planer the work which is supported on the table reciprocates past the stationary cutting tool and the feed is supplied by the lateral movement of the tool, whereas in a shaper the tool which is mounted upon the ram reciprocates and the feed is given by the crosswise movement of the table.

The planing m/c was developed by Richard Roberts, an English-men in year 1817. The design & working principle of the machine, of couse was almost identical to the present day machine.

Types of PLANNING MACHINE:-

The different types of planer which are mostly common used are.

1) Double housing planer.
2) Open side planer.
3) Pit planer.
4) Edge or plate planer.
5) Divided table planer

1. STANDARD OR DOUBLE HOUSING PLANER:-

The standard or double housing planer is most widely used in workshop. A double housing planer has a long heavy base on which a table reciprocates on an accurate guide ways. The length of the bed is little over twice the length of the table. Two massive vertical housings or uprights are mounted near the middle of the base, one on each side of the bed. To ensure rigidity of the structure, these two housings are connected to the top by a cast iron member. The vertical faces of the two housings are accurately machined so that the horizontal crossrail carries two tool heads may slide upon it. The tool heads which holds the tools are mounted upon the crossrail. These tools may be fed either by hand or by power in crosswise or vertical direction. In addition to these tool heads, there are two other tool heads which are mounted upon the vertical face of the housing. They can also be moved either in the vertical or horizontal direction to apply feed. The planer table may be driven either by mechanical or hydralic devices.

2. OPENSIDE PLANER:—

An openside planer has a housing only on one side of the base and the cross rail is suspended from the housing as the cantilever. This feature of the machine allows large and wide Jobs to be clamped on the table and reciprocated past the cutting tool. one of the planer being opened, large & wide Jobs may project out of the table and reciprocate without being interfered by the housing. In a double housing planer, the maximum width of the job which can be machined is limited by the distance betwen two housings. As the single housing has to take up the entire load, it is made extra massive to resist the forces. only (3) ~~three~~ tool heads are mounted on the m/c. The construction and driving features of the machine are same as that of a double housing planer.

3. PIT PLANER:— A pit type planer is massive in construction. It differs from an ordinary planer in that the table is stationary and the column carring the crossrail reciprocates on massive horizontal rails mounted on both sides of the table. This type of planer is suitable for machining a very large work which cannot be accommodated on a standard planer and the design saves much of the floor space. The length of the bed required in a pit type planer is little over the length of the table, whereas in a standard planer the length of the bed is nearly twice the length of the table. The uprights and the crossrails are made ~~[illegible]~~ sufficiently rigid to take up the forces while cutting.

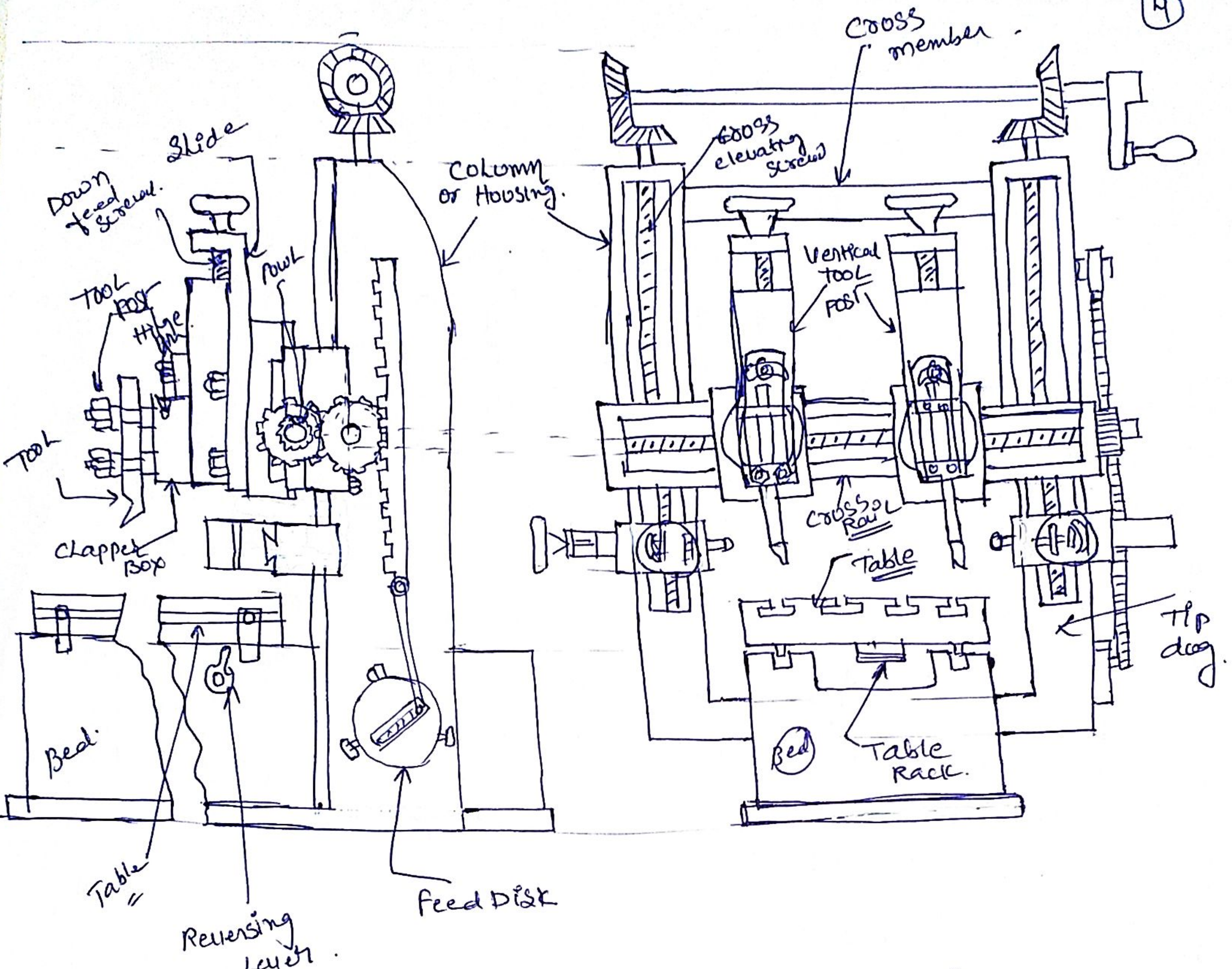
One or two tool heads can mount on cross rail with two side tool post housings. The whole unit travels beside the horizontal ways to and fro and therefore the tool moves past the work surface to complete the machining process.

4. EDGE or PLATE PLANER:-

The design of a plate or edge planner is totally unlike that of the ordinary planer. It is specially intended for squaring and beveling the edges of the steel plates used for different pressure vessels and ship building work. One end of ~~the~~ a long plate which remains stationary is clamped with the machine frame by a large number of air operated clamps. The cutting tool is attached to the carriage which are supported on two horizontal ways of the planer on its front end. The operator can stand on a platform extending from the carriage. The carriage holding the tool reciprocates past the edge of the plate. The feed and depth of cut is adjusted by the tool holder which can be operated from the platform.

5. DIVIDED TABLE PLANER:-

This type of planer has two tables on the bed which may be reciprocated seperately or together. This type of design saves much of idle time while setting the work. The setting up of a large number of identical work pieces on the planning machine table takes quite a long time. It may require as much time for setting up as may be necessary for machining. To have a continuous production one of the table is used for setting up the work, while the other reciprocates past the cutting tool finishing the work. When the work on the second table is finished, it is stopped and finished jobs are removed. Fresh jobs are now set up on this table while the first table holding the jobs now reciprocates past the tool. When a heavy & large jobs has to be machined, both the tables are clamped together and are given reciprocating movement under the tool.



↑ STANDARD DOUBLE HOUSING PLANER ↑

PLANNING MACHINE PARTS:-

A Standard double housing planer is illustrated in Fig. The principle parts the the planer are:-

1. Bed
2. Table or platen
3. Too head.
4. cross rail
5. Housing or column or upright
6. Driving and feed Mechanism.

BED:- The bed of a planer is box like casting having cross ribs. It is very large in size and heavy in weight and its supports the columns and all other moving parts of the machine. The bed is made slightly larger than twice the length of the table so that the full length of the table may be moved on it. It is provided with precision ways over the entire length on its top, surface and the table slides on it. In a standard M/c two V-type of the guideways are provided. Three or more guide ways may be provided on very large wide M/c for

supporting the table. Some of these guidways may be (5)
that type to lend support to the table. The guidway should be horizontal, true and parallel to each other. The way are properly lubricated and in moderen M/c's oil under pressure is pumped into the different part of the guidways to ensure a continuous and adequate supply of lubricants. The hollow space with in the box like structure of the bed houses the drive mechanism for the table.

2. TABLE:-

The table supports the work and reciprocates along the ways of the bed. The planer table is a heavy rectangular casting and is made of good quality cast Iron. The top surface of the planer table is accurately finished in order to locate the work correctly. T-slots are provided on the entire length of the table so that the work and work holding devices may be bolted upto it. Accurate holes are drilled on the top surface of the planer table at regular Intervals for supporting the poppets and stop pins. At each end of the table a hollow space is left which acts as a trough for collecting chips. Long works can also rest upon the troughts. A groove is cut on the side of the table for clamping planer reversing dogs at differt positions. In a standard planel, the table is made up of one single casting but in a divided table planer there are two seperateate tables mounted upon the bedways. The the table may be reciprocated indually or together. All planners have some form of safty device to prevent the heavily loaded table from running away in case electrical or mechanical failure which otherwise would have caused severe damage to the machine. Hydralic bumpers are sometimes fitted at the end of the bed to stop the table from over running giving cushioning effect. In some M/cs if the table overruns, a large cutting tool bolted to the underside of the table will take a deep cut on the replaceble block attached to the bed, obsorbing kinetic energy of the moving table.

3. HOUSING:- The housing called columns or uprights are rigid box-like vertical surfaces placed on each side of the bed.

They are havily ribbed to trace up severe forces due to
cutting. The front face of each housing is accurately machined to provide precision ways on which the crossrail may be made to slide up & down for accommodating differt heights of work.

Two side tool heads also slide upon it. The housing encloses the cross rail elevating screw, vertical and crossfeed screws for tool heads, counterbalancing weight for the crossrail etc. These screws may be operated either by hand or power.

4. CROSSRAIL:-

Cross rail is a rigid box-like casting connecting the two housings. This construction ensures rigidity of the machine. The crossrail may be raised or lowered on the face of the housing and can be clamped at any desired position by manually, hydraulic or electrical clamping devics. The cross rail when clamped should remain absolutely paralled to the top surface of the table, i.e it must be horizontal irrespective of its position. This is necessary to generate a flat horizontal surface on a workpiece because the tool follows the part on the crossrail during crossfeed. The two elevating screws in the housing are rotated by an equal amount to keep the crossrail horizontal in any position. The front face of the cross rail is accurately machined to provide a guide surface for the tool head saddle. Usually two tool heads are mounted upon the cross-rail which are called rail heads. The cross rail has screws for vertical and crossfeed of the toolheads and a screw for elevating the rail. The screws may be rotated either by hand or power.

5. TOOL HEAD:- The tool head of the planer is illustrated in fig. The Tool head of a Planer is similar to that of the shaper both in construction & operation.

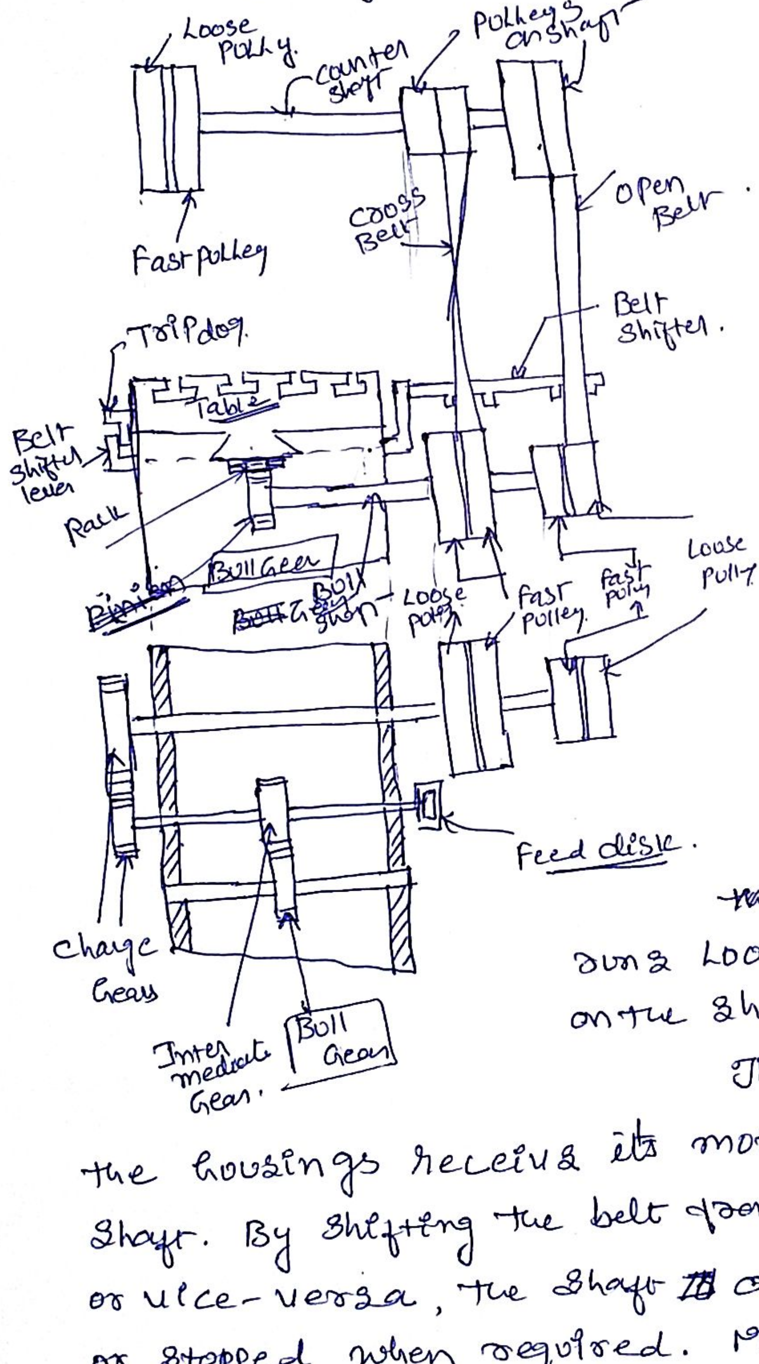
PLANER MECHANISM

The two important mechanisms of the planer are:-

1. Table drive mechanism
2. Feeding mechanism.

(1) The different mechanism used to drive the table are.

1. Open and cross belt drive
2. Reversible motor drive
3. Hydralic drive.



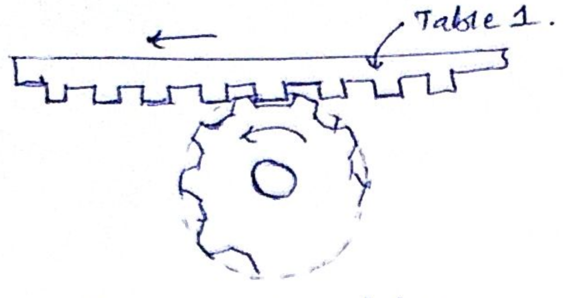
1. OPEN AND CROSS BELT DRIVE:-

The open and cross belt drive of the table is used in a planer of smaller size where the table width is less than 900mm. Fig. Illustrate the elevation and sectional plan of the mechanism. The sectional plan shows that the gearing arrangement is contained with in the bed. The momement of the table is effected by the cross & open belt drive ~~xxx~~. which runs on the pulleys. The polles ~~two~~ runs Loosely and inner polleys are tightey on the shaft.

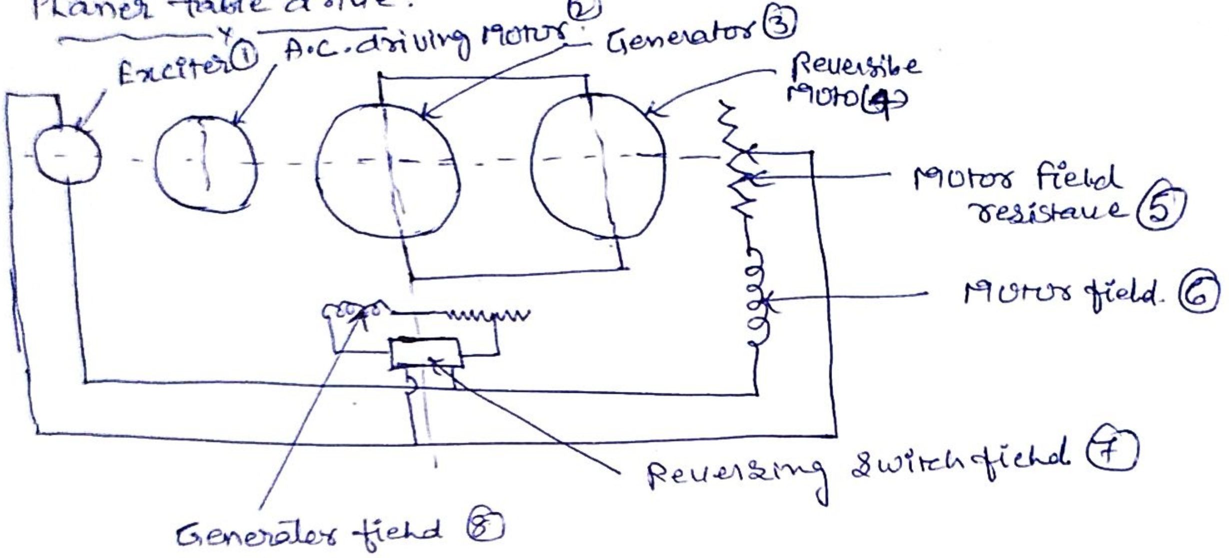
The counter shaft mounted upon the housings receive its motion from an overhead line shaft. By shifting the belt from the fast to Loose polley or vice-versa, the shaft ~~II~~ or the machine may be started or stopped when required. Mounted on the shaft are two polleys of different diameters which are keyed on the shaft. The cross belt connects the smaller diameter polley on the shaft with the larger diameter pulley which is keyed on the ~~shaft~~ ~~Bull~~ ~~Gear~~ shaft, two polleys at other end.

and the open belt connects the larger diameter pulley ⑧ on the shaft with the smaller diameter pulley which is loose on the shaft. If the shaft rotates the motion will be transmitted to the shaft through pulley which is held fast on the shaft. No motion will be transmitted by the open belt to the shaft 22. as it runs on the loose pulley 7. Motion

2. TABLE DRIVE BY REVERSIBLE MOTOR:-



Planer table drive.



QUICK RETURN MECHANISM OF A PLANER BY REVERSIBLE MOTOR

All modern planers are equipped with variable speed electric motors which drives the bull gear through a train of gearing. Fig. illustrate the electrical ckt layout for driving a reversible motor of a planer. The most efficient method of an electrical drive is based on Ward Leonard system which comprises four electrical M/c's. The usual supply being A.C. the power is taken from A.C. main to drive an A.C motor 2, which is couped to D.C generator 3 and a D.C exciter 1, on the same shaft. A D.C reversiable motor (variable speed) 4 is coupled with planer table drive gearing and ~~receives~~ receives power from the D.C generator 3. The field current for the generator and the reversible motor is supplied by the exciter 1. To start the machine, the motor generator set is started and the generator 3 supplies power to the reversible motor 4 which causes the table of the planer to move in a particular direction. At the end of the stroke a trip dog operates a switch 7, which reverses the field current in the generator 3 so, that the polarity of the

WORK HOLDING DEVICES

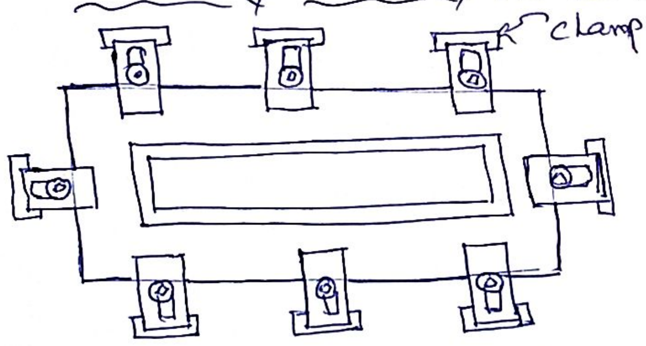
The work may be held on a planing m/c table by the following methods.

1. By standard clamping.
2. By special fixtures.

1. Standard clamping devices:- The standard clamping devices are used for holding most of the work on planer table. The devices are as follows:-

i) Heavy duty vises
ii) T-bolts & clamps
iii) Step blocks, clamps & T-bolts.
iv) Poppets or stopping pins & toedogs
v) Angle plates
vi) Planer jackes
vii) Planer centres
viii) Stops.
ix) V-blocks.

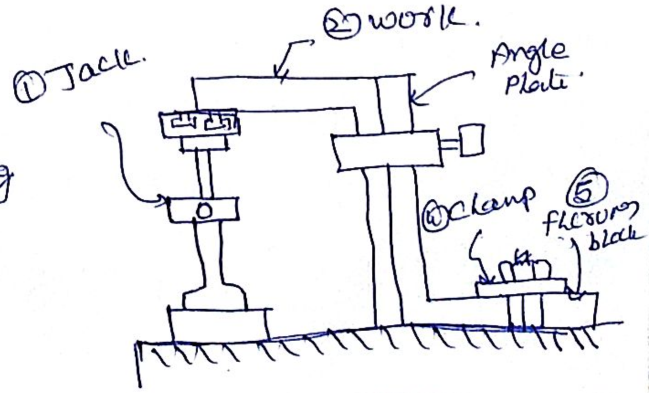
(iii) Step blocks, clamps & T bolts:-



Clamping large work in a planer table

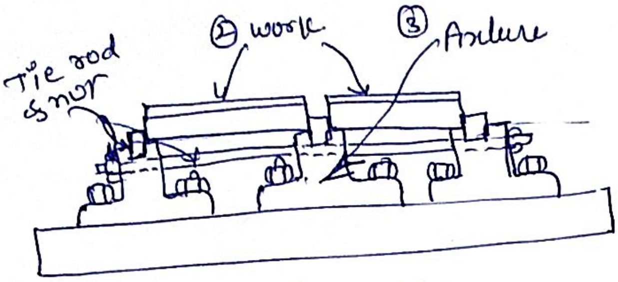
Most of the work pieces are clamped directly on the table by T-bolts & clamps. Different types of clamps are used for different types of work. Fig illustrates the method of clamping a large work on the planing m/c table. Step blocks are used to lend support to the other end of the clamps. Work pieces of different heights may be supported by using different steps of the step blocks.

(vi) PLANER JACKES:-



Planer jacks are used for supporting the overhanging part of a work to prevent it from bending

2. SPECIAL FIXTURES:-



USE OF FIXTURE

Special fixtures are used for holding a large number of identical pieces of work on a planer table. fixtures are specially designed for holding a particular type of work. By using a fixture the setting time may be reduced considerably compared to the individual setting of work by conventional clamping devices. fig illustrate the use of a fixture.

PLANER OPERATIONS:-

Operations performed in a planer are similar to that of a shaper. The only difference is that a planer is specially designed for planing large work, whereas a shaper can m/c only small work. The common type of work machined in a planer are i) the bases and tables of all kinds of m/c tools.

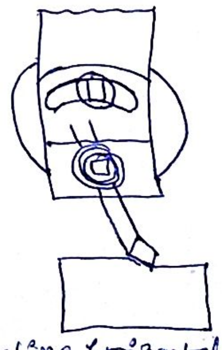
ii) large structures, frames of different engines.

iii) identical pieces of work which may be small in size but large in numbers.

The common operations performed in planer are

i) planing flat horizontal surfaces.
ii) planing vertical surfaces.
iii) planing at an angle and machining dovetails.
iv) planing curved surfaces.
v) planing slots & grooves.

i) PLANING FLAT HORIZONTAL SURFACES:-



Maching horizontal surface.

while machining horizontal surface, the work is given a reciprocating movement along with the table and the tool is is fed crosswise to complete the cut. Both the railheads may be used for simultaneous removal of metal from two cutting edges. The work is supported properly on the table, proper planning tool is selected, the depth of cut, speed and feed are adjusted and work is finished to the required dimensions by taking roughing & finishing cut.

ii) PLANNING VERTICAL SURFACES:-

The vertical surface of a work is planed by adjusting the saddle horizontally along the crossrail until the tool is in a position to give the required depth of the cut. The vertical slide ~~xxxx~~ is adjusted perpendicular to the table and the apron is swiveled in a direction so that the tool will swing clear

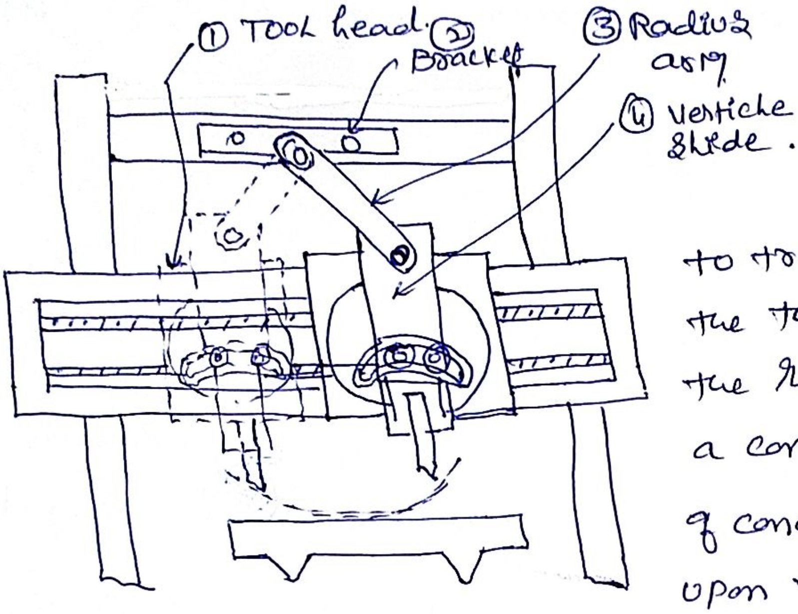
out of the machined surface during the return stroke. The downfeed is given by rotating the downfeed screw. The tool setting is similar to that shown in figure.

iii) PLANING ANGULAR SURFACE:-

For dovetail work, cutting V-grooves etc. the tool head is swiveled to the required angle and the apron is them further swiveled away from the work to give relief to the tool cutting edge during the return stroke. By rotating the down feed screw the tool is fed at an angle to the planer table. The tool setting is similar to that shown in fig.

iv) PLANING FORMED SURFACE:-

Fig. Illustrate a simple method of planing a concave surface with the aid of a special fixture consisting of a radius arm & 3 & a bracket 2. The bracket is connected to to the cross member attached to the two housings. one end of the radius arm '3' is pivoted on the bracket and the other end to the vertical slide 4 of the tool head. The downfeed screw the toolhead is removed. while planing, the crossrail and the tool which causes the saddle to traverse the crossrail and the tool which is guided by the radius arm 3. planes a concave surface. The radius of concave surface is dependent upon the length of the radius arm.



In planing m/c's various attachments can be utilized to generate various shapes. These attachments are:-

(a) Contour forming attachment.

(b) Helical grooving —"—

(c) oil grooving —"—

(d) Milling & grinding —"—

PLANING SLOTS AND GROOVES:- Slots or grooves are cut by using slotting tools. This operations are similar to that of shaper,

SLOTTING MACHINS (UNIT-4)

INTRODUCTION:-

The Slotting m/c falls under the category of reciprocating type of m/c tool similar to a shaper or a planer. It operates almost on the same principle as that of a shaper. The major difference betn the slotter and the shaper is that in a slotter the ram holding the tool reciprocates in the vertical axis, whereas in a shaper the ram holding the tool reciprocates in the horizontal axis. The vertical shaper and the slotter are almost similar to each other as regards to their construction, operation, and use. The only difference being, in the case of vertical shaper, the ram holding the tool may also reciprocate at an angle to the horizontal table in addition to the vertical stroke. The ram can be swiveled not more than 5° to the vertical. The slotter is used for cutting grooves, keyways and the slots of various shapes, for making regular & irregular surfaces both internal and external, for handling large and awkward work pieces, for cutting internal & external gears and many other operations which cannot be conveniently machined in any other m/c tool describe before.

The slotting m/c was developed by Brunel in the year 1800 much earlier than a shaper was invented.

TYPES OF SLOTTING MACHINE

There are two types of slotters. These are.

1) puncher slotter.
2) precision slotter.

1. PUNCHER SLOTTER:-

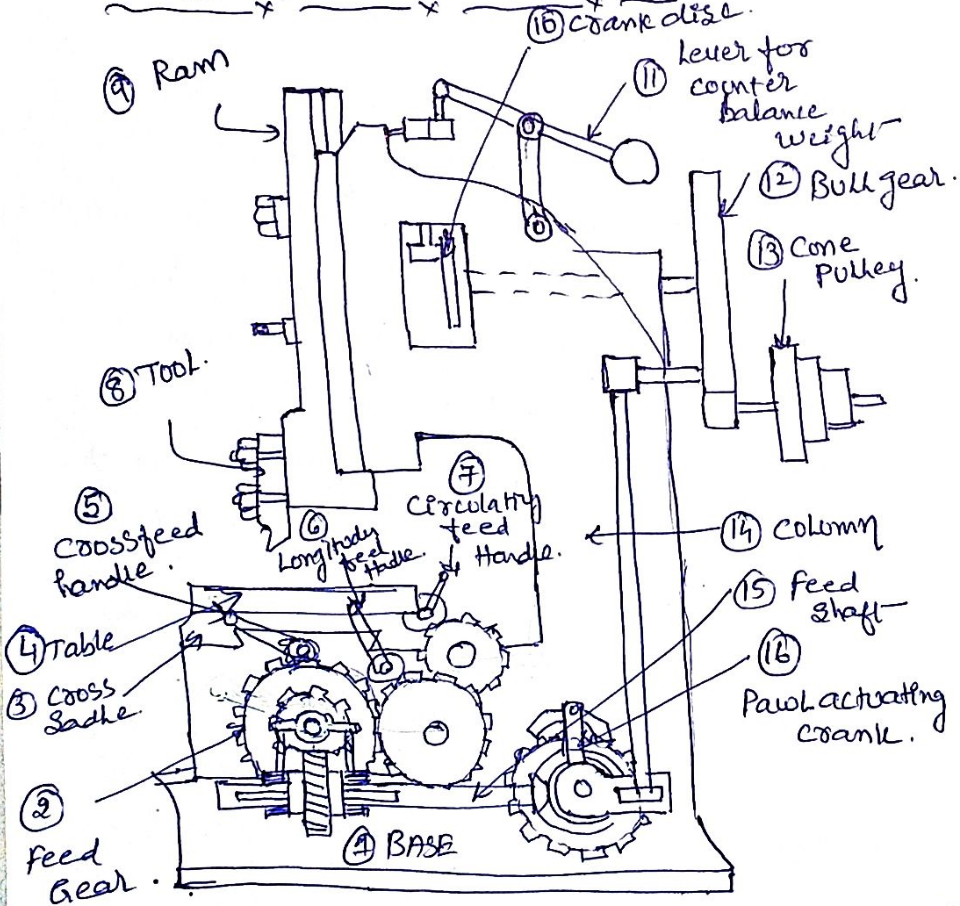
The puncher slotter is a heavy, rigid machine designed for removal of large amount of metal from large forging or castings. The length of the puncher slotter is sufficiently large. It may be as long as 1800 to 2000 mm. The puncher slotter ram is usually driven by a spiral

pinion meshing with the rack teeth cut on the underside (2)
of the ram. The pinion driven by a variable speed reversible electric motor similar to that of a planer. The feed is also controlled by electrical gears.

2. PRECISION SLOTTER:-

The precision slotter is a lighter machine and is operated at high speeds. The m/c is designed to take light cuts giving accurate finish. Using special jigs the m/c can handle a number of identical works on a production basis. The precision m/cs are also used for general purpose work and are usually fitted with whitworth quick return mechanism.

SLOTTING MACHINE PARTS:-



SLOTTING MACHINE

Fig illustrate the slotting m/c. The different parts of the slotting m/c are.

1. Base
2. column
3. saddle
4. cross slide
5. Rotating table
6. Ram & tool head assembly
7. Ram drive Mechanism
8. Feed mechanism.

1. BASE OR BED:-

The base is rigidly built to take up all the cutting forces and entire load of the machine. The top of the bed is accurately finished to provide guideways on which the saddle is mounted. The guideways are perpendicular to the column face.

COLUMN:- The column is the vertical member which is cast integral with the base and houses driving mechanism of the ram and feeding mechanism. The front vertical face of the column is accurately finished for providing ways on which the ram reciprocates.

SADDLE:-

The saddle is mounted upon the guideways and may be moved toward or away from the column either by power or manual control to supply longitudinal feed to the work. The top face of the saddle is accurately finished to provide guideways for the cross-slide. These guideways are perpendicular to the guideways of the base.

CROSS-SLIDE:-

The cross-slide is mounted upon the guideways of the saddle and may be moved parallel to the face of the column. The movement of the slide may be controlled either by hand or power to supply cross feed.

5. ROTARY TABLE:-

The rotary table is a circular table which is mounted on the top of the cross-slide. The table may be rotated by rotating a worm which meshes with a worm gear connected to the underside of the table. The rotation of the table may be effected either by hand or power. In some m/cs the table is graduated in degrees that enables the table to be rotated for indexing or dividing the periphery of a job in equal number of parts. 'T'-slots are cut on the top face of the table for holding the work by different clamping devices. The rotary table enables a circular or contoured surface to be generated on the workpiece.

6. RAM & TOOLHEAD ASSEMBLY:-

The ram is the reciprocating member of the machine mounted on the guideways of the column. It supports the tool at its bottom end on a tool head. A slot is cut on the body of the ram for changing the position of stroke.

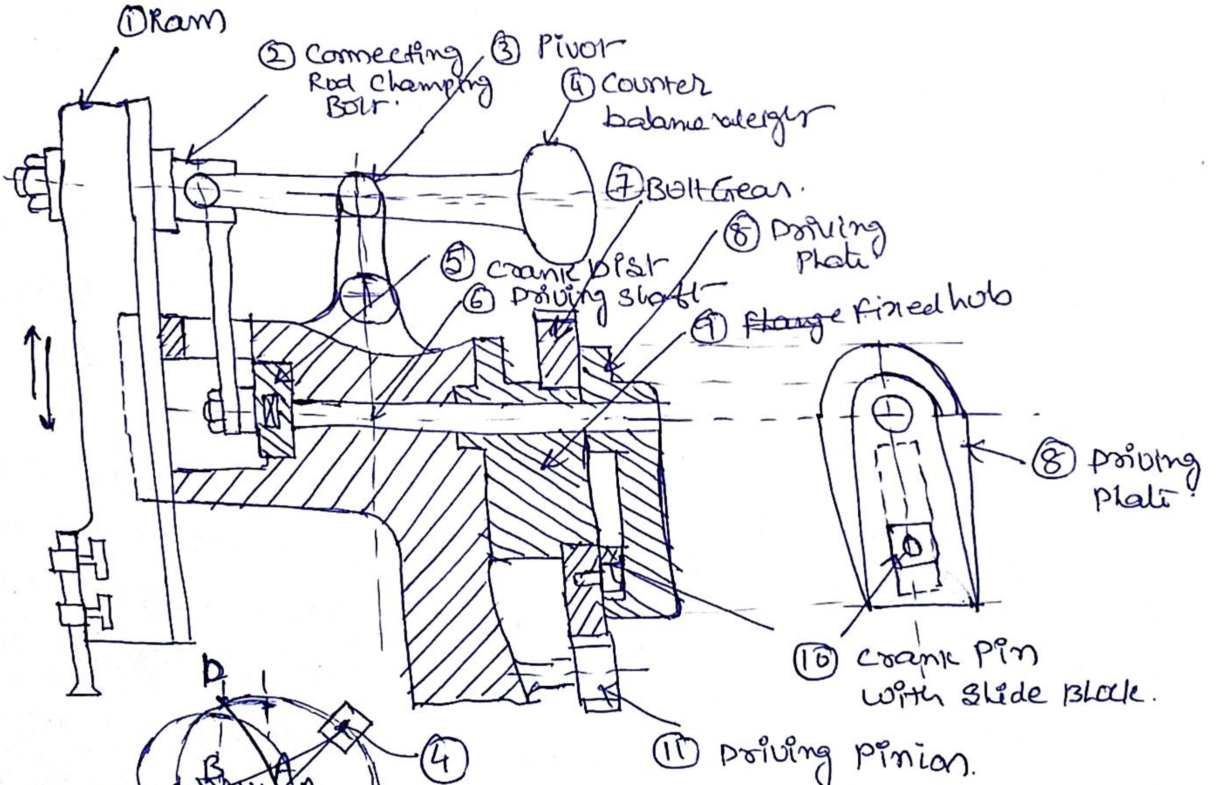
In some m/cs, Special type of tool holders are provided to releve the tool during its return stroke.

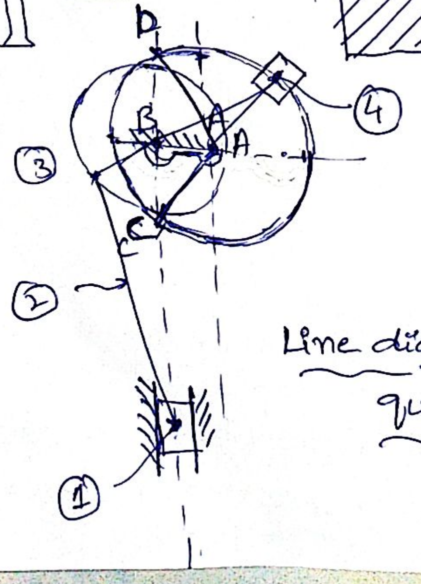
7) RAM DRIVE MECHANISM :-

A slotter removes metal only during downward cutting stroke where during upward return stroke no metal is removed. To reduce the idle return time, quick return mechanism is incorporated in the machine. The usual types of ram drive mechanism are.

i) whitworth quick return mechanism
ii) Variable speed reversiable motor drive mechanism.
iii) Hydralic drive mechanism.

i) whitworth quick return mechanism:-





Line diagram of whitworm quick return Mechanisms armature current in the reversible motor 4 is reversed, while the motor field circuit continues to receive current from the exiter at the same polarity. This causes the motor 4 to rotate in the opposite direction causing the planer Table to reverse. The speed during cutting stroke may be made slower than the return stroke by regulating the field current of the generator and the reversible motor with the help of resistance 5 & 8 placed in series with the field circuits. The return speed may be increased by weakening the motor field during return stroke. (5)

There are two general methods of driving the table rack.

i) Through a train of gearing to the bull gear engaging the rack.

ii) By a worm mounted on the motor spindle which meshes with the rack at an angle.

ADVANTAGES OF ELECTRICAL DRIVE:-

The electrical drive has certain distinct advantages over a belt driven planer. They are as follow:-

i) There is a very little change of any accident as the belt driving arrangement is eliminated.

ii) Large number of cutting speeds and return speeds are available.

iii) Control is quic and accurate. Push button controls the start, stop and inching movement of the machine.

iv) Return speed can be greatly increased reducing idle time.

v) During the end of each strock the table is brougut to rest by regenerative braking, the driving motor acting as generator absorbing K.E of the mechanical parts and returning back some of the power to the mains.

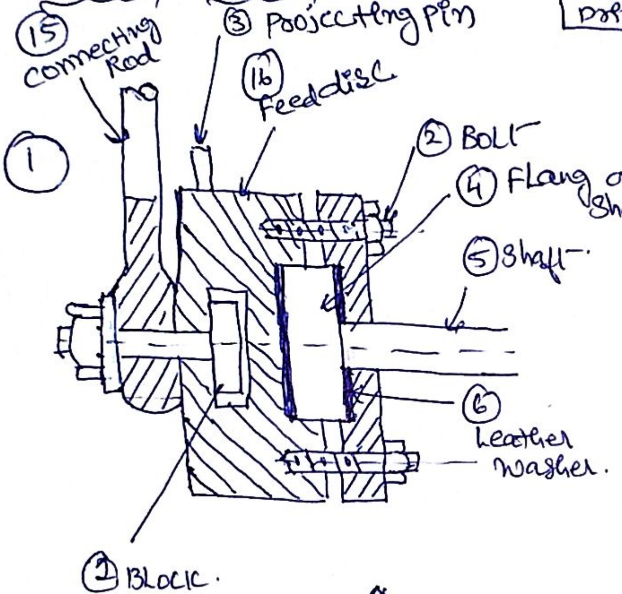
HYDRAULIC DRIVE:-

The mechanism for hydraulic drive of a shaper may be used in a planer with certain modification. The principle of reciprocating movement is otherwise same as that of a shaper.

FEED MECHANISM:-

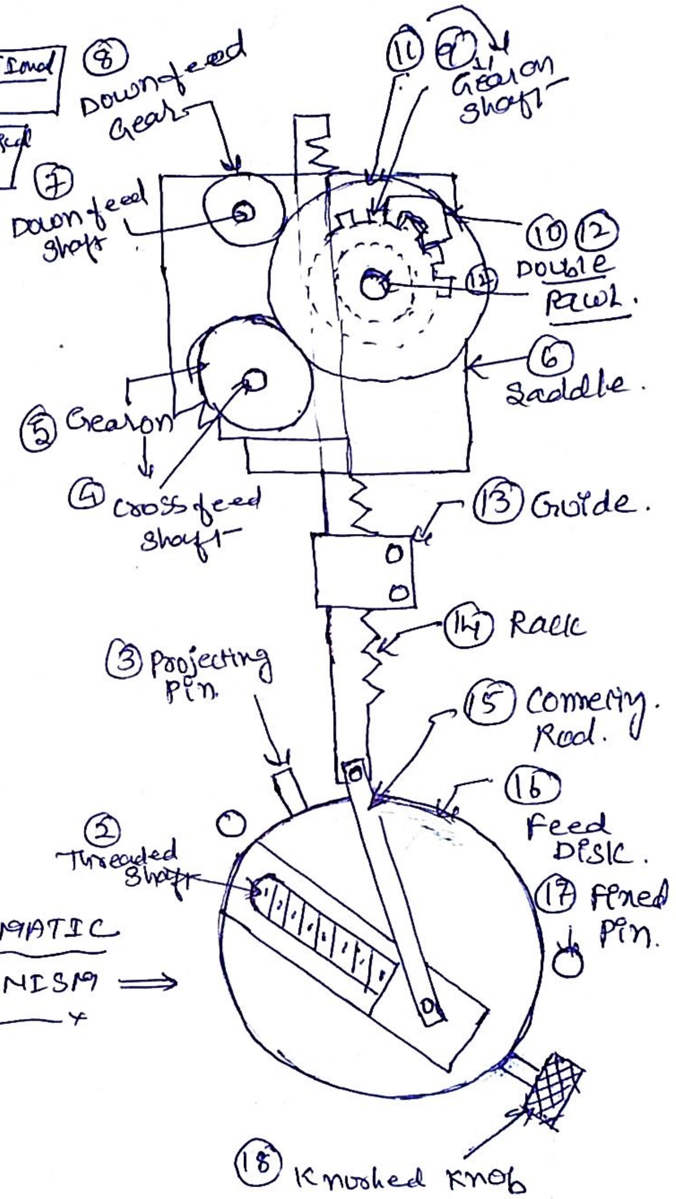
(1) By Frictional Drive

(2) By Electrical Drive.



⇑

SECTIONAL VIEW OF FEED DISC



FEED DISC AND AUTOMATIC FEED MECHANISM ⟹

(2) BY ELECTRICAL DRIVE:-

ELECTRICAL FEED MOVEMENT:-

Modern planers which are equipped with electrical drive use a seperate motor to operate the feed mechanism. The motor is energized simultaneously with the table reversing mechanism and rotates through a definite part of revolution. The revolution of motor may be half or one revolution only. At the appropriate time, the electrical control trips off the supply of electrical current and the motor is stopped by dynamic braking.

FEED MECHANISM :-

In a Slotter, the feed is given by the table, A Slotting machine table may have three types of feed movements :-

i) Longitudinal.

ii) Cross

iii) Circular.

If the table is feed perpendicular to the column toward or away from its face, the feed movement is termed as Longitudinal.

If the table is feed parallel to the face of the column the feed movement is termed as cross.

If the table is rotated on a vertical axis, the feed movement is termed as circular.

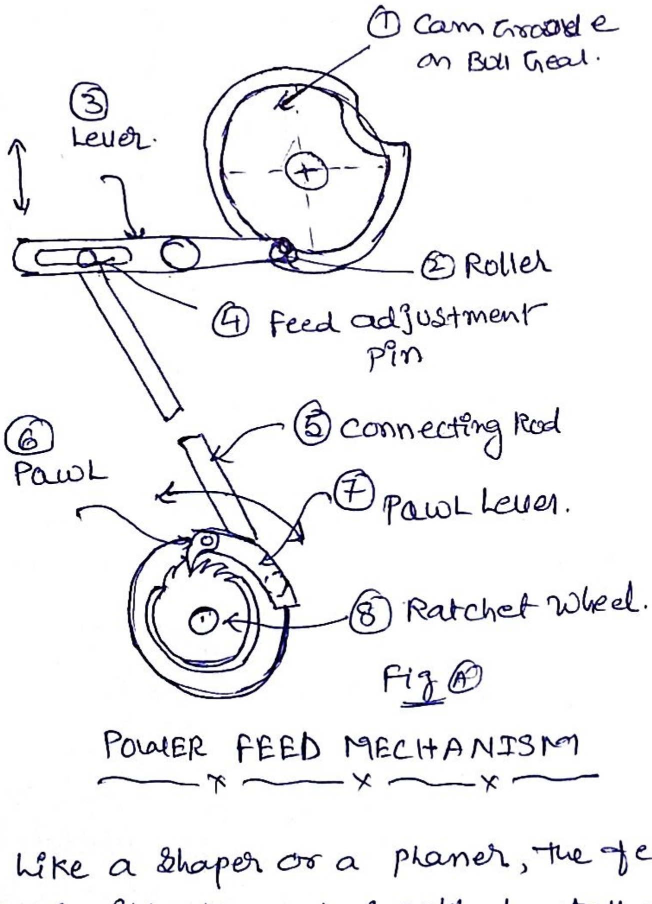
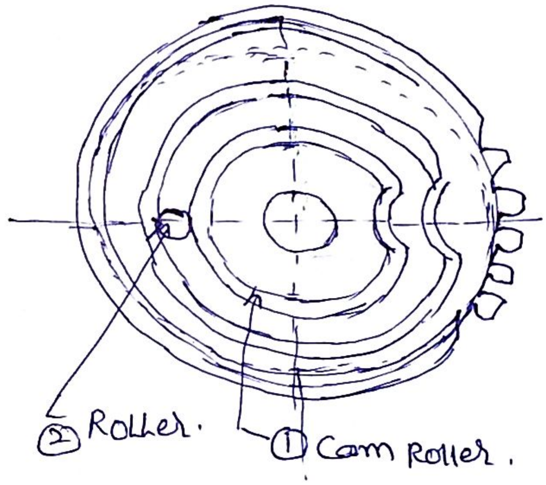


Fig Ⓐ

POWER FEED MECHANISM



CAM GROOVE ON BULL GEAR

Fig Ⓑ

Like a shaper or a planer, the feed movement of a slotter is intermittent and supplied at the begining of the cutting stroke. The feed movement may by supplied either by hand or power, The hand feed is supplied by rotating the individual feed screw.

The power feed mechanism is shown in fig Ⓐ A Cam Groove ① is cut on the face of the bull gear in which roller ② Slides, As the bull gear rotates, the roller attached to the lever ③ follows the contour of the cam groove and ⑧ moves up & down only during a very small part of revolution of the bull gear. The cam groove may be so cut that the movement of the lever ③ will take place only at the begining of the cutting stroke. Fig Ⓑ shows the cam groove cut on a bull gear. The rocking movement of the lever ③ is transmitted to the ratchet and pawl mechanism ⑥ & ⑧, so that the racher ⑧ will move in one direction only during this short period of the time. The ratchet wheel is mounted on rotary feed screws individually or together to impart power feed movement to the table.

WORK HOLDING DEVICES:-

The work is held on a slotter table by a vise, T-bolts, & clamps or by special fixtures. T-bolts and clamps are used for holding most of the work on the table. Before clamping pieces are placed below the work so as to allow the tool to complete the cut without touching the table. fixture are used for holding repetitive work.

SLOTTER OPERATIONS:-

The operations performed in a slotter are:-

i) Machining flat surfaces

ii) Machining cylindrical surfaces.

iii) Maching irregular surfaces & cam machining.

iv) Machining. slots, keyways and grooves.

i) Machining flat surfaces:-

The external and internal flat surfaces may be generated on the work pieces easily in a slotting m/c. The work to be machined is supported on parallel strips so that the tool will have clearance with the table when it is at the extreme downward position of the stroke. The work is than clamped properly on the table and the position and the length of the stroke is adjusted. A clearance of 20 to 25 is left before the begining of cutting stroke, so that the feeding movement may take place during this ideal part of the stroke. The table is clamped to prevent any longitudinal or rotary travel and the cut is started from one end of the work. The crossfeed is supplied at the begining of each cutting stroke and the work is completed by using a roughing and finishing tool. while Machining an internal surface a hole is drilled in the work piece through which the slotting tool may pass during the first cutting stroke. A second surface to the first machined surface can be completed without distrubing the setting by simply rotating the table throug 180° and adjusting the position of the saddle. A surface $\perp^{le}$ to the first machined surface may be completed by rotating the table by 90° and adjusting the position of the saddle and crossslide.

ii) MACHINING CIRCULAR SURFACES:-

The external and Internal surface of a cylinder can be also machined in slotting M/c. The work is placed centrally on the rotary table and packing pieces & clamps are to hold the work securely on the table. The tool is set radially on the work and necessary adjustments of the machine and tool are made. The saddle is clamped in its position and M/c is started. while Machining, the feeding is done by the rotary table feed screw which rotates the table through a small arc at the begining of each cutting stroke.

iii) MACHINING IRREGULAR SURFACES OR CAMS:-

The work is set on the table and necessary adjustments of the tool and the machine are made as detailed in other operations. By combining cross, longitudinal & rotary feed movement of the table any ~~xxxx~~ contoured surface can be machined on the work piece.

iv) MACHINING GROOVES OR KEYWAYS:-

Internal & external grooves are cut very conveniently on a slotting M/c. A slotter is specially intended for cutting internal grooves which is difficult to produce in other M/cs. External & Internal gear teeth can also be machined in a slotter by cutting equally spaced groves on the periphery of the work. The Indexing or dividing the periphery of the work is done by the graduations on the rotary table.