8

PLANING MACHINES

8.1 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 workpieces which cannot be accommodated on a shaper table. The fundamental difference between a shaper and a 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 machine was developed by Richard Roberts, an Englishman in the year 1817. The design and working principle of the machine, of course, was almost identical to the present day machine.

8.2 TYPES OF PLANING MACHINE

Different classes of work necessitates designing of different types of planing machine to suit to various requirements of our present day industry. The different types of planer which are most commonly used are:

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

Standard or double housing planer : The standard or double housing planer is most widely used in workshops. A double housing planer has a long heavy base on which a table reciprocates on accurate guideways. 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 at the top by a cast iron member. The vertical faces of the two housings are accurately machined so that the horizontal crossrail carrying two toolheads may slide upon it. The toolheads which hold 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 toolheads, there are two other toolheads which are mounted upon the vertical face of the housing. They can also be moved either in a vertical or horizontal direction to apply feed. The planer table may be driven either by mechanical or hydraulic devices.

Openside planer : An openside planer has a housing only on one side of the base and the crossrail is suspended from the housing as a cantilever. This feature of the machine allows large and wide jobs to be clamped on the table and reciprocated past the cutting tool. One side of the planer being opened, large and 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 between the two housings. As the single housing has to take up the entire load, it is made extra-massive to resist the forces. Only three toolheads are mounted on this machine. The constructional and driving features of the machine are same as that of a double housing planer.

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 carrying 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 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 crossrail are made sufficiently rigid to take up the forces while cutting.

Edge or plate planer : The design of a plate or edge planer is totally unlike that of an ordinary planer. It is specially intended for squaring and bevelling the edges of steel plates used for different pressure vessels and ship-building works. One end of 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 a carriage which is 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.

Divided table planer : This type of planer has two tables on the bed which may be reciprocated separately or together. This type of design saves much of idle time while setting the work. The setting up of a large number of identical workpieces on the planing 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 and large job has to be machined, both the tables are clamped together and are given reciprocating movement under the tool.

8.3 SIZE OF A PLANER

The size of a standard planer is specified by the size of the largest rectangular solid that can reciprocate under the tool. The size of the largest solid is known by the distance between the two housings, the height from the top of the table to the crossrail in its uppermost position, and the maximum length of table travel. The length of the table always almost equal to the table travel. Double housing planers range from 750mm × 750mm × 2.5m at the smallest upto 3000mm × 3000mm × 18.25m at the largest size. Usually the distance between the housings and the height from the table to the crossrail in its highest position are equal. For this reason a planer may be roughly specified as 750 mm planer or 3000 mm planer.

The size of an openside planer is specified by the size of the largest job that can be machined on its table. The size of the largest job is determined by the height of the crossrail from the top of the table, the maximum length of table travel and the planing width. The maximum width of the job that can be machined is known as the *planing width,* which is determined by the distance from the table side of the column to the tool in the outer toolhead in a vertical position. The toolhead extends beyond the table width by nearly 300 mm. Open side planers range from 900 mm × 1200 mm × 2.5 m to 2500 mm × 2800 mm × 18.25 m.

In addition to these basic dimensions, other particulars such as number of speeds and feeds available, power input, floor space required, net weight of the machine, type of drive, etc. are required to be stated in order to specify a planer fully.

8.4 PLANING MACHINE PARTS

A standard double housing planer is illustrated in Fig.8.1. The principle parts of the planer are :

1. Bed	4. Crossrail
2. Table or platen	5. Housing or column or upright
3. Tool head	6. Driving and feed mechanism

Bed : The bed of a planer is box like casting having cross ribs. It is a very large in size and heavy in weight and it supports the column and all other moving parts of the machine. The bed is made slightly longer 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 machine, two V-type of guideways are provided. Three or more guideways may be provided on very large wide machine for supporting the table. Some of these guideways may be flat type to lend support to the table. The guideways should be horizontal, true and parallel to each other. The ways are properly lubricated and in modern machines oil under pressure is pumped into the different part of the guideways to ensure a continuous and adequate supply of lubricants. The hollow space within the box like structure of the bed houses the driving mechanism for the table.

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 face 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 upon 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 troughs. A groove is cut on the side of the table for clamping planer reversing dogs at different positions. In a standard planer, the table is made up of one single casting but in a divided table planer there are two separate tables mounted upon the bedways. The tables may be reciprocated individually or together. All planers have some form of safety device to prevent the heavily loaded table from running away in case of electrical or mechanical failure which otherwise would have caused severe damage to the machine. Hydraulic bumpers are sometimes fitted at the end of the bed to stop the table from overrunning giving cushioning effect. In some machines, if the table overruns, a large cutting tool bolted to the underside of the table will take a deep cut on a replaceable block attached to the bed, absorbing kinetic energy of the moving table.

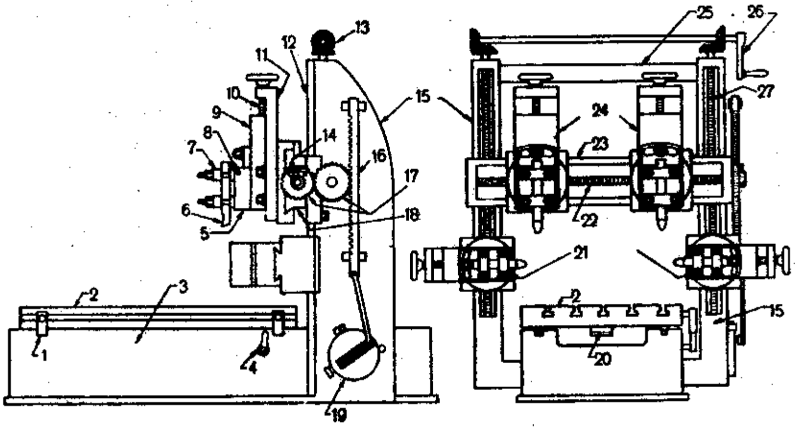

Figure 8.1 Standard double housing planer

1. Trip dog, 2. Table, 3. Bed, 4. Reversing lever, 5. Clapper box, 6. Tool, 7. Tool Post, 8. Hinge pin, 9. Vertical slide, 10. Downfeed screw, 11. Slide, 12. Guideways on column face, 13. Feed screw for elevating crossrail, 14. Pawl, 15. Column or housing, 16. Rack, 17. Feed gears, 18. Saddle, 19. Feed disc, 20. Table rack, 21. Slide toolhead, 22. Feed screw, 23. Crossrail, 24. Vertical toolheads, 25. Crossmember, 26. Crossrail, elevating handle, 27. Cross elevating screw.

Housing : The housings also called columns or uprights are rigid box-like vertical structures placed on each side of the bed and are fastened to the sides of the bed. They are heavily 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 and down for accommodating different heights of work. Two side-toolheads also slide upon it. The housing encloses the crossrail 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.

Crossrail : Crossrail 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 manual, hydraulic or electrical clamping devices. The crossrail when clamped should remain absolutely parallel 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 two housing are rotated by an equal amount to keep the crossrail horizontal in any position. The front face of the crossrail is accurately machined to provide a guide surface for the toolhead saddle. Usually two toolheads are mounted upon the crossrail which are called railheads. The crossrail has screws for vertical and cross feed of the toolheads and a screw for elevating the rail. These screws may be rotated either by hand or by power.

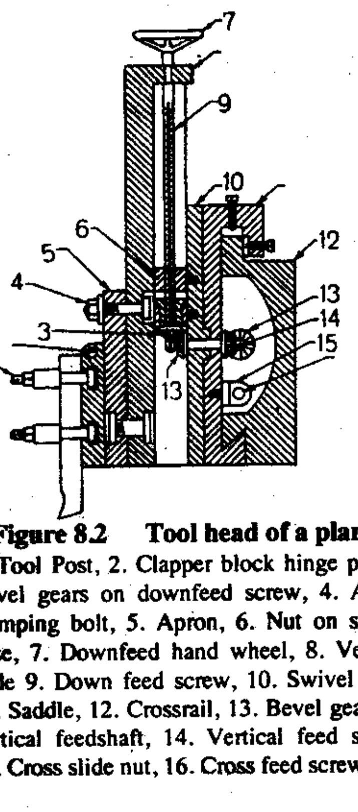

Figure 8.2 Tool head of a planer
1. Tool Post, 2. Clapper block hinge pin, 3. Bevel gears on downfeed screw, 4. Apron clamping bolt, 5. Apron, 6. Nut on swivel base, 7. Downfeed hand wheel, 8. Vertical slide 9. Down feed screw, 10. Swivel base, 11. Saddle, 12. Crossrail, 13. Bevel gears on vertical feedshaft, 14. Vertical feed screw, 15. Cross slide nut, 16. Cross feed screw.

Toolhead : Fig.8.2 illustrates the toolhead of a planer. The toolhead of a planer is similar to that of a shaper both in construction and operation. The important parts of a toolhead are :

1. Saddle,
2. Swivel base,
3. Vertical slide,
4. Apron,
5. Clapper box,
6. Clapper block,
7. Toolpost,
8. Down feed screw,
9. Apron clamping bolt,
10. Apron swivelling pin,
11. Mechanism for cross and downfeed of the tool.

Toolheads are mounted on the crossrail *12* by a saddle *11*. The saddle *11* may be made to move transversely on the crossrail to give crossfeed. The swivel base is pivoted on the saddle and is graduated on each side to 60°. The swivel base may be swivelled to any desired angle and the down feed screw is rotated to feed the tool at that angle for machining angular surface. The vertical slide *8* may be fed downwards by rotating the downfeed screw *9* which passes through a nut *6* fixed on the swivel base *10*. The apron *5* is clamped on the face of the vertical slide *8* by a clamping bolt *4* and may be swivelled upto 20° on each side of the slide for giving the tool clearance while machining vertical surface. The clapper block is hinged at *2* to the clapper box, and it holds the toolpost *1* in which the tool is clamped by straps. During the return stroke the toolhead is lifted upwards by the clapper block and prevents the tool cutting edge from dragging on the work. The toolhead is fed crosswise by rotating the crossfeed screw *16* within the crossrail which passes through a nut *15* attached to the saddle. Vertical slide *8* holding the tool may be fed up or down by rotating the feed screw *14* within the crossrail and the motion is transmitted to the downfeed screw through bevel gears *13* and *3*.

8.5 PLANER MECHANISM

The two important mechanisms of a planer are:

1. Table drive mechanism.
2. Feeding mechanism.

The different mechanisms used to drive the table are :

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

Open and crossbelt drive : The open and crossbelt drive of the table is used in a planer of smaller size where the table width is less than 900 mm. Fig.8.3 illustrates the elevation and sectional plan of the mechanism. The sectional plan shows that the gearing arrangement is contained within the bed. The movement of the table *19* is effected by an open and crossed belt drive *6* and *7* which run on the pulleys *9,10,11,* and *12*. The outer pulleys 9 and *12* run loosely and the inner pulleys *10* and *11* are tight on the shaft *22*.

The countershaft *3* mounted upon the housings receives its motion from an overhead line shaft. By shifting the belt from the fast to the loose pulley *2* to *1* or vice-versa, the shaft 3 or the machine may be started or stopped when required. Mounted upon the shaft *3* are two pulleys *4* and *5* of different diameters which are keyed to the shaft *3*. The crossed belt *7* connects the smaller diameter pulley *4* on shaft *3* with the larger diameter pulley *11* which is keyed on the shaft *22* and the open belt *6* connects the larger diameter pulley *5* on shaft *3* with the smaller diameter pulley *9* which is loose on the shaft *22*. If the shaft *3* rotates the motion will be transmitted to the shaft *22* through pulley *11* which is held fast on the shaft *22*. No motion will be transmitted by the open belt *6* to the shaft *22* as it runs on the loose pulley *9*. Motion of the shaft *22* is transmitted through a train of gearing *20, 21* and *24* to the bull gear *14* mounted on the shaft *13*. The gear *14* meshes with a rack *15* cut at the underside of the table *19* and the table will receive a linear movement. Fig.8.4 illustrates meshing of the bullgear with table rack.

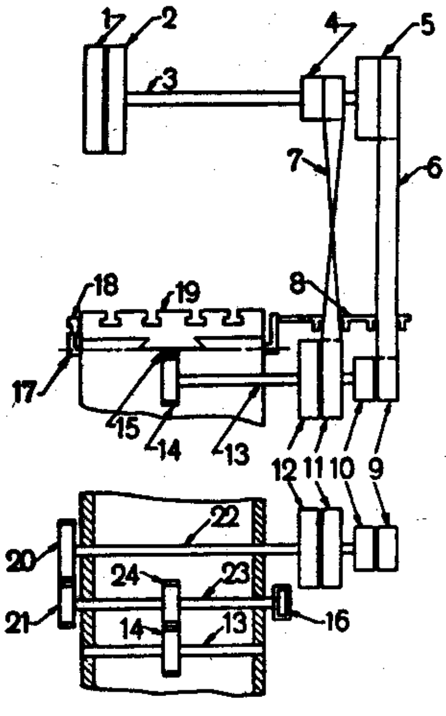

Figure 8.3 Quick return mechanism of a planer by open and crossbelt

1. Loose pulley, 2. Fast pulley, 3. Countershaft, 4, 5. Pulleys on shaft, 3, 6. Open belt, 7. Cross belt 8. Belt shifter, 9. Loose pulley, 10. Fast pulley, 11. Fast pulley, 12. Loose pulley, 13. Bull gear shaft, 14. Bullgear, 15. Rack, 16. Feed disc, 17. Belt shifter lever, 18. Trip dog, 19. Table, 20, 21. Change gears, 22. Shaft, for pulleys, 9, 10, 11 and 12, 23. Intermediate shaft, 24. Intermediate gear.

During cutting stroke, greater power and less speed is required. The crossed belt giving a greater arc of contact on the pulleys *11* and *4*, is used to drive the table on the cutting stroke. The greater arc of contact of the belt gives greater power and the speed is reduced as the belt connects smaller pulley *4* on the shaft *3* to larger pulley *11* on the shaft *22*. At the end of the forward cutting stroke, the trip dog mounted on the side of the planer table operates a belt shifter *8* through a lever arrangement *17*, so that the crossed belt *7* may be shifted from the driving pulley *11* to the loose pulley *12*, and the open belt *6* may be shifted from the loose pulley *9*, to the fast pulley *10*. The motion is now transmitted from the large pulley *5* on shaft *3* to the fast pulley *10* on shaft *22* and no motion is now transmitted by the crossed belt *7* to the shaft *22*. When the shaft *22* will receive motion from the open belt *6*, the direction of rotation of the shaft *22* will be reversed and the table *19* will start moving to perform return stroke. The speed during return stroke will increase as the open belt *6* connects larger diameter pulley *5* on shaft *3* with the smaller diameter pulley *10* on shaft *22* and quick return motion will thus be obtained. At the end of the return stroke, a second trip dog will hit against the belt shifter lever *17* causing the crossed belt *7* to be shifted on pulley *11* and the open belt *6* on pulley *9* and to repeat the cycle of cutting and return stroke. The length and position of stroke may be adjusted by shifting the position of dogs *18*.

Table drive by reversible motor : All modern planers are equipped with variable speed electric motor which drives the bullgear through a train of gearing. Fig.8.5 illustrates the electrical circuit 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 machines. The usual supply being A.C. the power is taken from A.C. mains to drive an A.C. motor 2 which is coupled with a D.C. generator *3* and a D.C. exciter *1* on the same shaft. A D.C. variable speed reversible motor *4* is coupled with the planer table drive gearing and 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 armature current in the reversible motor *4* is reversed, while

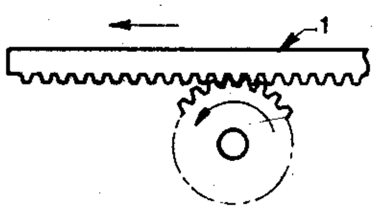

Figure 8.4 Planer table drive
1. Table

the motor field circuit continues to receive current from the exciter 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 resistances 5 and 8 placed in series with the field circuits. The return speed may be increased by weakening the motor field during return stroke.

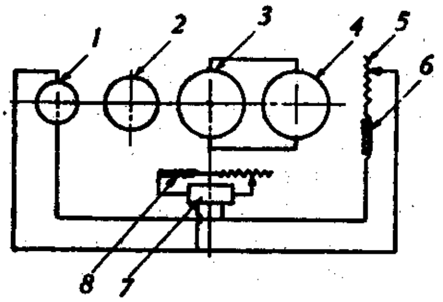

Figure 8.5 Quick return mechanism of a planer by a reversible motor
1. Exciter, 2. A. C. driving motor, 3. Generator. 4. Reversible motor, 5. Motor field resistance, 6. Motor field, 7. Reversing switch, 8. Generator field.

There are two general methods of driving the table rack :

1. Through a train of gearing to the bull gear engaging the rack.
2. 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 follows :

1. There is very little chance of any accident as the net driving arrangement is eliminated.
2. Large number of cutting speeds and return speeds are available.
3. Control is quick and accurate. Push button controls the start, stop and inching movement of the machine.
4. Return speed can be greatly increased reducing idle time.
5. During the end of each stroke the table is brought to rest by regenerative braking, the driving motor acting as generator absorbing kinetic energy 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 modifications. In a planing machine, the high speed required during cutting and return stroke posses the main problem and the pipe line becomes very much stressed during the time of reversal. Moreover a very long stroke is required in a planer. In some machines more than one cylinder is used to eliminate this difficulty. The principle of reciprocating movement is otherwise same as that of a shaper.

Feed mechanism : In a planer the feed is provided intermittently and at the end of the return stroke similar to a shaping machine. The feed of a planer, both downfeed and crossfeed, is given by the tool. The crossfeed is given while machining horizontal surface on a work mounted on the table. The tool which is clamped on the toolhead slides on the crossrail by a predetermined amount at the end of each return stroke of the table to give the necessary crossfeed. The down feed is applied while machining a vertical or angular surface by rotating the downfeed screw of the toolhead. Both the down and crossfeed may be operated either by hand or power by rotating two feed screws, *14* and *16* shown in Fig.8.2, contained within the crossrail. The power feed may be applied by the following methods :

1. By friction disc.
2. By electrical drive.

Feed mechanism by friction disc : The major difference between the feed mechanism of a shaper and a planer is that in a shaper when the bull gear rotates through one complete revolution, the ram holding the tool completes one forward cutting stroke and, one return stoke, and by a ratchet and pawl mechanism half of the revolution of the bull gear is used to impart feed movement. During the other half no feed movement is given. But in a planer as the length of stroke of the table is quite long, the bull gear will make a large number of revolutions in the forward cutting stroke and the same number of revolutions in the return stroke. By friction feed disc, only part of the revolution of the bull gear is

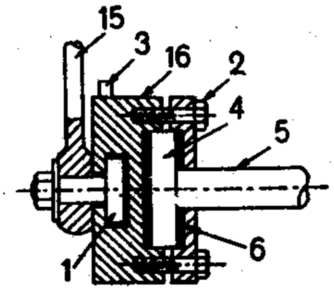

Figure 8.6 Sectional view of a feed disc

1. Block, 2. Bolt, 3. Projecting pin, 4. Flange on shaft 5, 5. Shaft, 6. Leather washer, 16. Feed disc, 15. Connecting rod.

used to operate the feed gearing at the end of the return stroke, and during the rest of the period, the feed mechanism remains inoperative.

In Fig.8.3 the feed motion is transmitted from the soft *23* to the feed disc *16*. The sectional view of the feed disc is shown in Fig.8.6. The feed disc consists of two parts having a cylindrical opening which encloses the flange *4* connected to the shaft *5* which is the shaft *23* shown in Fig.8.3. Leather washers *6* are placed between the flange *4* and disc openings and the bolts *2* are then tightened. A flexible connection is now made between the shaft *5* and the feed disc *16* through leather washers *6*. Fig.8.7 illustrates the end view of the feed disc showing the driving mechanism of the feed screws. A T-slot is cut radially on the face of the feed disc *16* within which a block *1* is fitted. By rotating the knurled knob *18* the position of the block *1* with respect to the center may be changed. A pin *3* connected to the driving disc *16* extends beyond the disc body. When the shaft *5* or *23* starts rotating during forward cutting stroke, the motion is transmitted to the disc *16* by the flange *4* shown in Fig. 8.6 and the disc *16* starts rotating. The motion of the disc 16 is limited by the projecting pin 3 hitting against a fixed pin *17* fitted upon the machine frame. Thus when the disc *16* rotates through a part of the revolution, the flange *4* connected to the shaft *5* or *23* continues to rotate within the disc *16* slipping over the leather washers *6* throughout the cutting stroke. When the table is reversed and the shaft *5* starts rotating in the opposite direction the disc *16* rotates through the same part of the revolution in the opposite direction due to the pin 3 hitting against a second fixed pin mounted upon the machine frame. Thus when the planer table reciprocates, the disc *16* rotates through a part of the revolution in one direction at the beginning of cutting stroke and again it rotates through the same part of the revolution in the opposite direction at the beginning of return stroke. This rotary movement of the disc *16* is transmitted to the rack *14* through the connecting rod *15* and a pinion mounted upon the shaft *12* which meshes with the rack receives rotary movement. Gears *9* and *11* are mounted upon the shaft *12* in which *9* is keyed to the shaft *12* and *11* is free. A double pawl *10* is pinned on the face of the gear *11* and any one end of the pawl may be pushed into the tooth space of the gear *9*. When the left hand end of the pawl is pushed within the gear *9*, the upward movement of the rack *14* will cause the gear *9* to rotate in the clockwise direction and the motion is communicated to the gear *11* through the pawl *10* and gear *11* will rotate in the clockwise direction. When the rack will be moving downward, the gear 9 will rotate in the anticlockwise direction and no motion will be transmitted to the gear *11* as the bevel edge of the pawl *10* will slip over the teeth of gear *9*. Thus the gear *11* will rotate through a part of the revolution in one direction only during a complete double stroke of the table and it may be so arranged that the gear *11* will operate during the beginning of cutting stroke only. Gear *11* may be made to mesh with two sliding gears *5* and *8* mounted upon the two feed shafts *4* and *7*. *7* is the down feed shaft and *4* is the crossfeed shaft contained within the crossrail. Feed motion is imparted to the toolheads by rotating these feed shafts separately or together.

The direction of feed movement may be reversed by changing the position of double pawl *10*.

Amount of feed movement may be varied by shifting the position of block *1* with respect to the centre. Feed is increased when the block is shifted away from the centre. The stroke length of the rack is increased due to the greater throw of eccentricity of the block *1* and the two gears *8* and *5* ultimately rotate through a greater amount.

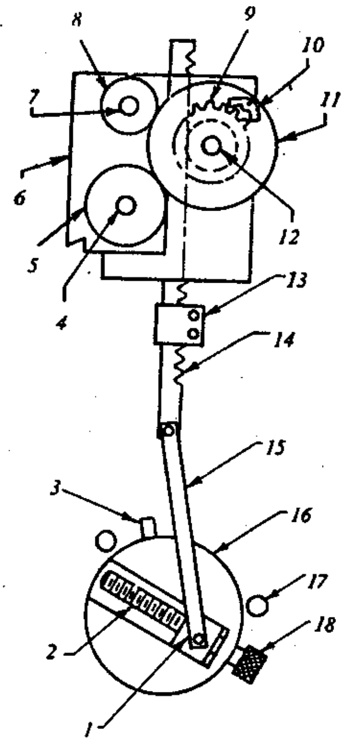

Figure 8.7 Feed disc and automatic feed mechanism

1. Block, 2. Threaded shaft, 3. Projecting pin, 4. Cross feed shaft, 5. Gear on crossfeed shaft, 6. Saddle, 7. Down feed shaft, 8. Gear on downfeed shaft, 9, 11. Gears on shaft 12, 10. Double pawl, 12. Pinion shaft, 13. Guide, 14. Rack, 15. Connecting rod, 16. Feed disc 17. Fixed pin, 18. Knurled knob.

Electrical feed movement : Modern planers which are equipped with electrical drive use a separate 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 the 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.

8.6 WORK HOLDING DEVICES

A planer table is used to hold very large, heavy and intricate jobs, and in many cases, large number of identical pieces together. Setting up of the work on a planer table requires sufficient amount of skill. The following three points are very carefully considered to hold the work correctly on a planer table.

1. The work should be rigidly connected to the table so that it may not be shifted out of its position while cutting activity progresses.
2. Proper clamping should be done all round the work, but undue clamping pressure should not be applied to cause distortion of the work. The work may spring back when the clamps are removed resulting inaccuracy in the machined surface.
3. The work should be so held that the surface planed should remain in proper position with other surfaces.

The work may be held on a planing machine table by the following methods :

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

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

1. Heavy duty vises.
2. T-bolts and clamps.
3. Stepblocks, clamps and T-bolts.
4. Poppets or stop pins and toe dogs.
5. Angle plates.
6. Planer jacks.
7. Planer centres.
8. Stops.
9. V-blocks.

Most of them have been described in Art.5.14 and Art.7.6. However, the special features which are useful in connection with the planing machine are described hereunder.

A *planer vise* is much more robust in construction than a shaper vise as it is used for holding comparatively larger sizes of work. The vise may be plain or swivelled base type. The work is clamped between the fixed and movable jaws. The movable jaw is rigidly bolted to the base of the vise after the work has been set. Most of the workpieces are clamped directly on the table by *T-bolts* and *clamps*. Different types of clamps are used for different types of work. Fig.8.8 illustrates the method of clamping a large work on a planing machine table. *Stepblocks* are used to lend support to the other end of the clamp. Workpieces of different heights may be supported by using different steps of the step blocks. *Angle plates* are used for holding *L* shaped work or job which cannot be conveniently held on a planer table directly. *Planer jacks* are used for supporting the overhanging part of a work to prevent it from bending. Fig.8.9 illustrates the use of a planer jack. *Planer centres* are used for holding work between two centres and cutting grooves and slots on the work. Indexing and gear cutting can also be done by using the device. *Stops* are used to prevent the work from moving endwise or sideways under the thrust of the cut. *Poppets and toe dogs* are used for holding thin pieces of work on a planer table. *V-blocks* illustrates *in* Fig.8.10 are used for holding round work.

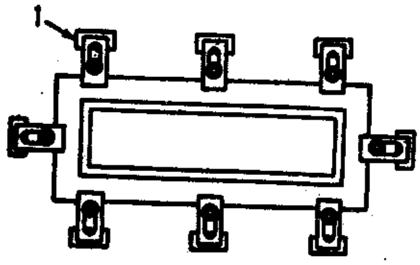

Figure 8.8 Clamping large work on a planer table
1. Clamp

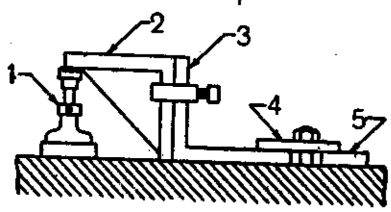

Figure 8.9 Use of planer jack
1. Jack, 2. Work, 3. Angleplate, 4. Clamp, 5. Fulcrum block.

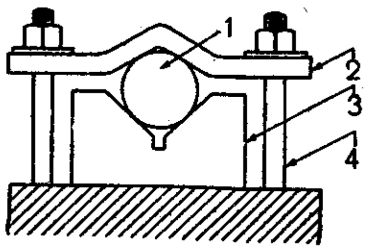

Figure 8.10 Use of V-block
1. Work, 2. Clamp, 3. V-block, 4. T-bolt

Special fixtures : 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 a work. By using a fixture the setting time may be reduced considerably compared to the individual setting of work by conventional clamping devices. Fig.8.11 illustrates the use of a fixture.

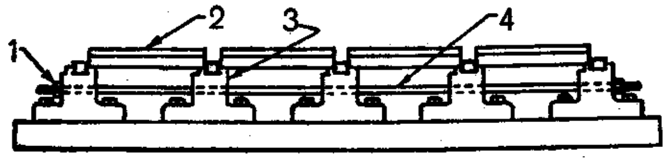

Figure 8.11 Use of a fixture
1. Tie rod nut, 2. Work, 3. Fixture, 4. Tie rod

8.7 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 machine only small work. The common types of work machined in a planer are : the bases and tables of all kinds of machine tools, large structures, frames of different engines and identical pieces of work which may be small in size but large in number. The common operations performed in planer are :

1. Planing flat horizontal surfaces.
2. Planing vertical surfaces.
3. Planing at an angle and machining dovetails.
4. Planing curved surfaces.
5. Planing slots and grooves.

Planing horizontal surfaces : While machining horizontal surface, the work is given a reciprocating movement along with the table and the tool is fed crosswise to complete the cut. Both the railheads may be used for simultaneous removal of the 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 the work is finished to the required dimension by taking roughing and finishing cuts. The tool setting is similar to that shown in Fig.7.19.

Planing vertical surface : 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 cut. The vertical slide is adjusted perpendicular to the planer table and the apron is swivelled 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 Fig.7.20.

Planing angular surface : For dovetail work, cutting V-grooves, etc. the tool head is swivelled to the required angle and the apron is then further swivelled away from the work to give relief to the tool cutting edge during the return stroke. By rotating the downfeed screw the tool is fed at an angle to the planer table. The tool setting is similar to that shown in Fig.7.21.

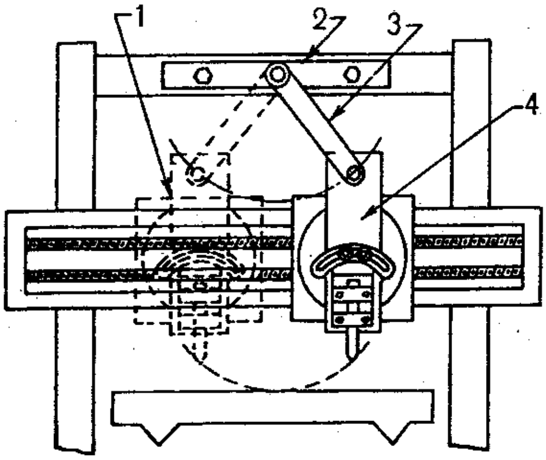

Figure 8.12 Planing concave surface
1. Toolhead, 2. Bracket, 3. Radius arm 4. Vertical slide.

Planing formed surface : Fig.8.12 illustrates a simple method of planing a concave surface with the aid of a special fixture consisting of a radius arm 3 and a bracket *2*. The bracket is connected 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 toolhead. The downfeed screw of 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.

Planing slots or grooves : Slots or grooves are cut by using slotting tools. The operation is similar to that of a shaper.

8.8 PLANER TOOLS

The cutting tools used on planers are all single point cutting tools. They are in general similar in shapes and tool angles to those used on a lathe and shaping machine. As a planer tool has to take up heavy cut and coarse feed during a long cutting stroke, the tools are made heavier and larger in cross-section.

Planer tools may be solid, forged type or bit type. Bits are made of high speed steel, stellite or cemented carbide and they may be brazed, welded or clamped on a mild steel shank. Cemented carbide tipped tools are used for production work. A planer tool may also be classified as right hand or left hand and roughing or finishing. The typical tools used in a planer are :

1. Right hand round nosed roughing tool for cast iron (Fig.8.13).
2. Right hand round nosed roughing tool for steel (Fig.8.14).
3. Square nosed side-facing roughing tool for cast iron (Fig.8.15)
4. Gooseneck finishing tool for cast iron and steel (Fig.8.16).
5. Left hand dovetail end cutting roughing tool for cast iron (Fig.8.17).

Round nose tool may be fed from left to the right or vice versa. The tool has no side rake. Right hand round nosed roughing tool is used for planning from right to the left. Square nosed roughing tool is used for making sharp corners. Gooseneck tool is used to prevent the tool cutting edge from digging into the work. Dovetail cutting tool is used for cutting sharp angles.

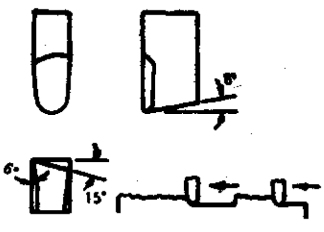

Figure 8.13 Right hand round nose roughing tool for cast iron

8.9 CUTTING SPEED, FEED AND DEPTH OF CUT

Cutting speed : As in a shaper, the cutting speed of a planer is the rate at which the metal is removed during the forward cutting stroke. The formula (7.4) holds good for a planer also. This is expressed in m/min.

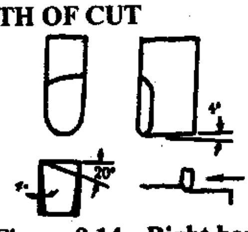

Figure 8.14 Right hand round nose roughing tool for steel

Feed : The feed in planing machine is the distance the tool head travels at the beginning of each cutting stroke expressed in mm per double stroke.

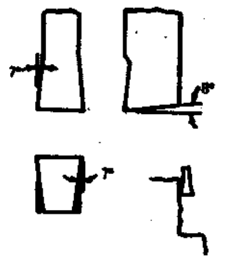

Figure 8.15 Square nose roughing tool for facing

Depth of cut : It is the thickness of metal removed in one cut and is measured by the perpendicular distance between the machined and nonmachined surface expressed in mm.

8.10 MACHINING TIME

If the cutting speed, feed, length of cutting stroke, breadth of the job and number of double strokes per minute for a planer operation are known, the machining time required for one complete cut may be calculated by using the formula given in Art.7.10.

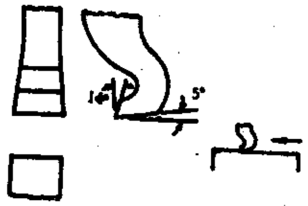

Figure 8.16 Goose neck finishing tool

The ratio of cutting time to return time usually varies from 2:1 to 4:1.

The Table 8.1 gives the average values of cutting speed, feed and depth of cut for different tool materials.

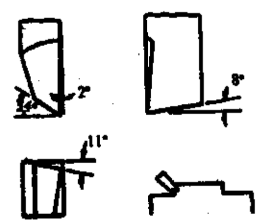

Figure 8.17 Left hand dovetail end cutting tool

8.11 SHAPER VERSUS PLANER

Shaper and planer are both reciprocating machine tools and both of them are primarily intended to produce flat surface, but they differ very much in construction, operation and use. The following are the main differences :

1. The relative movement between the tool and the work is different in a shaper and a planer. In a planer, the work is mounted on a table which reciprocates while the tool is held rigid on the machine frame and fed into the work. In a shaper, the tool is held on a ram which reciprocates and the work which is mounted on the table remains stationary and provides the feed.

2. Planers are machines capable of holding big jobs, whereas shapers are intended for small jobs. The maximum size of work that a standard shaper can accommodate is 900 mm cube (900 mm × 900 mm × 900 mm) whereas a modern planer can accommodate work as large as 3000 mm x 3000 mm x 18.25 m.
3. In a planer, the tool is rigidly supported when the work moves on precision ways and maximum accuracy on the machine surface is assured. In a shaper, due to the overhanging of the ram during the cutting stroke, and the machine being not very robust, the accuracy cannot be expected upto the mark.
4. High rate of power consumption and overall rigidity in a planer enables it to take deep cuts and apply heavy feed to rough finish a job quickly. A planer can consume upto 150 h.p. whereas a shaper can consume 15 to 20 h.p.
5. A planer is not suitable for machining relatively small, and medium size work one or few at a time that a shaper can do, but a planer is more economical and faster when large quantities are machined. A large number of jobs of identical shapes can be machined in one setting on a planer table.
6. Multiple tooling with double or four toolheads in a planer makes it possible to machine more that one surface together, thus reducing cutting time.
7. Cutting and return speed of a planer are almost uniform throughout the stroke. But in a shaping machine, particularly in a crank driven shaper, the speed varies throughout the length of the stroke.
8. In a planing machine, work setting requires much of skill and takes a long time, whereas in a shaper the work may be clamped easily and quickly.
9. Tools used in a planer are much more robust than that used in a shaper.
10. In modern planers wide range of cutting and return speeds are available and they may be changed independently.
11. Planers are heavier, larger, and costlier machines compared to shapers.

8.12 SAFETY ON THE PLANER

Planer is a very powerful machine tool having a heavy fast moving table. Unless the operator is very careful in operating the machine he get caught between the workpiece and machine parts. During machine table movement, he should not make any adjustment except setting table speed and cutting speeds. Further a planer processes quite large and heavy workpieces. Handling large parts is difficult and often damaging unless suitable precautions are followed. Some of the other precautions are listed hereunder.

1. Protect the machine table from burrs and irregularities of the workpieces. Leveling of machine tables should of the maintained properly.
2. Use of crane in fixing the workpiece should be done carefully. The operator must attach a clamps and a sling before the part is picked up by the crane.
3. For the surfacing work the tool head is set vertically. Appropriate tests should be carried out for the same.
4. The depth of the cu and the feed rate are always dependent on materials of tool and workpiece. It should not be set at a high value just because the planner is a powerful machine tool.
5. Safety clutch must be provided for feed and power rapid traverse, to provent breakage in the event the table should run against an obstruction.
6. Use of vertical power rapid traverse for feeding the table should never be allowed.

TABLE 8.1 CUTTING SPEED, FEED AND DEPTH OF CUT IN A PLANER

Work material		*Cast iron soft*	*Cast iron medium*	*Steel average*	*Bronze*	*Aluminium*
	v m.p.m.	15-27.5	11-21	9-23	38-46	46-61
h.s.s	s mm	0.8-3.1	0.8-3.1	0.8-3.1	0.8-2.4	0.8-2.4
	t mm	3-25	3-25	3-25	3-12	3-12
	v m.p.m.	27.5-48	23-38	14-32	m.t.s.	m.t.s.
Stellite	s mm	0.8-3.1	0.8-3.1	0.8-3.1	0.8-3.1	0.8-3.1
	t mm	3-25	3-25	3-25	3-25	3-25
Cemented Carbide	v m.p.m.	42-77	33-62	36-82	m.t.s	m.t.s.
	s mm	0.8-1.6	0.8-1.6	0.8-1.6	0.8-1.6	0.8-1.6
	t mm	1.5-19	1.5-19	1.5-19	1.5-19	1.5-19

m.t.s. = maximum table speed.

REVIEW QUESTIONS

1. What is the fundamental difference between a planner and a shaper ? List different types of planners.
2. How the size of a planer is specified ? Describe.
3. List and describe in brief the main parts of a planer.
4. List various mechanism for table drive in shaper. Describe one with simple sketch.
5. What are the various feed mechanism in a shaper ? Describe one in brief.
6. List the various work holding devices in planer indicating special features if any.
7. What types of operations can be performed efficiently by a planer ? List and explain.
8. Sketch various planer tool indicating applications.
9. List at least five differences between a planer and a shaper.