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Experiment No.-1

Object: - To practice of slab milling on milling machine

Equipment: - Horizontal milling machine, arbor size-25mm

(**Tools:** - Slab milling Cutter, work Clamps.

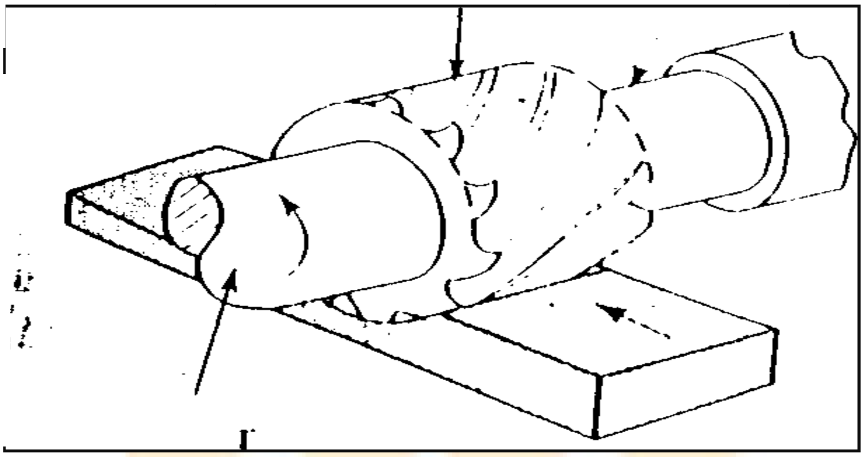

Figure: Practice of slab milling on milling machine

Material: - Mild Steel (40mmx40mmx50mm)

Theory: - In slab milling also called peripheral milling, the axis of cutter rotation is parallel to the work piece surface to be machined. The cutter, generally made of high speed steel, has a number of teeth along its circumference, each tooth acting like a single point cutting tool called a plain mill.

Cutters for slab milling may have straight or helical teeth resulting in, respectively, orthogonal or oblique cutting action. The helical teeth on the cutter are preferred over straight teeth because the load on the tooth is lower, resulting in a smother operation and reducing tooth forces and chatter.

Procedure: -

1. Set the machine for milling operation.
2. Fix the cutter on the arbor.
3. Clamp the work piece on milling machine table.
4. Set the cutter to take a depth of 2mm
5. Run the machine for operation and feed the cutter over the entire length of the work.
6. Check for the finish of the work piece.

Result: - We obtain the required finished work after measuring dimensions

Viva-Voce:

Experiment No.-2

Object: - To practice of slotting milling on milling machine

Equipment: - Horizontal milling machine, arbor size-25mm)

Tools: - Slotting milling Cutter, work Clamps.

Material: - cast iron block (40mmx40mmx50mm)

Theory: - The slotting is the operation of cutting a narrow groove at the top of the work piece. Circular cutters are used fro slotting. The teeth may be staggered slightly, like those in saw blade to provide clearance for the cutter when making deep slots.

Procedure: -

1. Set the machine for milling operation.
2. Clamp the work piece on the arbor.
3. Set the cutter to take a depth of cut of 2mm for the slot.
4. Run the machine for operation and feed the cutter over the entire length
5. Check for the slot of required dimensions

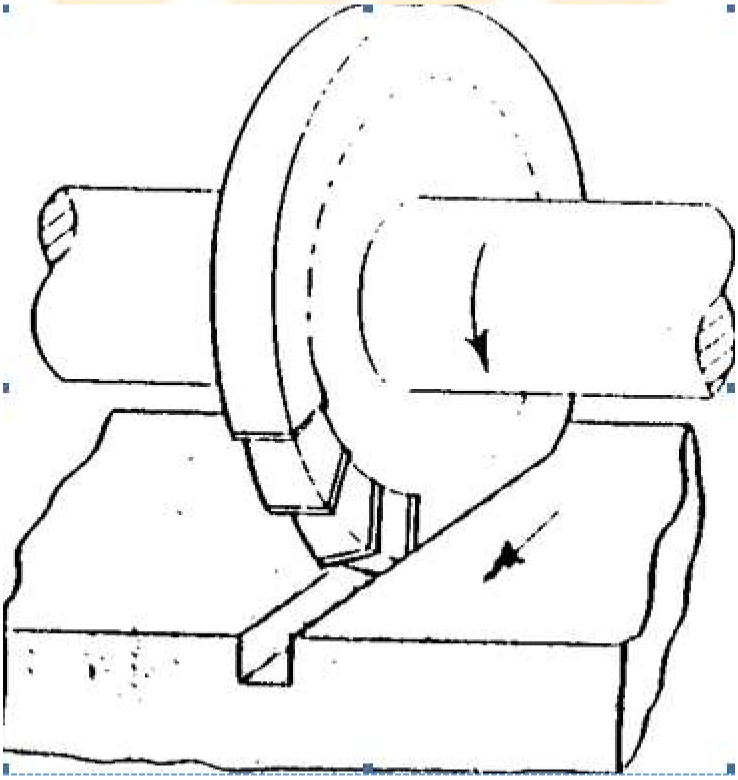

Figure: Slotting on milling machine

Result: Slotting on milling machine studied.

Viva-Voce:

Experiment no.-3

Aim: - To make spur gear on milling machine

Equipment: - milling machine, lathe machine, drilling machine, vernier caliper, 22 m drill bit, single point cutting tool, indexing head, form cutter

Material: - mild steel (50mm $ x 25)

Theory: - In cutting gear on milling machine and form cutters are used, in which profile of the cutting teeth conform to the tooth profile required on the gear, every gear cutter is specified by diameter pitch, cutter number pressure angle and the diameter of cutting bore.

Diameter of the gear blank = Pitch circle diameter + 2(addendum)

D = pitch circle diameter

P = pitch of the gear teeth

N = no. of teeth

M = Module

Type = Involute Teeth

= D+2/P { addendum = 1/p} = N/P + 2/P {D = N/P} = (N+2)/P = No. of teeth to be cut + 2

Diametrical pitch P = No of teeth to be cut + 2 Diameter of gear blank Gear blank diameter = N/P +• 2/P

= MN + 2M {1/P = M} = M(N+2)

M = diameter of gear blank / No. of teeth to be cut + 2

From the above relations to diametric pitch (P) of the cutter can be found out with the help of given data of gear or the module and then the cutter set for that D.P can be selected cutter set a particular cutter No. can be easily chosen according to the no. of teeth required to be cut.

DIVIDING HEAD

These heads helps in changing the angular position of the work piece in relation to the cutter. With their use it is possible to divide the periphery of the workpiece into any number of equal parts. These heads are generally of the following types:

Plain dividing head

Universal dividing head

Optical dividing head

Out of these the optical is the most precise one and used for very precise indexing work or fro checking the accuracy of the other types of dividing heads.

Plain Dividing head: - these indexing head are of two types. The first type carries the indexing plate directly mounted on its spindle and has no use of worm and worm wheel. It is the simplest type and used in direct indexing. The indexing plate carries 12 or 24 equispaced slots on its periphery.

Another useful form of the plain dividing head is the one used in simple indexing. It consists of a cast body, carrying the spindle. On the front end of the spindle are mounted the carrier arid the center. On its rear side the mounted the index plate, which is having different hole circles on its face and teeth on its periphery. The plate gets movement through a wo''rn cy rotating the handle. The plate having 3 circles of 16, 42 and 60 or 24, 30 and 36 ' jies are provided on these heads.

Universal dividing head: - universal dividing head is used for mostly all the operation of milling machine. The universal dividing head performs the following operation: -

1. It sets the workpiece in a desired position in relation to the machine table.
2. After each cut, it rotates the job through a desired angle and, thus, indexes the periphery of the work.
3. It provides a continuous rotary motion to the job during milling machine of helical grooves.

It, in conjunction with a tailstock, acts both as a holding as well as supporting device for the work during the operation.

WORKING: - Dividing head is to provide support to the work piece, hold it in position and rotates it through a desired angle after each cut is over. The index crank is rotated to provide rotary motion to the job and the index plate enables this rotation to take place always to the desired angle. When the crank rotates, the worm wheel rotates which in turn rotates the worm wheel. Since the wheel is mounted directly on the spindle the latter rotates along with the former.

The angle, through which the job will rotate, for each revolution of the crank, depends upon the velocity ratio between the worm and worm wheel. This ratio is usually 40 to 1, i.e. for 40 revolution of worm, or the crank, the job will make one revolution.

Indexing Methods: - the following indexing methods are commonly used: -

1. Direct indexing
2. Plain indexing or simple indexing
3. Compound indexing
4. Differential indexing
5. Angular indexing

Out of these the direct indexing is the simplest one, but we commonly use the plain indexing

Plain Indexing: - this method of indexing is used when the direct indexing method cannot be employed for obtaining the required number of divisions on the work. For this indexing method universal indexing head can be used. This method of indexing involves the use of crank, worm, worm wheel and index plate. Worm carries 40 teeth and worm is single start. The worm wheel is directly mounted on the spindle. Since the worm has single start thread and the worm wheel 40 teeth, with one turn of the crank the worm wheel will rotates through one pitch distance, i.e. equal to 1/40 of a revolution. Similarly 2 turns of the crank will make the work to rotate through 1\20 and a 3 turn through 3/40 of a revolution. Thus the crank will have to rotate through 40 turns in order to rotate the work through one complete turn. For n

divisions on the work piece, the crank will make 40/n turns. Suppose that the work has to be divided into 23 equal divisions then the corresponding crank movement will be given by: - .
_ Crank movement = 40 / 23 = 1

This means that for rotating work piece into 23 equal divisions, the crank has to rotate 1 complete revolution and 17/23 of a revolution or will move further 17 holes on 23 hole circle plate. In this fraction the numerator denotes the number of holes to be moved and the denominator the number of holes on the circle to be used.

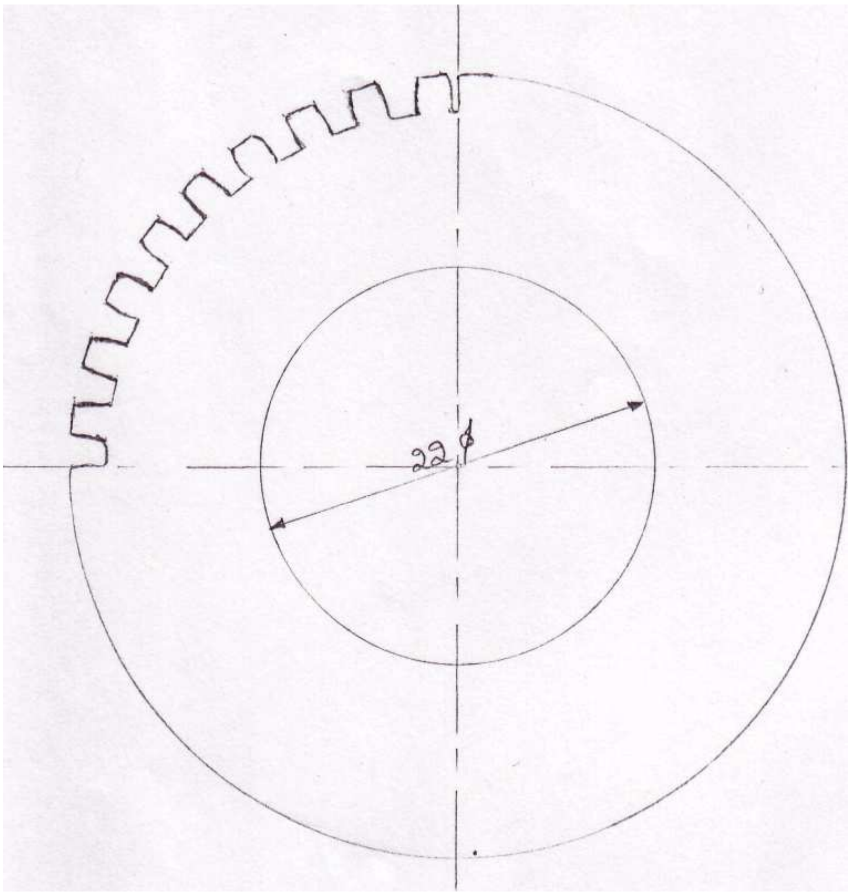

Figure: Spur gear on milling machine

Result: Spur gear has been cut on milling machine.

Viva-Voce:

Experiment No.-4

Aim: Introduction to various grinding wheels and demonstration on surface grinder.

GRINDING WHEELS

Grinding is a process of removing material by the abrasive action of a revolving wheel on the surface of a work-piece, in order to bring it to the required size and shape. The wheel used for performing the grinding operation is known as grinding wheel. It consists of sharp crystals, called abrasives, held together by a binding material or bond. The wheel may be a single piece or solid type or may be composed of several segments of abrasive blocks joined together.

Wheel Materials: -

A Wheel essentially consists of the following two materials.

1. Abrasive. It is that material of the grinding wheel which does the cutting action.
2. Bond. This material of the grinding wheel acts as a binder to hold the abrasive grains together.

Abrasives are the extremely hard material consisting of very small particles called grains, which carry a number of sharp cutting edges and corners. The abrasives are of two types:

1. Natural
2. Artificial

Artificial abrasives are directly obtained from mines. These are sand stone, emery, corundum, quartz, and diamond.

Artificial abrasives are manufactured under the controlled conditions in the furnace. The main artificial abrasives are silicon carbide (SiC) and aluminum oxide (AL_2O_3).

a) Plain or Straight Wheel **(b) Straight (one Side Recess)**

(c) Straight (both side recess) **(d) Tapered**

COMMON TYPE OF GRINDING WHEELS

The most common shapes of the grinding wheels are shown in fig. The straight wheels are shown at (a), (b), and (c) are used for internal grinding, tool grinding, center less grinding, cylindrical and off hand grinding and snagging. The recesses are provided to accommodate the mounting flanges. The plain wheel is commonly used for parting off and is not more than 3 mm thick.

The tapered wheel, shown at (d) is mainly used in snagging, thread grinding, and gear tooth grinding operations. It can be fitted with tapered mountings flanges so as to prevent the wheel pieces from flying off, if the same gets broken during the operation. Straight cup wheel (e) is mainly employed for surface grinding on both the horizontal and vertical spindle grinc^s Cylindrical wheel (f) has the same application as straight cup wheel. The saucer wheel (g) is principally used for sharpening the saws. Dish wheel (h) finds its application on tool and cutter grinders for grinding the teeth of various cutting tools, like milling cutters and broaches, etc. for the reason that its edge can easily enter the narrow spaces between adjacent teeth on the tool. Flaring cup wheel (i) is also mainly used on tool and cutter grinders. It may have a plain edge or beveled edge

(e) Straight cup wheel

(f) Cylindrical Wheel

(g) Saucer Wheel

(i) Flaring Cup Wheel

(h) Dish Wheel

Experiment No.-5

Aim: To study MIG welding

Equipment Used: MIG welding.

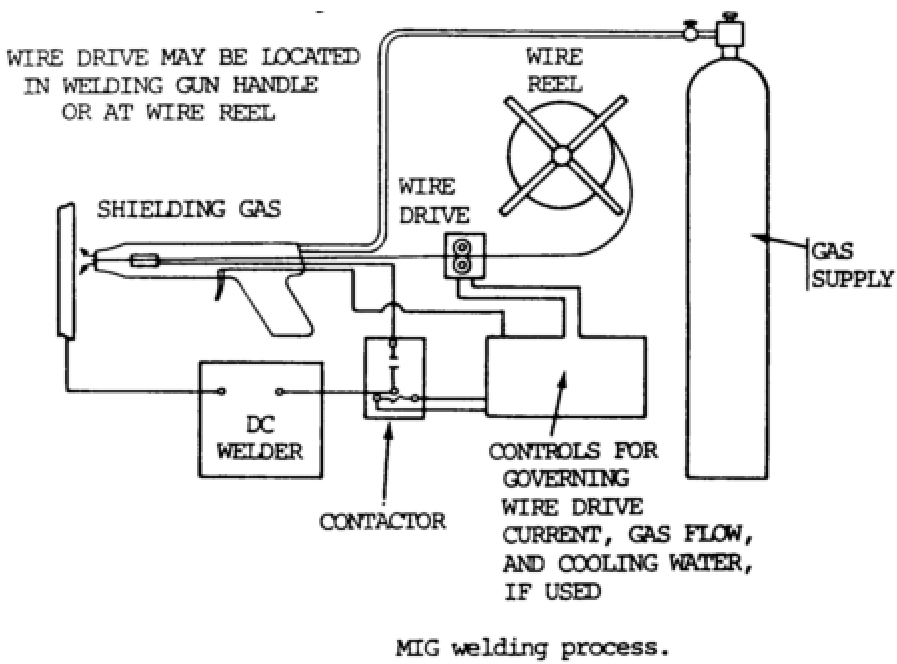

Figure: MIG welding

MIG WELDING

Gas metal arc welding is a process in which coalescence is produced by heating arc between a continuous filler metal (consumable) electrode and the work. Shielding is obtained entirely from an externally supplied gas or gas mixture. There are a number of variation of the gas metal arc welding process and the process has been given many different trade names, e.g. variations are called MIG welding, CO_2 welding, fine wire welding, spray arc welding, pulsated arc welding, electro slag welding and short-circuit welding.

PRINCIPLE OF OPERATION: -

The MIG welding process is shown by figure. The MIG welding process utilizes the heat of an arc between a continuously feed consumable electrode and the work to be welded. The heat of the arc melts the surface of the base metal and the end of the electrode. The metal melted of the electrode is transferred through the arc to the work where it becomes the deposited weld metal. Shielding is obtained from an envelop of gas which may be an inert gas an active gas or a mixture the shielding gas surrounds the arc area to protect it from contamination from the atmosphere the electrode is fed in to the arc automatically is usually from a coil. The arc is maintained automatically and travel can be manually or by machine.

The gas metal arc welding process, introduces in the late 1940s has been become one of the most popular arc welding process. Early development was for welding of aluminum using inert gas for shielding. Hence the name "metal inert gas" or MIG welding. For welding steels inert gases seemed to be too expensive and an active gas, CC>2 was selected. The selection of CC>2 was based on the analysis of gases formed by the disintegration of the coating of covered electrodes. This variation, named CO2 welding, was well adapted for welding mild steel.

Further development with different shielding gases led to the "spray arc" variation, which utilizes larger diameter electrodes, with a shielding gas mixture of 95% argon and 5% oxygen (other mixtures were 98-2 and 99-1 argon - oxygen mixtures). This gas mixtures produced a spray type metal transfer and welds with an extremely smooth surface. This variation as become extremely popular.

Another variation is electro gas welding which is a "method of gas metal arc welding wherein molding shoes coring the weld metal for vertical position welding. Additional shielding may or may not be obtained. Shielding is obtained from an externally supplied gas or gas mixture". This is a single - pass technique for automatic vertical welding.

Another variation is pulsed arc welding, whereby the welding current is pulsed at regular intervals to create a discrete transfer of metal across the arc rather than a random transfer, which occurs in the other variation.

ADVANTAGES: -

The major advantages of the MIG welding are:

1. High deposition rate when related to shielded metal arc welding.
2. High operator factor with respect to shielded metal arc welding
3. High utilization of filler material
4. Elimination of slag and flux removal
5. Reduction of smoke and fumes.
6. May be automated for high - operator factor.
7. Skill level in the semiautomatic method of application slightly lower than required for manual shielded metal arc welding.
8. Extremely versatile and wide and broad application ability.

The gas metal arc welding process is the fastest growing process in use today. Its growth is based on replacing shielded metal arc welding for welding thin metals, and for replacing gas tungsten arc welding for non-ferrous metals. It is replacing submerged arc in automatic applications.

WELDING CIRCUIT AND CURRENT: -

The gas metal arc welding uses a wire feeder system that controls the electrode wire feed and welding arc, as well as the flow of shielding gas and cooling water. The power supply is normally the constant voltage type. A gun or torch is used for directing the electrode and shielding gas to the arc area. For the electro slag method travel mechanism and retaining shoes are also required.

The gas metal arc welding process uses direct current. Alternating current has not been successfully used. Direct current electrode negative DCEN (straight polarity) can be used with special emissive coated electrode wires, which provides for better electron emission. DCEN is rarely used because the emissive-coated electrodes are more expensive. The welding current varies from as low as 20 amperes at a voltage of 18 volts to as high as 750 amperes at an arc voltage of 50 volts. The equipment required for MIG welding are 1) power source 2) the electrode wire feeder and control system 3) the welding gun and cable assembly for semiautomatic welding for automatic welding 4) the gas and water control system for the shielding gas and cooling water when used, and 5) travel mechanism and guidance for automatic welding. There is the extra factor of molding shoes when using the electro gas method. The power source for gas metal arc welding shall be rated for 100 % duty cycle

Result: MIG welding has been studied.

Viva-Voce:

Experiment No.-6

OBJECT: Introduction to tool and cutter grinder and dynamometer.

LATHE TOOL DYNAMOMETER

In the manufacture of various machine components , a number of machining operation are carried out .hence, it is essential to study the metal cutting processes for economical aspects of the manufacture of the components . To investigate the performance of cutting tools during metal cutting , the measurement of cutting forces is essential .

The helps the analysis of metal cutting as below :-

1) Effect of speeds and feeds on the action of cutting tools .
2) Effect of mechanical properties of work material on cutting forces .
3) Values of forces exerted on machine components on jigs and fixtures , and effect of these forces on the geometrical accuracy of the work pieces .
   in short , the tool force measurement i.e. tool dynamometer is as essential tool to analyze the process of metal cutting theoretically. Further , the test results are used to solve shop floor problems such as tool performance m, load exerted on the machines or on the jigs and fixtures .

ORTHOGONAL CUTTING PROCESS :-

In the metal turning process , generally , cutting edge of the tool is set at an approach angle less than 90^0 , resulting in the resultant force 'R' acting obliquely on the cutting edge . This process is known as oblique cutting.

To simplify the analysis of metal cutting ,radial force component is eliminated by taking a hollow work piece and cutting with a tool having an approach angle as 90^0 so that the resultant cutting force 'R' is resolved into two force components X and Y [see fig. B] This process is known as orthogonal cutting and force component X and Y are named as vertical and horizontal force component and third components which is perpendicular to both forces known as Z .

LATHE TOOL DYNAMOMETER :-

The Lathe Tool Dynamometer enable to measure forces at different cutting conditions and further makes it possible to construct Merchant circle diagram for orthogonal cutting . This dynamometer consists of a tool holder held rigidly in the dynamometer body . sensing is done using sensor on which resistance strain gauge is mounted . the dynamometer is mounted on the lathe in the place of compound slide and it's swivel base the dynamometer is clamped with the bolts in circular groove .

BRIDGE BALANCE UNIT

The bridge balance unit consist of :-

1) Power supply unit to supply power to both the bridges .

2) Three bridge circuits for vertical and two horizontal force components with the balancing for intial zero setting of the bridge circuit .

MEASUREMENT OF FORCE COMPONENT:- The output of the bridge is connected to the instruments for measurement of unbalanced voltage.

Reading are direct in kg. for three channels .

DESCRIPTIONS OF THE VARIOUS CONTROLS

1) Three digital meters are useful to read out of each channel indirectly and find out load in kg along with calibration chart .
2) pot X this is a ten turn potentiometer to read out of channel in directly to measure load in X direction
3) pot Y this is a ten turn potentiometer to read out of channel indirectly to measure load in Y direction

4) pot Z this is a ten turn potentiometer to read out of channel indirectly to measure load in Z

direction .

5) input X, Y, Z , are 4 amphenol sockets for connecting inputs to channels X, Y and Z respectively.

OPERATING INSTRUCTIONS FOR BRIDGE BALANCE UNIT

1. Place the sensing unit of Dynamometer in proper position.
2. With the help of cables, carefully connect X socket on the strain gauge amplifier unit. Repeat the same for Y and Z channel.
3. Connect the instrument to 230 volts, one phase supply and switch on the supply.
4. Ensure that Range selector switch is in full clockwise position.
5. Now the instrument is ready for use.
6. Obtained balance on 2 each channel by operating balancing pots the indicator for all the two channels , under specified condition.

PROCEDURE FOR L.T.D. OPERATIONS:

1. Mount the dynamometer on the top of the lathe cross slide and clamp is rigidly with bolts.
2. Use a orthogonal cutting tool (approach angle 90 degrees).
3. Adjust the speed and feed of the lathe machine and start the machine. Feed the tool manually to start cutting and then feed it automatically.
4. Wait to stabilize the output of the bridge and measure the output for vertical , horizontal and third direction which is perpendicular to first two.
5. All the forces on the dynamometer should not exceed the limit of 500 kg.

PRECAUTIONS

1. Amphonel sockets connection must be done carefully. See that during actual use of the instrument cables are not damaged or spoiled in any way.
2. Zero adjustment must be done delicately.
3. Do not apply excessive load on the sensing unit then specified.
4. To ensure long life, the balance pots x,y and z must also be operated carefully.

Result: Dynamometers have been studied.

Viva-Voce:

Experiment No.-7

OBJECT: To make a component on the lathe machine using copy turning.

Equipment Used: Copying mechanism

Hydraulic copying system can be used to produce the most complete forms, even threads accurately without producing any deflection, and power consumption is-also low. The contact pressure between the stylus and template is very low. Hydraulic system are basically servomotors which magnify a relatively small input force or signal to provide a larger output force or signal for operating the mechanism. It is just like a closed loop control system in which output signal is continually and automatically modified to suit variation in the input signal.

Fig. Shows the principle of operation of a hydraulic servo copying system. However, modern systems are highly complex. As the saddle traverses along the bed, the stylus follows the template edge always being kept in contact by spring pressure on the left hand end of the valve spool. If stylus moves to the right, then spool will also move to the right, thereby allowing the oil to the left of the piston to exhaust and allowing oil in to the right of the piston and thus moving it to the left. In this way the tool slide and tool will move to the left reproducing the template shape.

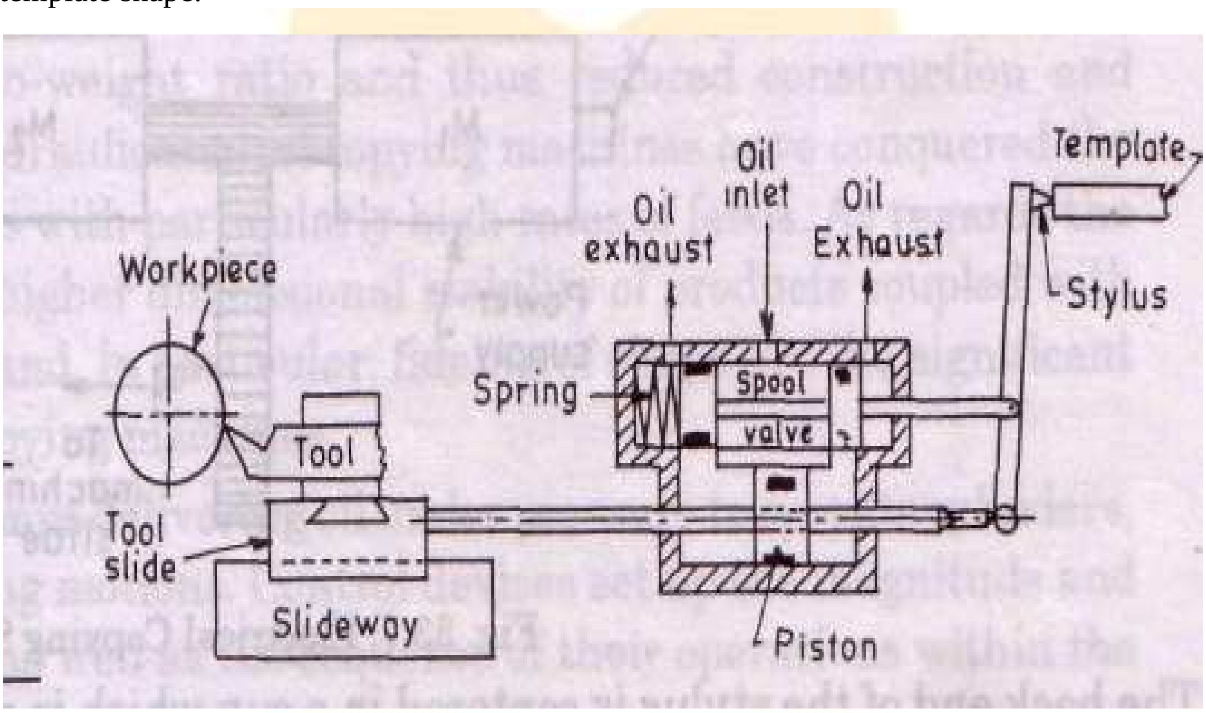

Figure: Copying turning mechanism

Result: Copying turning mechanism has been studied.

Viva-Voce:

Experiment No.-8

Aim: Practice of Drilling & Boring on Lathe machine

Material Required: Mild Steel Bar (50mm).

Tools and Equipments Used: Lathe machine, Single point cutting tool, Boring Bar, Single point Boring tool, Drill bits, Vernier caliper, Chuck key, Tool post key.

Procedure:

1. First of all take a work piece of 45mm of length and 50mm of diameter.
2. Perform the facing operation on either end of the work piece to reduce its length up to 40mm.
3. After doing the centering, Drilling operation is performed throughout the work piece up to
20mm diameter.
4. Then Boring operation is done to obtain the internal diameter 22.5mm.

Precautions:

1. The work piece should be firmly held in the chuck.
2. Centering and Boring operations should be carefully performed.
3. Depth of cut should be minimum in case of boring.

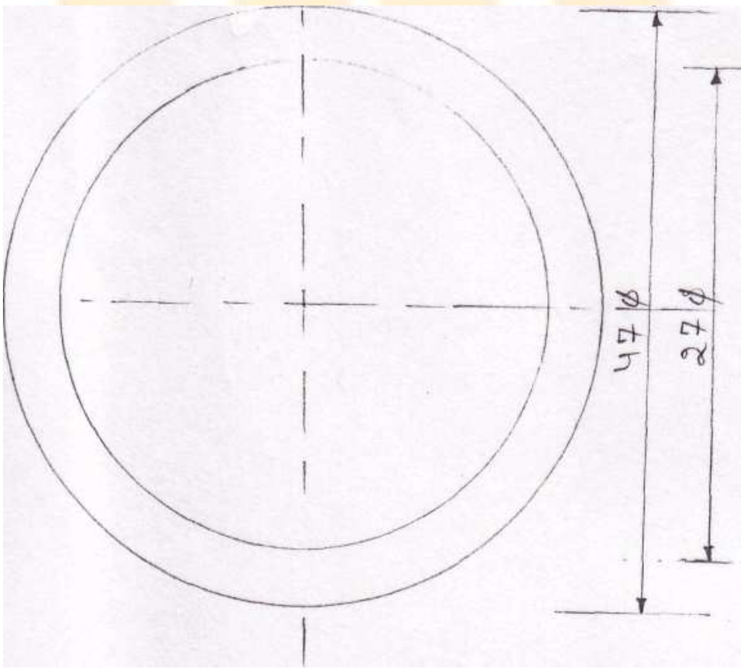

Figure: Drilling and boring Job

Result: Drilling and boring operations have been done.

Viva-Voce:

Experiment No.-9

Aim: Study the constructional detail and working of CNC lathes Trainer.

Computer Numerical Control (CNC)

CNC may be defined as an NC System in which a dedicated stored program computer is used to perform store or all of the basic NC functions in accordance with control programs stored in the read-write memory of the computer. CNC is also called soft-wired NC. In contrast, in the hard-wired controls, the logic functions are wired together in a fixed, pre-engineered arrangement. CNC is quite different than direct numerical control (DNC). Computers supporting DNC are used to disseminate manufacturing data to, and collect product information from, several machine controllers. CNC generally supports only one machine. The microprocessor of CNC is accordingly in close proximity of the machine but the computer of DNC is remote from the machine tools. The software supporting DNC is usually written to support overall manufacturing activity, *i.e.* machine loading, productivity and efficiency trends. Software for CNC is written specifically, for a particular machine device.

. Elements of CNC System. Fig

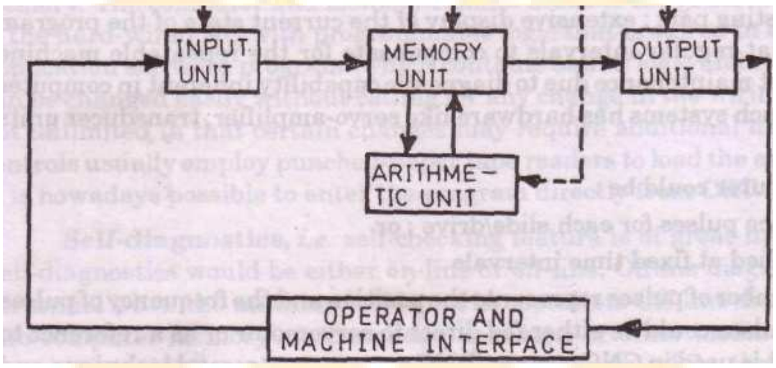

Figure: Various parts of CNC Trainer

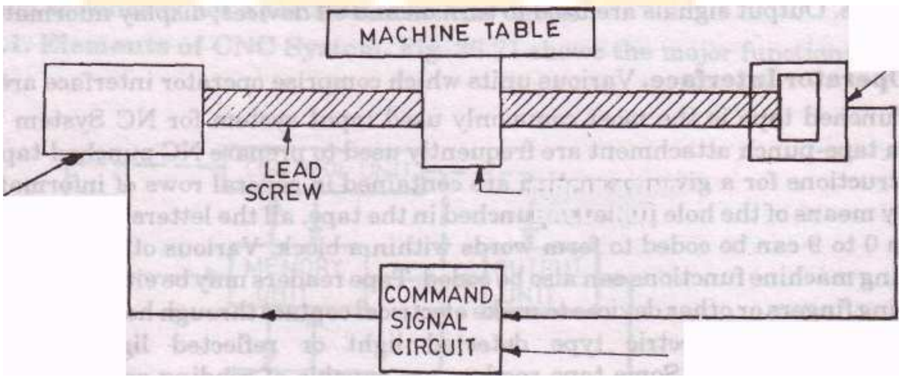

Figure: Machine table

The various units are discussed below:

Input Unit. It receives all the commands from operator interface (operation station containing all the switches, push buttons displays, etc, required to operate and monitor machine activities) and feedback or status of machine in the form of *a.c.*, *d.c.*, and analog signals. All input signals are made compatible (by input unit) to be understood by control unit (like conversion of signal to digital form by A/D converter, etc.), Software (system operating program, part programs and diagnostics) are input by means of paper tape, or magnetic devices stored in memory until needed by control unit. When the number of inputs are many, multiplexing technique is used in which the state of all inputs is monitored sequentially at desired interval, over a single channel.

Control Unit. It takes instructions from the memory unit and interprets them one at a time. It processes information received from the operator and machine interface. This information is interpreted and manipulated with hardware logic and computer programs. It then sends appropriate instructions to other units to cause instruction execution. It turns on and off machine outputs and controls machine motion *via* machine interface.

Memory Unit. It stores instructions and data received from the input. It also stores the results of arithmetic operations and supplies information to the output unit. The size of the programs and space required to manipulate data determine the amount of memory required. Part programs and usually stored in Random Access Memory (RAM) which provide immediate access to any storage location point in memory. Fixed programs (such as the system operating program and diagnostics) are stored on Read Only Memory (ROM) which stores information permanently. Information on ROM can be read but can't be altered

Arithmetic Unit-It performs calculations and makes decisions. Its results are stored in the memory unit.

Output Unit-It receives data from memory at the command of control unit. The signals are made compatible with output devices so that commands issued by output unit can be obeyed by them. Digital signals are first converted to analog form to control axis drive servomotors. Output signals are used to turn on and off devices, display information, position axes, etc.

Operator Interface. Various units which comprise operator interface are as follows.

Punched tape is the most commonly used input system for NC System Typewriters having a tape-punch attachment are frequently used to prepare NC punched-tape programs. The instructions for a given operation are contained in several rows of information called a block. By means of the hole patterns punched in the tape, all the letters of the alphabet as well as digits 0 to 9 can be coded to form words within a block. Various other symbols useful for controlling machine functions can also be coded. Tape readers may be either electromechanical type (using fingers or other devices to make electrical contact through holes of the tape, usually slow type) or photoelectric type detected light or reflected light type-faster than electromechanical type). Some tape-readers are capable of reading an entire block of holes simultaneously. Such tape-readers are used on simple positioning machines. These are not satisfactory for sophisticated applications where readers reading only one row of holes at a tate are used and these take advantage of the economics of variable-block format. It must be under stood that tape readers are used and these take advantage of the economics of variable-Uock format. It must be understood that tape readers are used for loading program only.

Magnetic devices (magnetic tape, disk, drum) having the ability to store large amounts rfdata on a small amount of surface are also used to feed input to memory unit.

Operator station forms a major operator interface. It is used to initiate automatic operation, to input data, and to monitor activities using display devices like CRT (cathode ray - :•=• LEDs (Light emitting diodes), plasma displays etc. Manual data input to override the program is also provided on operator station.

In certain applications a host computer may form operator interface. One typical use OKiid be to carry computation, while running a part, to correct for various machine conditions

such as tool wear or errors inherent in the machine tool itself like leadscrew error. The errors in lead screw are measured and stored in the host computer memory in the form of a table. When a part is made on this machine, the host computer modifies the part program while it is running by making corrections based on the error table to obtain improved accuracy on the part. Host computer could also be used for rapid search and recovery of a specific program from a large number of programs stored on a magnetic disk. Several machines may be serviced by one computer operating in this mode.

Machine Interface. It consists of all devices used to monitor and control machine tool, like extreme travel limit switches, miscellaneous position location, solenoids for hydraulic and air control, control valves, servomechanisms etc.

Usually two limit switches are provided to detect end of travel on any axis. Many machine functions are performed by applying air or oil pressure to devices like power drawbars, turret indexes, tool changer magazines, coolant flow etc. Many machine tools use hydraulic or air operated cylinders to control spindle speed and axis feed transmissions. The control of these devices is programmed in the controller and activated by control codes.

A servomechanism is a group of elements which convert the NC output into precision mechanical displacements. These elements include motors (hydraulic or electric), gear trains and transducers (velocity or position). The drive to spindle and slides in NC tools, is usually provided by either hydraulic or electric motors. Servomechanisms may be either open or closed loop. Fig. shows the mechanical elements of a CNC system.

signals from machine control unit and from the feedback device are fed to command signal circuit and then to servomechanism which amplifies it and provides power to move the desired machine slide or carry out a mechanical movement as required.

The servomechanism may be an electric motor which drives the machine table through a lead screw, or the system may involve hydraulic motors, hydraulic rams or other devices for moving the controlled machine elements or slides as required. Motors may drive the slides through low-friction lead screws employing circulating ball nuts or through rack-and-pinion arrangements. The rotary hydraulic motor uses the pressure of fluid flowing through gears or against pistons to effect a shaft rotation. These motors are usually small in size and of the positive displacement variety. Oil flow to the motor is controlled by a servo valve (which is typically an electro hydraulic unit using an electrical solenoid to actuate a small flapper which controls hydraulic pressure on a spool valve ; the spool valve directing oil to hydraulic motor,

which produces the desired mechanical motion). High-torque electrical motors which can be directly coupled to lead screws are used. A stepping motor is usually used which is actuated by pluses and moves a fixed angular unit (say 15°) for each electrical pulse. The motor is usually clamped magnetically at fixed angular position. On issuing one electional pulse, motor advances by 15° and remains held in position by a magnetic detent until the next electrical pulse advances it by another 15°. A slide driven by the motor would normally be geared so that each 15° step would move the table (0.003 to 0.013 mm).

The lead screw is almost universally used to convert rotary motion from electric/hydraulic motor into linear movement of a machine slide. The recirculating-ball lead screw is a precision screw with very low friction.

Velocity transducers (tachometer) are used to measure spindle speed and slide velocity, and position transducers are used to measure slide displacement.

Result: CNC lathe trainer has been studied.

Viva-Voce:

Experiment No.-10

Aim: Introduction, demonstration & practice on profile projector & gauges.

Optical Projectors Optical comparators which make use of the enlarged image principle are commonly knows as optical projectors.

Use : The optical projector is used for checking the shape or profile of a relatively small engineering components with an accurate standard or drawing. It enables *a* magnified image of part of a component to be projected on to a screen where it is compared with an enlarged profile drawing. The degree of magnification available may range from 5 to 100.

Principle of working: The essential elements of an optical projector are shown diagrammatically in Figure Light from the lamp *L* passes first through a condenser lens C, and then through' a projection lens *P*, The component supported on the work table between these two lenses, interrupts the light and causes an inverted magnified image to appear othe screens.

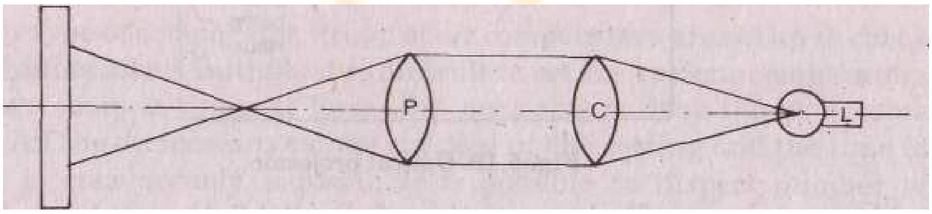

Figure: Optical projector

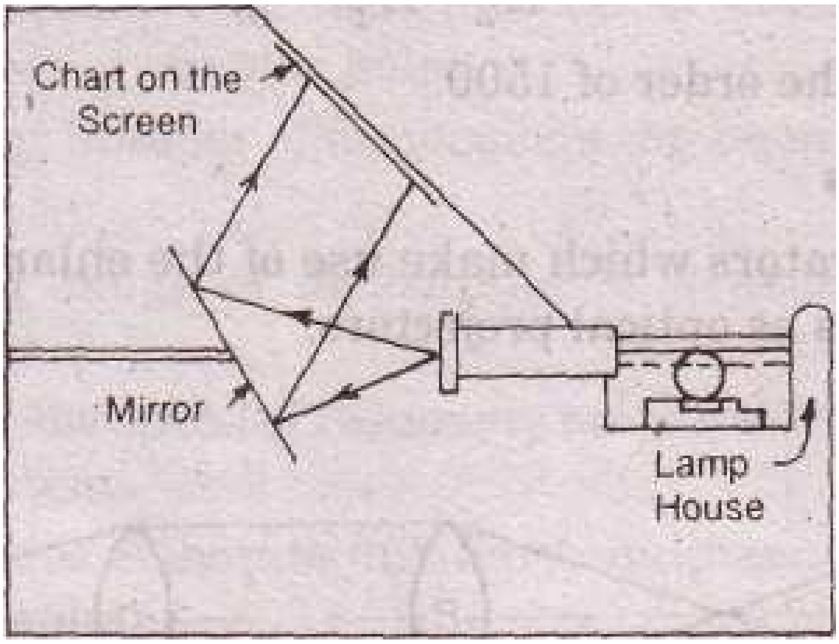

Figure: Optical projector

Commercial Projector

A commercial projector is shown in Fig. Its principle is the same, as described above.

Construction : It consists of:

(i) A projector (having a light Source, a condenser or collimaai lense system to direct the light part the part and into the optan system),

(ii) Suitable workholding table which may be fixed or movable.

(iii) Projection optics including both mirrors and lenses

(iv) Screen where the image of workpiece is projected and where measurements or comparisons are made

(v) Measuring devices. A good optical projector must have preos optical system, and means for precise mechanical measuremeri

When an object is placed before a light source, shadow of the profile s projected at some enlarged scale on a screen where it is compared master chart drawing. To reduce the thermal effects an extra arrangerr.en: for water lenses is generally provided. The magnification is usually fr to 100. the light source may be a tungsten lamp, filament lamp or high pressure mercury or zenon arc lamp.

A strong beam of light consisting of parallel light rays is produced by optical means. Beam of light should be of large enough diameter to provide coverage on the test piece and adequate illumination intensity for projection surface characteristics. The object to be tested is placed on the work table. The work table may be either stationary or moving type. Some tables are also equipped with an angular adjustment for positioning to the helix of threads and worms. These tables usually have in and out movement parallel to the axis of the beam for focusing purposes; and also provision for movements in other two planes. Micrometers in combination with dial indicators are fitted as measuring attachments for either two or three directions.

The light beam after passing the object to be projected passes into the projection system having lenses and mirrors which must be held in accurate alignment on rigid: supports. The lenses are used to obtain the desired magnification and mirrors to direct the beam of light on screen. The screens are usually made of glass with the surface facing the operator ground to very fine grain.

Result:

Viva-Voce: