CONTRACTION AND PERFORMANCE TESTING OF QUICK RETURN MECHANISM SHAPER MACHINE

A thesis

By

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Abstract

The purpose of this project is to increase cobblestone productivity of our country Ethiopia, so that it reduces the fatigue of the workers, create goodworking conditions, increase customary satisfaction and perform uniform tasks. To come into reality, the project uses direct observation, primary and secondary sources. A quick return mechanism is an apparatus to produce a reciprocating motion in which the time taken for travel in return stroke is less than in the forward stroke. It is driven by a circular motion source (typically a motor of some sort) and uses a system of links with three turning pairs and a sliding pair. A quick-return mechanism is a subclass of a slider-crank linkage, with an offset crank.

Quick return is a common feature of tools in which the action is performed in only one direction of the stroke, such as shapers and powered saws, because it allows less time to be spent on returning the tool to its initial position.

Quick-return mechanisms feature different input durations for their working and return strokes. The time ratio of a QR mechanism is the ratio of the change in input displacement during the working stroke to its change during the return stroke. Several basic types of mechanism have a QR action. These types include slider-crank and four-bar mechanisms. A project on QR mechanism design, within a first course on the theory of mechanisms, has been found to be effective for exposing students to concepts of mechanism design and analysis. This paper reviews basic QR mechanisms, presents a project problem and solution examples, and discusses the value of inclusion of such project problems within theory-of-mechanism courses

Table of contents

Review of Literature

The shaper is a reciprocating type of machine, basically used to produce flat surfaces and many more. This type of machine is used in our college to conduct experiments and practice the exam models.

Hence, we are servicing and overhauling this machine, due to lots of major and minor problems, which has been identified. In this machine the various alignments were varied such as tool post alignment, table and table stand alignment, etc. We are going to replace some items and components such as screw rod, nuts, pawl mechanism parts, crank pin and rod, etc. The working condition of bull gear mechanism and gear box is quite difficult, so we are re-servicing it and making it accurate and fine. Additional feature we are providing is sensor, so to avoid defects and safety at accident cases and also down feed indicator system. And finally, we are re-painting it for good outlook appearance.

Also we are analyzing for more improvements from existing design.

Chapter-01

INTRODUCTION:

The shaper is a reciprocating type of machine tool intended primarily to produce flat surfaces. These surfaces may be horizontal, vertical, or inclined. In general, the shaper can produce any surface compost of straight line element. Modern shaper can generate contoured surface. The metal working shaper was developed in the year 1836 by James Nasmyth an, Englishman.

Shaper Machine

Figure: 1, shaper machine

History

Roe (1916) credits James Nasmyth with the invention of the shaper in 1836. Shapers were very common in industrial production from the mid-19th century through the mid-20th. In current industrial practice, shapers have been largely superseded by other machine tools (especially of the CNC type), including milling machines, grinding machines, and broaching machines. But the basic function of a shaper is still sound; tooling for them is minimal and very cheap to reproduce; and they are simple and robust in construction, making their repair and upkeep easily achievable. Thus they are still popular in many machine shops, from jobbing shops or repair shops to tool and die shops, where only one or a few pieces are required to be produced and the alternative methods are cost- or tooling-intensive. They also have considerable retro appeal to many hobbyist machinists, who are happy to obtain a used shaper or, in some cases, even to build a new one from scratch.

Fig 02: a shaper Machine

A shaper is a type of machine tool that uses linear relative motion between the work piece and a single-point cutting tool to machine a linear tool path. Its cut is analogous to that of a lathe, except that it is (archetypal) linear instead of helical. (Adding axes of motion can yield helical tool paths, as also done in helical planning.) . A shaper is analogous to a planer, but smaller, and with the cutter riding a ram that moves above a stationary work piece, rather than the entire work piece moving beneath the cutter. The ram is moved back and forth typically by a crank inside the column; actuated shapers also exist.

A simple procedure to perform common
Operations that are specified in a given diagram

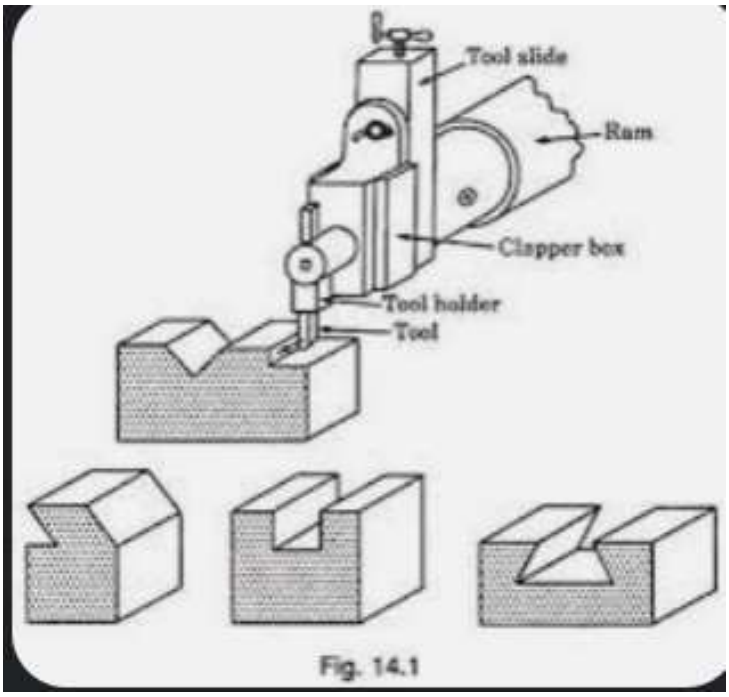

Fig 03: a shaper Machine Operation

To machine a V-block as shown in the sketch out of the work piece provided.

Discussion on how to make a shaper machine

A machine tool is nothing but a tool that helps in attaining a specified shape of any rigid material or metal. It is as same as a woodworking shaper that provides a smooth and flat surface to the wood whereas the shaper machine is responsible for providing a smooth surface to the metals.

• In most of the manufacturing processes, the use of metalworking planer is abundant.

• The shaper machine is also like the same, but the significant difference is the size and the process.

In the shaper machine, the tool moves for shaping the workpiece while in the metalworking planar the job moves.

Planning of making shaper machine

The work piece is mounted on the table and the table is rigid and box-shaped and placed in front of a machine or near the machine. The height of the table is easily adjustable and it is adjusted to match the work piece. The motion of the table is control manually. The table is equipped with an automatic feed mechanism and works with a feed screw. This is for cutting and the ram is adjustable for stroke.

Before we start to discuss the working principle of the shaper machine, we need to talk about the cutting tool. The function of the cutting tool is to remove the material from a work piece. There is a single-point cutting tool used in the shaper with only one cutting edge. The turning tool is the best example of a single-point cutting tool. It is placed in the tool holder and also mounted on the ram.

Chapter-02

Making process of shaper machine

This machine is good at making internal keyways, making slots and grooves as well as producing contour of concave or convex. A disc is use as a tool in order to obtain forward and backward rotary movement in some type. The cutting tool is used to give the shape to the hard surface of metal by scraping off the unwanted parts.

Fig 05:MS Angle cutting

Fig 06 : Structural Making

2. Principal Parts Of Shaper Machine:

Equipment:

Tools Required:

01. Vernier caliper-150mm
02. Chuck key
03. Box spanner
04. Side cutting tool ½” H.S.S
05. Vernier height gauge
06. C – clamp
07. Try square
08. Centre punch

09. Ball peen hammer
10. Shaping machine
11. Straight tool holder
12. Fly cutter
13. Magnetic chuck handle
15. Equal angle cutter 60’

Fig 07 : a shaper Machine

2.1base:

The base is the necessary bed or support required for all machine tools. The base may be rigidly bolted to the floor of the shop or on the bench according to the size of the machine. It is so designed that it can take up the entire load of the machine and the forces setup by the cutting tool over the work. It is made of cast iron to resist vibration and take up high compressive lad.

2.2 Column:

The column is a box like casting mounted upon the base. It encloses the ram driving mechanism. Two accurately machined guide ways are provided on the top of the column on which the ram reciprocates. The front vertical face of the column which serves as the guide ways for the cross rail is also accurately machined. The lid on the left side of the column may be opened for inspection and oiling of the internal mechanism with the column. The other side of the column contains levers, handles, etc. for operating the machine.

2.3 Cross Rail:

The cross rail is mounted on the front vertical guide ways of the column. It two parallel guide ways on its top in the vertical plane that are perpendicular to the ram axis. The table may be raised or lowered to accommodate different sizes of jobs by rotating an elevating screw which causes the cross rail to slide up and down on the vertical face of the column. A horizontal cross feed screw which is fitted within the cross rail and parallel to the top guide ways of the cross rail actuates the table to move in a crosswise direction.

2.4 Saddle:

The saddle is mounted on the cross rail which holds the table firmly on its top. Crosswise movement of the saddle by rotating the cross feed screw by hand or power causes the table to move sideways.

Fig 08 : Saddle

2.5 Table:

The table which is bolted to the saddle receives crosswise and vertical movements from the saddle and cross rail. It is a box like casting having T – slots both on the top and sides for clamping the work. In a universal shaper the may be swiveled on a horizontal axis and the upper part of the table may be tilted up or down. In heavier type shaper, the front face of the table is clamped with a table support to make it more rigid.

Fig 09: a shaper Machine Table

2.6 Ram:

The ram is the reciprocating member of the shaper. This is semi cylindrical in form and heavily ribbed inside to make it more rigid. It slides on the accurately machined dovetail guide ways on the top of the column and is connected to the reciprocating mechanism contained within the column. It houses a screwed shaft for altering the position of the ram with respect to the work and hoods the tools head at the extreme forward end.

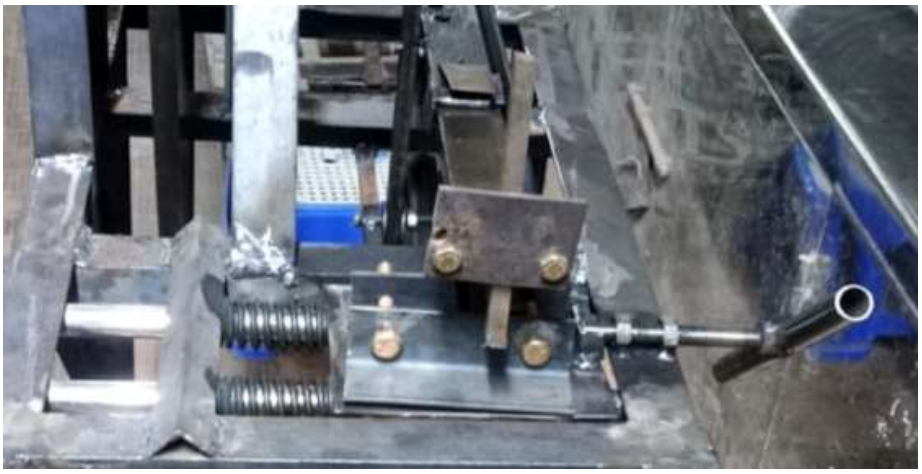

Fig 10: shaper Machine Ram

2.7 Tool Head:

The tool head of a shaper holds the tool rigidly, provides vertical and angular feed movement of the tool and allows the tool to have an automatic relief during its return stroke. The vertical slide of the swivel base which is held on a circular seat on the ram. The swivel base is graduated in degrees, so that the vertical slide may be set perpendicular to the work surface or at any desired angle. By rotating the down feed screw handle, the vertical slide carrying the tool executes down feed or angular feed movement while machining vertical or angular surface. The amount of feed or depth of cut may be adjusted by a micrometer dial on the top of the down feed screw. Apron consisting of by a screw. By releasing the clamping screw, the apron may be swiveled upon the apron swivel pin either towards left or towards right with respect to the vertical slide. This arrangement is necessary to provide relief to the tool while making vertical or angular cuts. The two vertical walls on the apron called clapper box houses the clapper block which is connected to it by means of hinge pin. The tool post dismounted upon the clapper block. On the forward cutting stroke the clapper block fits securely to the clapper box to make a rigid tool on the work lifts the block –out of the clapper box a sufficient amount preventing the tool cutting edge form dragging and consequent wear. The work surface is also prevented from any damage due to dragging.

2.7.1 Tool Head of Shaper:

1. Down feed screw micrometer dial.
2. Down feed Screed
3. Vertical Slide
4. Apron
5. Apron Clamping bolt
6. Clapper Block
7. Tool post
8. Washer
9. Apron swivel pin
10. Swivel base

2.8 Clapper Box:

Clapper box helps to avoid damage to machined surface during the return stroke of tool.

1. Specification of shaper:

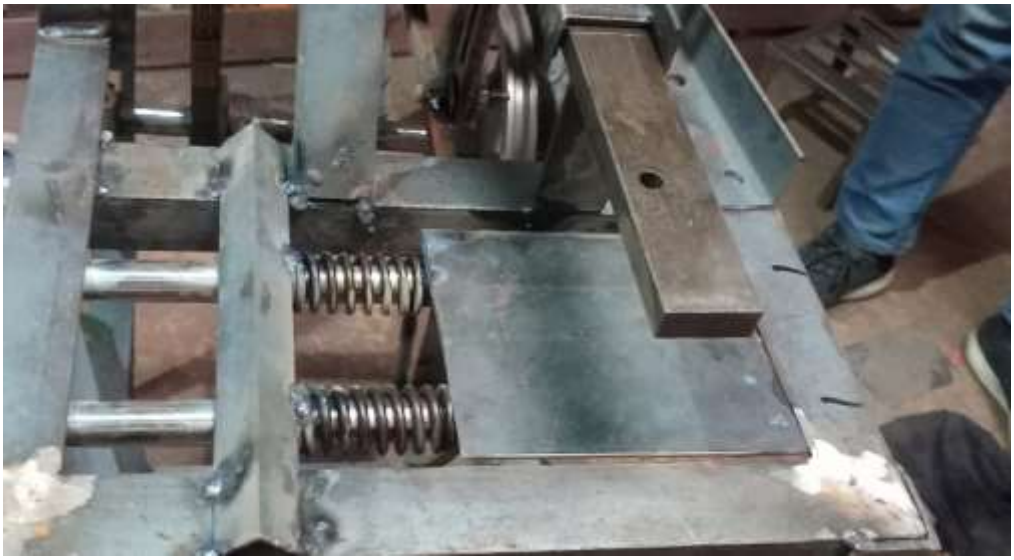

Fig 11: a shaper Machine Clapper Box

The size of a shaper is determined by the maximum length of stroke or cut it can make. The usual size ranges from 175 to 900 mm. The length of stroke indicates, in addition to the general size of the machine, the size of a cube that can be held and planed I the shaper. Thus in a 250 mm shaper the length of stroke may be adjusted from 0 to 250 mm, the cross feed adjusted of the table will be 250 mm and the extreme bottom position of the cross rail will permit the table to accommodate a work piece 250 mm high. The length of stroke of a shaper merely figure: indicates the overall size of the shaper other particulars, such as the type of drive : belt or individual motor drive, power input, floor space required, weight of the machine, cutting to return stroke ratio, number and amount of feed etc. are also sometimes necessary.

Chapter-03

Setting Tool, Stroke Length & Position Of Stroke:

3.1 Setting the Tool:

Tool overhang should be minimum.

Tool should be clamped properly with adequate support.

3.2 Setting The Stroke Length:

Max. Stroke length depends on the machine (18”, 24”, 36” etc.)

Stroke length can be adjusted to a value less than maximum.

Stroke length depends on the length of job.

3.3 Setting The Position Of Stroke:

Position of stroke is the starting point & end point of stroke.

3.4. Shaper Mechanism:

In a shaper machine, the rotary- motion of the drive is converted into Reciprocating motion of a ram holding the tool, by means of mechanism inside the column of a machine. In a shaper, the metal is removed during forward cutting stroke, while in return Stroke no metal is removed. Therefore, in order to reduce total machining time, the Shaper mechanisms should be designed

The quick return mechanism of a machine can e obtained by the following
Methods:

1. Crank and slotted link mechanism.
2. Whit worth quick return mechanism.
3. Hydraulic shaper mechanism.

Chapter-04

4.1 Crank And Slotted Link Mechanism:

The crank and slotted link mechanism as shown in fig:

Fig 12: Crank And Slotted Link Mechanism

Large bull gear mounted within a column and a radial slide bolted to the center of the bull gear, which carriers sliding block into which the crank pin is fitted. The power is transmitted from the motor through the driving pinion to the bull gear. The rotation of the bull gear causes the crank pin to revolve at uniform speed. The rocker are sliding block mounted on crank pin is fitted within the slotted link or rocker arm, which is provided at its bottom end attached to the column frame. The upper arm of the rocker arm is connected to the ram block in a rocker arm slides up and down, giving rocking movement to the ram, thus rotary motion to the bull gear is converted into reciprocating motion of the ram.

Fig 13: a shaper Machine

The principal of quick return motion is illustrated in fig 5.1.(b). When the slotted link is at the position PQ, the ram is at the extreme backward position of the stroke, and when it is at PR, the ram extreme forward position. PQ and PR are two tangents to the crank pin circle. Therefore the forward stroke takes place. When crank rotates through an angle C1KC2 and the return stroke takes place when crank rotates through an angle C2LC1. The forward stroke angle C1KC2 is greater than the return stroke angle C2LC1, therefore, return stroke is completed within a shorter time for which it is known as

quick motion.

The ratio between cutting time to return is given by:

$$\frac{\text{Cutting Stroke}}{\text{Return Stroke}} = \frac{\text{C1KC2}}{\text{C2LC2}}$$

4.2. Whit Worth Quick Return Mechanism:

A whit worth quick return mechanism is shown in fig and its simple line Diagram is shown in fig.5.2. The bull gear is mounted on a fixed pin A which is free to rotate. The crank plate is pivoted eccentrically on affixed pin at O A crank pin with sliding block fitted on the face of the bull gear slides into the slot provided on A crank plate the other end of the crank plate is connected to a connecting rod by Means of pin and the another end of a connecting rod is connecting to a ram which reciprocates in a horizontal axis. When the bull gear rotates at a constant speed, the sliding block slides in a slot of a crank plate causing it to about point 'O' The rotary motion of a crank plate is converted into reciprocating motion of a ram by a connecting rod.

When the crank pin is at the position 'C' the ram will be at the extreme backward position and when the crank pin is at 'B' the ram will be at extreme forwrd position. When crank pin travels from C to B, the ram performs the forward cutting stroke and when crank pin travels from B to C, the ram performs the backward return stroke. As the crank pin rotates at constant speed, the time taken during forward cutting stroke through an arc CEB is greater than the time taken during return stroke through an arc BDC. Thus a quick return motion is obtained by this mechanism.
The length of stroke of the ram can be changed by changing position of a connecting

rod on crank plate from the fixed point 'O'. The position of stroke can be altered by changing the position of pin on the ram.

4.3 Equipment And Tools Required:

01. Vernier calipers
02. Chuck key
03. Box spanner
04. Side cutting tool ½" H.S.S
05. Vernier height gauge
06. C - clamp
07. Try square
08. Centre punch
09. Ball peen hammer

10. Shaping machine
11. Straight tool holder
12. Fly cutter
13. Magnetic chuck handle
14. Surface gauge
15. Equal angle cutter 60’

4.4 Operation:

01. Measuring
02. Facing
03. Chalk Appling
04. Marking
05. Punching
06. Setting
07. Shaping
08. Milling
09. Keyway cutting
10. Dovetail
11. Checking
12. Finishing

4.5 Observations:

a. Measure all dimensions (up to second decimal place) on the specimen machined by your group. Make a neat sketch and indicate all measured dimensions.
b. Calculate the machining time for the bottom surface of the specimen.
c. Inspect the machined model with precision measuring instrument.

At the end of return stroke another shaper dog hits the reversing lever changing the direction of the piston and this cycle is repeated. In this case, the quick return motion is affected by the difference in stroke, volume of the cylinder at both ends. The left side being smaller due to the presence of piston rod. As the pump has a constant discharge and same quantity of oil will be supplied on both the ends, which increase the pressure on left side than right side and increasing the speed during return stroke. The position and length of stroke is adjusted y changing the position of reversing dogs. The cutting speed may be changed by controlling the throttle valve, which regulates the flow of oil.

Chapter-05

Shaper Machine Operations:

5.1 Making Of Chuck Key:

This type of key is use in tightening the tool in tool post for doing different operation; it is easily done by shaper with single point cutter tool.

5.2 Making Of Internal Keyway:

The internal keyways are cut by holding the tools on a special tool holder so that, the tool post will not hit against the work at the end of the shown in figure.

5.3 Making Of External Keyway:

Slots or grooves on work piece, external keys on pulleys can be cut easily by using shaper

Operation:

1. Measuring
2. Facing
3. Chalk Appling
4. Marking
5. Punching
6. Setting
7. Shaping
8. Milling
9. Keyway cutting
10. Dovetail
11. 11.Checking
12. Finishing

The Following Parts Are Dismantled To Service And Some Of Them Were Replaced.

1. Tool Post:

This tool post as been dismantled each and every part for diesel waste and some parts. We have made the reading visible and also painted the tool post. The alignment is corrected.

2. Vice:

The vice as dismantled, washed with diesel and paint

3.Table :

The table as dismantled from vertical column. For worn out surfaces we have applied metal paste putty and from sand paper with water we have scribed to smooth surface finishing. And alignment corrected And finally we have painted for aesthetic appearance. The slider as fitted below the table slide has machined for perfect fit.

4.Ram:

Fig 14: Ram Construction

The ram as been removed from head of the column .For worn out surfaces we have applied metal paste putty and from sand paper with water we have scribed to smooth surface finishing. And finally we have painted for aesthetic appearance.

Fig 15: a shaper Machine

9.Belt Drive (V-Belt):

This belt is used to drive the ram. this are replace by new one due to old was cut off and worn out the belt sizes are A-46 and B-55 .

10.Bearing (Thrust Bearing):

This are used to enable rotational or linear movement, while reducing friction and handling stress. We have replaced due to worn out old one. Set of 2 are purchased.

11. Screw Rod and Nut:

The screw rod is re-machined to a required dimension and accurately. The nut is newly manufactured because old one was damaged. The handles, measuring disc, down feed handle etc. and many others were chromed for aesthetic outlook appearance.

12. Chroming:

The handles, measuring disc, down feed handle etc. and many others were chromed for aesthetic outlook appearance.

13.Other Parts:

The many other parts like jibs, sliding plats, bevel gears, collars, blocks, nuts, bolts, washers, rods etc., and this part are washed by diesel and oiled to protect from corrosion.

14.Elevating Screw:

This screw is used to support and move the table up and down this part is wash by diesel and finally applied grease to free movement.

15.Supporting Jack Type:

The frame support type was replaced by jack type. In which base of the jack was welded by a 10mm flat and drilled either two sides with respect to the bed holes. Then at the top of the jack the L-section flat is welded, So that the angle plate slides over that. We need to rotate the jack to required height while doing operation. The reason of making jack type because previously we need to loosen the nut and bolt then bring it too required position and to adjust it, it was so complicated, then we analyzed and build this type we become more easy compare to frame type.

16.Feed Indicator (Additional:

Shaper tool feed indicating arrangement is made by us is as shown in figure. It is a direct measuring arrangement. the purpose of this arrangement is to know the down feed of tool in to the work piece this arrangement mainly consists of 50x00mm x5mm ,flat,1/2'' 2 bush nuts, dia15*400mmm.s rod, scriber(point indicator),150mm scale, dia25*60mm m.s rod, 60*80mm s.s flat. It involves following operations. first we welded 2 m.s flat like 't' joint then make two 12mm drilling holes, on the upper flat then we clamped to the shaper table using bolt and nuts, then we make the dia20*50mm drilling hole inside the dia25*60mm round rod it is welded on the m.s flat vertically which holds the dia15*400mm rod, then we takes 2 bush nuts and we make 6.5mm drilling hole in both the nuts

and we done taping operation using 8mm tap wrenches to insert the screws ,then one bush nut is welded to the second m.s flat it helps to lock the dia15*400mm m.s rod to the required height ,then we weld the scriber with the another bush nut it insert to the rod it is free to move throughout the rod it helps to adjust scriber to the required height , then we take the s.s flat and make 3 drilling holes of dia9mm to clamp it to the tool post using nuts and bolts ,then we fixed the 150mm scale using gum, then we place a work piece in the vice when tool touches the work piece we adjust the scriber to zero by moving the bush nut up and down ,then as well as we feed give to tool scriber moves on the scale thus indicates the mm of feed of the tool in to the work piece.

17.Overall Paint:

Overall paint to get aesthetic appearance.

Fig 16: a shaper Machine

Chapter-06

Performance Test (Or) Methodology

A Simple Procedure To Perform Common Operations That Are Specified In A Given Diagram Below

To machine a V-block as shown in the sketch out of the work piece provided.

Outline Of Procedure:

i) Run the machine at low speed and observe the motions, which control the shapes of the surfaces produced. Note particularly the features, which control the geometrical form of the surface.

ii) Learn the names of the major units and the components of each machine. (Please ensure that the main isolator switch is off and check that the machine cannot be inadvertently started. Do not remove guards). Use the manufacture's handbook for details that cannot be inspected.

iii) Record the obtainable speed and feed values iv) Note down the special features of the speed and feed control on each machine.

iv) Pay attention to the following:

a. Size specification of various machine tools.

b. Machine tool structures and guide ways I slide ways.

c. Drive mechanism for primary (cutting) motion. d. Drive mechanism for secondary (feed) motion.

Observations:

a) Measure all dimensions (up to second decimal place) on the specimen machined by your group. Make a neat sketch and indicate all measured dimensions.

b) Calculate the machining time for the bottom surface of the specimen.

c) Inspect the machined model with precision measuring instrument.

Chapter -07

Making of Experiment Gallery

Fig 17: V belt & Pulley

Fig 18: UC Bearing with Bearing House

Fig 19: CI Pulley

Fig 20: Shaft

Fig 21: Construction of shaper Machine

Fig 22: Construction of Shaper machine

Outline of Procedure:

i) Run the machine at low speed and observe the motions, which control the shapes of the surfaces produced. Note particularly the features, which control the geometrical form of the surface.

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vi) Pay attention to the following:

   a. Size specification of various machine tools.
   b. Machine tool structures and guide ways I slide ways.
   c. Drive mechanism for primary (cutting) motion.
   d. Drive mechanism for secondary (feed) motion.

Conclusion:

- we can conclude that the feed mechanism is an essential mechanism in any shaper machine.
- One main feature is that it links the motor rotation which feeds the quick return mechanism with the table feed.
- We could change the feed independently changing the offset distance of the link.