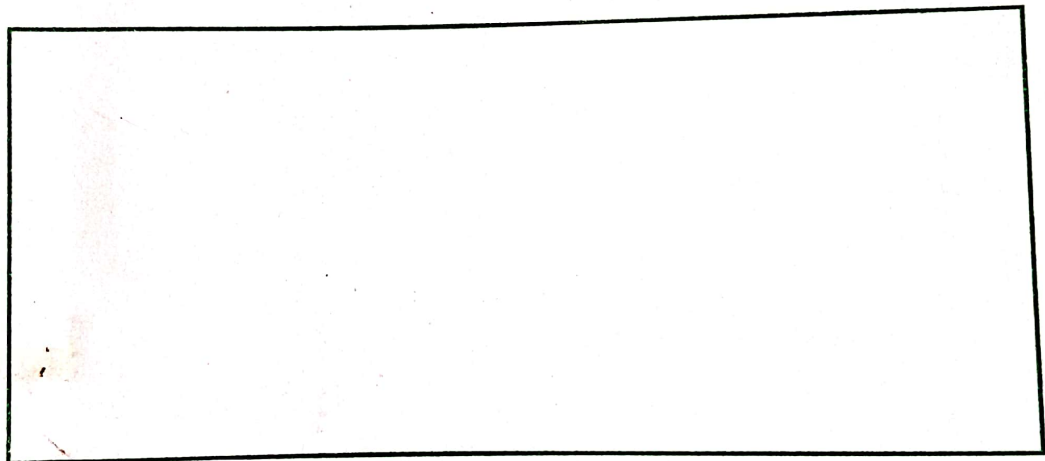


GOVERNMENT POLYTECHNIC, BALANGIR



LARKIPALI, BALANGIR



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GOVERNMENT POLYTECHNIC, BALANGIR

DEPARTMENT OF MECHANICAL ENGINEERING



INDEX PAPER

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AIM OF THE EXPERIMENT :-

To study about 2 stroke and 4 stroke petrol and diesel engine.

APPARATUS REQUIRED :-

1. Mod 1 of 2 stroke petrol engine.
2. Mod 1 of 4 stroke petrol engine.
3. Model of 2 stroke diesel engine.
4. Model of 4 stroke diesel engine.

Theory :-

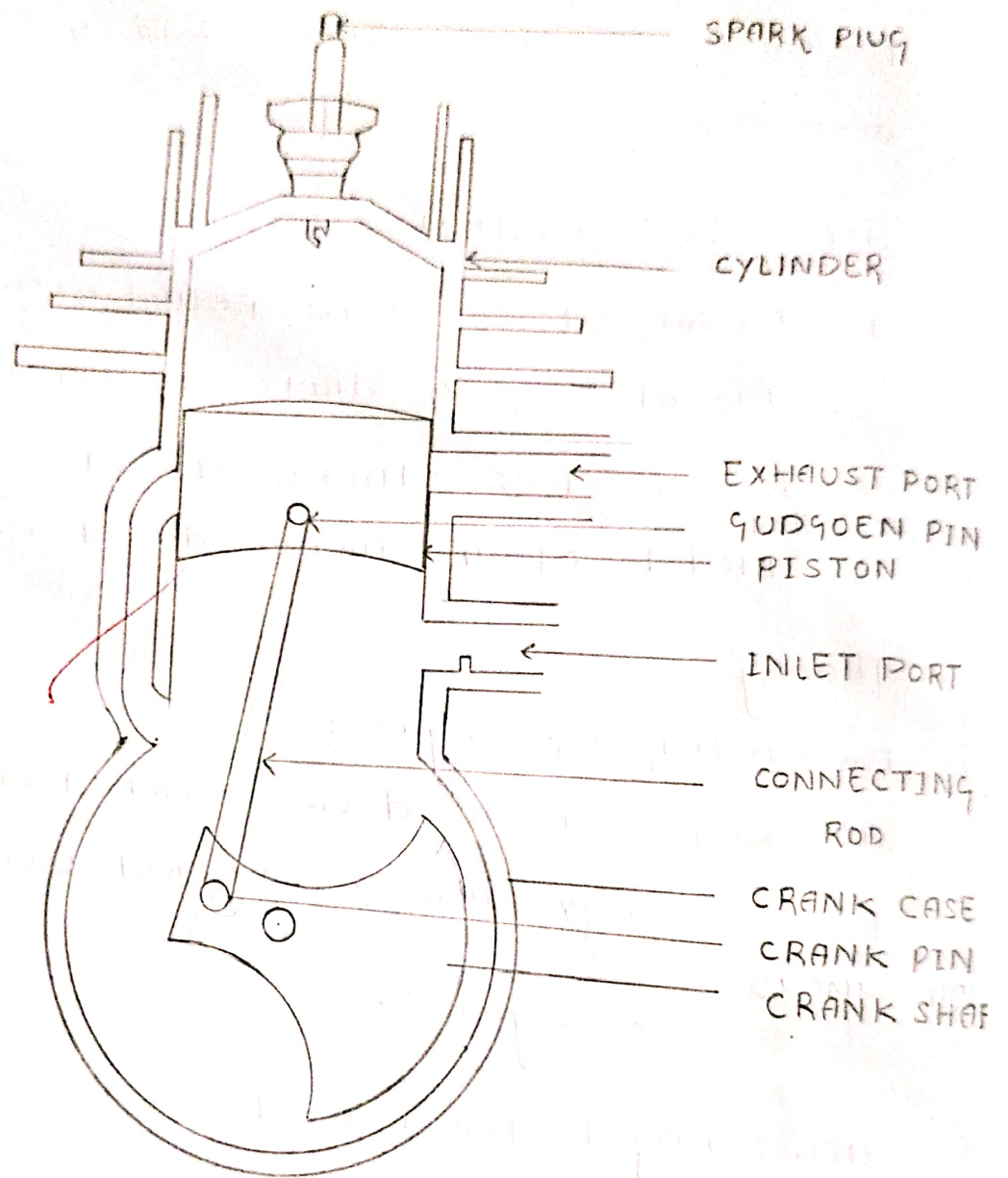
Definition of engine :-

An engine is a device which transform heat energy into mechanical work.

Types of engine :-

According to fuel used :-

1. Petrol engine
2. Diesel engine.



BLOCK DIAGRAM OF TWO STROKE PETROL ENGINE

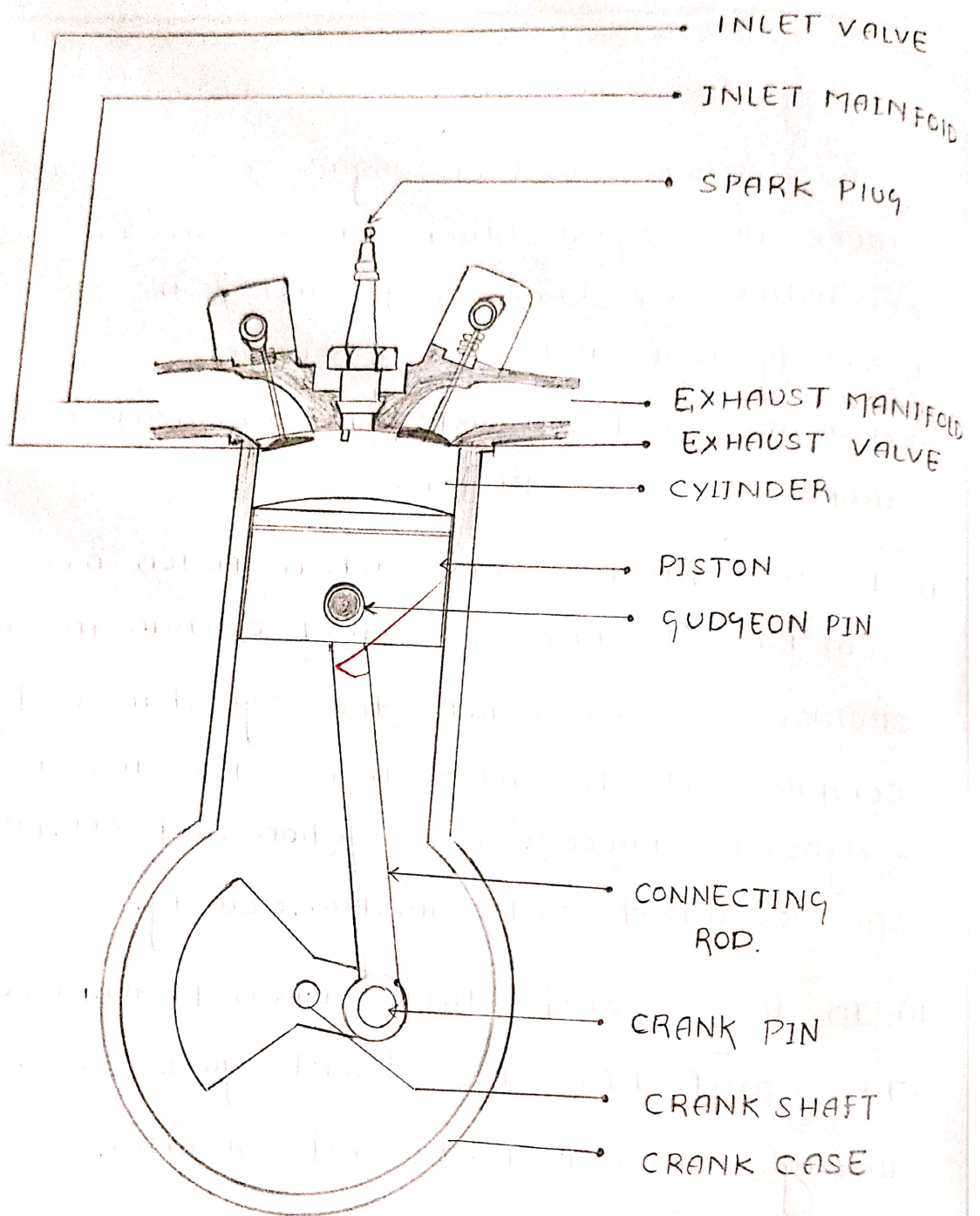
Working principle of 2 stroke petrol engine :-

In two stroke petrol engine one working stroke or power stroke is obtain in one revolution of crankshaft. Here the four thermodynamic process. i.e suction, compression, expansion and exhaust are carried out 2 stroke of the piston.

I> In the first stroke when piston moves from BDC to TDC the fuel contain in the crankcase enter into the cylinder and get compressed. In this stroke the two thermodynamic process i.e suction and compression are carried out simultaneously.

II> In the second stroke when piston moves from TDC and BDC the burnt gases are out through exhaust port and simultaneously the power transfer to the crankshaft. In this stroke two thermodynamic process i.e expansion and exhaust simultaneously.

III> In two stroke petrol engine petrol, gasoline (petrol) is the working fluid. Here the spark plug is responsible for the ignition of the fuel.



FOUR STROKE PETROL ENGINE

Working principle of 4 stroke petrol engine:-

In four stroke engine the cycle of operation is completed in four strokes of the piston and two revolution of the crankshaft. The process which are carried out in 4 stroke petrol engine are given below.

i) Suction:- It takes place when the piston is at the TDC. The inlet valve is open at this time and exhaust valve is closed. Due to the suction created by the motion of piston towards the BDC the air fuel mixture enters into the cylinder.

ii) Compression:- The air fuel mixture taken into cylinder during suction is now compressed. During this stroke both inlet and exhaust valve are closed. At the end of compression stroke the air fuel mixture is ignited with the help of spark plug. During this process the chemical energy of the fuel is converted into heat energy by producing a temperature of 200°C .

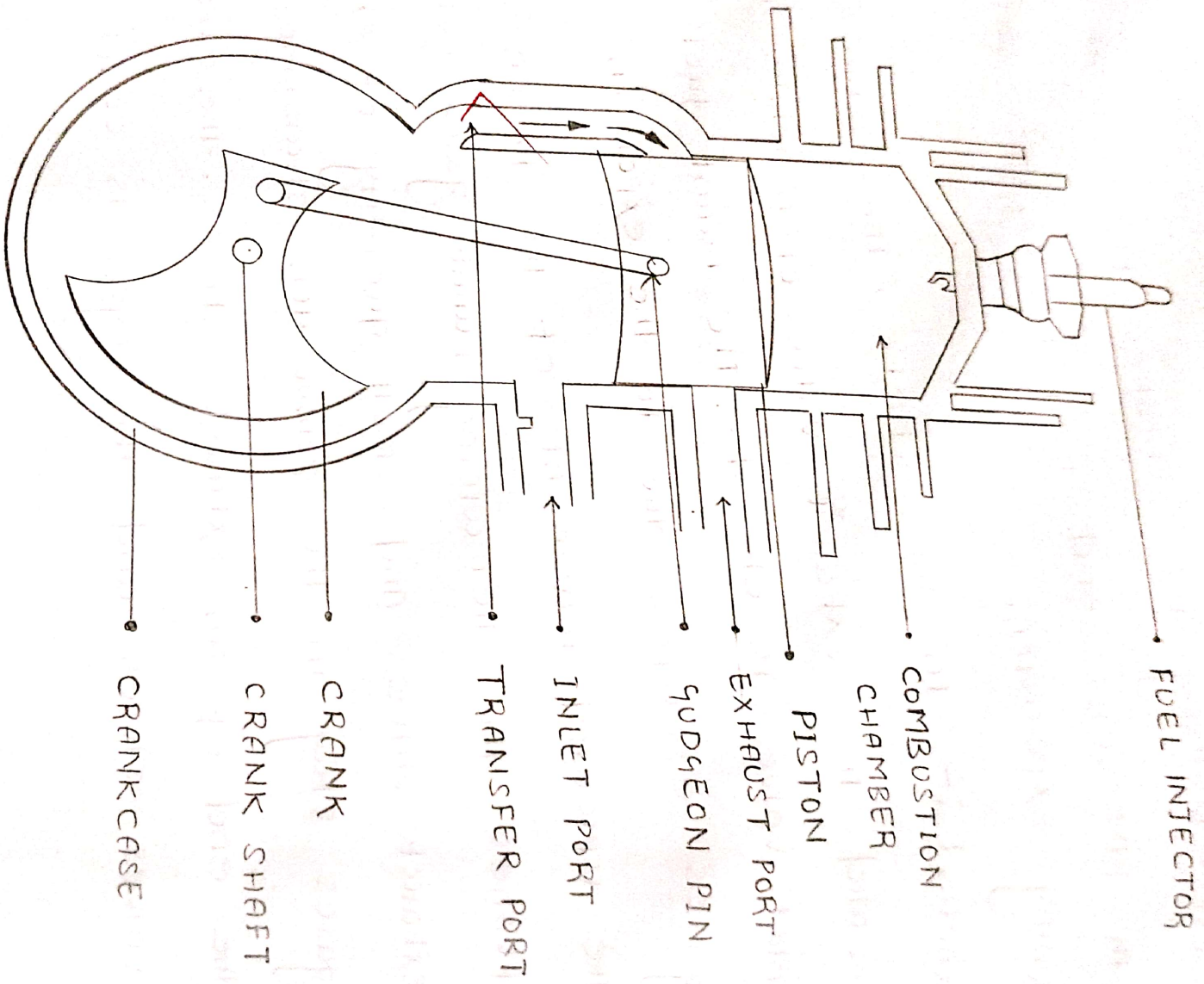
iii) Expansion - The high pressure of burnt gases forces the piston towards BDC.

GOVERNMENT POLYTECHNIC, BALANGIR



In this process both the valves are closed. During this stroke power is produced. Both pressure and temperature decrease during expansion.

Exhaust :- In this stroke, the piston moves upward. The exhaust valve opens while the inlet valve is closed. The burnt fuel gases escape due to the expansion. The upward movement of the piston pushes the remaining burnt gases out by exhaust valve. And small quantity of exhaust gases stay in the combustion chamber. At the end of an exhaust stroke, the exhaust valves close and the cycle is completed.



TWO STROKE DIESEL ENGINE

Working Principle of four stroke diesel engine:-

In four stroke diesel engine one working stroke or power stroke is obtained in two revolutions of the crankshaft. The thermodynamic processes which are carried out i.e. suction, compression, expansion, and exhaust.

1. Suction :- At the start, when the piston moves from TDC to BDC, the intake manifold air enters into the cylinder through the inlet port. During this suction stroke the inlet valve is ~~open~~ and at the end of the suction stroke inlet valve is closed. The exhaust valve is closed during this process. After suction is done, the piston moves from BDC to TDC.

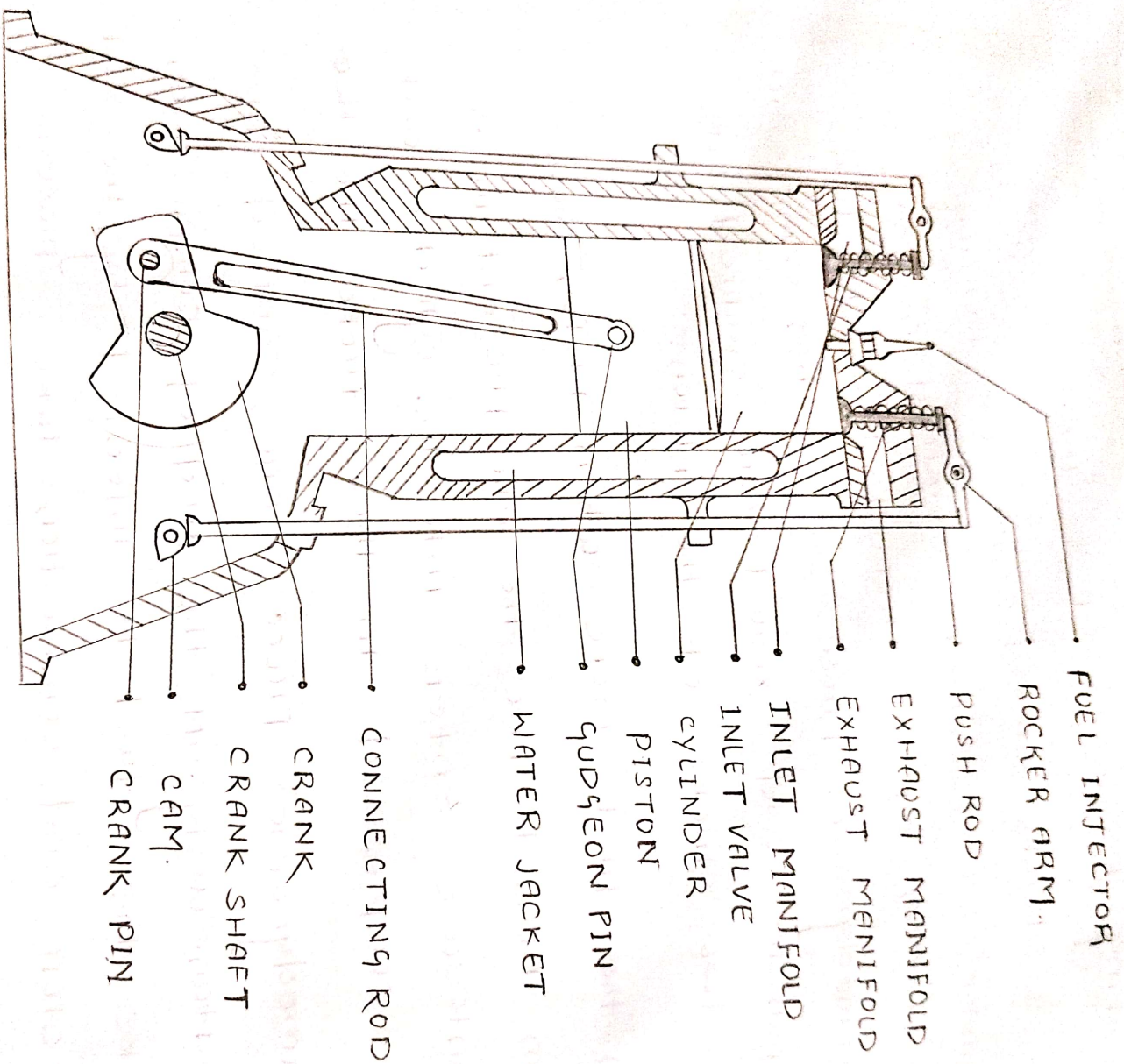
II. Compression :- During this stroke both the valves are closed. After compression of air, fuel injector spray the fuel inside the cylinder, ~~the~~ fuel is ignited. The ignition takes place in high pressure inside the cylinder and push the piston towards BDC.

Working principle of 2 stroke diesel engine.

In a 2 stroke diesel engine one working stroke on power is obtained in one revolution of crankshaft. Here the four thermodynamic process i.e suction compression expansion and exhaust are carried out in two stroke of the piston.

I. In the first stroke, when piston moves from BDC to TDC the air present in the crankcase enters into the cylinder and get compressed in this stroke the two thermodynamics process are carried out simultaneously. At the end of compression stroke the fuel is injected by the fuel injector and combustion takes place.

II. Due to the combustion at the end of compression stroke the piston moves from TDC to BDC because of this the burnt gases expand out and the power is transformed to the crankshaft simultaneously.



(4 - STROKE DIESEL ENGINE)

111. > Expansion :- In this stroke, both the inlet and exhaust valve remain closed. The hot gases which are produced due to ignition of fuel during compression stroke and compressed air now expand adiabatically in the cylinder pushing down the piston to BDC and the ~~power~~ work is done.

1V) Exhaust :- During this exhaust stroke only the exhaust valve is open and the end of this stroke exhaust valve closes and inlet valve open to suck fresh air. In this way cycle continuous and power obtained.

Conclusion :- In this experiment we have successfully studied two stroke and four stroke Petrol and diesel engine.

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AIM OF THE EXPERIMENT :-

To determine the brake thermal efficiency of single cylinder petrol engine.

APPARATUS REQUIRED :-

Sl. No	Equipment	Specification.	
1	Single cylinder petrol engine		Honda
		BHP	3 HP
		Speed	3000 RPM
		No of cylinder	1
		Compression ratio	7 : 4 : 1
		Bore	57 mm
		Stroke	57 mm
		Orifice diameter	20 mm
		Ignition type	Spark Ignition
		Type of cooling	Air cooled
		Type of loading	Hydraulic
		Type of starting	Kick

THEORY :-

Loading system:- The engine test ring is directly coupled to a hydraulic dynamometer which is loaded by water flow into the dynamometer at 0.5 kg/m^3 constant head pressure. The load can be varied by operating gate valve provided on the inlet line of the dynamometer. A greater value is provided at the bottom of dynamometer which is to be kept crack open throughout working range. The outlet will be



connected to a valve to be adjusted depending upon the load condition.

PROCEDURE:-

1) Connect the inlet of the engine jacket calorimeter & hydraulic dynamometer to a 0.5 kg/cm² constant head water source.

2) Open the inlet gate valves of the engine jacket & calorimeter to suitable desired flow rate.

3) Connect the instrumentation power input plug to 230 V single phase power source.

4) Fill the fuel tank with commercial grade petrol mixed with castor oil in 20:1 ratio.

5) Start the engine using the kickstarter provided with keeping the throttle lever slightly open.

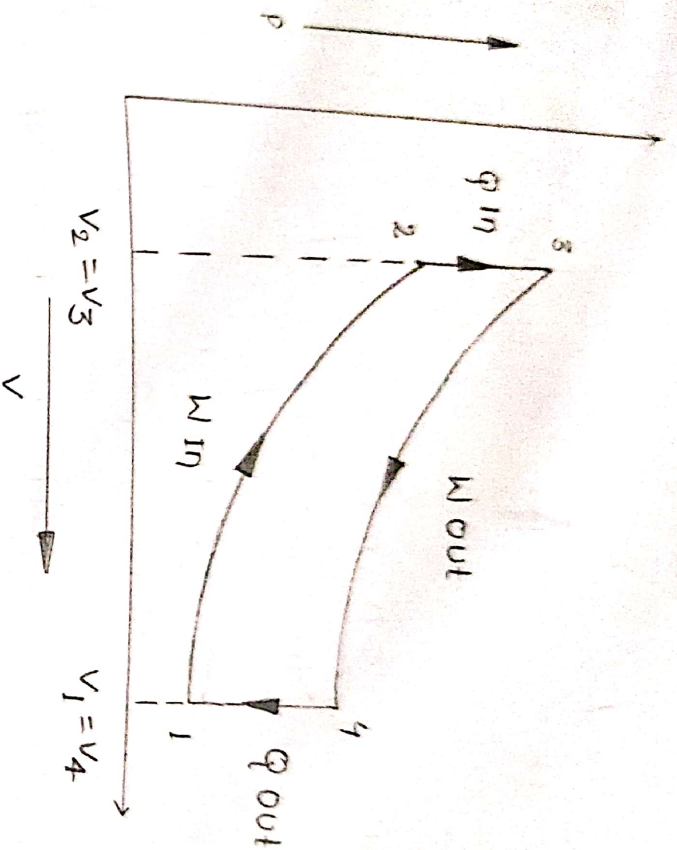
6) Adjust the throttle lever till 3000 rpm is reached.

7) Now open the dynamometer inlet gate valve gradually to load the engine through hydraulic dynamometer. The dynamometer arm having the length of $\pi = 0.2$ m gives the torque (T)

$$T = \pi \times S \text{ (S - load indicated in spring balance)}$$

8) Operates the inlet gate valve of the dynamometer & set the load.

9) Allow the engine to run at the set load which the speed for few minutes.

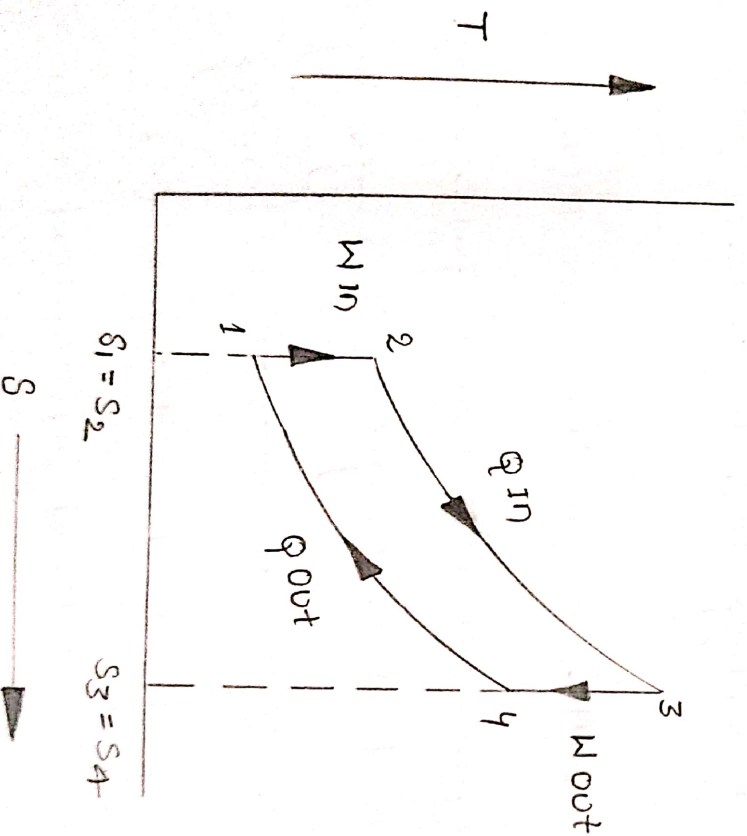


1-2 : Isentropic compression

~~2-3~~ : Constant volume heat addition

3-4 : Isentropic expansion

4-1 : Constant volume heat Rejection.



Pv and T.s Diagram

- 10) Note down all the required parameters.
- 1) speed of engine from digital fuel indicator in $\frac{kg}{hr}$
- ii) load from spring balance.
- iii) fuel consumption from digital fuel indicator in $\frac{kg}{hr}$
- iv) Temperature from digital temperature indicator
- v) Water flow rate through rotameter.
- ii) Repeat step 7 and 8 and increase the load & take a set of reading for.
- i) $1\frac{1}{2}$ load (1.8 kg + spring balance error)
- ii) $3\frac{1}{4}$ load (2.7 kg + spring balance error)
- iii) fluid load (3.6 kg + spring balance error)
- iv) over load (4 kg + spring balance error)
- 12) with the above parameters the calculation are obtained.

CALCULATION:-

$$BHP = \frac{2\pi NT}{4500} \quad \text{HP} \quad \text{where} \quad \begin{array}{l} N - \text{RPM} \\ T - \text{Torque} \end{array}$$

Brake thermal efficiency is given by.

$$= \frac{BHP \times 4500 \times 60}{427 \times CV \times MF} \times 100$$

where,

=

CV = calorific value of fuel
MF = weight of fuel consumed.

CONCLUSION :-

The brake thermal efficiency of single cylinder petrol engine was found to be 87.50%.

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AIM OF THE EXPERIMENT :-

To determine the brake thermal efficiency of a single cylinder diesel engine.

OBJECTIVE :-

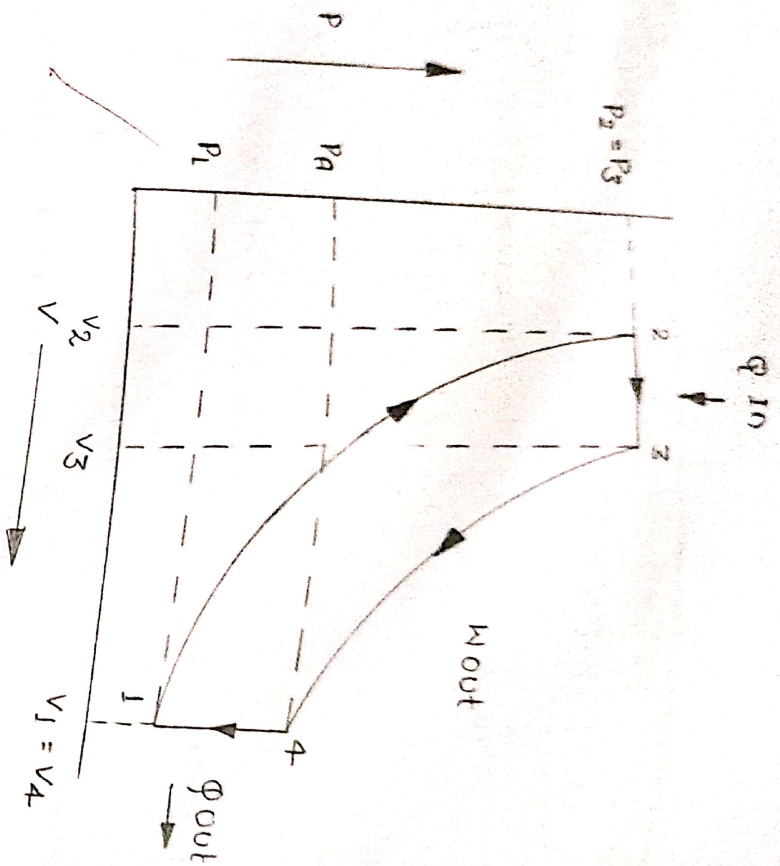
- After performing this experiment we will be able to -
- know about single cylinder ~~diesel~~ engine.
 - Determination of brake thermal efficiency of single cylinder engine.

APPARATUS :-

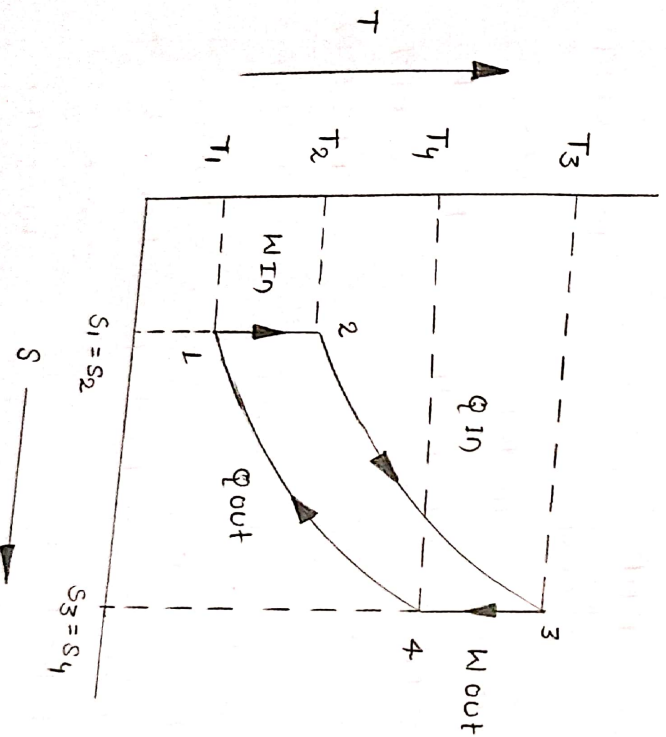
Sl. No	Equipment	Specification.	
			Honda
1	single cylinder diesel engine	BHP	5
		Speed	1500 RPM
		No. of cylinder	one
		Compression Ratio	16:5:1
		Bore	80mm
		Stroke	110mm
		Orifice diameter	17mm
		Type of ignition	Compression
		Method of loading	Rope brake
		Method of starting	crank start
		Method of cooling	Water.

THEORY :-

In Diesel engine use diesel as the working fluid. Have high compression ratio of fuel



- 1-2 : Isentropic compression
- 2-3 : Constant pressure heat addition
- 3-4 : Isentropic expansion
- 4-1 : Constant volume heat rejection.



P-V and T-S Diagram of diesel cycle.



ignites the fuel. Diesel cycle consists of four different stages i.e. suction, compression, expansion & exhaust, Here only air which is sucked in suction stroke is compressed in compression stroke. Then fuel from fuel injector enters into the engine cylinder at the end of compression & combustion of fuel takes place. After combustion, the exhaust stroke takes place where the burnt gases escape from the engine cylinder.

Brake thermal efficiency:- It is the ratio of energy in the brake power (BP) to the input fuel energy in appropriate units.

PROCEDURE:-

- 1) Fill the fuel in the fuel tank mounted on the panel frame.
- 2) Check the lubricating oil in the engine sump with the help of dipstick provided.
- 3) Open the fuel lock provided under the fuel tank & ensure that no air is trapped in the fuel line connecting to fuel tank & engine.
- 4) Decompress the engine by decompression lever provided on the top of the engine head.
- 5) Crank the engine slowly with the help of handle provided & as certain proper flow of fuel into the pump & in turn through the



nozzle into the engine cylinder.

c) When maximum cranking speed is attained pull the de-compression lever down now. The engine start, allow the engine to run & stabilize

7) Now load the engine by placing the necessary dead weights on the weighing hanger. to load the engine in steps of $1/4$, $1/2$, $3/4$ fuel & 10% over load. allow the engine to stabilize on every load change.

8) Record the following ~~parameters~~ indicated on the panel instruments each load step.

(a) speed of the engine from RPM indicator.

(b) Rate of fuel from burette.

9) Exact load in kg (W) on engine by adding the amount of weight added on the pan in kg (W₁) plus weights of pan in kg (W₂) minus spring balance reading in kg (W₃)

10) To stop the engine after the experiment is over push/pull the governor lever towards the engine cranking side.

CALCULATION:-

In this experiment, we have to calculate the brake thermal efficiency of single cylinder four stroke diesel engine.

$$B.P = \frac{\pi N (W - S) (D + d)}{600 \times 1000} \text{ kW}$$

Hare

- W - Dead weight in N.
- S - spring balance reading in N
- D - Diameter of brake drum in m
- d - Diameter of rope in m.

Brake thermal efficiency = $\frac{\text{Brake Power}}{\text{Energy supplied to the engine.}}$

$$\eta_{Bth} = \frac{B.P}{m_f \times CV}$$

Hare
CV - calorific value of fuel (diesel) = $46200 \frac{\text{kJ}}{\text{kg}}$
 m_f = mass of fuel
Density of Petroleum diesel = 850.8 kg/m^3

CONCLUSION:-

The brake thermal efficiency of single cylinder four stroke diesel engine was found to be 25.33%.

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AIM OF THE EXPERIMENT :-

Determine the B.H.P, I.H.P and BSFC of multi cylinder engine by Morse test.

APPARATUS REQUIRED :-

Sl No	Equipment	Specification	
		BHP	10
1	Four cylinder Petrol engine test Rig	Speed	1500 RPM
		No of cylinder	4
		compression Ratio	7 : 8 : 1
		Bore	68 mm
		Stroke	75 mm
		orifice diameter	20 mm
		Type of ignition	SPARK
		Type of cooling cooling	Water
		Type of loading	Hydraulic
		Type of starting	Self.

THEORY :-

- The Morse test is used to find out the indicated power of a multi cylinder reciprocating engine.
- The engine is run at a particular speed and the torque is measured by cutting out the firing of each cylinder in turn & nothing the fall in brake power each time while maintaining set engine speed by reducing load.
- The observed difference in brake power between all cylinder firing & with one cylinder cut out is the indicated power of the cut out cylinder



PROCEDURE:-

- 1) connect the water inlet of the engine jacket calorimeter & hydraulic dynamometer to a constant head water source.
- 2) open the inlet gate valves of the engine jacket & calorimeter to suitable desired flow rate.
- 3) connect the battery terminals to a well charged 12 V battery with the terminals marked (+) & (-) respectively to the engine cable terminals.
- 4) connect the battery instrumentation power input plug to a 230V single phase power supply.
- 5) Fill up Petrol into Petrol tank provided mounted on a 5 kg capacity lead cell unit the fuel weight meter reads approximately 4000 gms
- 6) Open the Petrol cock provided underneath the Petrol tank & ensure all the knife switches provided for the Morse test are in engaged position. Also ensure the accelerator knob is in off position.
- 7) Insert the ignition key into the starter switch & turn deflection will be shown at the bottom of the panel.
- 8) Increase the speed by turning the accelerator knob clockwise until the RPM indicator reads 1500 RPM
- 9) Now open the dynamometer inlet gate valve to load the engine through hydraulic dynamometer.



10) load the engine to full load at rated speed as a result the speed of the engine drops down by operating the water inlet valve to reduce the load slowly so that the speed of the engine comes back to its rated speed. Record the spring balancing reading.

11) Pull out the next knife switch immediately & observe the engine speed.

TABULATION:-

Sl No	Condition	N (RPM)	W (kg)	BHP	IHP	BSFC

CALCULATION:-

$$BHP = \frac{2\pi NT}{4500} \text{ HP}$$

let, W = Dynamometer load in kg

N = RPM of engine

B - BHP of 4 cylinder

IHP - Indicated horse Power

BHP - Brake horse Power

B₁ = BHP of 3 cylinder 1st cut off

B₂ = BHP of 3 cylinder and 1st cut off

B₃ = BHP of 3 cylinder 3rd 1st cut off



B₄ - BHP of 3 cylinder 4th is cut off

IHP calculation:-

IHP of 1st cylinder : B - B₁

IHP of 2nd cylinder : B - B₂

IHP of 3rd cylinder : B - B₃

IHP of 4th cylinder = B - B₄

Total IHP of the engine = IHP (1st + 2nd + 3rd + 4th)

BSFC Calculation:-

It is the ratio between mass of fuel consumed per hour to the BHP

$$BSFC = \frac{M_f}{BHP} \quad \text{kg/BHP.hr}$$

where m_f = fuel consumed in kg/hr

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AIM OF THE EXPERIMENT :-

To study of pressure measuring device like manometer and Bourden tube pressure gauge.

APPARATUS REQUIRED :-

Sl. No	EQUIPMENTS	SPECIFICATION	QUANTITY
1	Manometer	U-tube	1
2	Bourden tube pressure gauge		1

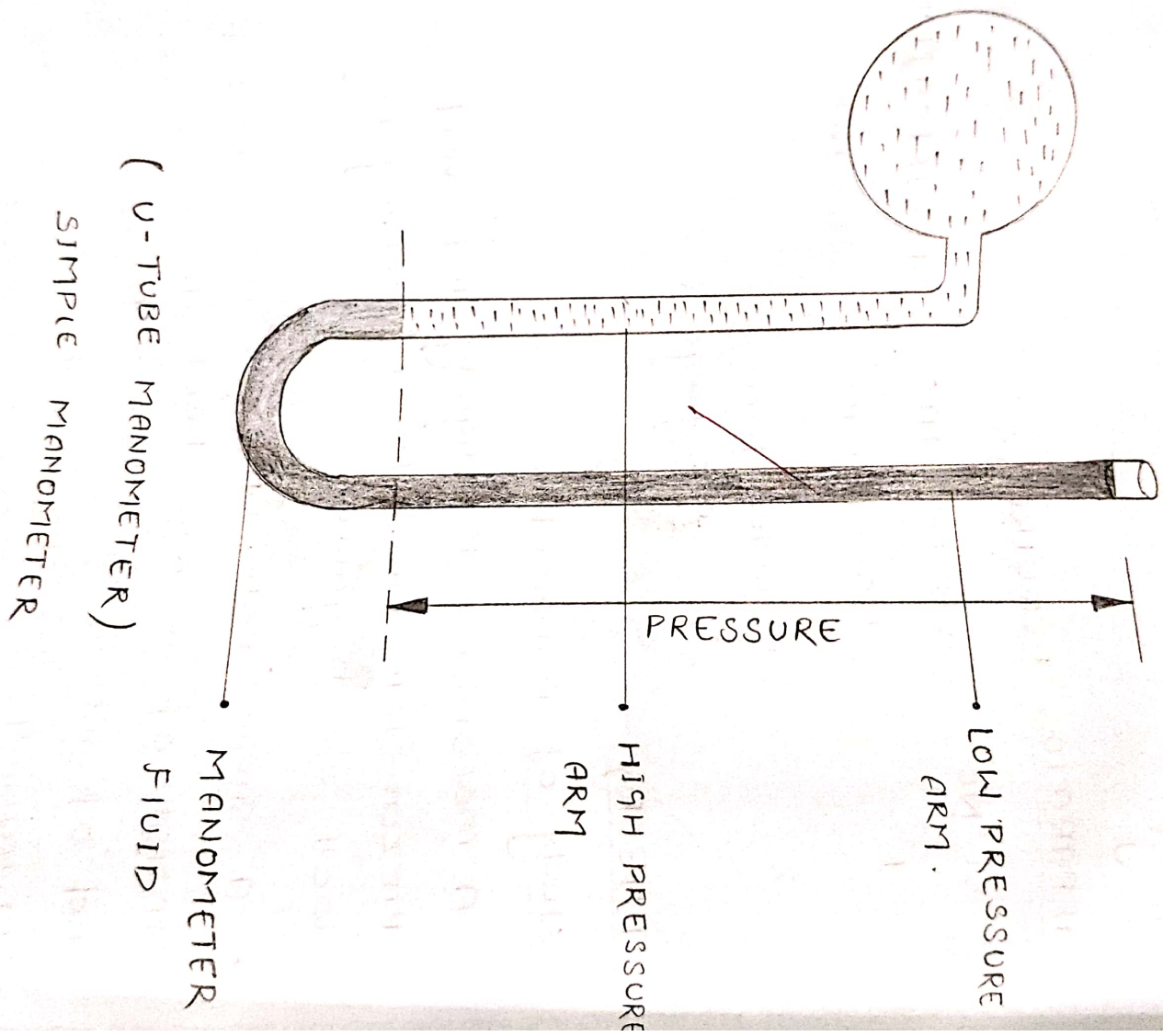
THEORY:-

Study of manometer

→ A manometer is slightly improved from a piezometer tube for measuring high as well as negative.

→ A simple monometer in its simplest form consist of a tube bent in U-shape one end of which is connected to the vessel containing the liquid whose intensity of pressure is to be measured & other end is open to the atmosphere.

→ The liquid used in bent tube is generally mercury (Hg) which is 13.6 having than water.





- The pressure of the liquid containing in vessel with force manometer liquid to raise upto in the right hand vertical limb v-tube.
- If pressure in the vessel is less than atmosphere, the deflection of manometric liquid will be observed in left hand limb on the v-tube.
- Since below the surface above the liquid is homogenous & since the liquid is at rest the pressure along the plane AB in the left hand limb of v-tube is equal to pressure in the right hand limb of v-tube manometer along the AB.
- Then measuring the difference in mercury level above line AB & equating the pressure at A & B. we can measure pressure in the liquid flowing in the pipe.

STUDY OF BOURDEN TUBE PRESSURE GAUGE →

- Bourden tube ~~PER~~ pressure gauge consist of a circular spring tube, it is called Bourden tube.
- The Bourden tube is made up of special quality bronze & oval in cross-section.
- one end of the bourden tube is closed

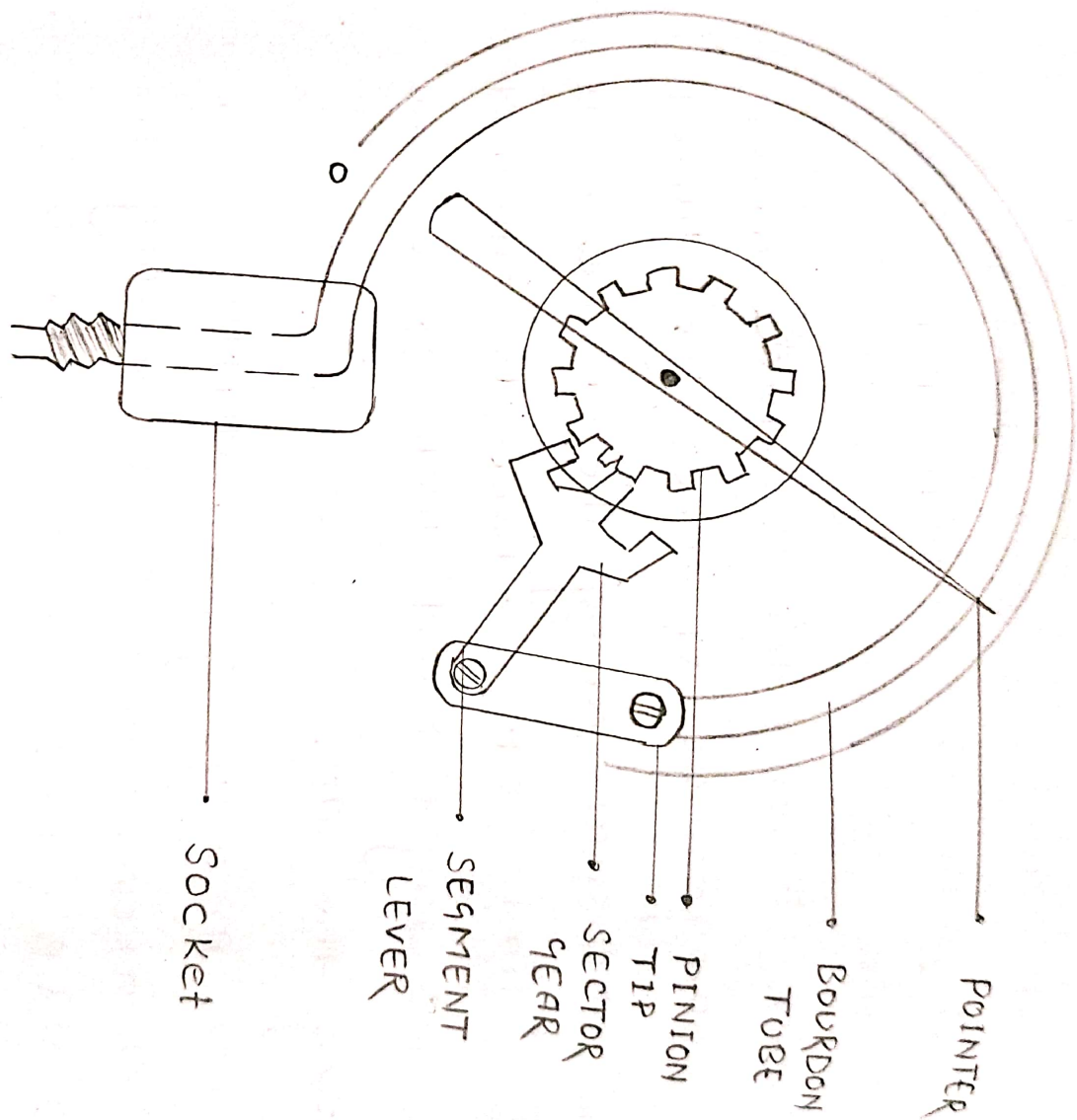


Fig-2 Bourden Tube Pressure Gauge

& connected to limb link & the other end is secure in a vertical tube 'g'.

→ The link 'l' connected the closed end of the Bourden tube to a toothed sector 'c' which is hinged at 'o'.

→ The tooth sector 'c' gear with a pinion 'b' which is mounted in a central spindle carrying a point 'p' the point move on a dial graduated pressure unit.

→ The pressure gauge is connected to the vessel containing fluid under pressure.

→ Due to fluid pressure in the Bourden tube it has tendency to achieve a circular shape.

→ This tendency of straightening moves the face end of the Bourden tube outwards.

→ As a result the toothed sector moves about the hinge 'o' & causes the pinion

'D' to rotate which in turn moves the pointer 'F' to move on a dial graduated in bar.

→ The movement of the free end of the Bourden tube & is proportional to the difference between the external atmospheric pressure & internal fluid pressure.



→ Hence the Pressure gauge records the gauge pressure which is the difference between fluid pressure and outside atmospheric pressure.

CONCLUSION:-

Hence we successfully studied about manometer and Bourdon tube pressure gauge.

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AIM OF THE EXPERIMENT :- 06

To verify the Bernoulli's theorem :-

OBJECTIVE :-

After completion of the experiment, we will be able to know.

- (i) about the mathematical formula of theorem
- (ii) about the different type of the energy head
- (iii) about the utility of the theorem.

APPARATUS :-

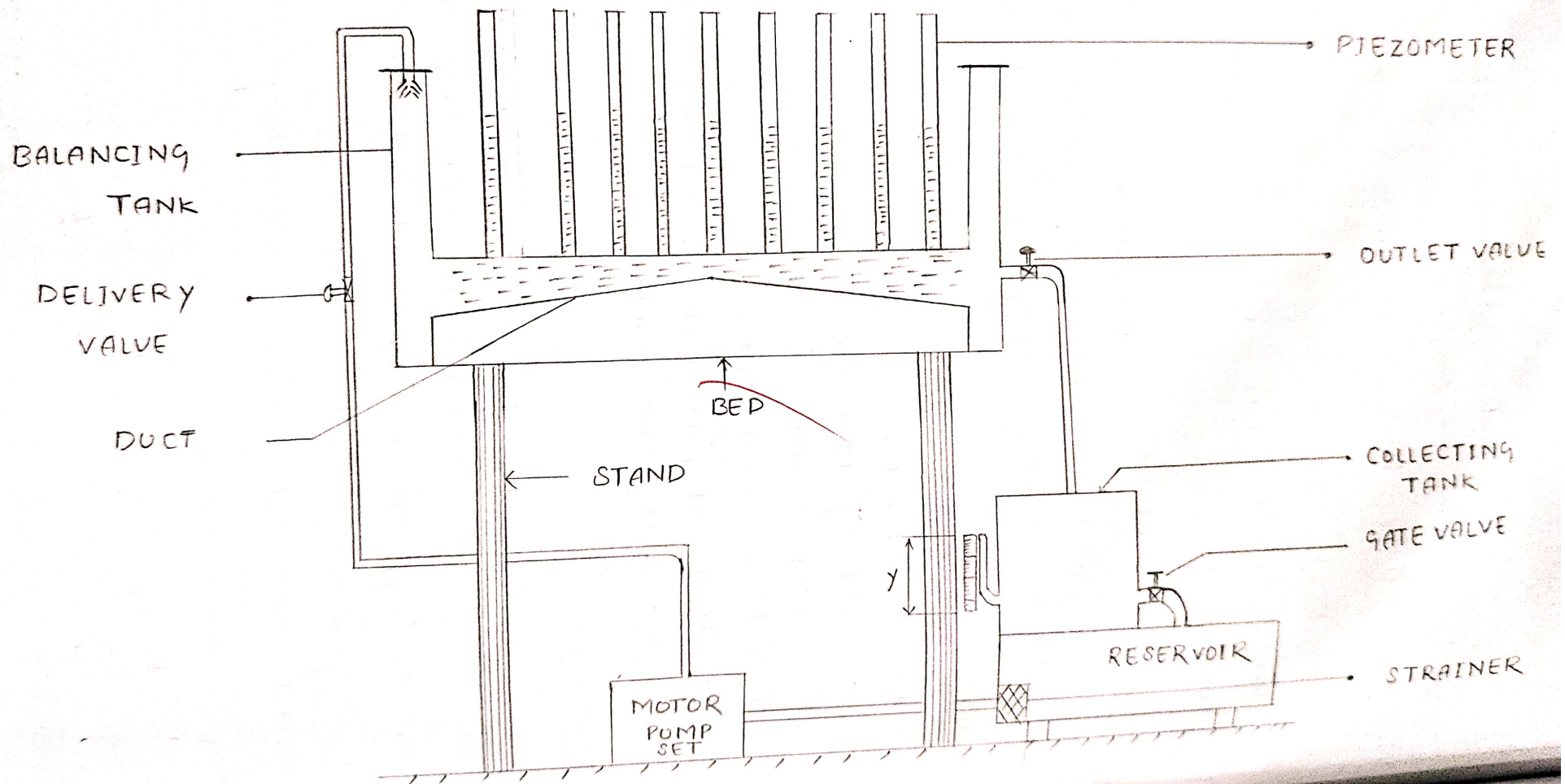
- 1. Steel rule.
- 2. SUPPLY tank of water
- 3. stop watch,
- 4. Measuring tank.
- 5. Inclined pipe with piezometer tube lifted at different point.

THEORY :-

The Bernoulli's theorem states that an ideal fluid with steady flow along with stream line flow, the total energy or energy head remain constant at any point of flow suppose we are taking two section one and two, so according to

Bernoulli's theorem

$$\frac{P_1}{\rho g} + \frac{V_1^2}{2g} + z_1 = \frac{P_2}{\rho g} + \frac{V_2^2}{2g} + z_2$$





When,

$$\frac{P_1}{\rho g} = \text{Pressure energy (head)}$$

and

$$\frac{V_1^2}{2g} \text{ and } \frac{V_2^2}{2g} = \text{Kinetic energy (head)}$$

$$z_1 \text{ and } z_2 = \text{Datum energy head.}$$

PROCEDURE:-

- The valve is open water is allowed to flow, slowly from the supplied tank.
- The flow is adjusted to get a constant head in the supplied tank.
- By using stop watch the quantity of water collected in a particular time period inside the measuring tank.
- By using the continuity equation the V_1 and V_2 are calculated.
- The pressure head of the two points are measured from the piezometer tube.
- The datum head $z_1 = z_2$ also noted.

[illegible]

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EXPERIMENT :- 07

AIM OF THE EXPERIMENT :-

Determination of the

(Cd) from venturimeter.

APPARATUS REQUIRED :-

Sl NO	EQUIPMENT	SPECIFICATION	QUANTITY.
01	venturimeter test ring		01
02	stop watch	Digital	01
03	Steel rule	L = 30 cm	01

THEORY :-

A venturimeter is an instrumental used to measure the rate of discharge at different sections of the pipe line. v

venturimeter consists of 3 parts :-

- Converging section.
- Throat section
- Divergent section.

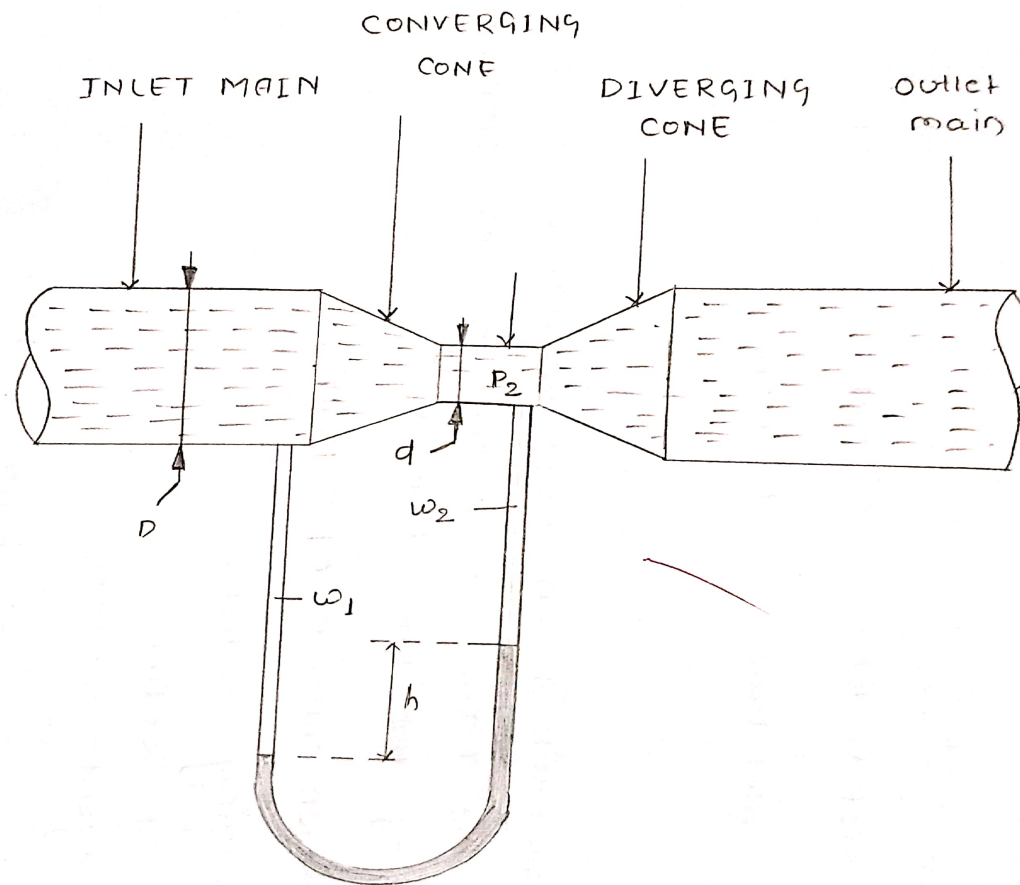
Co-efficient of discharge = $\frac{Q_{act}}{Q_{theo}}$

Where

$$Q_{act} = \frac{L \times b \times h}{t}$$

L = length of discharge tank.

b = breadth of discharge tank.



VENTURIMETER

h = height of discharge tank.
 t = time taken in sec.

$$Q_{thca} = \frac{A_1 \times A_2 \times \sqrt{2gh}}{\sqrt{A_1^2 - A_2^2}}$$

A_1 = inlet area of venturimeter.

A_2 = outlet area of venturimeter.

PROCEDURE :-

1) Set the manometric pressure tube to atmospheric pressure by opening valve. the upper valve.

2) Now the supply of water may be controlled by the stop valve.

3) one of the valves of any pipe may be opened and close all of other three valves / pipes.

4) Note the discharge reading for the particular flow by measuring the height of the discharge tank.

5) Note the time taken by stop watch for the particular flow.

6) Note the reading for the pressure head from the U-tube manometer, with its corresponding reading of discharge.

7) Now take three readings for this pipe and calculate cd for that instrument using formula given above.

8) Now close this valve and open another valve having different diameter pipe and repeat this.



procedure as mentioned above. Three such readings also taken and calculate cd .

q) similarly take readings for all other diameters pipe and calculate cd in each case.

TECHNICAL SPECIFICATION:-

length of discharge tank $l = 35.7 \text{ cm}$

Breadth of discharge tank $b = 35.7 \text{ cm}$

Height of discharge tank $h =$

inlet dia of venturimeter $D_1 = 35 \text{ mm}$

inlet Area $(A_1) = \pi/4 \times (D_1)^2 =$

Outlet dia of venturimeter $D_2 = 26 \text{ mm}$

Outlet Area $(A_2) = \pi/4 \times (D_2)^2$

$$\text{Specific gravity of mercury} = \frac{\text{Density of mercury}}{\text{Density of water}} = \frac{13600}{1000} = 13.6$$

CALCULATION TABLE:-

Sl NO	Pipe area $D_1 (\text{cm}^2)$	Pipe area $D_2 (\text{cm}^2)$	L in cm	$h_3 \left(\frac{\text{cm}}{\text{min}} \right)$	Actual measuring tank h_{axh}	$Q_{theo} = \frac{a_1 a_2 \sqrt{2gh}}{\sqrt{a_1^2 - a_2^2}}$	$cd = \frac{Q_{act}}{Q_{theo}}$



CONCLUSION :-

From the above experiment the co-efficient of discharge (C_d) of venturimeter was found out to be. _____

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AIM OF THE EXPERIMENT:-

Determination of the C_c , C_d , and C_v from orifice meter.

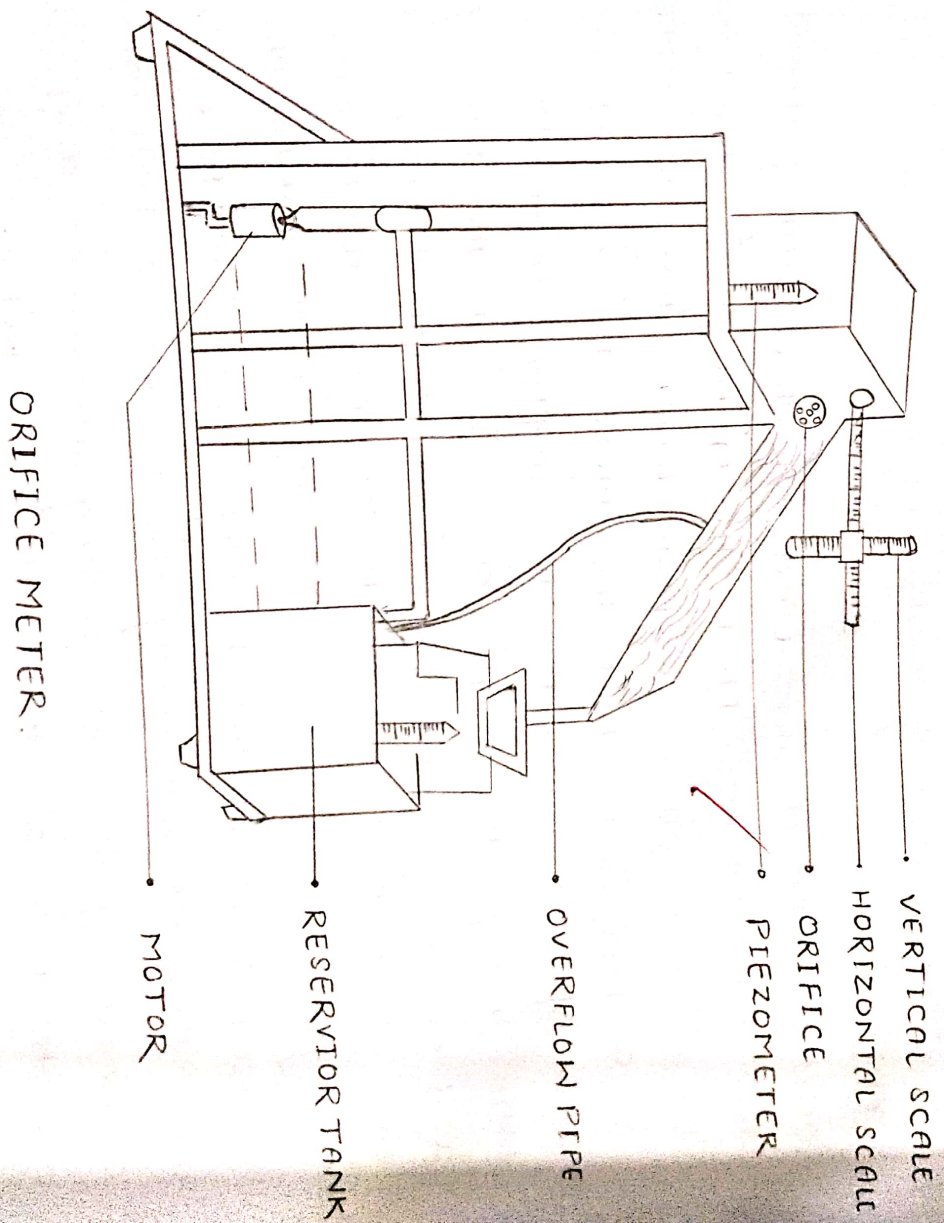
APPARATUS:-

01. Orifice tank with Piezometer. - 01
02. Digital stop watch - 01
03. Collecting tank - 01

THEORY:-

Orifices are devices used for discharging fluids into the atmosphere. It is the opening in the wall of a tank or in a plate which may be fitted in a pipe such that the plate is normal to the axis of the pipe. The discharging fluid from the tank through the orifice comes out in the form of a free jet. In the process the total energy of the fluid in the tank is converted to kinetic energy as the jet issues out into the atmosphere. The jet cross-section initially contracts to a minimum and then expands partly due to viscous resistance offered by the surrounding ~~atmosphere~~ and partly due to inertia of the fluid particles.

The actual velocity of vena contracta is smaller than the theoretical velocity due to frictional resistances at the orifice edges. The ratio between the actual velocity and the theoretical velocity of the jet is known as coefficient of velocity. C_v . Its value also depends upon the size



and shape of the orifice and the head causing flow. The coefficient velocity for a vertical orifice is determined experimentally by measuring the horizontal and vertical co-ordinates of the jet while converting horizontal distance, the jet is acted upon by gravity with a downward acceleration g . Suppose it falls through a vertical distance 'y' in a horizontal distance 'x' in time 't' sec. Then,

$$x = Vt \text{ and } y = \frac{1}{2}gt^2$$

$$\text{or } y = \frac{1}{2} \frac{gx^2}{V^2}$$

$$\text{or } V = \sqrt{\frac{gx^2}{2y}}$$

But theoretical velocity.

$$V_{\text{theo}} = \sqrt{2gH}$$

$$\text{So } C_v = \sqrt{\frac{gx^2}{2y \times 2gH}} = \sqrt{\frac{x^2}{4yH}}$$

since actual area of jet is less than the area of the orifice and the actual velocity is less than the theoretical velocity. therefore actual discharge. The ratio between actual discharge is less than the theoretical discharge. The ratio between actual discharge and theoretical discharge is called co-efficient of discharge C_d

$$C_d = \frac{Q_{\text{act}}}{a \sqrt{2gH}}$$

Where, $\sqrt{2gH}$ is the theoretical discharge

The actual discharge passing through an orifice is given by actual velocity of vena contracta $\times$

$$= C_v \sqrt{2gH} \times C_c \times a$$

Area of jet at vena contracta.

But $\sqrt{2gH}$ is the theoretical discharge

$$\text{So, } \frac{\text{Actual discharge through orifice}}{\text{Theoretical discharge through orifice}} = \frac{C_v \sqrt{2gH} \times C_c \times a}{a \sqrt{2gH}} = C_c \times C_v$$

or $C_c = \frac{C_d}{C_v}$

$$\text{Where } C_d = \frac{Q_{\text{act}}}{Q_{\text{theo}}}$$

The value of C_d of a standard orifice varies from 0.61 to 0.67

$$\text{Actual discharge } Q_{\text{act}} = \frac{A \times R}{t} \text{ m}^3/\text{s}$$

A = Area of measuring tank (m)

R = Rise in water level in measuring tank (m)

t = time taken for the water level rise.

$$\text{Theoretical discharge } Q_{\text{theo}} = a \sqrt{2gH} \text{ m}^3/\text{sec}$$

a = area of the orifice (m²)

g = acceleration due to gravity (m/s²)

H = head of the orifice (m)

PROCEDURE:-

- Adjust the in flow of water to the inlet tank
- til the study state condition is achieved by in and out flow from the orifice and the head causing flow

→ using the hook gauge, measure x and y coordinates at different points on the center line of the jet. knowing 'H' the head causing flow and x and y co-ordinates coefficient of velocity can be obtained from the formula.

$$C_v = \sqrt{\frac{x^2}{4yH}}$$

→ Note the initial reading of water level in the measuring tank, and at the same time start the stop watch. After an interval of time note the reading of the water level knowing area of measuring tank actual discharge Q_{act} can be obtained
Hence

$$C_d = \frac{Q_{act}}{a\sqrt{2gH}}$$

→ Calculate $C_c = \frac{C_d}{C_v}$

→ Repeat the above steps for different heads 'H' and take five readings.

→ Repeat the experiment for mouth piece and converging orifice.

OBSERVATION:-

Dia of circular orifice = 10mm = 1cm

Area of circular orifice (a) = $\frac{\pi d^2}{4} \text{ cm}^2 = 0.785 \text{ cm}^2$

Dia of circular mouth piece = 10mm = 1cm

Area of circular mouth piece (a) = $\frac{\pi d^2}{4} \text{ cm}^2 = 0.78 \text{ cm}^2$
 Sump tank capacity = 50 liter.
 Collecting tank capacity = 30 liter
 Area of collecting tank (A) =

TABULATION:-

Sl No	Rise of Water level = h	At	Discharge $Q = \frac{\Delta h}{\Delta t}$	Water head	x_1	y_2	x_2	y_2	$x = x_2 - x_1$	$y = y_2 - y_1$
1	8	95	103.136	16.5	40.9	23.3	50.6	25.7	9.7	2.4
2	8.5	60	101.135	15.5	39.1	29	59	35	24.9	6
3	7.5	90	102.062	17.5	40.9	22.3	49.6	24.7	8.7	2.4

Coefficient of discharge, $C_d = \frac{Q_{act}}{Q_{theo}}$

Coefficient of velocity, $C_v = \frac{x}{\sqrt{4yH}}$

Coefficient of contraction $C_c = \frac{C_d}{C_v}$

CONCLUSION:-

From the above experiment the value of C_d , C_c and C_v of orifice meter was found to be $C_d = 0.73$, $C_v = 0.77$
 $C_c = 0.94$

SUBMITTED BY:-

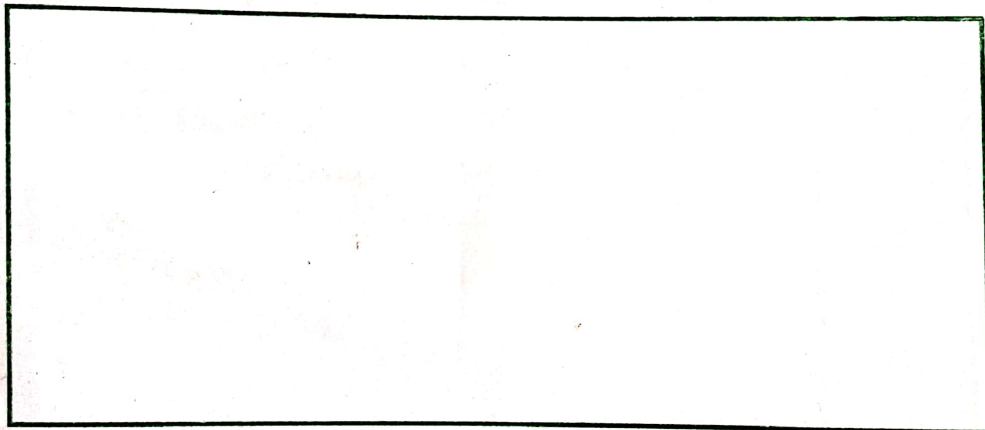
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Branch Mechanical Group 'B'

Subject TOM and Measurement lab

GOVERNMENT POLYTECHNIC, BALANGIR

DEPARTMENT OF Mechanical Engineering



INDEX PAPER

Sl. No.	Name of the Department	Date	Sheet Used	Remarks
01	To determine the length of a mild steel flat specimen using a vernier caliper to an accuracy of 0.1 mm.	07/02/24	1 to 6	AMB 08/2/24
02	To measure the height of the mild steel specimen by using vernier height gauge with an accuracy of 0.02 mm.	08/02/24	07 to 13	AMB 10/2/24
03	To determine the diameter of a cylindrical component to an accuracy of 0.01 mm using micrometer.	15/02/24	14 to 19	AMB 17/2/24
04	To determine the length of ground MS flat specimen by slip gauge.	24/02/24	20 to 22	AMB 7/3/24
05	To study of different type of cam and followers.	29/02/24	23 to 28	AMB 14/3/24
06	To determine the unknown angle of a specimen using sine bar.	14/03/24	27 to 28	AMB
07	To determine the centrifugal force of water governor by using governor apparatus.	28/03/24	29 to 31	AMB 23/3/24

GOVERNMENT POLYTECHNIC, BALANGIR

DEPARTMENT OF



INDEX PAPER

Sl. No.	NAME OF THE EXPERIMEN	DATE	SHEET USED	REMARKS
08	To determine the centrifugal force of a porter governor by using governor apparatus.	03-04-24 22-03-24	32 to 34	AMBAY 6/4/24
09	To find the centrifugal force of porter governor and to find also the stiffness of spring used in the governor setup	18-04-24	35 to 38	AMBAY 25/4/24
10	Study and demonstration of epicyclic gear train and find out input, output and holding torque by epicyclic gear train apparatus	25-04-24	39 to 44	AMBAY 26/4/24
11	To study about static and dynamic balancing using balancing apparatus.	25-04-24	45 to 47	AMBAY 27/4/24

Experiment-1

Aim of the experiment :-

To determine the length of a MS flat specimen using vernier calliper to an accuracy of 0.1 mm.

Apparatus required :-

- (1) Vernier calliper
- (2) MS flat specimen
- (3) steel rule.

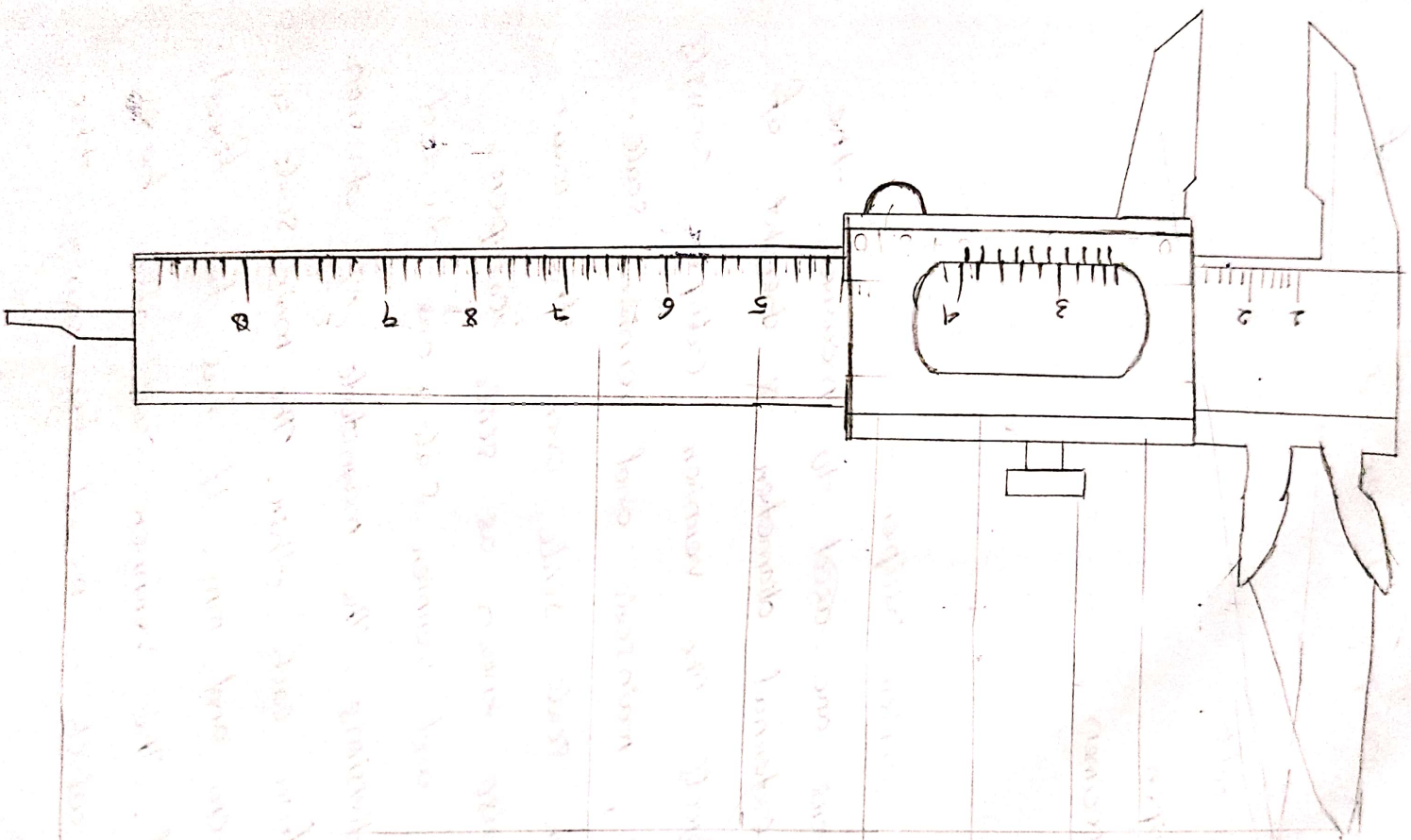
Theory

Description of vernier calliper :-

Vernier callipers are used to measure the internal and external diameter & height of a hollow objects. The vernier calliper consists of two scales, main scale and vernier scale.

As the vernier scale slide over the main scale. It is also known as slide caliper.

The main scale and vernier scale are divided into smaller divisions. The magnitude of division are different from each other. The main scale is graduated in cm and mm. It has two fixed jaws attached. The vernier scale also has movable jaw which is moved by using the thumb screw.



(VERNIER CALIPER)

Page No. 2

Leaf of the book by Le

Least Count :-

→ The minimum measurement that can be measured by the instrument is called as least count of that instrument.

$$\text{Least Count} = 1 \text{ MSD} - 1 \text{ VSD}$$

$$10 \text{ VSD} = 9 \text{ MSD}$$

$$1 \text{ VSD} = \frac{9}{10} \text{ MSD}$$

$$1 \text{ MSD} - 1 \text{ VSD}$$

$$= 1 \text{ MSD} - \frac{9}{10} \text{ MSD}$$

$$= 1 - \frac{9}{10} = \frac{1}{10} = 0.1 \text{ mm} \\ = 0.01 \text{ cm}$$

$$50 \text{ VSD} = 49 \text{ MSD}$$

$$1 \text{ VSD} = \frac{49}{50} \text{ MSD}$$

$$\text{Least Count} = 1 \text{ MSD} - \frac{49}{50} \text{ MSD}$$

$$= 1 - \frac{49}{50} = 0.02 \text{ mm} \\ = 0.002 \text{ cm}$$

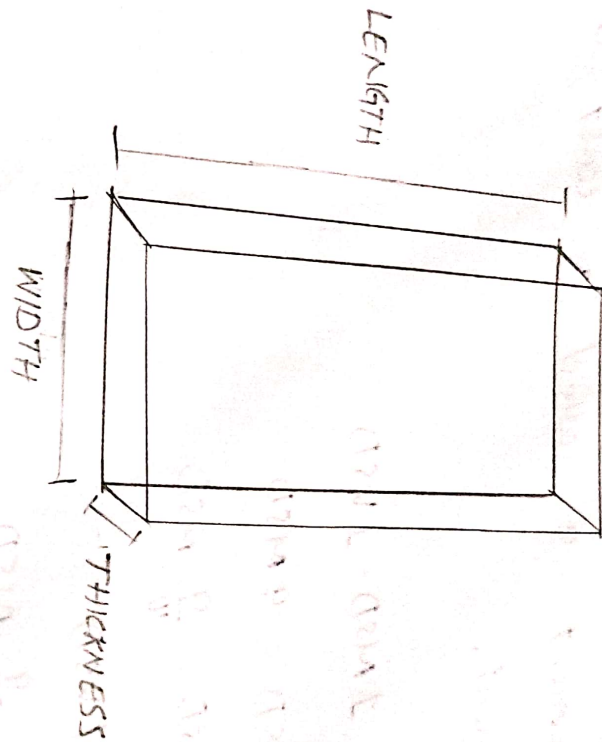
Vernier Coincidence (VC) :-

→ Any division of the vernier scale which coincides with main scale is called the vernier coincidence. As if it is a number of divisions it has no unit.

Vernier Scale Reading (VSR)

$$\rightarrow \text{Least Count (LC)} \times \text{Vernier coincidence (VC)}$$

SP (SPECIMEN)





Main Scale Reading (MSR) :-

→ The reading taken on main scale directly.

Error :-

→ Three types :- (1) Zero error

(2) Positive error

(3) Negative error

(1) Zero error :-

→ If the zero division of the main scale is coincide with the zero division of the vernier scale is known as zero error.

(2) Positive error :-

→ If the zero division of the vernier scale is towards right of the zero of the main scale is called as positive error.

(3) Negative error :-

→ If the zero division of the vernier scale is towards left of the zero of the main scale is called as negative error.

* If there is error than actual reading of the positive (+ve) error :-

$$= (MSR + VSR) - (VC \times LC)$$

$$= MSR + (VC \times LC) - (VC \times LC)$$



Negative (-ve) error

$$= MSR + (VC \times LC) + (VC \times LC)$$

Observed reading :-

$$\rightarrow MSR + VSR$$

$$= MSR + (VC \times LC) \pm \text{error}$$

Procedure :-

- The main scale was standardized by our steel rule.
- The jaws of vernier caliper was kept closed and observed the zero mark of the main scale. If must perfectly coincide with that of the vernier scale.
- The least count of the instrument was determined.
- The specimen was inserted between two jaws.
- The exact vernier coincidence (VC) was calculated.
- The vernier scale reading (VSR) was calculated by using the formula $VC \times LC$.
- The length was calculated using formula $(MSR + VSR)$.
- Took 10 observations with the different observations.
- The mean value of the specimen was calculated.

Observation Table :- (for length)

Sl NO.	Least count (in mm)	Error	Vernier Coincidence (in mm)	MSR (in mm)	VSR = VC x LC (in mm)	Observed reading = MSR + VSR (in mm)	Mean Value
01	0.1	0	6	49	0.6	49.6	$\frac{495.5}{10}$ $= 49.55 \text{ mm}$
02	0.1	0	5	49	0.5	49.5	
03	0.1	0	4	49	0.4	49.4	
04	0.1	0	6	49	0.6	49.6	
05	0.1	0	7	49	0.7	49.7	
06	0.1	0	5	49	0.5	49.5	
07	0.1	0	5	49	0.5	49.5	
08	0.1	0	4	49	0.4	49.4	
09	0.1	0	7	49	0.7	49.7	
10	0.1	0	6	49	0.6	49.6	





Precaution points :-

- Do not apply excessive force to vernier side.
- Pushing against slide, or attempting to move without pressing the thumb lock may cause damage or inaccuracy.
- Wipe off any corrosion, dirt or oil from measuring surfaces and slide.

Conclusion :-

- In the above procedure we measured the length of the specimen and it was found to be 49.55 mm.

Submitted by

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Branch - Mechanical
Semester - 4th

Date - 08/02/2024

Chandana
2/2/2024



EXPERIMENT-2

AIM OF THE EXPERIMENT :-

→ To measure the height of the mild steel specimen by using vernier height gauge with an accuracy of 0.02 mm.

APPARATUS REQUIRED :-

- (1) Vernier height gauge
- (2) Steel rule
- (3) Mild steel specimen

THEORY :-

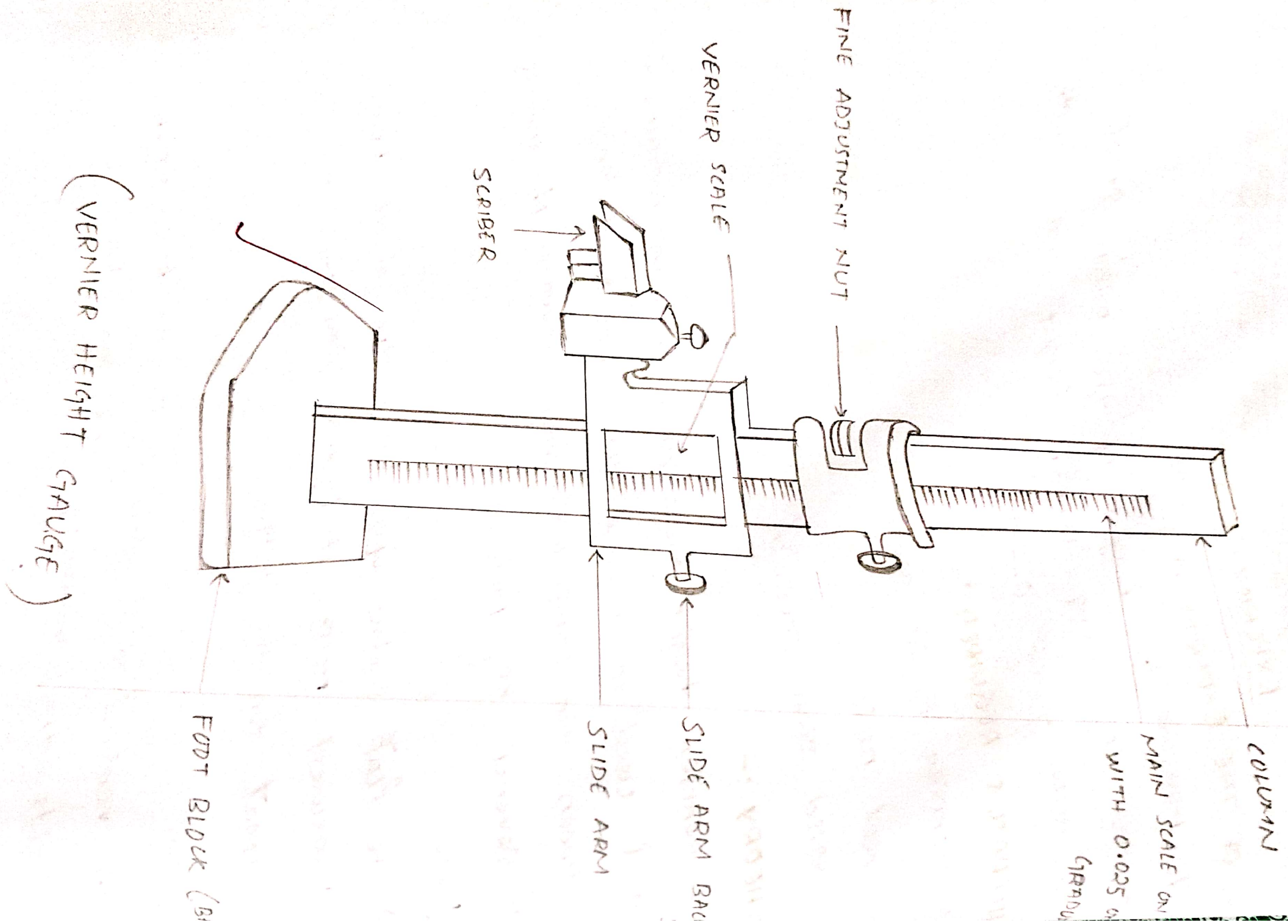
→ A vernier height gauge is a precision measurement tool used to measure the vertical distance between two points with high accuracy. It consists of several key parts :-

Base

→ The flat surface upon which the objects being measured rests. It provides stability and support for the gauge.

Beam

→ A vertical arm attached to the base, which holds the measuring scale and vernier scale.



Measuring scale

→ A graduated scale marked in units of length along the length of the beam. It provides the primary measurement.

Vernier scale

→ A secondary scale that slides along the beam and provides more precise readings than the main scale. It consists of smaller divisions that align with divisions on the main scale.

Vernier scale locking screw

→ A screw used to secure the vernier scale in place once the measurement has been taken.

Fine adjustment knob

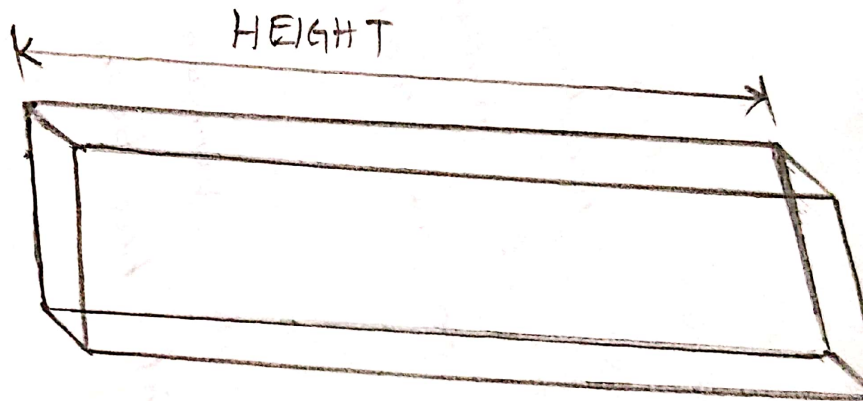
→ A knob used to make small adjustments to the position of the vernier scale for precise measurements.

Scraper

→ A pointed attachment at the bottom of the gauge used to mark the measurement point on the object being measured.

* These components work together to allow us to accurately measure the height of objects with an accuracy of 0.02 mm.

(SPECIMEN)



LEAST COUNT :-

→ The minimum measurement that can be measured by the instrument is called as least count of that instrument.

$$50 \text{ MSD} = 49 \text{ MSD}$$

$$1 \text{ MSD} = \frac{49}{50} \text{ MSD}$$

$$\text{Least count} = 1 \text{ MSD} - \frac{49}{50} \text{ MSD}$$

$$= 1 - \frac{49}{50} = 0.02 \text{ mm}$$

VERNIER COINCIDENCE :-

→ Any division of the vernier scale which coincides with main scale is called the vernier coincidence.
As it is a number of division it has no unit.

VERNIER SCALE READING (VSR)

→ Least count (LC) $\times$ Vernier coincidence (VC)

MAIN SCALE READING (MSR)

→ The reading taken on main scale directly.

~~ERROR :-~~

→ Three types :- (1) Zero error

(2) Positive error

(3) Negative error

(1) Zero error :-

→ If the zero division of the main scale is coincide with the zero division of the vernier scale is known as zero error.

(2) Positive error :-

→ If the zero division of the vernier scale is towards right of the zero of the main scale, is called as positive error.

(3) Negative error :-

→ If the zero division of the vernier scale is towards left of the zero of the main scale is called as negative error.

* If there is error than actual reading of the

Positive (+ve) error :-

$$= (MSR + VSR) - (VC \times LC)$$

$$= MSR + (VC \times LC) - (VC \times LC)$$

Negative (-ve) error

$$= MSR + (VC \times LC) + (VC \times LC)$$

Observed reading :-

$$\rightarrow MSR + VSR$$

$$= MSR + (VC \times LC) \pm \text{error}$$

Procedure :-

- The main scale was standardized by our steel rule.
- The jaws of vernier caliper was kept closed and observed the zero mark of the main scale. It must perfectly coincide with that of the vernier scale.
- The least count of the instrument was determined.
- The specimen was inserted between two jaws.
- The exact vernier coincidence (vc) was calculated.
- The vernier scale reading (vsr) was calculated by using the formula $vc \times LC$.
- The height was calculated using formula $(MSR + VSR)$.
- Took 10 observations with the different orientations.
- The mean value of the specimen was calculated.

Observation Table :-

Sl. No.	Least Count (in mm)	Error	Vernier Coincidence (in mm)	MSR (in mm)	VSR = VC X LC (in mm)	Observed reading = MSR + VSR (in mm)	Mean Value
01	0.02	0	50	85	1	86	$\frac{860.04}{10}$ $= 86.004 \text{ mm}$
02	0.02	0	51	85	1.02	86.02	
03	0.02	0	49	85	0.98	85.98	
04	0.02	0	50	85	1	86	
05	0.02	0	50	85	1	86	
06	0.02	0	51	85	1.02	86.02	
07	0.02	0	49	85	0.98	85.98	
08	0.02	0	50	85	1	86	
09	0.02	0	51	85	1.02	86.02	
10	0.02	0	51	85	1.02	86.02	



Precaution points :-

Excessive force should not be applied to vernier scale.

Any corrosion, dirt or oil from measuring surfaces and slide should be wiped off.

Conclusion :-

→ In the above procedure we measured the ~~length~~ height of the specimen and it was found to be 86.004 mm.

Handwritten signature
10/02/24

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Mechanical

4th sem

~~08/02~~ 10/02/2024



AIM OF THE EXPERIMENT :-

→ To determine the diameter of a cylindrical component to an accuracy of 0.01 mm using micrometer.

APPARATUS REQUIRED :-

- (1) Micrometer
- (2) Steel rule
- (3) Mild steel specimen.

THEORY :-

→ A micrometer, also known as a micrometer screw gauge, is a precision measuring instrument used to measure small distances with high accuracy. It consists of a calibrated screw with a finely threaded spindle that rotates against a precision threaded at the screw, causing the spindle to move forward or away from the anvil.

* The main parts of micrometer include -

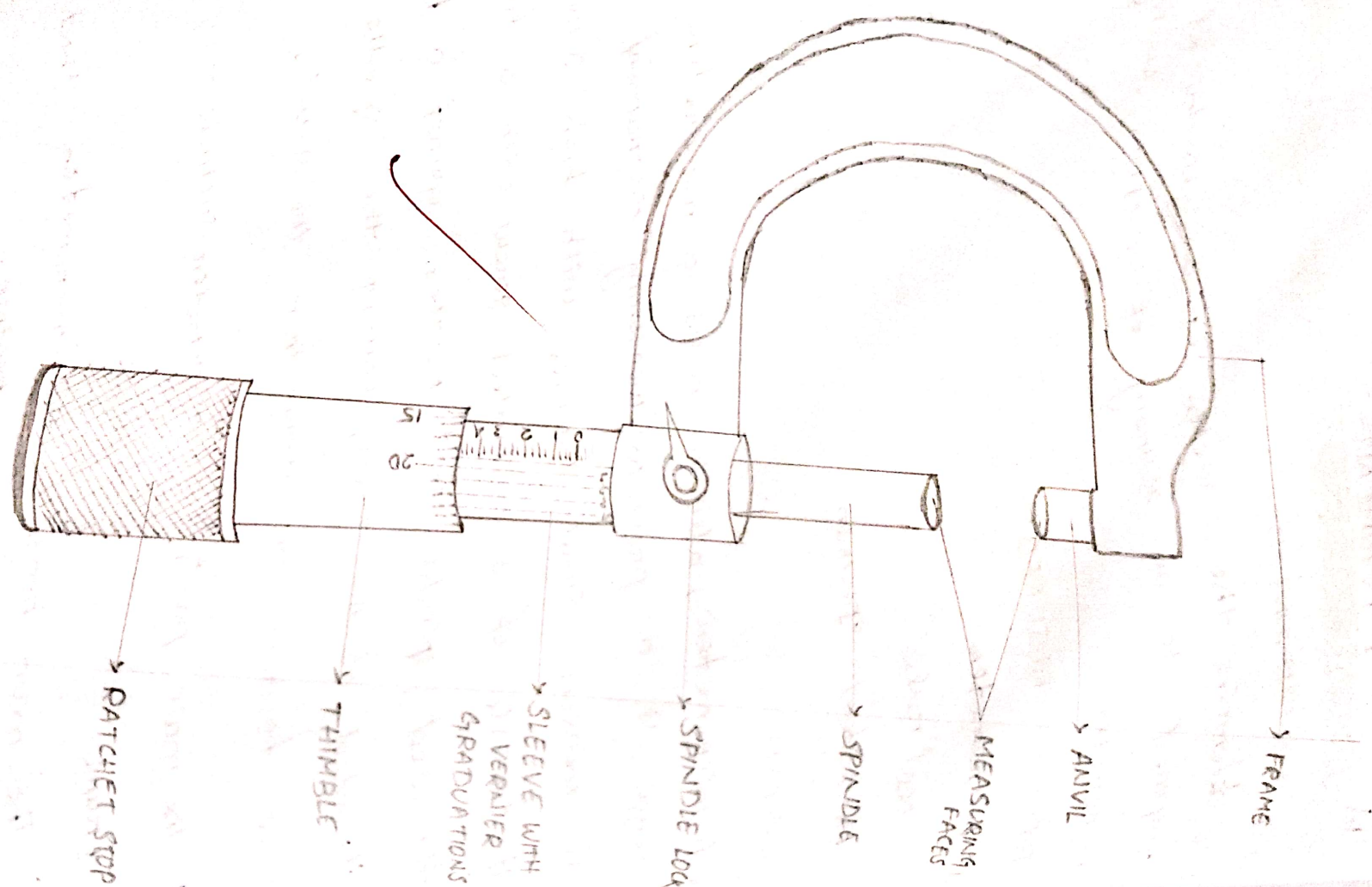
Frame

→ The main body of the micrometer that holds the other components together.

Anvil

→ The fixed reference point against which the object being measured is pressed.

(MICROMETER)



Page No.

Spindle
→ The
the
Thimble
→ The
Sleeve
Ratchet
→ A
with
* D
→ (1)
→ (2)
→ (3)
→ (4)

Spindle

→ The movable part that advances or retreats as the screw is turned.

Thimble

→ The rotating outer portion of the micrometer sleeve with a calibrated scale.

Ratchet

→ A mechanism used to apply constant pressure when measuring to ensure accuracy.

* Difference between connected with micrometer -

(1) Pitch

→ The axial advancement of circular scale on linear scale is one rotation.

(2) Least Count

→ The minimum measurement that can be measured by that instrument.

$$LC = \frac{\text{Pitch}}{\text{no. of division in circular scale}}$$

$$= \frac{0.5}{50} = \frac{5}{500} = 0.01 \text{ mm}$$

(3) ICSR (Initial Circular Scale Reading)

→ The reading of the circular scale which coincides with the linear scale when the job is inserted between anvil and spindle.

(a) F.C.S.R (Final Circular Scale Reading) (F)

→ The reading of the circular scale when anvil and spindle just touch.

* Number of rotation (N)

→ The number of complete rotation taken when anvil and spindle both touch each other.

* Extra division (INF)

$$15 \text{ I} > \text{F} \Rightarrow \text{INF} = \text{I} - \text{F}$$

$$15 \text{ F} > \text{I} \Rightarrow \text{INF} = (\text{I} + n) - \text{F}$$

(n = no of circular scale division)

Observed reading

$$\text{MSR} + \text{CSR}$$

$$= \text{MSR} + (\text{INF}) \text{LC}$$

$$= (P \times N) + (\text{INF}) \text{LC}$$

$$\text{Main Scale Reading (MSR)}$$

$$= (\text{Pitch} \times \text{no. of complete rotation})$$

$$[P \times N]$$

$$\text{Circular Scale Reading (CSR)}$$

$$\Rightarrow \text{CSR} = (\text{INF}) \times \text{LC}$$





PROCEDURE :-

- Before measuring the specimen it was ensured that it has error on not.
- The linear scale was standardised by the steel rule.
- The pitch was found by taking 10 rotation or 30 rotation.
- The least count was found by dividing pitch by no. of circular scale division.
- The job was inserted between anvil and spindle and TCSR (T) was taken when both just touch.
- Number of complete rotation (A_1) were found.
- Then FCSR (F) was taken.
- Then main scale Reading (MSR) was taken by multiplying pitch and no. of complete rotation.
- The circular Scale Reading (CSR) was taken by multiplying extra division and least count.
- Then observed reading was taken by adding MSR and CSR.
- 10 number of observations were taken and the mean was found.

$$\frac{271.84}{10} = 27.184 \text{ mm}$$

Sl No.	Pitch (15 mm)	Least Count = $\frac{P}{50}$	Error	I.C.S.R (I)	N = no. of complete rotation	F.C.S.R (F)	M.S.R (P x N)	C.S.R = (MF) x LL	Observed reading (MSR + CSR)	Mean value
01	0.5	0.01	0	16	10	0	27	0.16	27.16	
02	0.5	0.01	0	17	10	0	27	0.17	27.17	
03	0.5	0.01	0	20	10	0	27	0.20	27.20	
04	0.5	0.01	0	21	10	0	27	0.21	27.21	
05	0.5	0.01	0	17	10	0	27	0.17	27.17	
06	0.5	0.01	0	16	10	0	27	0.16	27.16	
07	0.5	0.01	0	16	10	0	27	0.16	27.16	
08	0.5	0.01	0	20	10	0	27	0.20	27.20	
09	0.5	0.01	0	20	10	0	27	0.20	27.20	
10	0.5	0.01	0	21	10	0	27	0.21	27.21	



PRECAUTION POINT :-

- Excessive force was not given between the anvil and spindle.
- While measuring care should be taken such that no portion of the specimen touches the 'U' shaped frame.
- The specimen should be kept tightly between anvil and spindle.

CONCLUSION :-

- In the above procedure the specimen was measured by the vernier caliper and it was found to be

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[Signature]
12/12/24

EXPERIMENT-4

AIM OF THE EXPERIMENT :-

To determine the thickness/height of ground MS flat specimen by slip gauge.

APPARATUS REQUIRED :-

1. Slip gauge block
2. Vernier caliper for checking
3. Surface plate

THEORY :-

Slip gauge are end standard used in linear measurement with an accuracy of 0.001 mm (L.C). They are also known as gauge block, They are designated into 5 grade namely grade 0, grade 1, grade 0, grade 00 and calibration grade etc. They can be used measure tolerance in the range of 0.001 to 0.005 from very accurately, Square with centre hole and square without centre holes. They are rectangular block of hardened and stabilized high grade steel or Invarium, Invar, ZnO.

Material - stainless steel, carbide, Tungsten carbide, chromium plate steel etc slip gauge stick together. The source of forces holding gauge block together are thought to come from an Pressure from the surrounding environment as the

1	1.001	1.002	1.003	1.004	1.005	1.006	1.007	1.008	1.009	1.01	1.02	1.03	1.04	1.05	1.06	1.07	1.08	1.09
1.1	1.2	1.3	1.4	1.5	1.6	1.7	1.8	1.9	2	3	4	5	6	7	8	9	10	
20	30	40	50	60	70	80	90											

(SLIP GAUGE)

air is squeezed out when the block and slide together surface tension from oil that remain on the gauge block is water vapour from the air that act as an adhesive to hold them together stress is called molecular adhesive mechanism.

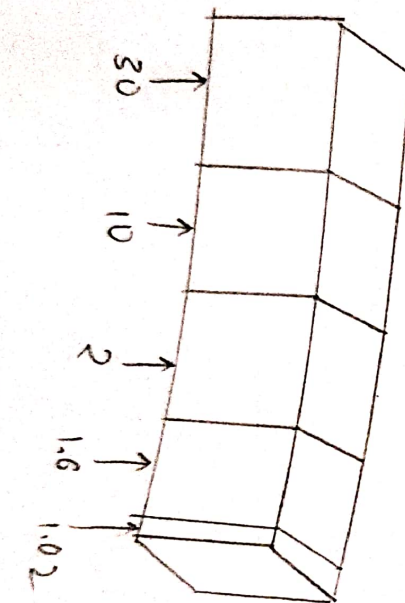
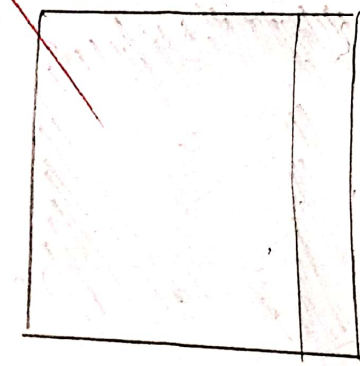
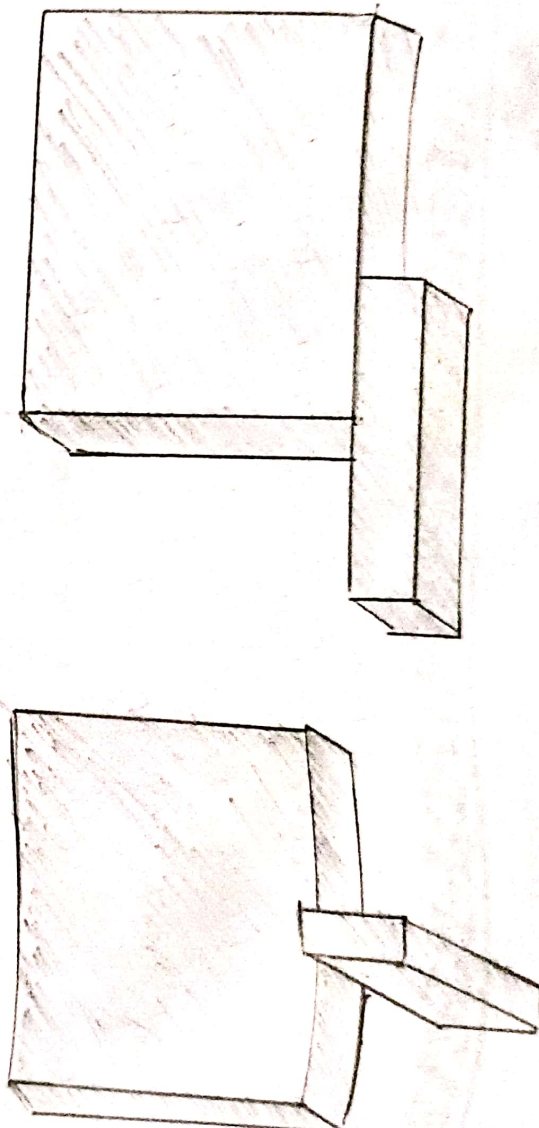
They work on wringing process if 2 slip gauge are fixed against each other on measuring faces because of constant pressure gauge stick together and considerable force is required to separate them block.

PROCEDURE :-

- The specimen was kept on the surface.
- Different slip gauges are kept over one another by wringing process till the top surface of specimen.
- Then all the sizes are added to find the total thickness specimen.

PRECAUTION :-

- Slip gauge are kept below 20°C .
- They should be kept in dust free, moisture free environment to avoid corrosion.



(LENGTH OF
SPECIMEN)

CONCLUSION :-

→ In the above procedure the height of specimen was measured by using slip gauge and checked by vernier caliper and it was found to be

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AIM OF THE EXPERIMENT:-

To study of different type of cam and followers.

APPARATUS REQUIRED:-

Model of cam and follower

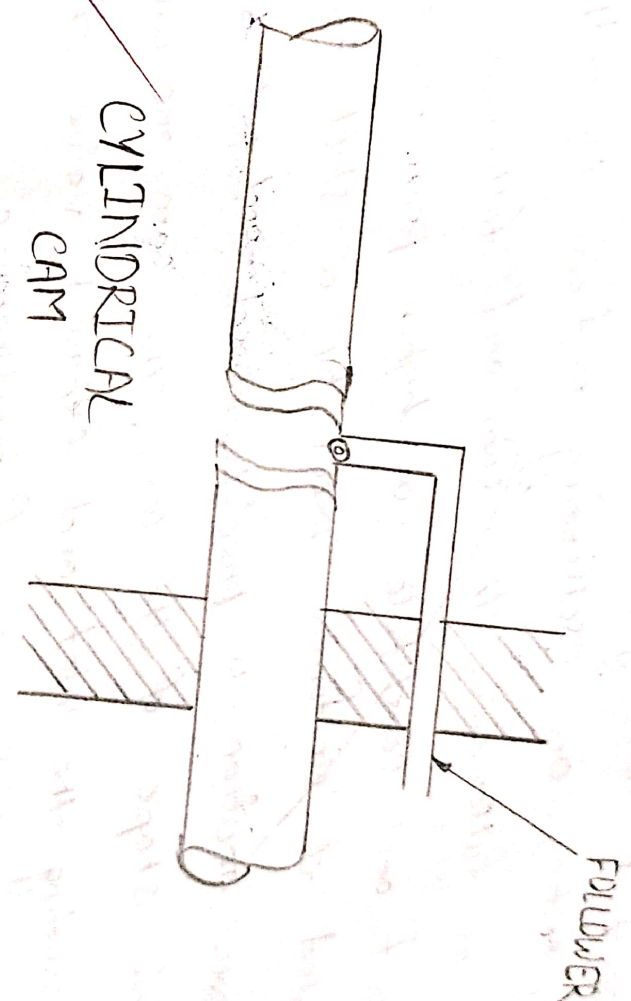
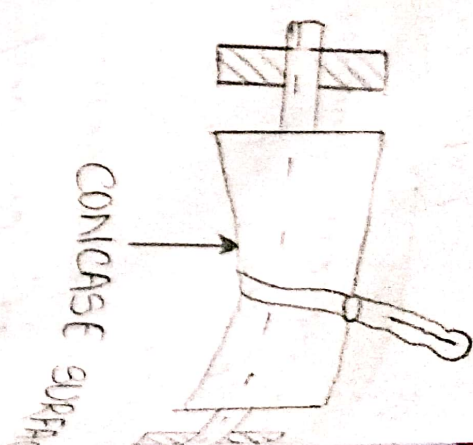
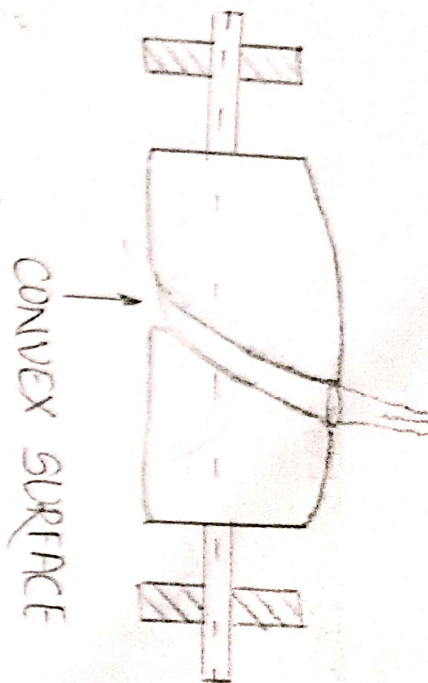
THEORY:-

A cam is a rotating machine element which gives reciprocating or oscillating motion to another element known as followers. The cam and followers have a line contact and constitute a higher pair. The cam are rotated at uniform speed by a shaft but the followers motion is predetermined and will be according to the shape of the cam. The cam are widely used for operating the inlet and exhaust valve of an I.C engine attachment of machines, paper cutting machines, spinning and weaving textile machines, feed mechanism and automatic loathe machines.

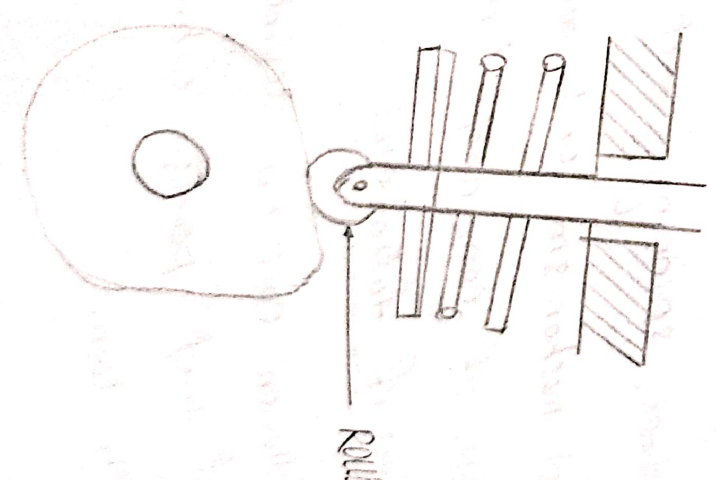
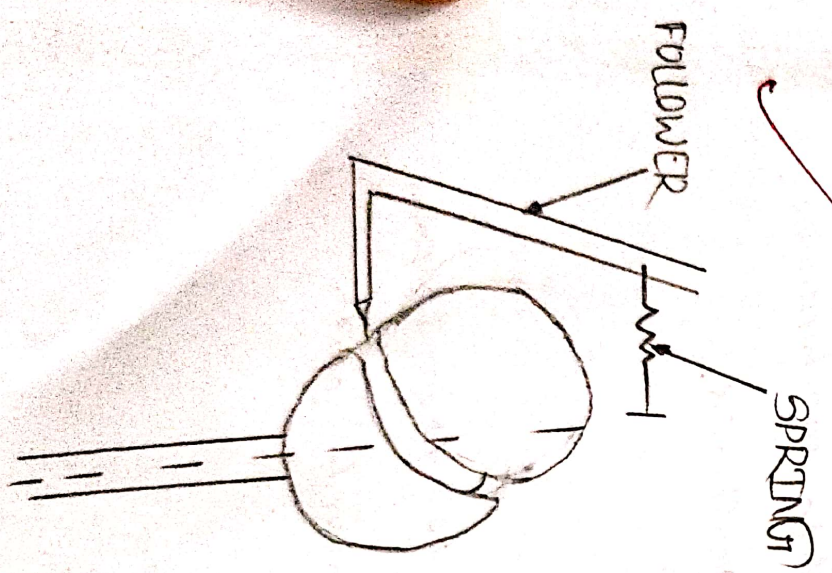
Types of cam and followers :-

Types of followers

Follower can be divided according to the shape of that parts which is in contact with the cam.



CYLINDRICAL CAM



ROLLER FOLLOWER

(a) Knif edge :-

→ There are not often used due to the rapid rate of the wear of the knif edge. This design produces a considerable side thrust between the followers and the guide.

(b) Roller follower :-

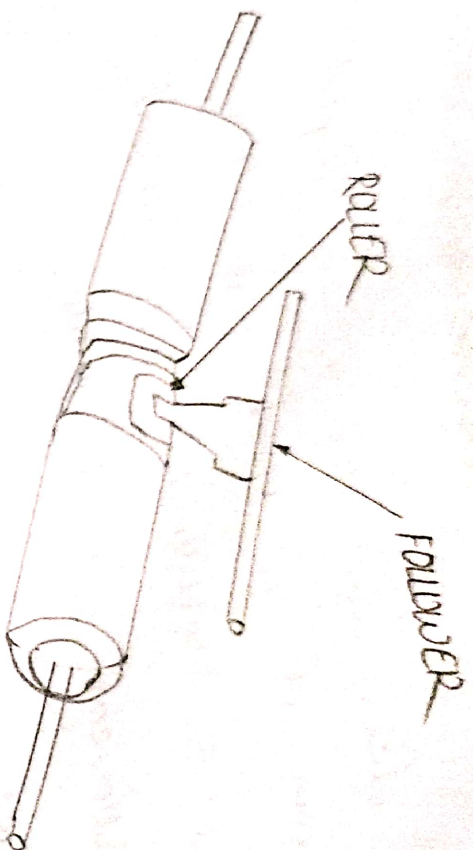
→ The roller follower has the advantage that the sliding motion between cam and follower is largely replaced by rolling motion. Sliding is not entirely eliminated since the inertia of the roller prevent it from responding ~~instantaneously~~ to the change of angular velocity required by the varying peripheral speed of the cam this type of follower also produce a considerable side thrust.

(c) Flat on mushroom follower :-

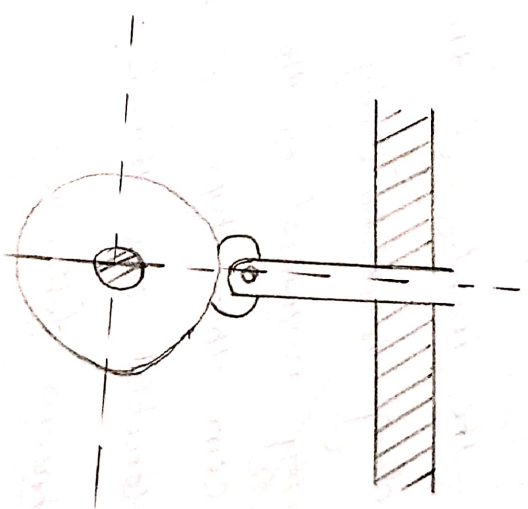
→ These have advantage that only side thrust is flat due to friction between the constant surface of cam and followers. The relative motion is one of sliding but it may be possible to reduce this result is the followers resulting on the influence of the cam.

(d) Flat faced followers

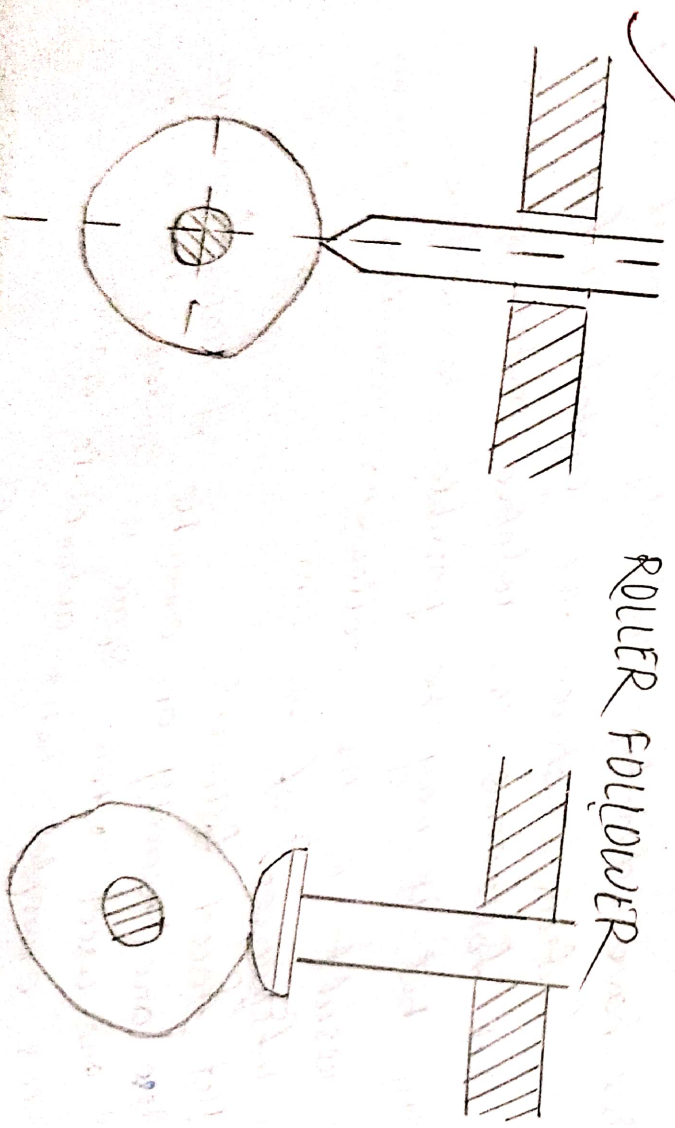
→ These are really an example of flat follower and are used where space is limited, the most obvious examples being automobile engine.



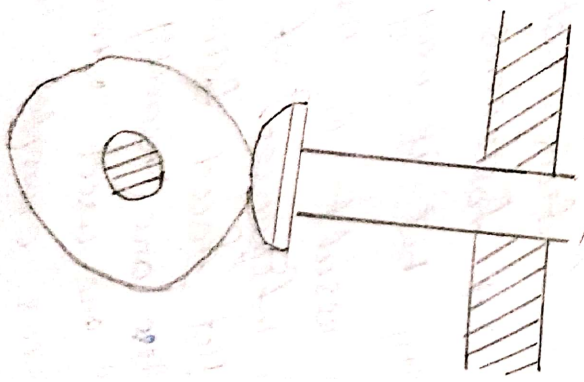
RECIPROCATING FOLLOWER



ROLLER FOLLOWER



KNIFE EDGE FOLLOWER



SPHERICAL FOLLOWER



TYPES OF CAMS:-

A cam is reciprocating, oscillating or rotating body which parts reciprocating or oscillating motion to a second body called follower with which it is in contact, the space of the cam depends on its own motion, the required motion of the follower and the shape of the contact face of the followers.

Oscillating motion:-

The cam motion that attracts backward and forward, linear motion is a motion belong a straight line path. Such as a bicycle of the many types of cam, in general the motion of the followers is only determined by the cam during a part of each stroke while during the remainder of the stroke contact between the cam and follower has been maintained by an external force often supplied by a spring. In this connection it should be noticed that the cam does not as would at first appear likely, determine the motion of the follower during the whole of its outstroke, actually owing to the inertia of the follower. It is only during the first part of the outstroke and latter part of the return that the motion of the follower is positively controlled by the cam.



Cam are classified according to the direction of displacement of the follower with respect to the axis of the cam.

(a) Disc or radial cam :-

→ These are working surface of the cam is shaped that the reciprocation or oscillation of the follower is in a plane at right angle to the axis of the cam.

(b) Cylindrical cam :-

→ These are often used in machine tools and the cam imparts an oscillation or reciprocation to the followers in a plane parallel to the axis of the cam.

AMBM

Submitted by :-

Sunay Behara

Roll No 4055

4th Sem

Mechanical



AIM OF THE EXPERIMENT :-

To determine the unknown angle of a specimen using sine bar.

APPARATUS REQUIRED :-

- (i) Sine bar
- (ii) Surface plate
- (iii) Dial Indicator
- (iv) Slip gauge (gauge block)

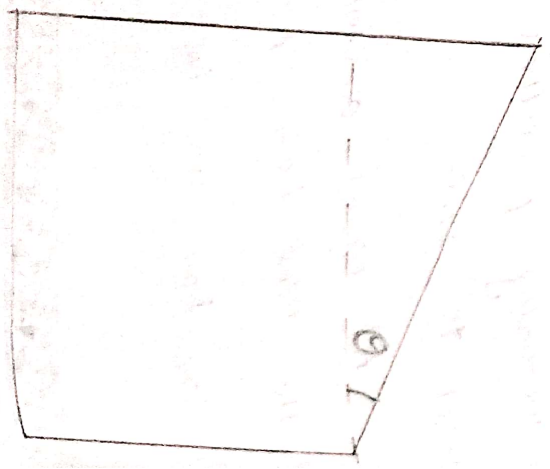
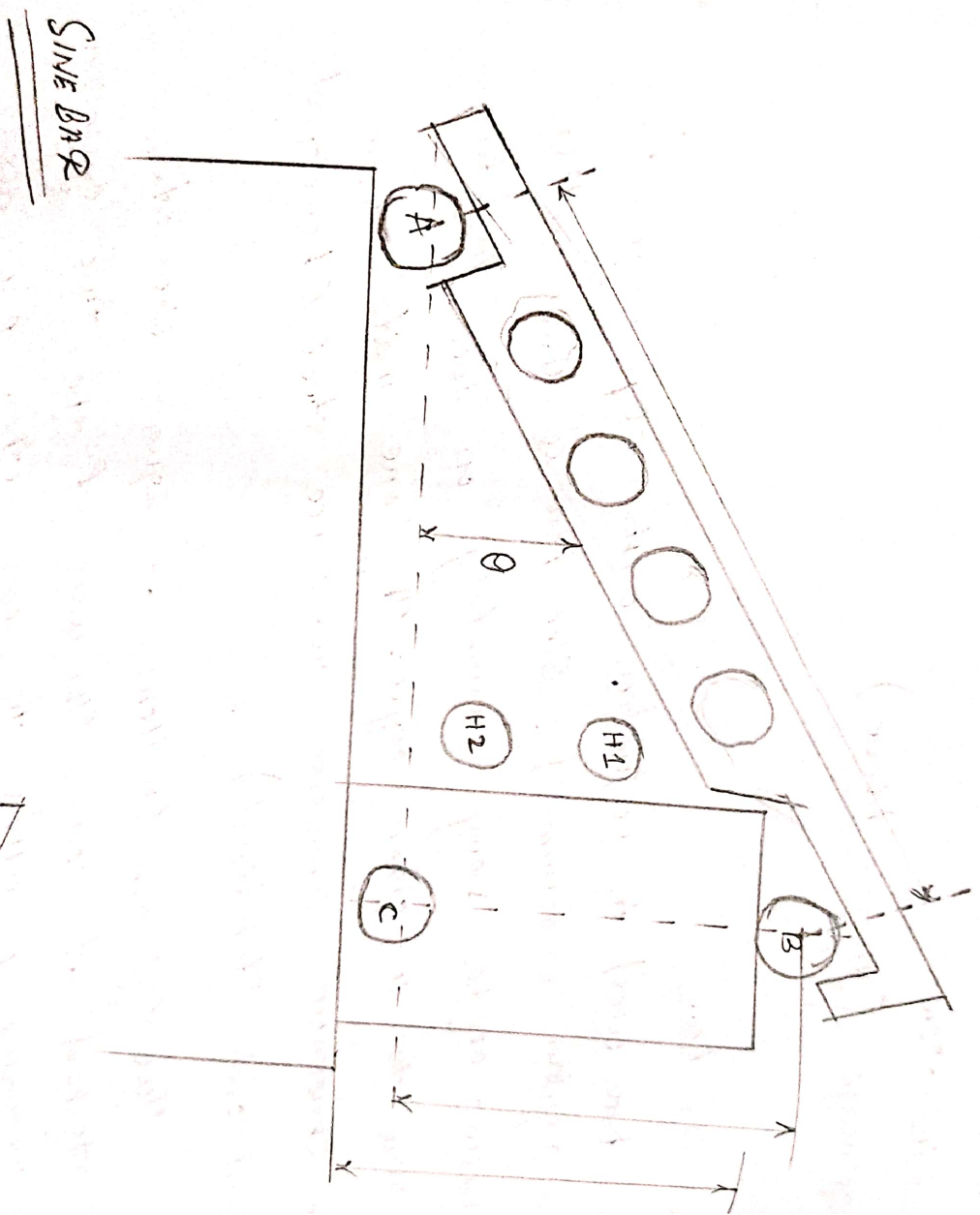
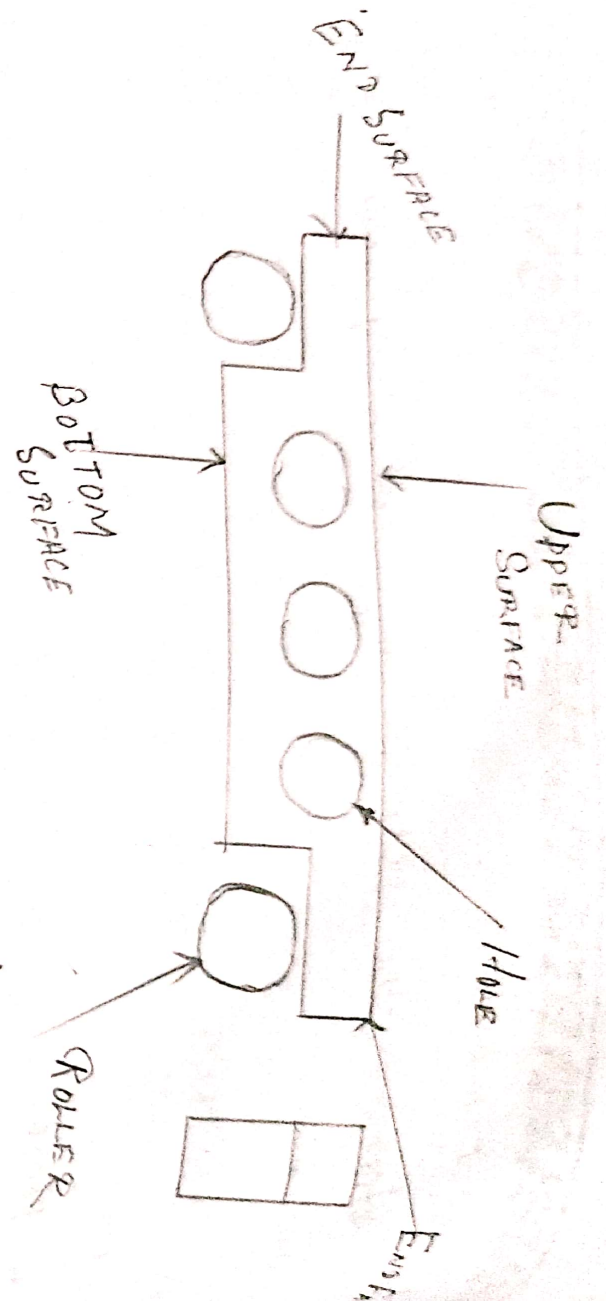
THEORY :-

About Sine bar

Sine bar used in conjunction with slip gauge for precise angular measurement. Sine bar is used either to measure angle very accurately on face rotating any work to a given angle. They are made from high, chromium, corrosion resistance steel (hardened ground and stabilized).

Two cylinders (rollers) of equal diameter are attached at ends. The axis of the two cylinders are mutually parallel to each other and also parallel to ends.

At equal distance from the upper surface of the sine bar. Accuracy with 0.01 mm length of sine bar can be obtained.



PRECAUTION:-

1. The sine bar should not be used for angle greater than 45° .
2. Accuracy of sine bar should be ensured.
3. As far as possible longer sine bar should be used since many errors are reduced by using longer sine bar.

PROCEDURE:-

1. Surface plate is placed in a horizontal surface.
2. Slip gauge are built up for proper height by using process.
3. One of the cylinder (rallen) is placed on surface plate and other on slip gauge.
4. Dial indicator is set at one end of component and moved to the other end. The deviation is dial reading.
5. The dial indicator reading is taken to assume zero deviation.
6. Slip gauge height are taken to perform calculation by sine angle theorem.

$$\text{as } \sin \theta = \frac{h}{L}$$

$$\theta = \sin^{-1} \left(\frac{h}{L} \right)$$

$$50 + 30 + 20 + 10 = 110 \text{ mm}$$

$$\sin \theta = \frac{h}{L} \Rightarrow \theta = \sin^{-1} \left(\frac{110}{200} \right)$$

$$= 33.66^\circ$$

$$= 33^\circ 21' 36''$$

CONCLUSION:-

From the above experiment we calculate the unknown angle of the specimen is 33° .

Submitted by:-

Suraj Behara

F22110704055

4th sem

Mechanical

AIM OF THE EXPERIMENT:-

To determine the centrifugal force of watt governor by using governor apparatus.

APPARATUS REQUIRED:-

- (1) Governor Setup
- (2) Steel rule
- (3) Tachometer

THEORY:-

Watt Governor is a centrifugal type of governor. It consists of two fly balls attached to the upper & lower link. Lower link is connected in a slip which moves over the spindle.

Centrifugal force -

When a body moves in a circular path a force is caused which acts away from the centre of axis of rotation. That force is called centrifugal force. It is denoted by (F_c) .

$$F_c = m\omega^2 r$$

where m = mass of the fly ball

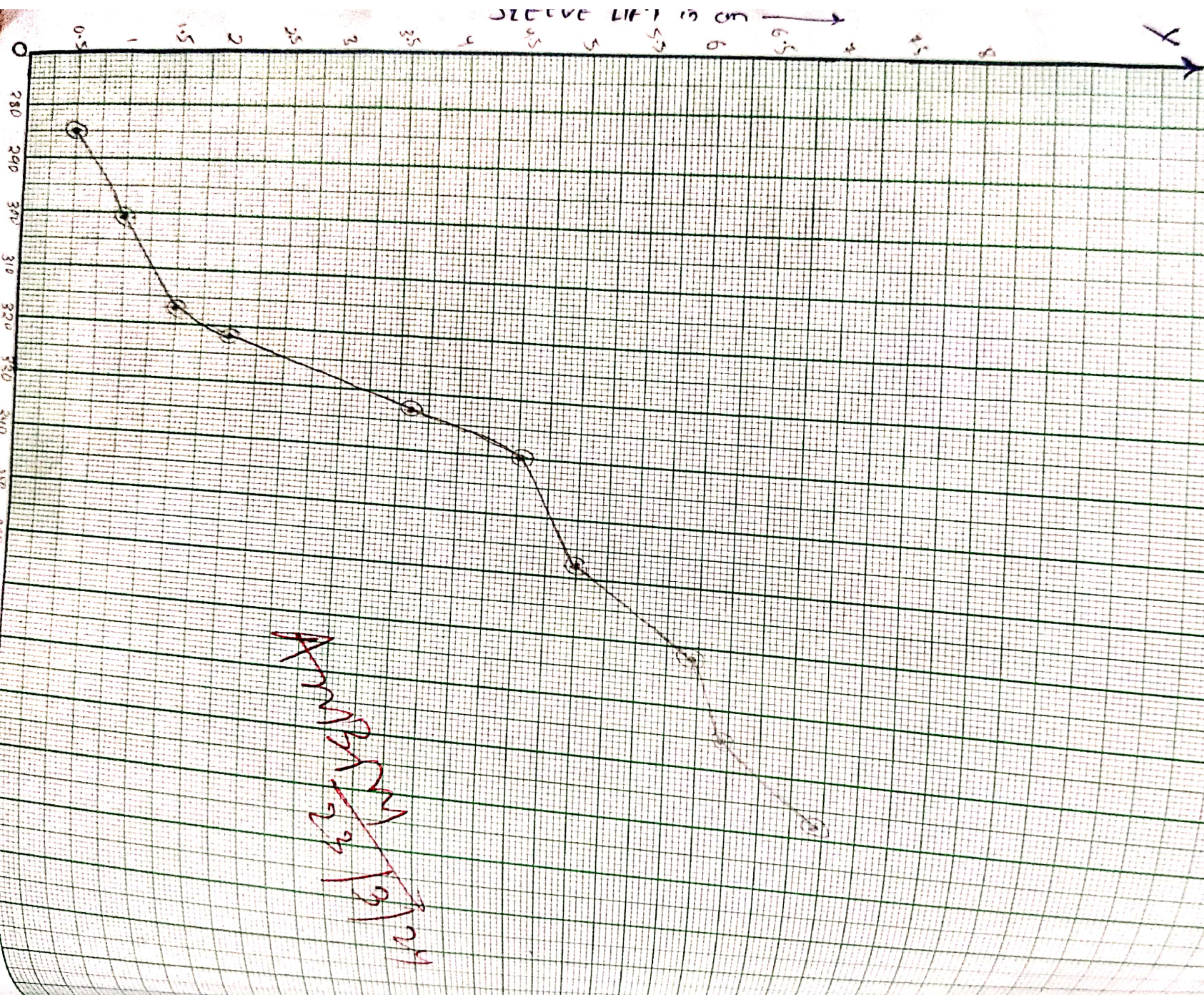
ω = angular velocity

r = mean radius of rotation

$$N = \frac{r \cdot P \cdot M}{1000}$$

$$\text{where } \omega = \frac{2\pi N}{60}$$

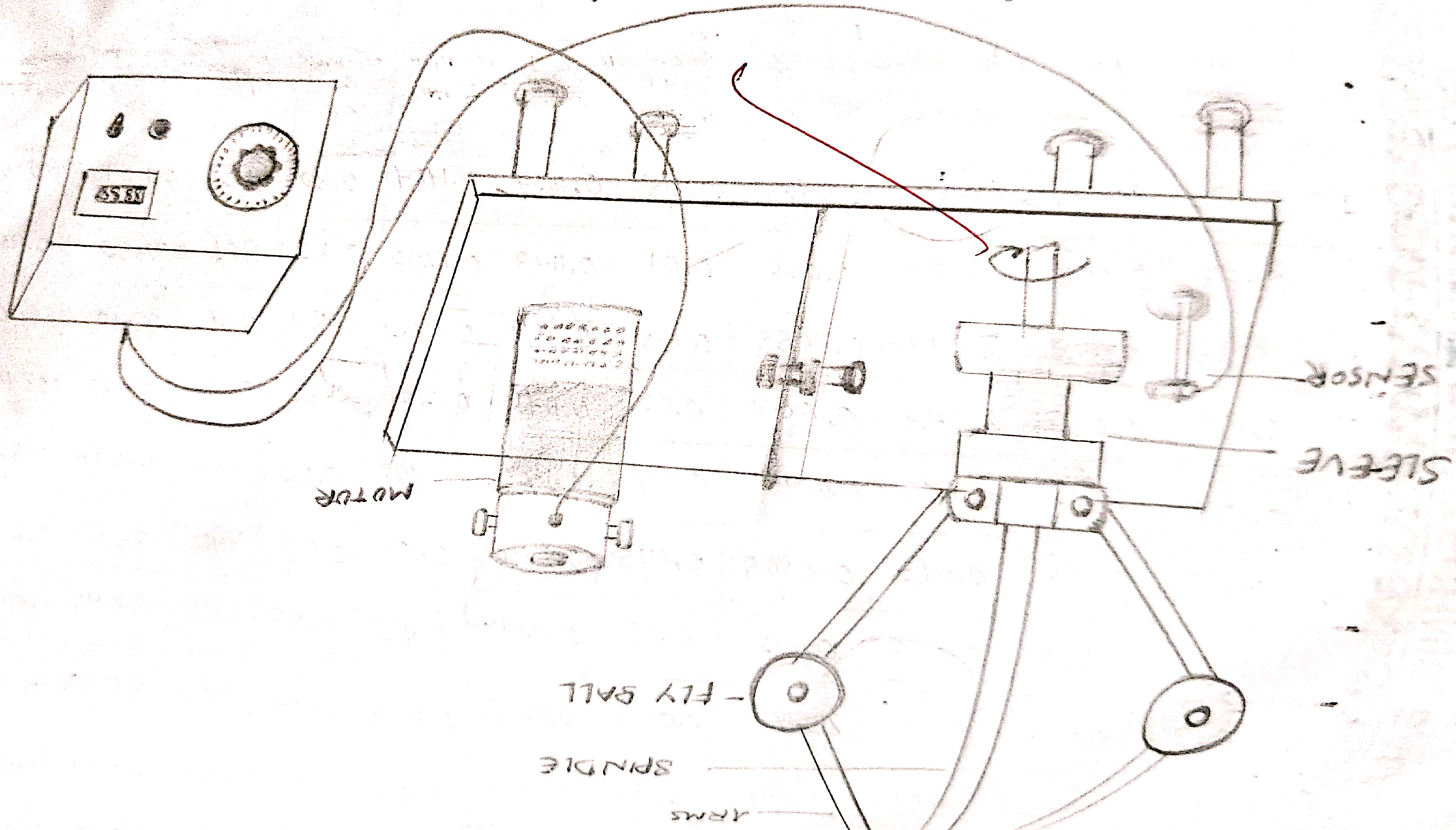
Surya Behara
Regd no - F22110004055



189.965 m

So. no.	length of arm in m	r_2 in m	h_0 in m	$h = h_0 - \frac{r}{2}$ in m	$r = \text{slave offset}$ in m	$r_1 = \sqrt{r^2 + h^2}$ in m	$r_2 = r_1 + r_2$ in m	$m = \text{mass}$ in kg	$N = \text{rpm}$	$\omega = \text{angular velocity}$ in rad/s	$F_c = m\omega^2 r$ in N	Mean force in m
1	0.133	0.058	0.073	0.0705	0.005	0.1127	0.1707	0.82	285	29.84	121.636	
2	0.133	0.058	0.073	0.068	0.01	0.1143	0.1723	0.82	301	31.52	140.369	
3	0.133	0.058	0.073	0.0655	0.015	0.1157	0.1737	0.82	317	33.19	156.901	
4	0.133	0.058	0.073	0.063	0.02	0.1171	0.1751	0.82	322	33.71	163.161	
5	0.133	0.058	0.073	0.0545	0.037	0.1213	0.1793	0.82	333	34.87	178.771	
6	0.133	0.058	0.073	0.0505	0.045	0.1230	0.181	0.82	340	35.60	188.101	
7	0.133	0.058	0.073	0.048	0.05	0.1240	0.182	0.82	358	37.48	209.644	
8	0.133	0.058	0.073	0.043	0.059	0.1256	0.1836	0.82	372	38.95	228.402	
9	0.133	0.058	0.073	0.041	0.064	0.1265	0.1848	0.82	385	40.31	245.83	
10	0.133	0.058	0.073	0.385	0.069	0.1273	0.1853	0.82	398	41.67	263.837	

(WATT GOVERNER)



PROCEDURE :-

- The watt governor was set and the power was switched on.
- Initial height was measured. different
- The value of ~~SPR~~ lift is corresponding to 1 rpm. were measured
- Centrifugal force was calculated by using the formula given.
- The observation table was completed by taking 10 observations.
- The mean value of centrifugal force was calculated.

CONCLUSION :-

- In this above procedure centrifugal force of the watt governor was found from the different speed.

Am 30/3/21.

~~Am 30/3/21.~~

Submitted by :-

Alene - Suraj Bokra

Regd. no - FA2110004055

Branch - Mechanical

Sem - 4th

No.

EXPERIMENT :-

EXPERIMENT :-

aim of THE EXPERIMENT :-
To determine the centrifugal force of a portion
governor by using governor apparatus.

REQUIRE :-

- APPARATUS
- (1) Generator Setup
 - (2) Steel rule
 - (3) Tachometer
 - (4) ~~Additional~~ mass of 1.5 kg

THEORY :-

THEORY :-
→ Porten governen is a ~~centralized~~ type of governen,
the only difference between wett governen and
Porten governen is ~~that~~ only additional masses
are used in the spindle.

Contributed from

Centrifugal force
→ When a body moves in a circular path a force is cause which acts away from the centre of axis of rotation. That force is called as centrifugal force. It is denoted by ' F_c '.

$$F_c = m\omega^2 r$$

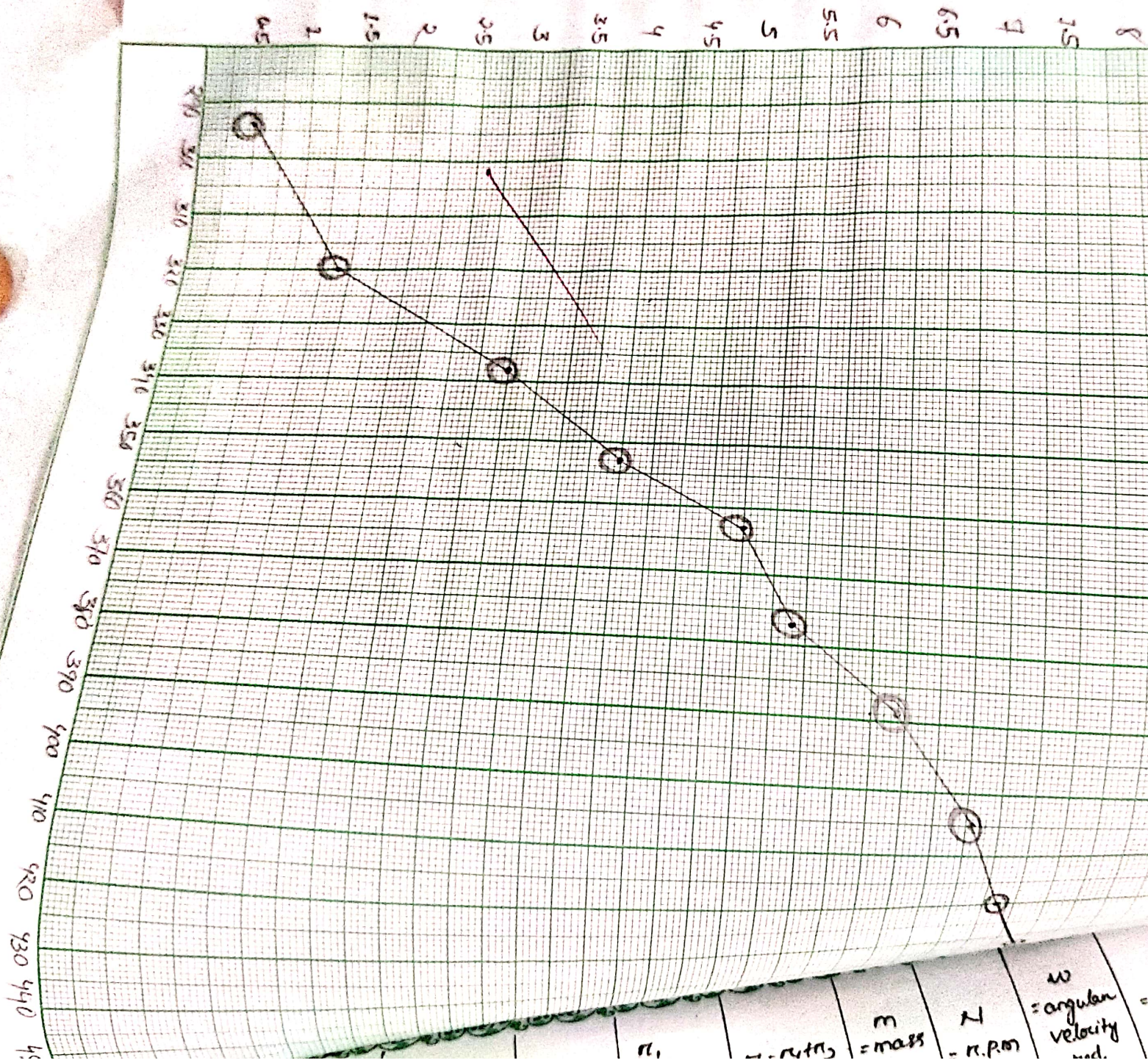
where, $m =$ mass of the fly ball

$\omega =$ angular velocity

r = mean radius of rotation

$$|K| = \pi \cdot p \cdot m$$

where, $w = \frac{2\pi r}{60}$



ω
 = angular velocity
 rad/s

F_c
 = $m\omega^2 r$
 is N

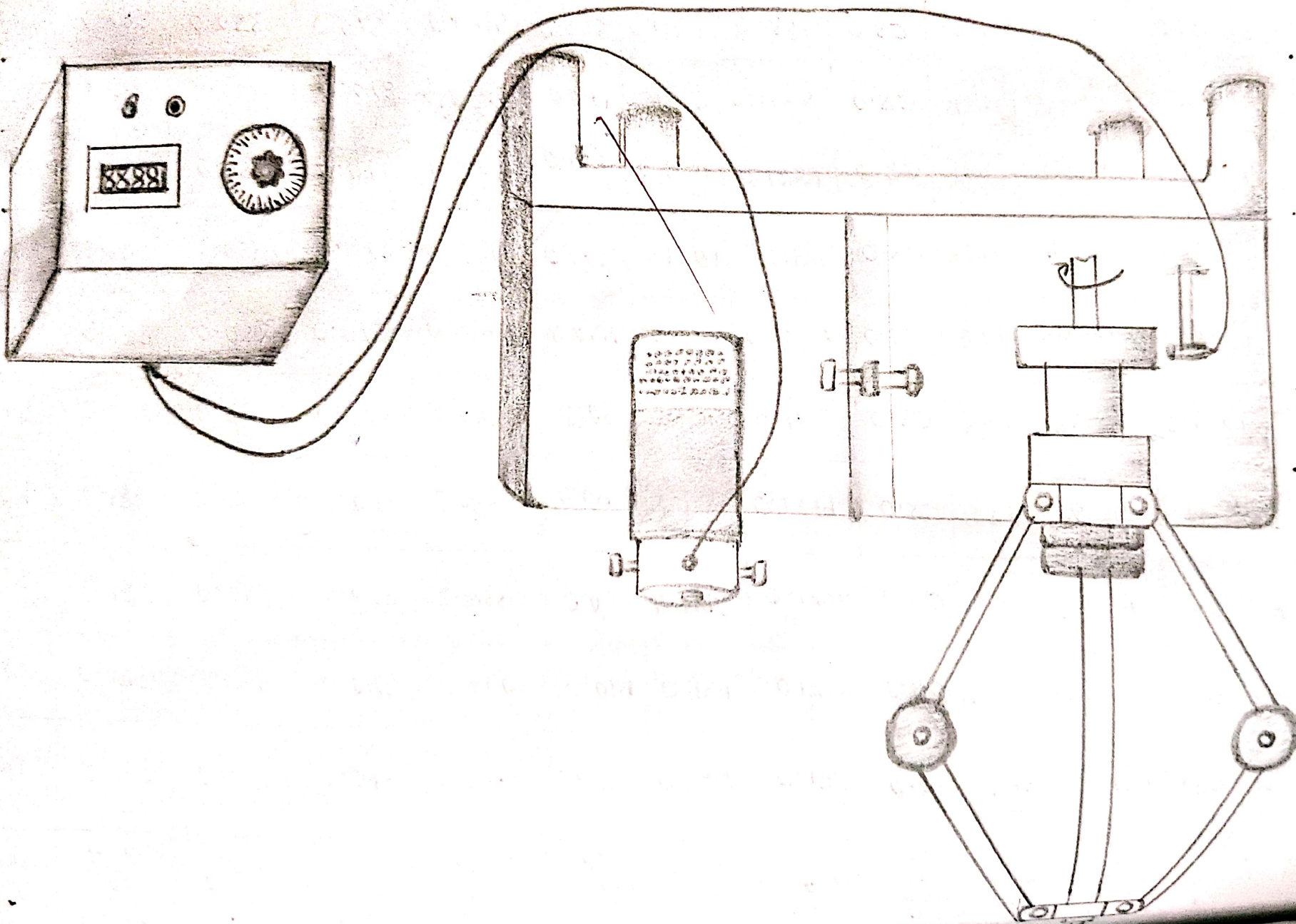
mean
 centrifugal
 force
 is N

Ex No.

Sl. No.	Length of arm in m.	r_2 in m.	h_0 in m.	$h = h_0 - \frac{x}{2}$ in m.	x = skew eht in m.	$r_1 = \sqrt{L^2 - h^2}$ in m.	$r = r_1 + r_2$ in m.	m = mass in kg.	N = R.P.M.	ω = angular velocity = rad/s.	$F_c = m\omega^2 r$ in N.	mean Centrifugal force in N.
01	0.133	0.058	0.073	0.0705	0.005	0.1127	0.1707	0.82	294	30.787	132.612	
02	0.133	0.058	0.073	0.066	0.014	0.1154	0.1734	0.82	320	33.51	159.665	
03	0.133	0.058	0.073	0.058	0.03	0.1196	0.1776	0.82	338	35.39	182.397	
04	0.133	0.058	0.073	0.053	0.04	0.1219	0.1799	0.82	353	36.96	201.515	
05	0.133	0.058	0.073	0.048	0.05	0.1240	0.182	0.82	363	38.01	215.615	
06	0.133	0.058	0.073	0.046	0.054	0.1247	0.1827	0.82	377	39.47	233.392	
07	0.133	0.058	0.073	0.042	0.062	0.1261	0.1841	0.82	389	40.73	250.435	
08	0.133	0.058	0.073	0.039	0.068	0.1271	0.1851	0.82	405	42.41	272.996	
09	0.133	0.058	0.073	0.0345	0.071	0.1276	0.1856	0.82	420	43.98	294.375	
10	0.133	0.058	0.073	0.0355	0.075	0.1281	0.1861	0.82	430	45.02	309.293	

2252.295
10 = 225.2295 N

(PORTER GOVERNOR)





PROCEDURE :-

- The Porter governor was set and the power was switched on.
 - Initial height was measured.
 - The value of slip lift is corresponding to different rpm were measured.
 - Centrifugal force was calculated by using the formula $m\omega^2 r$.
 - The observation table was completed by taking 10 observations.
 - The mean value of centrifugal force was calculated.
- CONCLUSION :-**
- In this above procedure centrifugal force of the porter governor was found from the different speed.

Submitted by

Name - Suresh Babu

Regd No - F220110004055

Branch - Mechanical

Sem - 4th

[Signature]
6/11/21



AIM OF THE EXPERIMENT:-

To find the centrifugal force of Hartnell governor and to find also the stiffness of spring used in this governor setup.

APPARATUS REQUIRED:-

- (1) Hartnell governor apparatus setup.
- (2) A given spring whose stiffness is to be found
- (3) Graph paper
- (4) Tacometer
- (5) Steel rule.

Theory:-

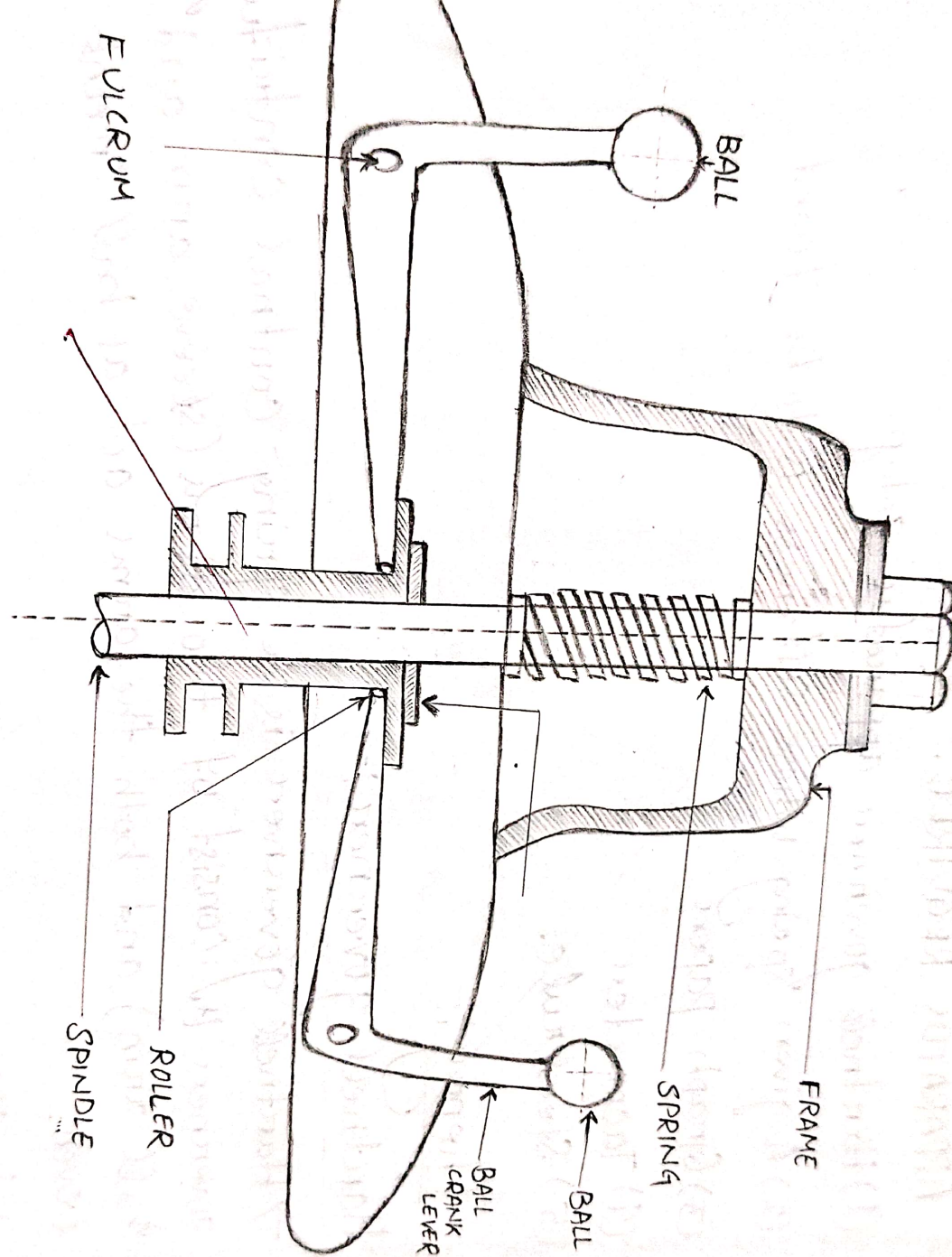
Hartnell governor:-

→ Hartnell governor is a spring control centrifugal governor. It consists of two arms (sleeve arm and ball arm) and both the arms act as bell crank lever.

→ In this governor the centrifugal force is governed by spring force.

- m = mass of fly ball
- M = mass of sleeve
- r_1 = minimum radius of rotation
- r_2 = maximum radius of rotation

(HARTNELL GOVERNER)





N_2 = minimum r.p.m

N_1 = maximum r.p.m

S_1 = Spring force at N_1

S_2 = Spring force at N_2

x_1 = length of ball arm

y_1 = length of sleeve arm

r = distance of fulcrum to axis of spindle

h_v = initial height

a = Sleeve lift

$$h_0 = 14.5 \quad y_1 = 10$$

$$r = 15.5 \quad m = 1.64$$

$$x_1 = 8$$

F_{c1} = Centrifugal force at N_1

F_{c2} = Centrifugal force at N_2

~~S = Stiffness of Spring~~

~~formula to be used~~

$$h = h_0 - \frac{a}{2}$$

$$\Rightarrow h_1 = h_0 - \frac{a}{2}$$

$$h_2 = h_0 - \frac{a}{2}$$

Stiffness (S) :- $\frac{\text{load}}{\text{deflection}}$

$$= \frac{W}{\delta} \text{ N/mm}$$



Formula to be used

$$(1) \frac{h_1}{y_1} = \frac{r_1 - r_2}{r_1} \Rightarrow r_1 = r_2 \left(\frac{h_1}{y_1} \right)$$

$$(2) \frac{h_2}{y_1} = \frac{r_1 - r_2}{r_1}$$

$$(3) m_1 + s_1 = 2 F c_1 \times \frac{r_1}{y_1}$$

$$(4) m_2 + s_2 = 2 F c_2 \times \frac{r_2}{y_2}$$

$$(5) s = \frac{s_1 - s_2}{h} = 2 \left[\frac{F c_1 - F c_2}{r_1 - r_2} \right] \left(\frac{r_1}{y_1} \right)^2$$

Sl. no.	r_1	h_0	r_1	y_1	x	N	$h = h_0 - x$	r_1	r_2	$F c_1$	$F c_2$
01	0.155	0.145	0.08	0.1	0.01	223	0.14	—	0.043	—	38.457
02	0.155	0.145	0.08	0.1	0.015	345	0.1375	—	—	—	—
03	0.155	0.145	0.08	0.1	0.02	452	0.135	—	—	—	—
04	0.155	0.145	0.08	0.1	0.022	583	0.134	—	—	—	—
05	0.155	0.145	0.08	0.1	0.025	711	0.132	0.049	—	449.125	—

$$s = \frac{s_1 - s_2}{h} = 2 \left[\frac{F c_1 - F c_2}{r_1 - r_2} \right] \times \left(\frac{r_1}{y_1} \right)^2$$

$$s = 82133.6$$

$$= 82.133 \text{ N/mm}$$



PROCEDURE :-

- The governor setup was assemble.
- To the electrical connection was connected.
- The main power of switch is on.
- The length of arm of governor original height of arm of governor of rotation at rest position was measured.
- To share of particular rpm was noted.
- The centrifugal force was calculated by using formula $F_c = m\omega^2 r$.

CONCLUSION :-

- From the above experiment we have studied and found the stiffness of the given spring to be

[Signature]
11/11/20

Submitted by :-

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Branch - Mechanical

Sem - 4th



AIM OF THE EXPERIMENT:-

→ Study and demonstration of epicyclic gear train and find out input, output and holding torque by epicyclic gear train apparatus.

APPARATUS REQUIRED:-

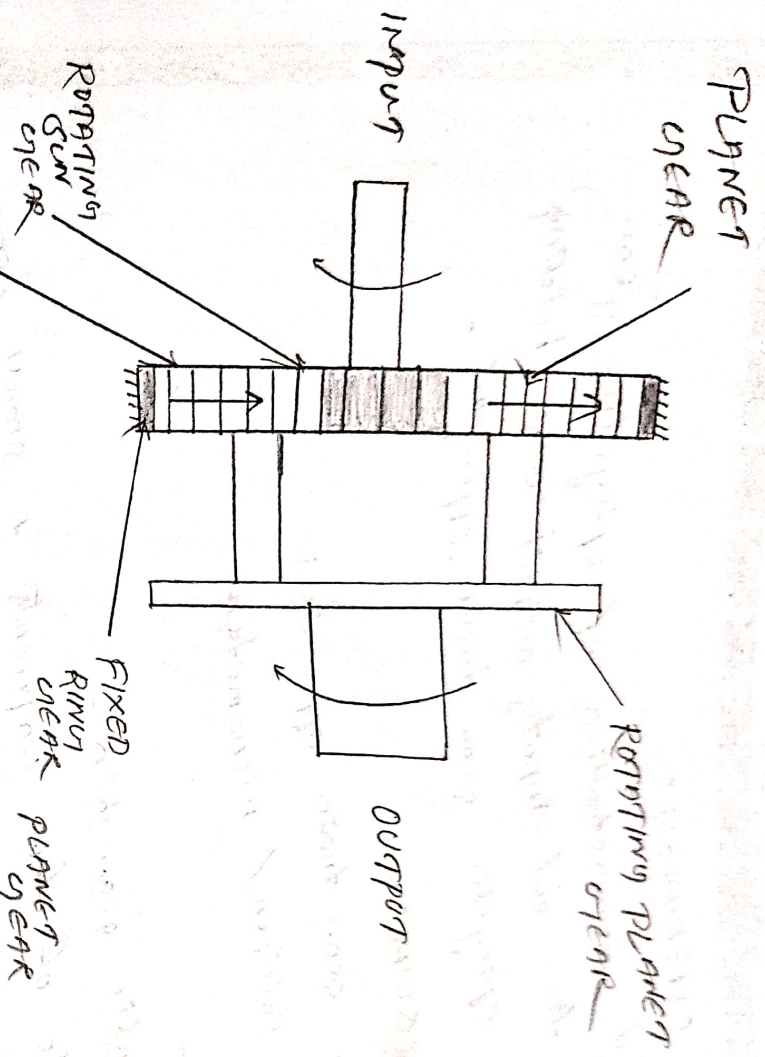
- (1) Epicyclic gear train apparatus
- (2) Vernier Caliper/ micrometer

THEORY:-

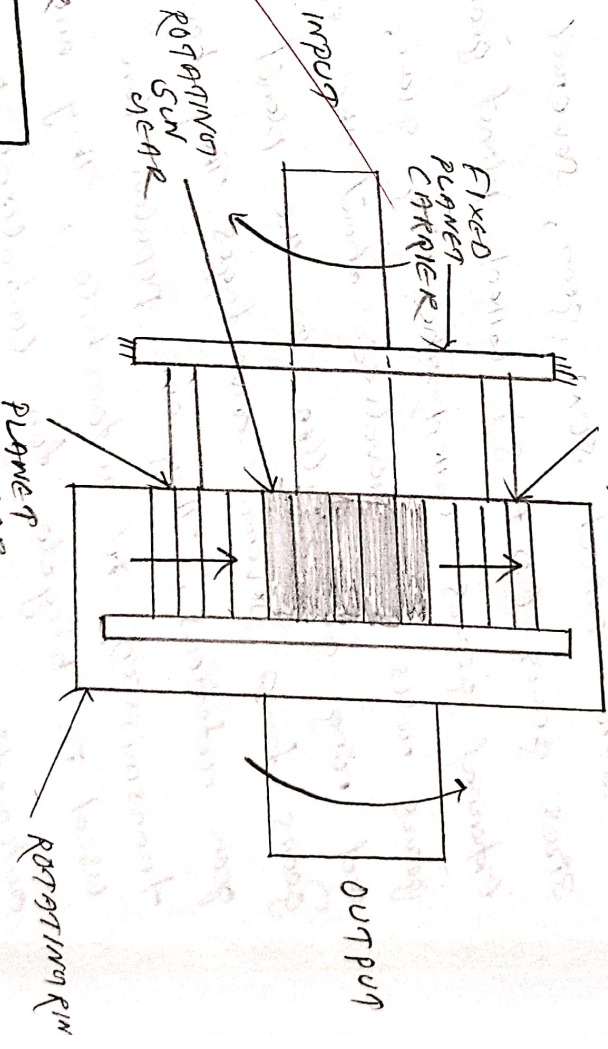
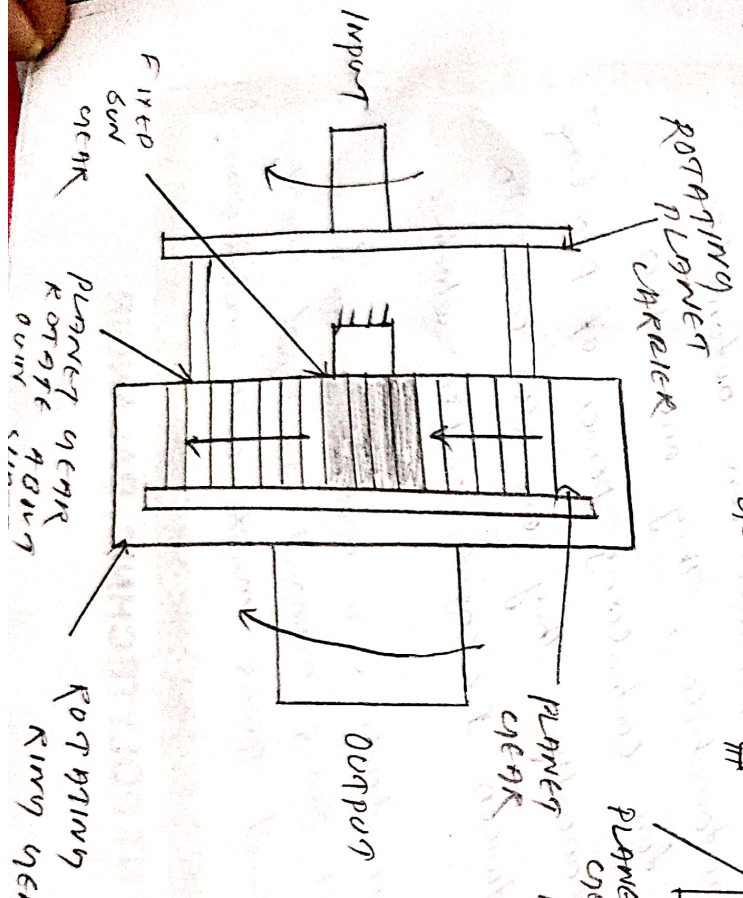
About epicyclic gear train -

→ It is made of few components. A small gear of centre called sun gear, several medium size gears (2 to 5) called planet gear and large external gears called the ring gear, the planet gears rolls and revolves about the sun gear and ring gear rollers on the planet gears, planeting gears have several advantages. They have high gear rotations. They are popular for automatic transmission in automobile, They are also used in bicycle for controlling power of pedalling automatically or manually, They are also used in power train between I.C engine and in electric motors.

Epicyclic gear train is a motorised unit consisting of sun gears mounted on input shaft, Two or three planet gears mesh with annular gear.



PLANET GEARS
ROTATE ABOUT
DUAL SHAFT





These planet gear one mounted on a common arm to which output shaft is fitted. Loading arrangement is provided for loading the system and to measure torque externally planet gears mesh over a shaft, this shaft also carries a pulley, both the pulley one provided with rope brake with spring balance so that either planet carries pulley on entered gear pulley can be held stationary and output torque can be measured. Input torque can be calibrated in term of motor current.

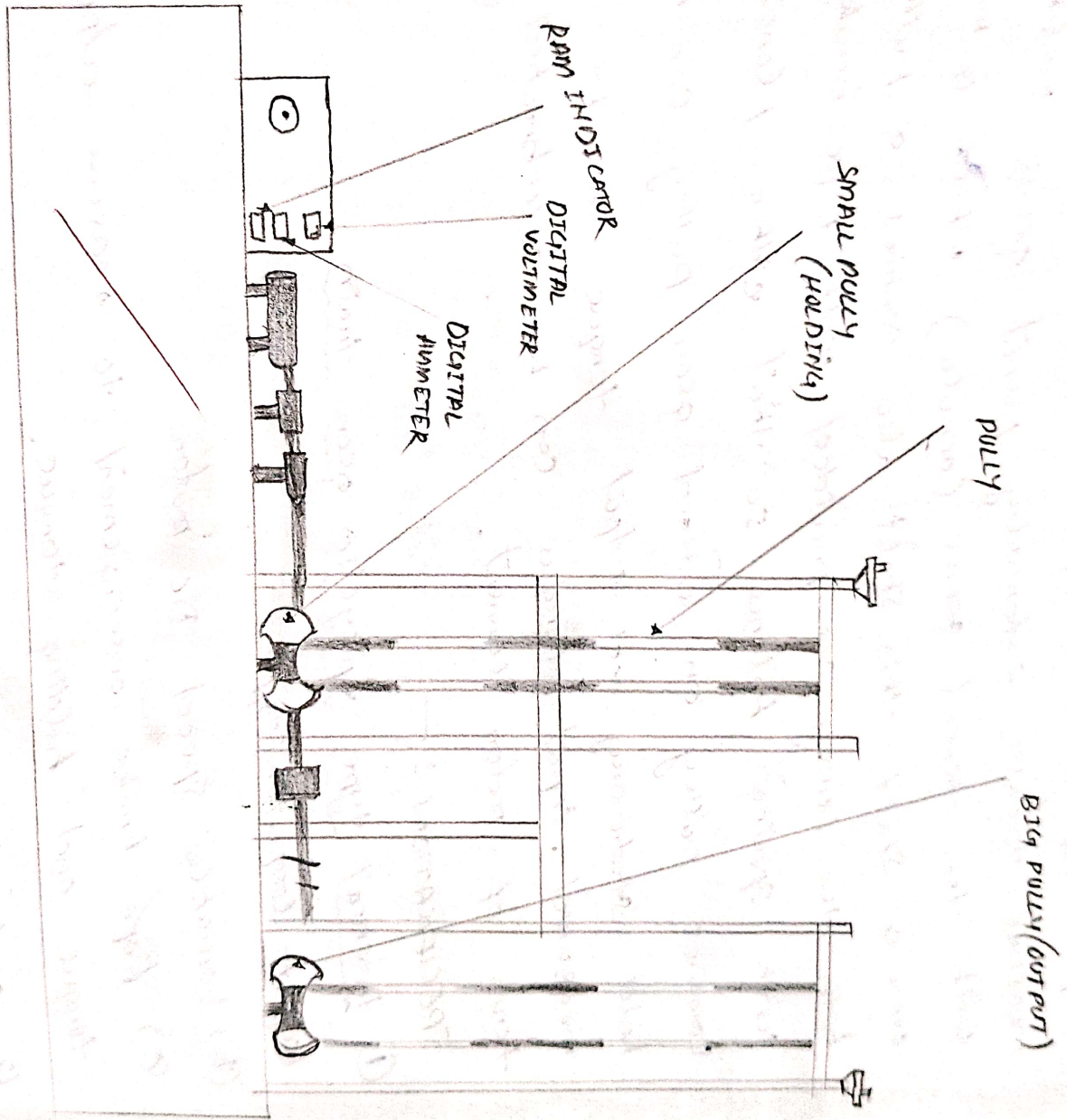
SPECIFICATION :-

① Internal type epicyclic gear train

- (a) A computer type
- (b) Variable Speed DC motor
- (c) Rope brake arrangement to measure output torque and holding torque.

② Control panel consisting of

- (a) Digital ammeter and voltmeter
- (b) RPM indicator
- (c) Speed controller



(EPICYCLIC GEAR TRAIN)

EXPERIMENTATION :-

- ① To measure epicyclic gear ratios between input and output shaft.
- ② To measure epicyclic gear ratio between input shaft and holding drum.
- ③ To measure input, output and holding torque.

PROCEDURE :-

- ① All nut-bolt are tightened and electric supply is connected motor is started.
- ② Tighten the rope on planet carrier pulley so that it doesn't rotate, now slightly tighten the rope over internal gear pulley.
- ③ Note down the observation and repeat the procedure for different torque (Note-down on internal gear pulley in tightest planet) carrier starts rotating keep in the tension of rope over pulley (entering gear pulley) so that it just does not rotate.
- ④ Now hold the planet carrier pulley and let external gear pulley to rotate, repeat the same procedure from different torques and complete the observation table.



FORMULA :-

$$P_1 = V \cdot I \quad (\text{where } V = \text{voltage})$$

$$T_1 = \frac{60 \times P_1}{2\pi N_1} \quad (\text{Input torque where } N_1 = \text{rpm of input shaft})$$

$$P_2 = \eta \times P_1$$

$$T_2 = \frac{60 \times P_2}{2\pi N_2} \quad (N_2 = \text{rpm of output shaft})$$

OBSERVATION TABLE :- (without load)

Sl. no.	V	I	P_1 W	T_1	T_2	$\frac{P_2}{T_2/T_1}$
1	11.2	1.04	116.48	1.62	2.11	1.704
2	11.5	1.41	162.15	2.46	2.003	0.753

Diameter of the rope = 1 cm
= 0.01 m

Circumference = 46 cm

Radius of the smaller pulley = 0.069

Radius of the bigger pulley = 0.080

With load

Sl. no.	V	I	P	T_1 N-m	T_2 N-m	Load kg	$GR = \frac{T_2}{T_1}$
1	112	1.04	116.48	2.11	4.39	5.60	1.584
2	115	1.41	162.15	2.003	4.67	2.46	2.331

CALCULATION:-

Small pulley torque = 0.00911 N-m

Big pulley torque = 0.086 N-m

Input r.p.m $\rightarrow N_1 = 525$

$V_1 = 112$

$I = 0.104$

$$\text{Input torque, } T = \frac{P \times 60}{2\pi N} = \frac{112 \times 1.04 \times 60}{2\pi \times 525} = 1.062 \text{ N-m}$$

$$S_1 = 8.2 \times 200 = 16.40 \text{ kg}$$

$$S_2 = 6.2 \times 200 = 12.40 \text{ kg}$$

$$(S_1 - S_2) = 16.40 - 12.40 = 4 \text{ kg}$$

$$\text{Torque on Small pulley} = 4 \times 9.81 \times 0.009 = 2.11 \text{ N-m}$$

$$S_3 = 9.4 \times 200 = 18.80 \text{ kg}$$

$$S_4 = 6.6 \times 200 = 13.20 \text{ kg}$$

$$(S_3 - S_4) = 18.80 - 13.20 = 5.60 \text{ kg}$$

$$\text{Torque on big pulley} = 5.60 \times 9.81 \times 0.050 = 4.39 \text{ N-m}$$



Reading-2

Input, $N_2 = 580$

$V_2 = 115$

$I = 1.41$

$$\text{Input torque} = \frac{1.41 \times 115 \times 60}{2\pi \times 580} = 2.66 \text{ N-m}$$

$$S_1 = 9.9 \times 200 = 18.18 \text{ kg}$$

$$S_2 = 7.61 \times 200 = 15.22 \text{ kg}$$

$$(S_1 - S_2) = 18.18 - 15.22 = 2.96 \text{ kg}$$

Torque on Small Pulley = $2.96 \times 9.81 \times 0.089 = 2.003 \text{ N-m}$

$$S_3 = 9.8 \times 200 = 18.16 \text{ kg}$$

$$S_4 = 6.1 \times 200 = 12.20 \text{ kg}$$

$$(S_3 - S_4) = 18.16 - 12.20 = 5.96 \text{ kg}$$

Torque on big pulley = $5.96 \times 9.81 \times 0.080 = 4.67 \text{ N-m}$

Reading-1

Holding torque = output - input

$$= 4.89 - 2.77 = 1.62 \text{ Nm}$$

Reading-2

$$\text{Holding torque} = 4.67 - 2.003 = 2.66 \text{ N-m}$$

CONCLUSION:-

From the above experiment we have studied various gear input, output and torque.

Submitted by:-

Sury Behara

F20110004055

Mechanical

4th Sem

(Signature)
28/11/21



AIM OF THE EXPERIMENT :-

To study about static and dynamic balancing using balancing apparatus.

OBJECTIVE - The objective is to show static and dynamic balancing.

APPARATUS REQUIRED :-

- (1) Balancing apparatus
- (2) Steel rule

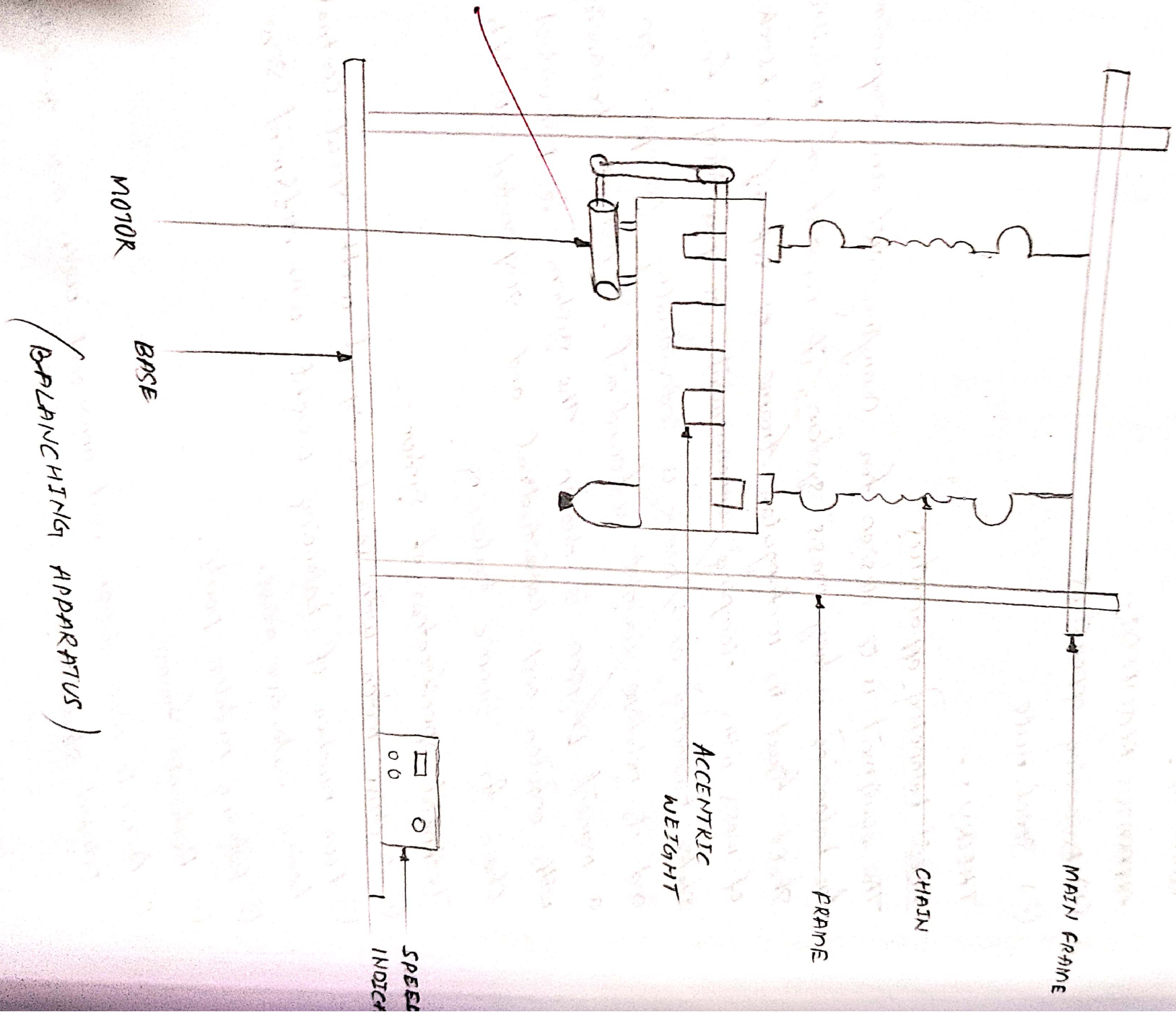
THEORY :-

About balancing apparatus -

The requirement is to design for carrying out an experiment for balancing rotary mass system, it consist of metal shaft fixed in rectangular frame. A set of 4 block of mass with clamping arrangement is provided for static balancing each block is individually clamped on and its relative weight is found out, in dynamic balancing a moment polygon is drawn. The system is provided with angular and longitudinal and suspended with chain for dynamic balancing.

Technical specification of system :-

- ① A drive motor with variable speed with speed control.
- ② Four number of balancing weight with different size having extensive mass.
- ③ Rotating metallic part.
- ④ Rectangular frame
- ⑤ A whole well design and arranged with good quality painted structure.





⑥ Balancing of rotating machinery is common problem in engineering which required solution, balanced machine are quite and repeat minimal load if the centre of gravity of mass and axis of rotation lies in line of machine which balanced but practically it doesn't happened due to dynamic force setup at always it required to reduce the dynamic forces within it expectable limit.

Balancing condition -

① Taking moment about axis of rotation and the summation is equal to zero,

$$\sum m_i \cdot r_i = 0, \quad i = 1 \text{ to } n \quad \text{--- (1)}$$

② Taking moment about the fixed datum such that the summation is equal to zero.

$$\sum m_i \cdot r_i \cdot \theta_i = 0 \quad \text{--- (2)}$$

PROCEDURE :- (Simple static balancing)

- First one block is clamped at 0° at 0°.
- The shaft is rotated by hand so that zero is by cursor.
- Block-2 is positioned at 45° at 180°.
- Similarly block-3 is positioned at 180° at distance 125mm and block-4 is positioned at 180° at distance 75mm.
- The belt is removed and is rotated by hand.
- If it rotated and stop without reversible direction it is said to be statically balanced.



(Simple static dynamic balancing)

- The belt is connected over the pulley.
- Moments are taken about datum and summation is found, if summation equal to zero, the system is dynamically balanced.
- Then motion is started and see the vibration.

CONCLUSION:-

→ In this way we have studied the static & dynamic balancing by balancing apparatus.

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~~X~~ ~~Signature~~

GOVERNMENT POLYTECHNIC, BALANGIR



LARKIPALI, BALANGIR

State Council Regd. No. L23130004012

Name..... Raja Radhan

Roll No. 4011 **Semester** 1st **Session**.....

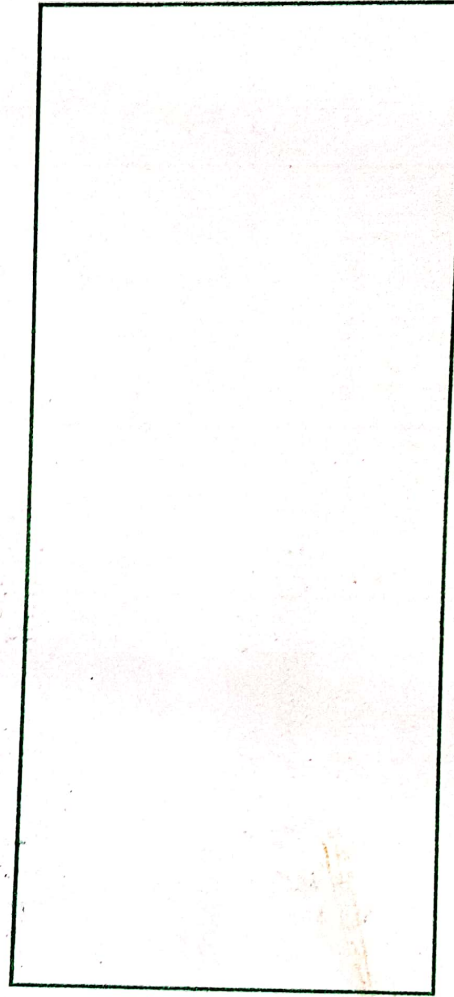
Branch Mechanical **Group**..... "B"

Subject..... work shop

GOVERNMENT POLYTECHNIC, BALANGIR



LARKIPALI, BALANGIR



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Branch Mechanical Group 'B'

Subject Work Shop



GOVERNMENT POLYTECHNIC, BALANGIR

DEPARTMENT OF



INDEX PAPER

Sl. No.	NAME OF THE EXPERIMENT	DATE	SHEET USED	REMARKS
1.	Job involving drilling machine.	29/01/2024 to 30/01/2024	01 to 05	<u>IP</u> 30/1/24
2.	Job involving machine (Bearing)	12/02/2024	06 to 11	<u>IP</u> 13/2/24
3.	Internal/external threading on turning job.	18/03/2024	12 to 15	<u>IP</u> 20/3/24
4.	To perform a step turning operation on the given cylindrical work piece		16 to 17	<u>IP</u> 27/3/24
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				<u>IP</u> 12/5/24



SECTION : Machine

JOB. NO 01

DATE OF STARTING : 29/02/2024

DATE OF FINISHING :

DATE OF DIPOSIT :

GRADE AWARD OF :

1. NAME OF THE JOB :

Job involving drilling machine

2. RAW MATERIAL REQUIRED :

MS ROD of specified diameter

3. JOB PERFORMANCE ;

JOB SKETCH



ALL DIMENSION ARE IN MM

TOLERANCE: +

Theory :-

Drilling:- Drilling is the operation of producing a cylindrical hole in a workpiece. It is done by a rotating tool, the rotating side of the cutter, known as a drilling drill. In this operation, the workpiece is revolving in a chuck on a free plate and the drilling is the held in tailstock drill holder or drill chuck. Drilling is a cutting process that uses a drill bit to cut a hole of circular cross-section in solid materials. The drill is usually a rotary cutting tool, often multi-point. The bit is passed against the work piece and rotated at rates from hundreds to thousands of revolution per minute. This forces cutting edge against the piece, cutting off chips from the holes as it is drilled.

Construction of Drilling Machine:-

The parts are as follows:-

- 1) Base (Bed) : The base is made of a cast iron which has the capability of high compressible strength, good wear resistance and good absorbing capability and for these reasons, it acts as a base to the drilling machine.
- 2) Column : It is exactly placed at the center of the base which can act as a support for rotating the swivel table and holding the power transmission system.

3) Swivel Table: It is attached to the column which can hold the machine vice in the grips and thereby, the workpiece is fixed in the machine vice to carry out the drilling operation. The swivel table can move up and down by means of rotational motion and can be locked to the column by means of locking nut.

4) Power Transmission system: It consists of motor, stepped pulley, V-belt and the spindle. The power transmission is explained in the working of the drilling machine.

5) Hand wheel: by the rotation of hand-wheel the spindle moves up and down in the vertical direction in order to give the necessary amount of feed to the work.

Here the rotational motion is converted into linear by means of a rack and pinion mechanism which was explained below

6) Chuck:

It is used to hold the drill bit.
Working Principle of drilling machine:-

When the power is given to the motor the spindle rotates and thereby the stepped pulley attached to it also rotates. On the other end, one more stepped pulley is attached and this is inverted to increase or decrease the speed of the rotational motion.



Page No. 04

Now, a v-belt is placed in between the stepped pulleys so as to drive the power transmission. Here a v-belt is used instead of a flat belt, in order to increase the power efficiency.

Now the drill bit also rotates which was placed in the chuck and which is in connection with the spindle. As the pulleys rotate, the spindle also rotates which can rotate the drill bit.

Now the rotation of hand-wheel, the spindle moves up and down in the vertical direction in order to give the necessary amount of feed to work and this drill bit is used to make the holes on the component piece in the machine vice.

Drive Mechanism of Drilling Machine:

Rack and Pinion Mechanism

This drive mechanism is based on Rack and pinion mechanism.

When the hand-wheel is rotated, it is converting the rotation motion to the linear motion by means of rack and pinion.

The setup consists of Rack, Pinion, chuck and the drill bit. The drill bit was placed in the chuck and the chuck is connected to rack and when the hand-wheel rotates the pinion is inserted in the grooves of rack and thereby the rotational motion is converted to linear motion. And as the mechanism is running, by means of Rack and pinion called as Rack and pinion mechanism.



TYPES OF DRILLING MACHINE:

- 1 - Radial drilling machine
- 2 - Upright drilling machine
- 3 - Automatic drilling machine
- 4 - Multiple drilling machine
- 5 - Deep hole drilling machine
- 6 - Sensitive drilling machine

Procedure: * At first the round bar is fitted on the lathe chuck by the help of the help of a surface gauge chuck key. Then facing operation is done on the job and then flat plain turning is done.

- * Locate the centre of the work piece by using tailstock.
- * Now the dead centre is removed from the tailstock and socket with sleeve and a drill bit fitted into it.
- * Now we can use the lathe machine for making power switch on.
- * After this drill bit is required to move forward by the tailstock hand wheel which will penetrate into the rotating job and drilled the required sized hole.

Conclusion:

Finally we made a drill on the given round bar.

Submitted by

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Aim of the experiment: -

Job involving machine

Apparatus Required: -

SL No.	Name of the Apparatus
01	Drill bit
02	Drill chuck
03	sleeve
04	Lathe
05	Boring tool

Raw material Required: -

MS ROD of specified diameter

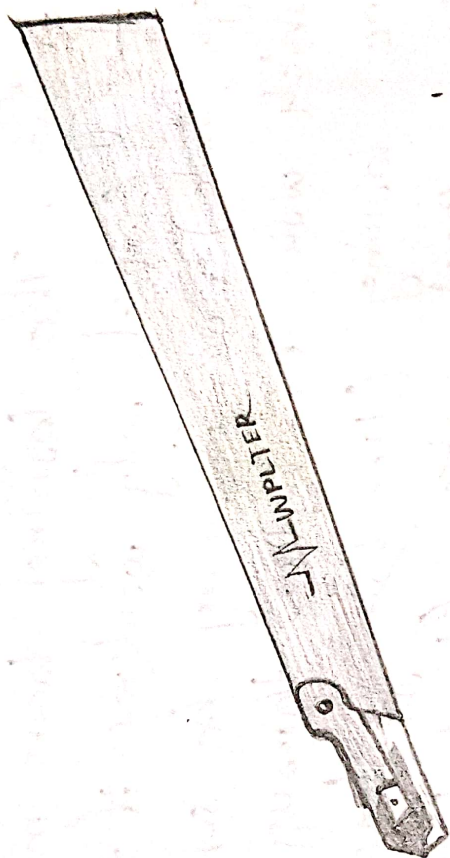


Theory: — In machining, boring is the process of enlarging a hole that has already been drilled (or cast) by means of a single-point cutting tool (or of a boring head containing several such tools), such as in boring a gun barrel on an engine cylinder. Boring is used to achieve greater accuracy of the diameter of a hole, and can be used to cut a tapered hole. Boring can be viewed as the internal diameter counterpart to turning.

which cut external diameter,

types of boring. There are various types of boring. The boring bar may be supported on both ends (which only works if the existing hole is a through hole), or it may be supported by ~~at~~ one end (which works for both through holes and blind holes). Line boring (line boring, line boring) - Impulse the former.

Back boring (back boring) is the process of reaching through an existing hole and then boring on the back side of the work piece (relative to the machine head stock). Because of the limitation on tooling design imposed by the fact that the work piece mostly surrounded the tool, boring is inherently somewhat more challenging. rigidity, increased clearance angle requirement. Limiting the amount of support that can be given to the cutting edge.) and difficulty of inspection of the resulting surface (size, form, surface roughness).



Naming

These are the reason why boring is viewed as an area of machining precise in its own right, separate from turning. With its own tips, tricks, challenges and body of expertise despite the fact that they are in some ways identical.

Lathe boring is a cutting operation that uses a single-point cutting tool as a boring head to produce conical or cylindrical surface by arranging an existing opening in a work piece. For non-tapered holes, the cutting tool moves parallel to the axis of rotation. For tapered holes, the cutting tool moves at an angle to the axis of rotation. Geometric boring from simple to extremely complex in a variety of diameters can be produced using boring applications boring is one of the most basic lathe operation next to turning and drilling.

Lathe boring usually requires that the work piece be held in the chuck and rotated as the work piece is rotated, a boring bar with an insert attached to the tip of the bar is fed into and moving the work piece, a chip is formed, depending on the types of tool used the material and the feed rate, the chip may be continuous or segmented the surface procedure is called a bore.



Construction of boring machine

The parts are as follows:—

Head stock:—

This is most important unit of the machine. The entire machine is built around it supports, drives and feeds the tool. It may contain any or more spindles one spindle is heavy and slow moving for the heavier operations of boring or drilling. The other spindle is lighter and faster for drilling and tapping small holes and mill work. Spindle rotating is reversible in either case for backing out tools and for right and left hand cutters.

Column:— The column provides support for the headstock and guides it up and down accurately by means of ways. It is heavily constructed and is hollow to have the counter weight which balance the head stock and make it easier to move. Columns are keyed, dowelled, and fitted to base. Some columns are stationary where as others move with their base.

The Column base:— The base supports and secures the column. Houses the various gears and driving mechanism on floor type machine the column base is mounted so that the spindle is at right angle to the way of the ram way, on planer type machines, the spindle is parallel to the way to the ram way.

End support column! — For operating involving the use of long boring bars and heavy tool, on cast bedded bedding is used to support the end of the bar. There is an open end a closed type of end support on table and planer type machines. the bearing block double in synchronism with the head stake of machine. when such an end support is used floor type machines, it is adjusted separately from the head stake and aligned by means of an accurate scale and vernier.

Run way! — These are used in planer type machines to the main column end-support column, and in some cases a rotatable table. when the column, end base, column and head stake are traversed as a complete, the member upon which is traversed is called a run way and not a pad.

Table and spindle! — the chief function of a table is to provide a support for holding the work piece. It also provides a means of blocking and clamping the work. it is equipped with suitable range of feed as well as rapid traverses. The table usually traverses at right angles to the axis of the spindle provided with saddle the function of the saddle is to provide a compound movement of the table so that it can move axially as well as transversely to the spindle.

Bed! — It may be cast into one or several pieces if several to support the column and head stake the end support the table, the saddle and the various feed and control shafts. It contains all the necessary feed mechanisms for the table as well as a coolant tank.



Floor plate: — Floor plate is made up of several section keyed and dowelled together to form a continuous surface for fastening work. The floor plate are mounted on a foundation and are not adjustable after travelling into position. T-slots are provided for work - clamping.

Cross rail: — It is used only on the multiple-head machine.

Types: —

- line boring machines
- tanned boring machines
- horizontal boring machines
- directional boring machines
- vertical boring machines
- portable boring machines
- gig boring machines

Procedure: — At first the workpiece is fitted properly on the lathe work by the help of a surface gauge and chuck key. Then facing and plan turning is done on the workpiece.

- 1) The centre of the workpiece is located by the help of tail stake.
- 2) Now we run the lathe machine by power switch on.
- 3) Now a drill bit to be fixed with the tail stake and to be locked on.
- 4) then drill will penetrated into the rotating work piece and sufficient feed is given until the required drilling is done.
- 5) After drilling the drill bit is removed and a boring tool is fitted into the tool post.
- 6) Then the boring operation is done by the boring tool.

Conclusion: — Finally we did the boring operation on the given round bar.

Submitted by

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13/12/21

Aim of the experiment :-

Internal / external threading on turning job.

Raw material Required :-

Mild steel rod of specified diameter.

Tool's and Equipment Required :-

1. Drill bit
2. Drill chuck
3. V-thread cutting tool
4. Lathe

Procedure :-

- first of all job will be fitted in the lathe chuck and properly centered by surface gauge.
- Then fit the drill bit in the tail stock of lathe and locked it.
- Now we run the lathe machine by making power switch on.
- The drill bit was allowed to penetrate into the workpiece with sufficient speed.
- After drilling the drill bit was removed and the thread cutting tool is fitted into the tool post.
- Then the thread cutting tool was allowed to go into the drilled hole slowly which cut the internal surface of the drilled hole and finally an internal V-thread will be obtained.

Theory:—

Threading is the process of creating a screw thread. More screw threads are produced each year than any other machine element. There are many methods of generating threads, including subtractive methods (many kind of thread cutting and grinding, as detailed below). Thread cutting as compared to thread forming and rolling is used when full thread depth is required, when the quantity is small when the blank is not very accurate, when threading up to a shoulder is required. When threading a tapered thread, or when the material is brittle.

A common method of threading is cutting with taps and dies. Unlike drill bits, hand taps do not automatically remove the chips they create. A hand tap cannot cut a thread in a single rotation because it creates long chips which quickly jam the tap. An effect known as crowding [aidation needed] possibly breaking it. Therefore, in manual thread cutting, normal wrench usage to cut the threads $1/2$ to $2/3$ of a turn (180 to 240 degree rotation). They reverse the tap for about $1/6$ of a turn (60 degrees) until the chips are broken by the back edge of the cutters. It may be necessary to periodically remove the tap from the hole to clear the chips, especially when a blind hole is threaded.

For continuous tapping operations (i.e. power tapping) specialized spiral point or "gun" taps are used to get the chips and prevent crowding.

Single point threading, also colloquially called single point (or just thread cutting when the context is implicit), is an operation that uses a single-point tool to produce a thread from on a cylinder or cone. The tool moves linearly while the piece rotates of the workpiece determines the lead of the thread. The process can be done to create external or internal threads (male or female). In external thread cutting, the piece can either be held in a chuck or mounted between two centers, with internal cutting, the piece is held in a chuck. The tool moves across the piece linearly taking chips off the workpiece with each pass. Usually 5 to 7 light cuts create the correct depth of the threads.

The coordination of various machine elements including leadscrew, slides, and change gears was the technological advance that allowed the invention of the screw-cutting lathe, which it today.

Internal threads are cut by serial taps or by nut taps serial taps: They consist of two or three tools the disting using feature being the design of the cutting points. The entering tap (1st pass) has a long chamfer and trapeziform cutting edges, it does approximately 60% of the cutting work.

In external thread cutting, the piece can either be held in a chuck or mounted between two centers, with internal thread cutting, the piece is held in a chuck. The tool moves across the piece linearly, taking chips off the workpiece. With each pass, usually 5 to 7 light cuts create the correct depth of the thread.

Conclusion! —

Hence the internal V-threading is done successfully by the help of required machine and tool.

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20/12/2020

STEP TURNING OPERATION

Aim of the experiment! — To perform a step turning operation on the given cylindrical work piece

Apparatus! —

- 1) Lathe with standard accessories
- 2) work piece

Principle! —

Turning is a lathe operation in which an external cylindrical surface is produced by generating.

The cutting tool is first adjusted for the desired depth of cut, using the cross slide. Then as the work piece rotates, the cutting tool is advanced relatively slowly a direction parallel to the rotational axis of the spindle. The motion is known as the feed. These combined motions cause the work piece by adjusting the feed so that the helical path of the tool tips overlaps and generates a cylindrical surface on the work piece.

A spindle R.P.M which gives a desired cutting speed at the circumference of the cylindrical surface should be reflected.

This may be calculated using the following formula,

$$\text{spindle speed, rpm} = \frac{\pi d^{1/2}}{4}$$

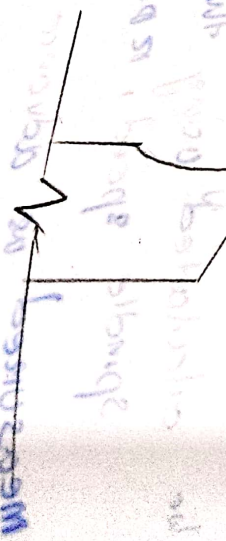
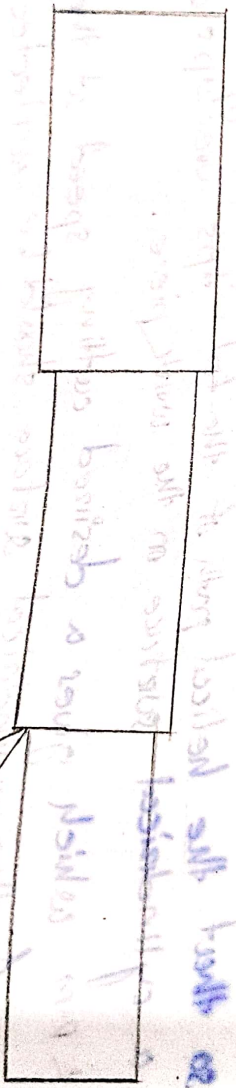
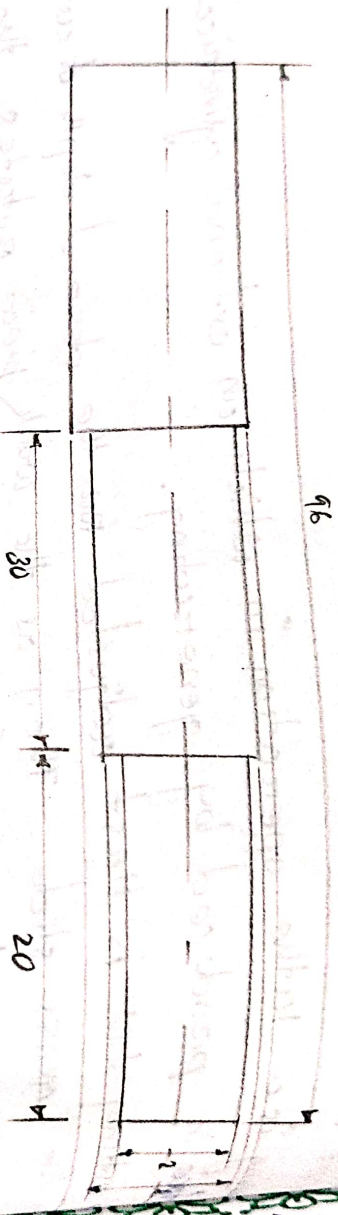
Feed is measured as advance of the cutting tool per revolution of the work piece.

Tools! — steel rule, outside callipers, tool holder with key, chuck key, HSS cutting tool bit.

Material! —

mild steel round rod of diameters 20 mm.

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Handwritten notes in the bottom right corner, possibly describing a process or material.

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Procedure:-

Initially the given work piece is fitted the chuck using a duck key. The high speed tool is positioned in the tool cutting duck key. The work piece is kept at an angle to the axis of the given work piece. During this process positioned in the tool holder the speed of the lathe is high. After this operation, the diameter of the work piece is to be reduced according to the given dimension by turning process. While doing the work piece one end of the work piece is reduced to the required diameter and after this, chamfering process is performed by skewing the tool but at 45° inclination and by turning the tool in contact with the edge of the job, this process removes all sharp edges of the component.

Precautions:-

- 1) The duck key must be removed immediately after the use.
- 2) The power supply switched off before measuring diameter
- 3) Before performing facing they must be in same line.

Result:-

The required steps are made on the work piece for the given dimensions.

Submitted by

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mechanical

YTH



EXPERIMENT-5

Aim of the experiment :-

To study about the capstan lathe.

Apparatus Required :-

1) Lathe machine

Theory :- Capstan lathe is the modified form of engine lathe and center lathe in which the tailstock is replaced by a hexagonal turret tool head. It was first developed by Pratt and Whitney in America in 1860.

It was needed to develop capstan lathe because in center lathe there was only one tool post and only tool can be fitted in the tailstock so it was very time consuming for every time we have to change the tool while changing the operation to be performed on the work piece. Center lathe was not suitable for mass production. To overcome these problems capstan lathe was developed. Capstan lathe is a modified form of the center lathe.

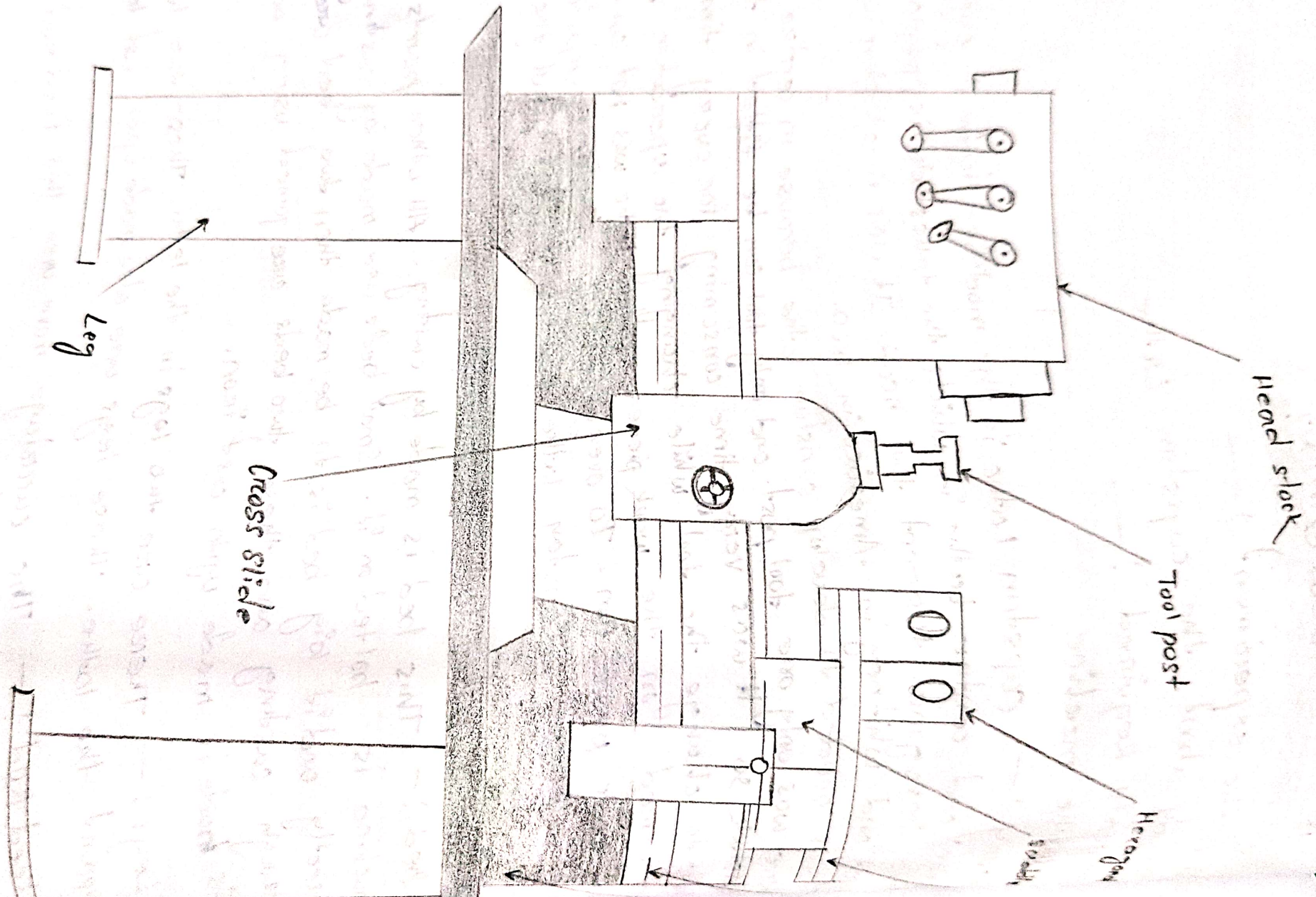
Parts of capstan lathe :-

1) Bed :- This bed is made by casting. All other parts of lathe machine is bolted on it. Small beds are made by casting directly and big bed is to be made then two bed are made through casting and these two beds are joined using bolts. This bed is made upto cast iron.

2) Legs :- There are two legs in the lathe. These two legs support the lathe. These legs are also made upto cast iron.

3) Feed Rod :- The carriage move over this feed rod. This feed rod has threads.

4) Head stock :- Head stock is present over the bed. It is a chamber with all the driving mechanisms inside it. This driving mechanism can contain gears, pulleys and motors.



5) Chuck! — This chuck is of two types. one is three jaw chuck and another one is four jaw chuck. Three jaw chuck is a universal chuck. Its main work is to hold the work piece.

6) Guideways! — There are guideways on the bed over which the carriage and cross-slide moves.

7) Saddle! — This saddle slides along the bed way and support the cross-slide, compound rest and tool post.

8) Cross-slide! — Cross-slide moves cross in the direction perpendicular to the movement of the ram.

9) Tool post! — It is present over the saddle. There are two tool post which can also move cross i.e. in direction perpendicular to the direction of movement of saddle.

Instead of tail stock there are certain parts present in cupstan lathe which are! —

(i) Saddle! — This saddle can move left and right. It carries ram and hexagonal tool head which it is used to take the ram and hexagonal tool head near the work piece.

(ii) Ram! — Ram can also move left and right. It carries hexagonal tool head and is used for shorter movement of tool after the saddle is fixed in its position.

(iii) Hexagonal tool post or turret head! —

It is present over the ram. It can hold six face which can hold six different types of machining tool for various operations.

(iv) Hand wheel: —

This hand wheel is used to move the saddle along with the ram and hexagonal tool head.

submitted by

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Aim of the experiment : —

To study the shaper machine

Apparatus Required : —

1) Shaper Machine

Theory : — The shaper machine is a reciprocating type of machine tool intended to produce flat surface. The surface may be horizontal, vertical or inclined.

Shaper Machine Parts : —

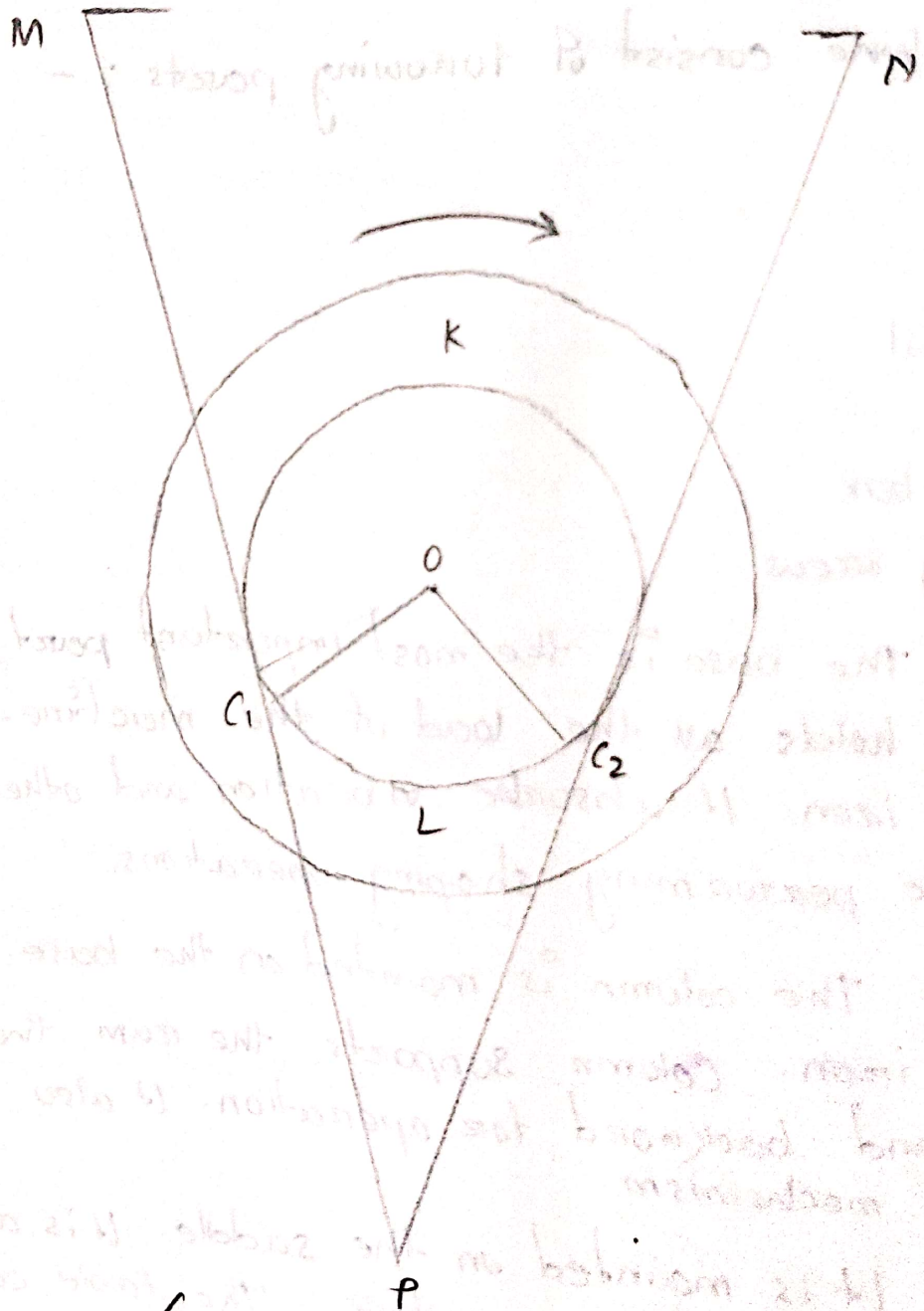
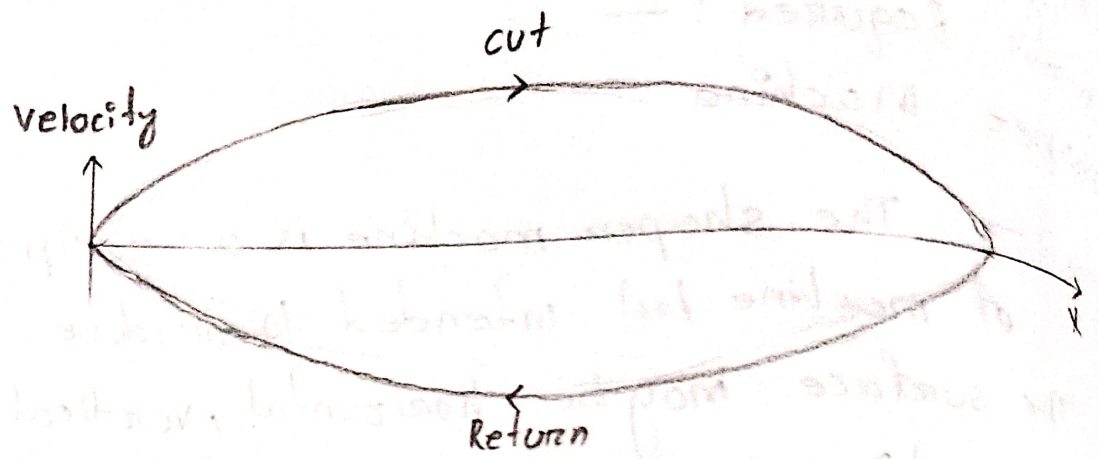
Shaper machine consist of following parts : —

- * Base
- * Column
- * Table
- * Cross rail
- * Ram
- * Clapper box
- * Elevating screw

Base : — The base is the most important part of the shaper because it holds all the load of the machine. It is made up of cast iron. It absorb vibration and other forces that occur while performing shaping operations.

Column : — The column is mounted on the base. It is also made up of cast iron. Column supports the ram that is moving forward and backward for operation. It also acts for covering the drive mechanism.

Table : — It is mounted on the saddle. It is also one of the important parts of the machine. The table can be moved away by rotating the crossfeed rod and also for vertically rotating the elevating screw. It is a box-line casting with an accurately machined side on top surface.



(Principle of quick
Return mechanism)

These surface having T-slots for clamping the work. In heavier type shaper machines, the table clamped with table support to make it more rigid.

Cross rail! — It is also mounted on the column on which the saddle is mounted. The vertical movement and Horizontal movement is given to the table by raising or lowering the cross rail. using the elevating screws and by moving the saddle using the cross feed screws.

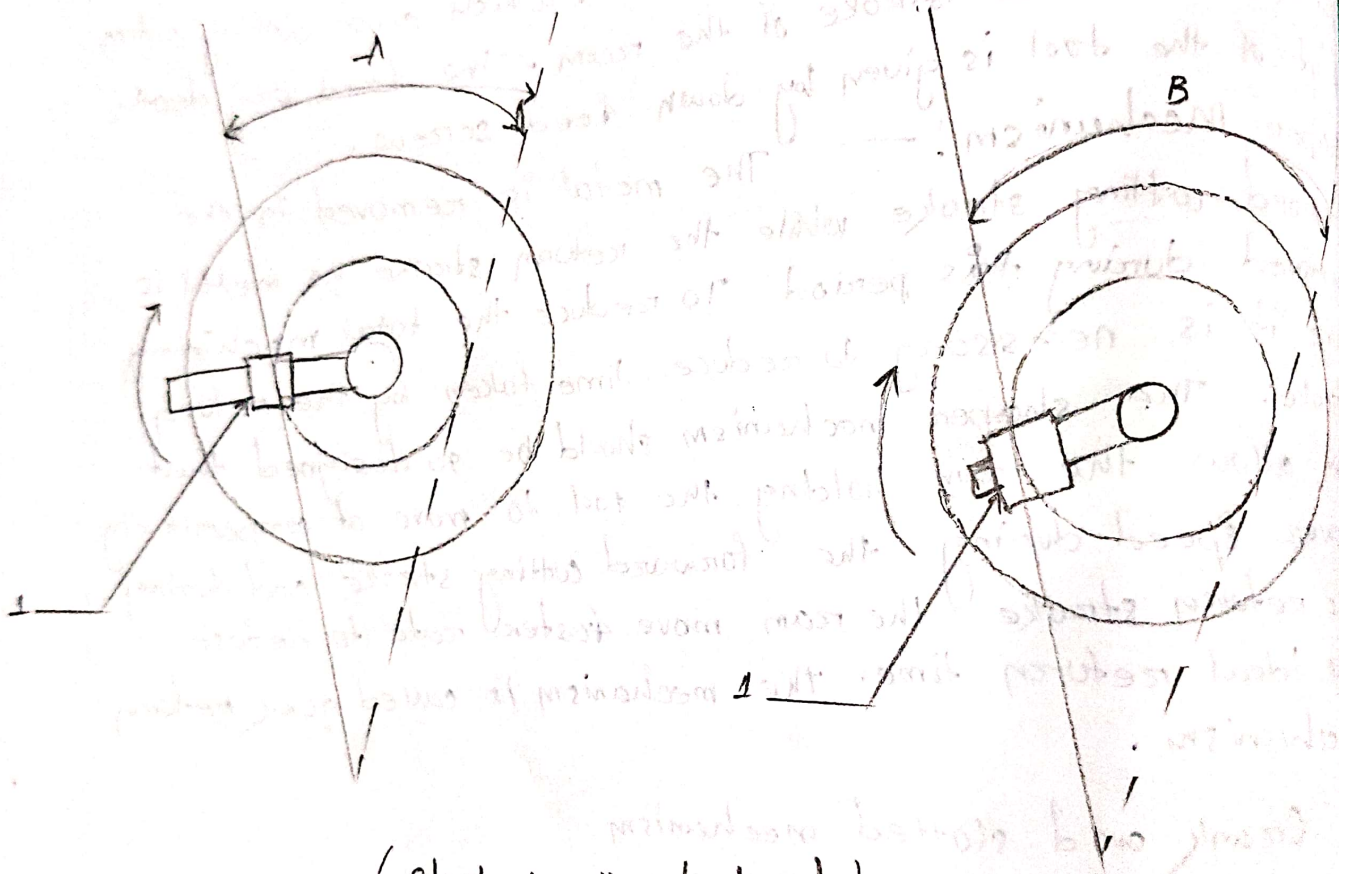
Ram! — The Ram reciprocating and it carries the tool head in which single point cutting tool is attached.

The tool head is in the clapper box, which cause cutting action only in a forward stroke of the ram. The feed or depth of cut of the tool is given by down feed screws.

Shaper Mechanism! — The metal is removed in the forward cutting stroke while the return stroke no metal is removed during this period. To reduce the total machining time it is necessary to reduce time taken by the return stroke. The shaper mechanism should be so designed that can allow the ram holding the tool to move at comparatively slower speed during the forward cutting stroke and during the return stroke the ram move faster rate to reduce the ideal return time. The mechanism is called quick return mechanism.

1. Crank and slotted mechanism
2. Whitworth quick return mechanism

Crank and slotted mechanism! — The motion or power is transmitted to the ball gear through a pinion which receives motion from an individual motor or overhead line shaft through speed control mechanism. speed can be change by shifting gears.



(Stroke length adjustment)

1 position of crankpin A. short stroke length,
B. Long stroke length

A radial slide is hatted to the centre of the ball gear. Carries a sliding block into which the crank pin is fitted. Rotation of the ball gear causes the crank pin to rotate at a uniform speed. Sliding block which is inverted on the crank pin is fitted within the slotted link. The slotted link: the slotted link is pivoted its bottom end attached on the frame of the column. When the link is in the position PM, ram will be at the extreme backward of its stroke. When at P's extreme forward position PM & P's are tangent to the crank pin circle.

1. $C_1 C_2 \rightarrow$ forward cutting stroke and
2. $Q_1 \rightarrow$ return stroke.

Worth Quick Return Mechanism :-

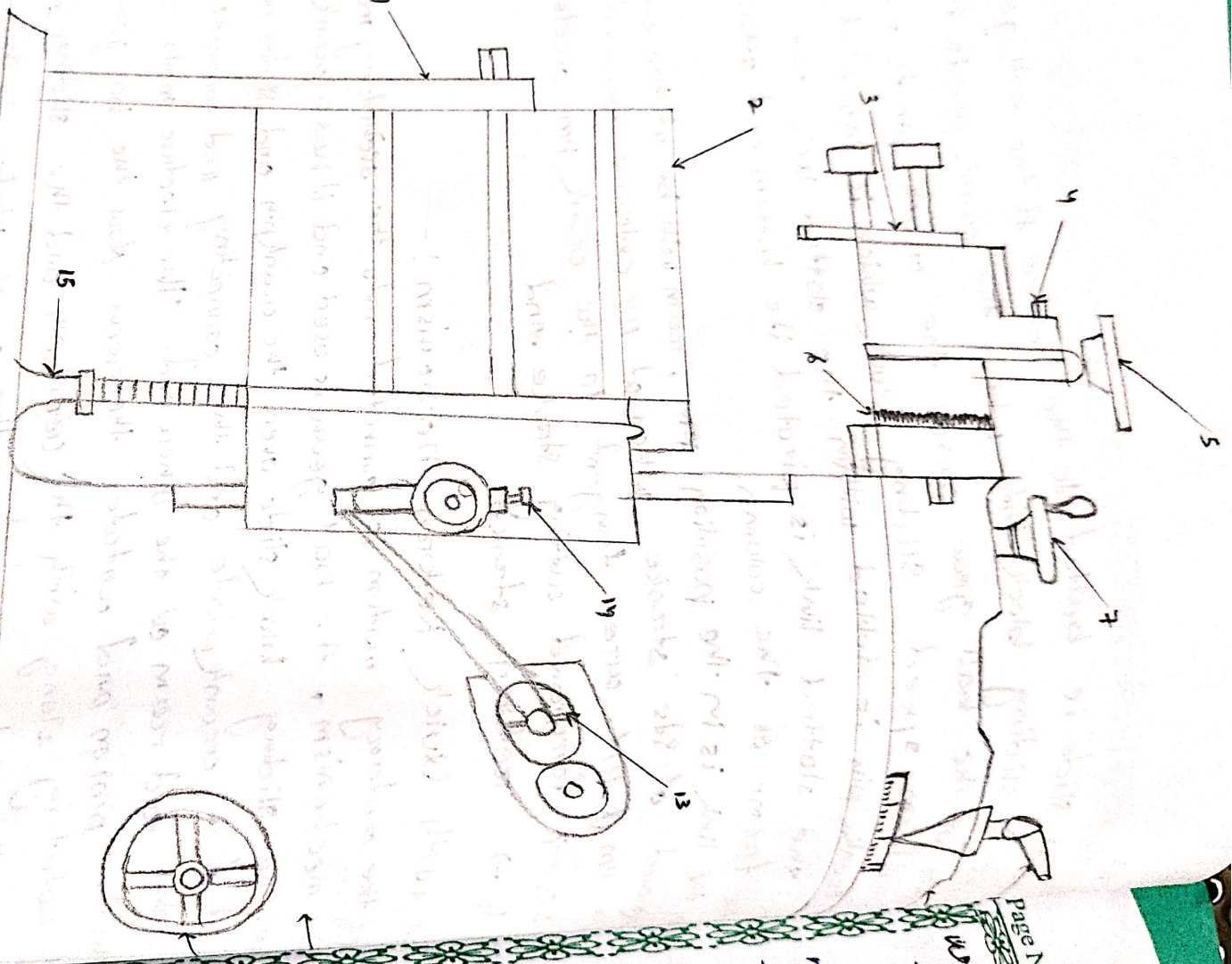
Here the rotary motion is converted into the oscillatory motion. In this mechanism, the ball gear is used and it has a crank pinion. The sliding block slide over the crankpin and slides inside the slot of a crank plate and the connecting rod connects the pin at one end and ram at the other end. The electric motor shaft drives the pinion and rotates the gear. Now the ball gear is also rotating along with the crankpin and the sliding block slides on the slot provided on the crank plate. So this process makes the ram move up and down by the connecting rod.

$\Rightarrow$ Time of cutting stroke
Time of return stroke

$$= \frac{\beta}{\alpha} = \frac{\beta}{360^\circ - \beta} \quad \text{or} \quad \frac{360^\circ - \alpha}{\alpha}$$

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Parts of a standard shaper

- 1- Table support, 2- Table, 3- Reciprocating table support, 4- Apron block, 5- Downfeed hand wheel, 6- Swivel base degree graduated, 7- Position of stroke adjustment hand wheel, 8- Ram block, 9- Column, 10- Driving pulley, 11- Base, 12- Feed disk, 13- Power mechanism, 14- Elevating screw

Working Principle :-

The job is fixed rigidly in a suitable vice or directly clamped on the machine table. The tool is held in the post mounted on the ram of the machine. This ram reciprocates to and fro sending oblong so makes the tool to cut the material in the forward stroke. No cutting take place during the return stroke of the ram. It is called ideal stroke. The job is given an intended feed, in a direction normal to the line of action of the cutting tool.

Conclusion :-

In this way we can prepare a job using capstan turret lathe.

Submitted by

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22/05/21