Department of Mechanical Engineering
Basic Mechanical Engineering and Manufacturing Practices Lab

Laboratory in charge

Prof. Pradeep Singh Hada

Prof. Shubham Kanungo

Laboratory Technician

Mr. Prakash Take

List of Experiments

1 To perform a tensile test on UTM.

2 To verify Bernoulli's Theorem using Bernoulli's apparatus.

3 Study of Two and Four Stroke SI Engine.

4 Study of Two and Four Stroke CI Engine.

5 Study of Boilers, their Mounting and Accessories.

6 Study of Lathe & Drilling Machine.

7 To prepare a job in Fitting shop.

8 To prepare a job in Carpentry shop.

9 To prepare a job in Black Smithy shop.

10 To prepare a job in Welding shop.

List of Equipment with Price

S. No.	List of Equipment	Date	Price (in Rs.)
1.	Model of Babcock and Wilcox boiler	01/12/2015	7300/-
2.	Model of Cochran boiler	01/12/2015	5600/-
3.	Model of Simple Vertical boiler	01/12/2015	7300/-
4.	Model of Four Stroke Petrol engine	01/12/2015	1925/
5.	Model of Four Stroke Diesel engine	01/12/2015	1925/-
6.	Model of Two Stroke Petrol engine	01/12/2015	1925/-
7.	Model of Two Stroke Diesel engine	01/12/2015	1925/-
8.	Model of Steam Engine with boiler	01/12/2015	6200/-
9.	Model of Nestler boiler	05/03/2019	9540/-
10.	Model of Joule's apparatus	05/03/2019	4860/-
11.	Model of Steam Engine with boiler(New)	05/03/2019	6975/-
12.	Boiler Mountings and Accessories		
	a. Lever Safety valve	01/12/2015	1350/-
	b. Spring loaded safety valve	01/12/2015	1200/-
	c. Dead weight Safety valve	01/12/2015	1200/-
	d. Combined high steam and low water safety valve	01/12/2015	2120/
	e. Water level indicator	01/12/2015	1740/-

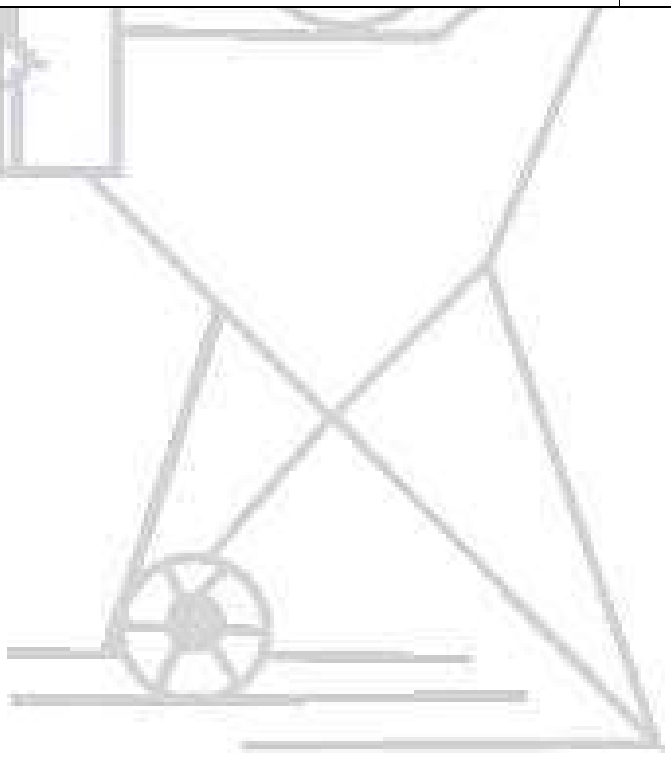
	f. Steam stop valve	01/12/2015	1825/-
	g. Feed Check valve	01/12/2015	1825/-
	h. Steam injector	01/12/2015	2120/-
	i. Pressure gauge	01/12/2015	1400/-
	j. Blow of Cock	01/12/2015	960/-
	k. Reducing valve	01/12/2015	1540/-
	l. Fusible plug	01/12/2015	1345/-
	m. Expansion steam trap	01/12/2015	1640/-
	n. Green's Economizer	01/12/2015	3840/-
	o. Sudgen Superheater	01/12/2015	3275/-
	Total		**79580/-**

List of Major Equipment with Price

S. No.	List of Equipment	Date of Purchase	Price (in Rs.)
1.	Model of Babcock and Wilcox boiler	01/12/2015	7300/-
2.	Model of Cochran boiler	01/12/2015	5600/-
3.	Model of Simple Vertical boiler	01/12/2015	7300/-
4.	Model of Nestler boiler	05/03/2019	9540/-
	Total		**29740/-**

List of Equipment purchased in Last Five Years with Price

S. No.	List of Equipment	Date of Purchase	Price (in Rs.)
1.	Model of Nestler boiler	05/03/2019	9540/-
2.	Model of Joule's apparatus	05/03/2019	4860/-
3.	Model of Steam Engine with boiler(New)	05/03/2019	6975/-
	Total		**21375**



IPS Academy, Indore

Institute of Engineering & Science

Mechanical Engineering Department

LAB MANUAL

Basic Mechanical Engineering & Manufacturing Practices Lab

(ESC-202)

Name …….

Session ……Semester …….

Enrollment No. ……..

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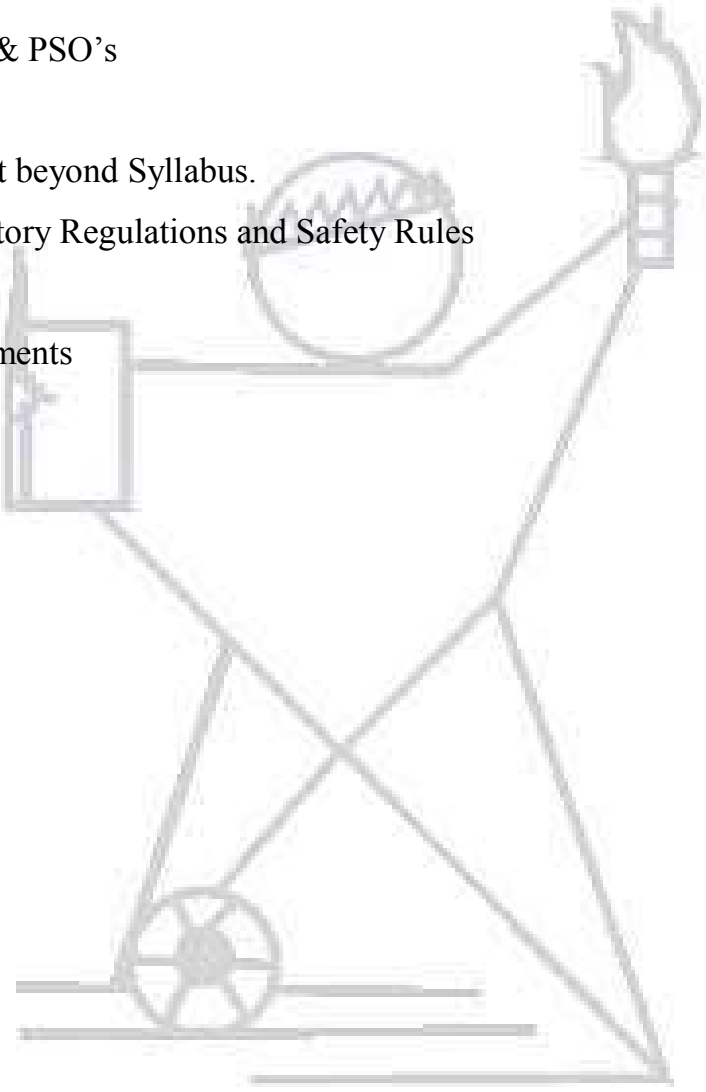


Vision of the Institute

To be the fountainhead of novel ideas & innovations in science & technology & persist to be a foundation of pride for all Indians.

Mission of the Institute

M1: To provide value based broad Engineering, Technology and Science where education in students is urged to develop their professional skills.

M2: To inculcate dedication, hard work, sincerity, integrity and ethics in building up overall professional personality of our student and faculty.

M3: To inculcate a spirit of entrepreneurship and innovation in passing out students.

M4: To instigate sponsored research and provide consultancy services in technical, educational and industrial areas.

Vision of the Department

To be a nationally recognized, excellent in education, training, research and innovation that attracts, rewards, and retains outstanding faculty, students, and staff to build a Just and Peaceful Society.

Mission of the Department

M1: Imparting quality education to the students and maintaining vital, state-of-art research facilities for faculty, staff and students.

M2: Create, interpret, apply and disseminate knowledge for learning to be an entrepreneur and to compete successfully in today's competitive market.

M3: To inculcate Ethical, Social values and Environment awareness.

Program Education Objectives (PEO's)

PEO1: To enrich graduates with fundamental knowledge of Physics, Chemistry and advanced mathematics for their solid foundation in Basic Engineering science.

PEO2: To provide graduates to design the solution of engineering problems relevant to mechanical engineering design through the process of formulating, executing & evaluating a design solution as per need with socio-economic impact consideration and related constraints.

PEO3: To provide graduates with experience in learning and applying tools to solve theoretical and open ended mechanical engineering problems.

PEO4: To provide a contemporary grounding in professional responsibility including ethics, global economy, emerging technologies and job related skills such as written and oral communication skills and to work in multidisciplinary team.

PEO5: Prepare graduates to be interested, motivated, and capable of pursuing continued life-long learning through beyond curriculum education, short term courses and other training programme in interdisciplinary areas.

Program Outcomes (PO's)

Engineering Graduates will be able to:

PO1: Engineering knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of Mechanical engineering problems.

PO2: Problem analysis: Identify, formulate, and analyze mechanical engineering problems to arrive at substantiated conclusions using the principles of mathematics, and engineering sciences.

PO3: Design/development of solutions: Design solutions for mechanical engineering problems and design system components, processes to meet the specifications with consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO4: Conduct investigations of complex problems: An ability to design and conduct experiments, as well as to analyze and interpret data.

PO5: Modern tool usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to mechanical engineering problems with an understanding of the limitations.

PO6: The engineer and society: Apply critical reasoning by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the Mechanical engineering practice.

PO7: Environment and sustainability: Understand the impact of the Mechanical engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

PO8: Ethics: An understanding of professional and ethical responsibility.

PO9: Individual and teamwork: Function effectively as an individual, and as a member or leader in teams, and in multidisciplinary settings.

PO10: Communication: Ability to communicate effectively. Be able to comprehend and write effective reports documentation.

PO11: Project management and finance: Demonstrate knowledge and understanding of engineering and management principles and apply this to Mechanical engineering problem.

PO12: Life-long learning: ability to engage in life-long learning in the broadest context of technological change.

Program Specific Outcomes (PSOs)

PSO1: Engage professionally in industries or as an entrepreneur by applying manufacturing and management practices.

PSO2: Ability to implement the learned principles of mechanical engineering to analyze, evaluate and create advanced mechanical system or processes.

Course Outcomes (CO's)

Basic Mechanical Engineering (ESC-202)

Course Objective:

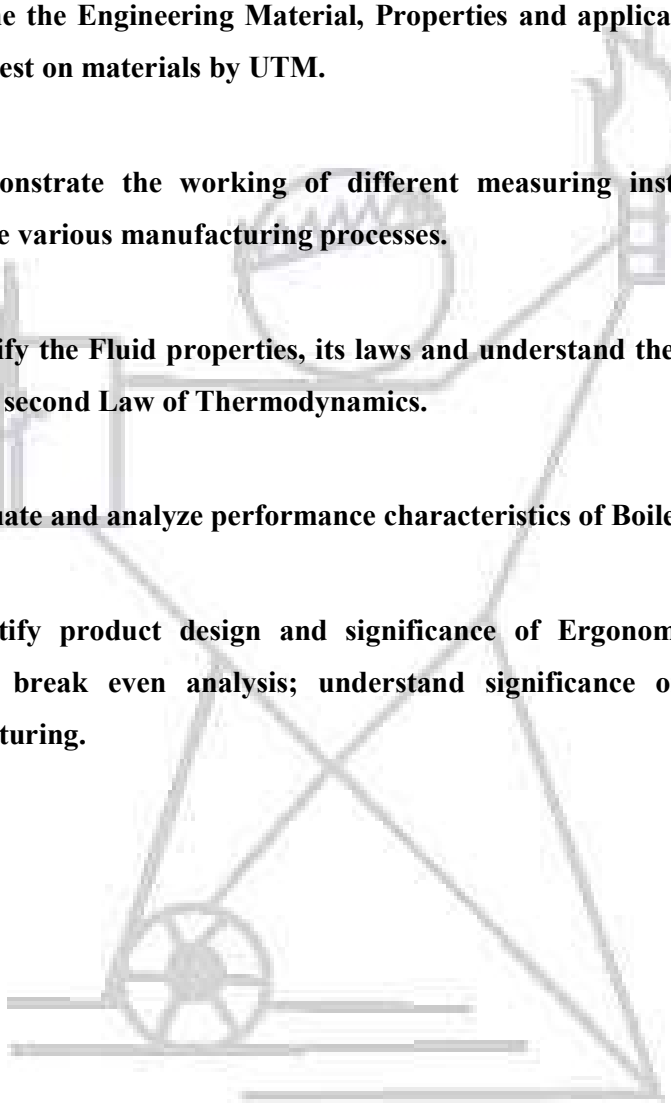
1. **To Define the Engineering Material, Properties and applications and list the various test on materials by UTM.**

2. **To Demonstrate the working of different measuring instruments and to introduce various manufacturing processes.**

3. **To identify the Fluid properties, its laws and understand the basic concept of first and second Law of Thermodynamics.**

4. **To Evaluate and analyze performance characteristics of Boilers.**

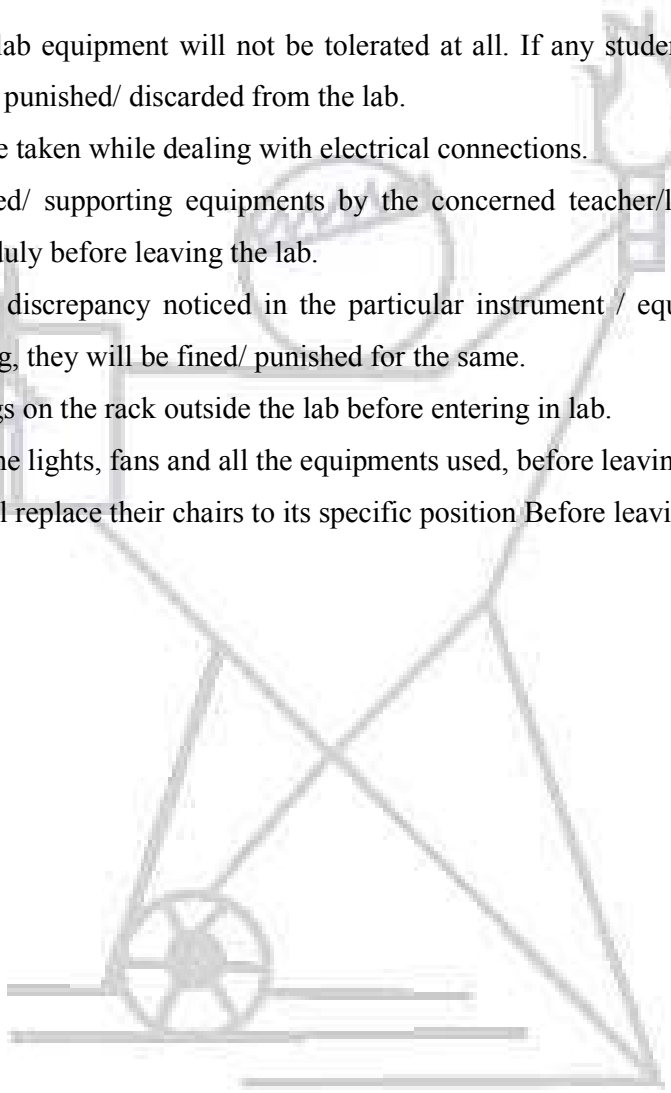
5. **To Identify product design and significance of Ergonomics and able to perform break even analysis; understand significance of automation in manufacturing.**



Laboratory Regulations and Safety Rules

Instructions for Students

1. Read the instructions mentioned in the manual carefully and then proceed for the experiment.
2. Mishandling of lab equipment will not be tolerated at all. If any student is found guilty; he/she should be punished/ discarded from the lab.
3. Care must be taken while dealing with electrical connections.
4. Issued the needed/ supporting equipments by the concerned teacher/lab. Technician & return the same duly before leaving the lab.
5. If any defect or discrepancy noticed in the particular instrument / equipment while the students are using, they will be fined/ punished for the same.
6. Put your bags on the rack outside the lab before entering in lab.
7. Switch off the lights, fans and all the equipments used, before leaving lab.
8. Students will replace their chairs to its specific position Before leaving the lab



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S. No.	Name of Experiment	Date	Grade	Signature
1.	To perform a tensile test on UTM.			
2.	To verify Bernoulli's Theorem using Bernoulli's apparatus.			
3.	Study of Two and Four Stroke SI Engine.			
4.	Study of Two and Four Stroke CI Engine.			
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8.	To prepare a job in Carpentry shop.			
9.	To prepare a job in Black Smithy shop.			
10.	To prepare a job in Welding shop.			

Experiment No. 1

Aim: To perform tensile test on UTM.

Objective: To conduct a tensile test on a mild steel specimen and determine the following:

(i) Limit of proportionality

(ii) Elastic limit

(iii) Yield Strength

(iv) Ultimate Strength

(v) Young's modulus of elasticity

(vi) Percentage elongation

(vii) Percentage reduction in area.

Apparatus:

(i) Universal Testing Machine (UTM)

(ii) Mild steel specimens

(iii) Graph paper

(iv) Scale

(v) Vernier Caliper

Schematic diagram of Universal Testing Machine

Theory: The Universal Testing Machine consists of two units.

1) Loading unit, 2) Control panel.

Loading unit:

It consists of main hydraulic cylinder with robust base inside. The piston which moves up and down. The chain driven by electric motor which is fitted on left hand side. The screw column maintained in the base can be rotated using above arrangement of chain. Each column passes through the main nut which is fitted in the lower cross head.

The lower table connected to main piston through a ball & the ball seat is joined to ensure axial loading. There is a connection between lower table and upper head assembly that moves up and down with main piston. The measurement of this assembly is carried out by number of bearings which slides over the columns.

The test specimen each fixed in the job is known as 'Jack Job'. To fix up the specimen tightly, the movement of jack job is achieved helically by handle.

Control panel:

It consists of oil tank having a hydraulic oil level sight glass for checking the oil level. The pump is displacement type piston pump having free plungers those ensure for continuation of high pressure. The pump is fixed to the tank from bottom. The suction & delivery valve are fitted to the pump near tank Electric motor driven the pump is mounted on four studs which is fitted on the right side of the tank. There is an arrangement for loosing or tightening of the valve. The four valves on control panel control the oil stroke in the hydraulic system. The loading system works as described below.

The return valve is close, oil delivered by the pump through the flow control valves to the cylinder & the piston goes up. Pressure starts developing & either the specimen breaks or the load having maximum value is controlled with the base dynameters consisting in a cylinder in which the piston reciprocates. The switches have upper and lower push at the control panel for the downward & upward movement of the movable head. The on & off switch provided on the control panel & the pilot lamp shows the transmission of main supply.

Method of Testing:

Initial Adjustment: - before testing adjust the pendulum with respect to capacity

of the test i.e. 8 Tones; 10 Tones; 20 Tones; 40 Tones etc.

For ex: A specimen of 6 tones capacity gives more accurate result of 10 Tones capacity range instead of 20 Tones capacity range. These ranges of capacity are adjusted on the dial with the help of range selector knob. The control weights of the pendulum are adjusted correctly. The ink should be inserted in pen holder of recording paper around the drum & the testing process is started depending upon the types of test as mentioned below.

Tension test:

Select the proper job and complete upper and lower check adjustment. Apply some Greece to the tapered surface of specimen or groove. Then operate the upper cross head grip operation handle & grip the upper end of test specimen fully in to the groove. Keep the lower left valve in fully close position. Open the right valve & close it after lower table is slightly lifted. Adjust the lower points to zero with the help of adjusting knob. This is necessary to remove the dead weight of the lower table. Then lock the jobs in this position by operating job working handle. Then open the left control valve. The printer on dial gauge at which the specimen breaks slightly return back & corresponding load is known as breaking load & maximum load is known as the ultimate load.

Study of extensometer:

This instrument is an attachment to Universal / Tensile Testing Machines. This measures the elongation of a test place on load for the set gauge length. The least count of measurement is being 0.01 mm and maximum elongation measurement is up to 3 mm. This elongation measurement helps in finding out the proof stress at the required percentage elongation.

Working of the instrument:

The required gauge length (between 30to 120) is set by adjusting the upper knife edges (3) A scale (2) is provided for this purpose. Hold the specimen in the upper and lower jaws of Tensile / Universal Testing Machine. Position the extensometer on the specimen. Position upper clamp (4) To press upper knife edges on the specimen. The extensometer will be now fixed to the specimen by spring pressure. Set zero on both the dial gauges by zero adjusts screws (7). Start loading the specimen and take the reading of load on the machine at required elongation or the elongation at required load. Force setter accuracies mean of both the dial gauge (8) readings should be taken as elongation. It is

very important to note & follow the practice of removing the extensometer from the specimen before the specimen breaks otherwise the instrument will be totally damaged. As a safety, while testing the instrument may be kept hanging from a fixed support by a slightly loose thread.

Technical data:

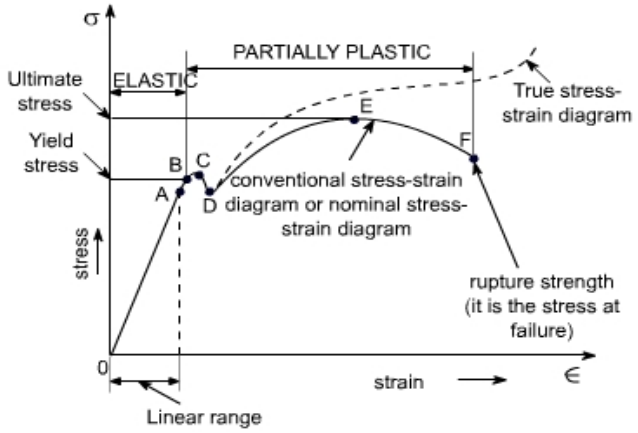
Measuring Range: 0 – 3 mm.

Least Count: 0. 01 mm.

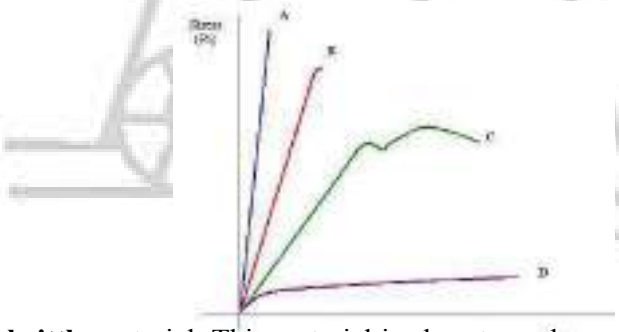
Gauge Length adjustable from: 30 – 120 mm

Specimen Size: 1 to 20 mm Round or Flats up to 20 x 20 mm.

A) Stress-strain graph of Mild Steel



B) Stress-strain graphs of different materials.



- Curve **A** shows a **brittle** material. This material is also strong because there is little strain for a high stress. The fracture of a brittle material is sudden and catastrophic, with little or no plastic deformation. Brittle materials crack under tension and the stress increases around the cracks. Cracks propagate less under compression.
- Curve **B** is a **strong** material which is not ductile. Steel wires stretch very little, and break

suddenly. There can be a lot of elastic strain energy in a steel wire under tension and it will "whiplash" if it breaks. The ends are razor sharp and such a failure is very dangerous indeed.

- Curve **C** is a **ductile** material.
- Curve **D** is a **plastic** material. Notice a very large strain for a small stress. The material will not go back to its original length.

The tensile test is most applied one, of all mechanical tests. In this test ends of test piece are fixed into grips connected to a straining device and to a load measuring device. If the applied load is small enough, the deformation of any solid body is entirely elastic. An elastically deformed solid will return to its original from as soon as load is removed. However, if the load is too large, the material can be deformed permanently. The initial part of the tension curve which is recoverable immediately after unloading is termed as elastic and the rest of the curve which represents the manner in which solid undergoes plastic deformation is termed as plastic. The stress below which the deformations are essentially entirely elastic is known as the yield strength of material. In some material the onset of plastic deformation is denoted by a sudden drop in load indicating both an upper and a lower yield point. However, some materials do not exhibit a sharp yield point. During plastic deformation, at larger extensions strain hardening cannot compensate for the decrease in section and thus the load passes through a maximum and then begins to decrease. This stage the "ultimate strength"' which is defined as the ratio of the load on the specimen to original cross-sectional area, reaches a maximum value. Further loading will eventually cause 'neck' formation and rupture.

Procedure:

1. Measure the original length and diameter of the specimen. The length may either be length of gauge section which is marked on the specimen with a preset punch or the total length of the specimen.
2. Insert the specimen into grips of the test machine and attach strain-measuring device to it.
3. Begin the load application and record load versus elongation data.
4. Take readings more frequently as yield point is approached.

5. Measure elongation values with the help of dividers and a ruler.
6. Continue the test till Fracture occurs.
7. By joining the two broken halves of the specimen together, measure
8. The final length and diameter of specimen.

Observation:

A) Material:

B) Original dimensions

Length = ----------

Diameter = ---------

Area = ----------

C) Final Dimensions:

Length = ----------

Diameter = ----------

Area = ----------

Observation table:

S. No.	Load (N)	Original Gauge Length	Extension (mm)	Stress = Load/Area (N/mm^2)	Strain= Change in length/Original length
1.					
2.					
3.					
4.					
5.					

To determine the following:

(i) Ultimate strength $= \frac{Maximum\ tensile\ load}{Original\ area\ of\ cross-section}$ =……N/mm^2

(ii) Young's modulus, E $= \frac{\text{stress below propornality limit}}{\text{Corresponding strain}}$ = ……..N/mm^2

(iii) Percentage elongation = $\frac{\text{Final length (at fracture) – original length}}{\text{Original length}}$ = ……%

(iv) Percentage reduction in area = $\frac{\text{Original area} - \text{area at fracture}}{\text{Original area}}$ = ……%

Result: i) Average Breaking Stress = …….

ii) Ultimate Stress = …….

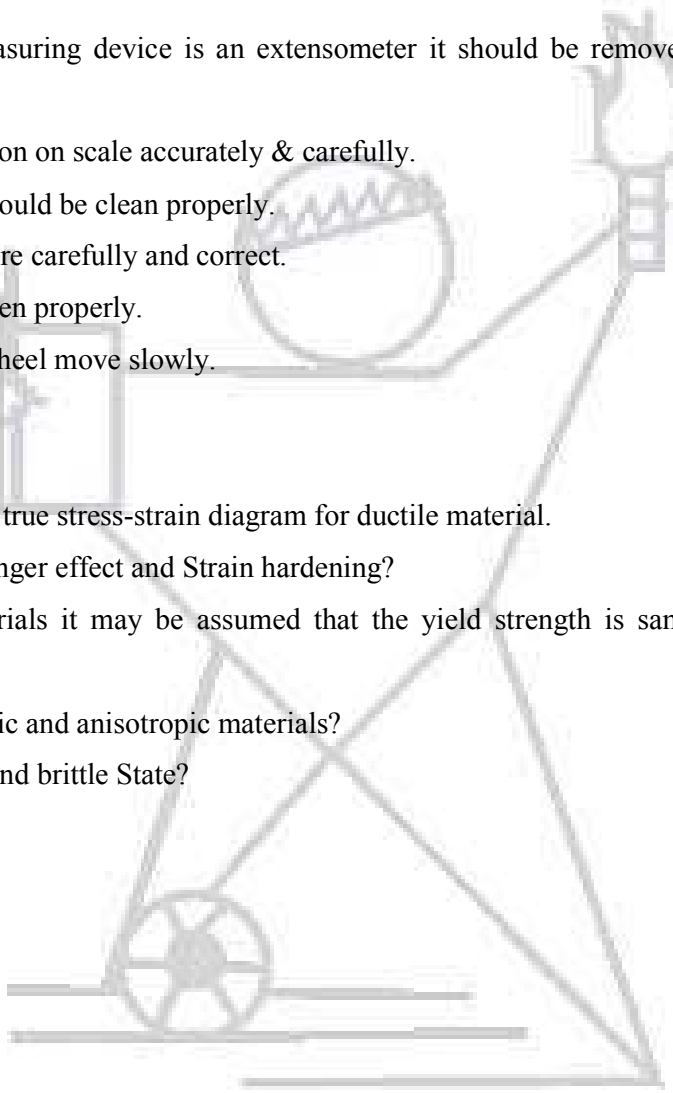
iii) Average % Elongation = …….

Precaution:

1. If the strain measuring device is an extensometer it should be removed before necking begins.
2. Measure deflection on scale accurately & carefully.
3. The specimen should be clean properly.
4. Take reading more carefully and correct.
5. Place the specimen properly.
6. Jack adjusting wheel move slowly.

Questions:

1. Draw & Explain true stress-strain diagram for ductile material.
2. Explain Bauschinger effect and Strain hardening?
3. For which materials it may be assumed that the yield strength is same in tension and compression?
4. What are isotropic and anisotropic materials?
5. What is ductile and brittle State?



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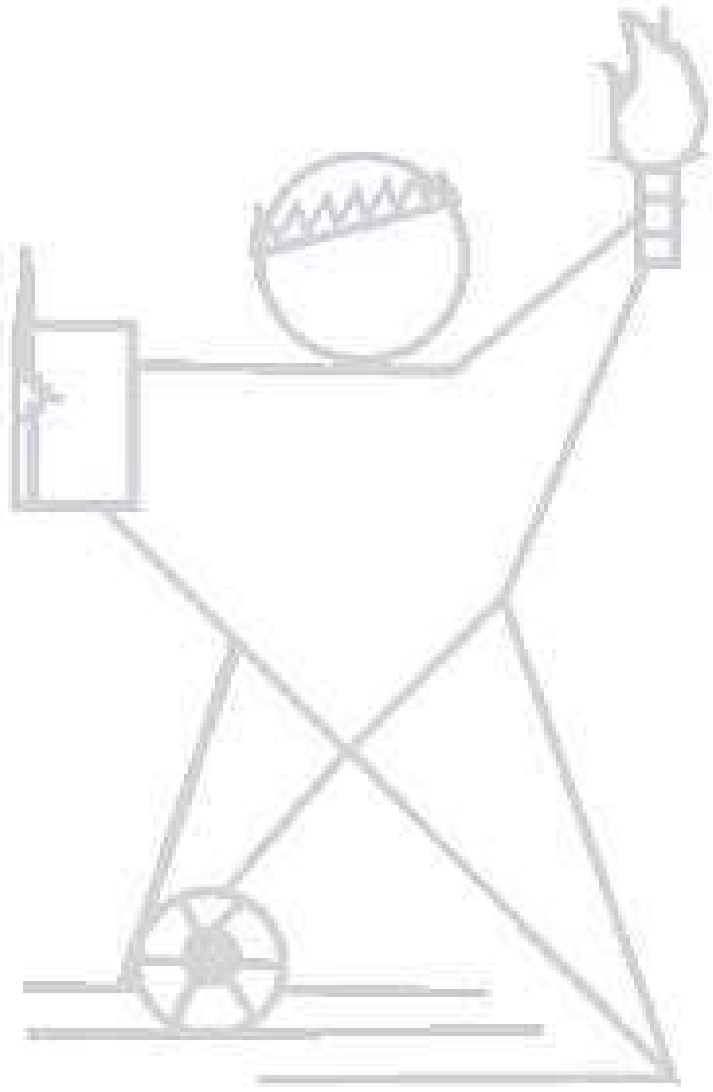

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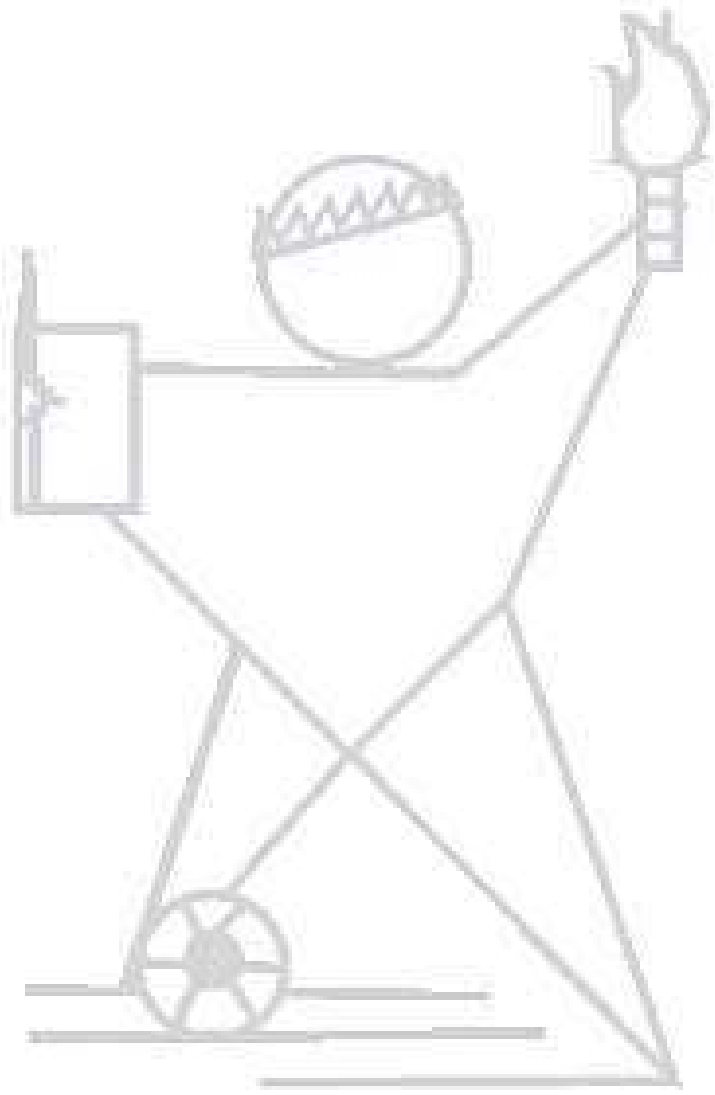

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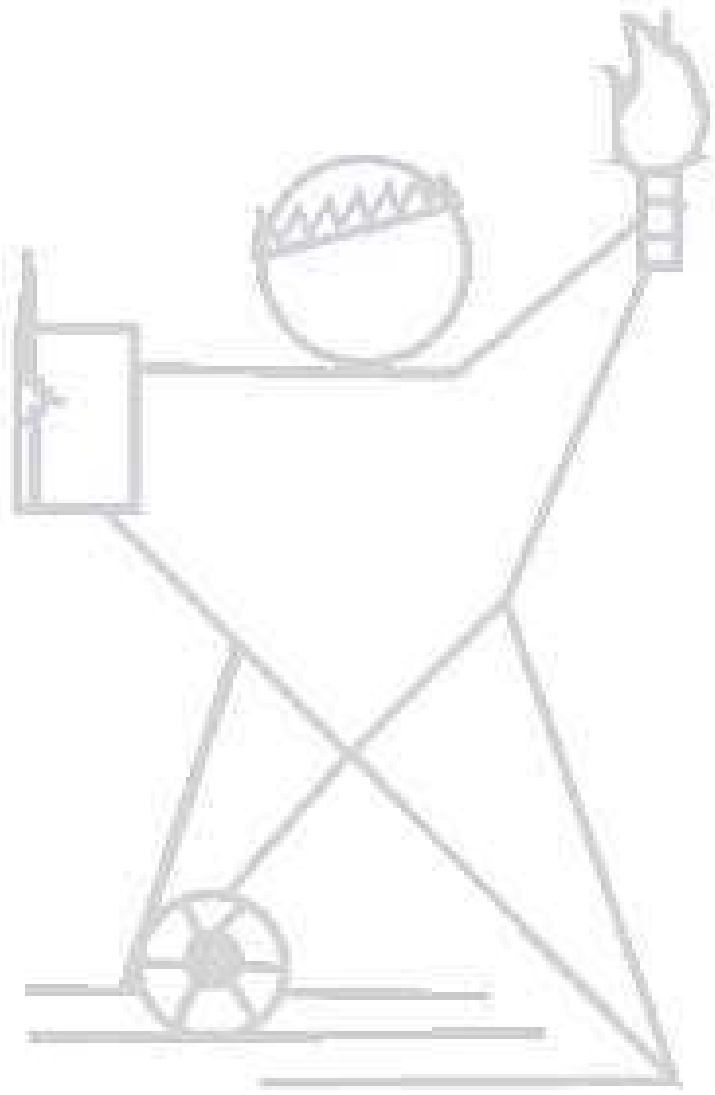


Experiment No. 2

Aim: To verify the Bernoulli's theorem

Apparatus: Stop watch, measuring tank, Bernoulli's apparatus.

Bernoulli's Apparatus

Theory: Bernoulli's theorem states that the total energy (i.e. sum of pressure energy, potential energy & kinetic energy) of an incompressible, non viscous fluid in steady flow through a pipe remains constant throughout the flow, provided there is no source or sink along the length of the pipe. This statement is based on the assumption that there is no loss of energy due to friction and the flow is laminar & uniform. Mathematically-

We will integrate the Euler's equation of motion in order to secure the Bernoulli's equation.

$$\int \frac{\partial P}{\rho} + \int VdV + \int gdZ = 0$$

$$\frac{P}{\rho} + \frac{V^2}{2} + gZ = const.$$

$$\frac{P}{\rho g} + \frac{V^2}{2g} + Z = const.$$

$\frac{P}{\rho g}$ = Pressure head

$\frac{V^2}{2g}$ = Kinetic head

Z = Potential or Elevation head

Assumptions made for deriving the Bernoulli's equation from Euler's equation of motion is as mentioned here.

1. Fluid is ideal, i.e. inviscid and incompressible.
2. Fluid flow is steady, one-dimensional and uniform.
3. Fluid flow is irrational.
4. Forces which are considered are only pressure force and gravity force. Rest forces acting on fluid are neglected.

As we have discussed above various assumptions during deriving the Bernoulli's equation, such as fluid will be ideal, i.e. inviscid and incompressible. In reality, all real fluid will be viscous and will surely offer some resistance to flow. Therefore, there must be some losses in fluid flow and we will have to consider these losses also during application of Bernoulli's equation.

Therefore Bernoulli's equation for real fluid between two points could be mentioned as here.

$$\frac{P_1}{\rho g} + \frac{V_1^2}{2g} + Z_1 = \frac{P_2}{\rho g} + \frac{V_2^2}{2g} + Z_2 + h_L$$

h_L = Frictional head loss

When a fluid flows through a confined passage, such as a pipe or converging- diverging duct, velocity of the fluid changes in accordance with the equation of continuity. Consequent to the change in velocity, the change in pressure is governed by the Bernoulli's equation.

The total head at the entry to the duct, H_1 = The total head at any given cross section H_2

Procedure:

1. Measure the distance 'x' of each pressure tap location, located at entry- section ahead of the duct.
2. Calculate the area of the tank.
3. Calculate the flow-rate by noting the difference of water level for two minutes.
4. Once the flow becomes constant, measure the piezo-head with reference to the datum.
5. Note down the area of each tube.
6. Calculate the velocity head at each point and find the total head.
7. Plot the desired graphs.

Observations:

The value of Q =

Tube no.(or) Position of Section	**rea, A (m^2)**	**Potential head ,Z (m)**	**Pressure head (or)Piezometric reading, h=$P/\varrho g$ (m)**	**Velocity V = Q/A**	**Velocity head $\frac{v^2}{2g}$**	**Total head (H) (Or)Total energy**
1	$0.500x10^{-3}$	0.016				
2	$0.425x10^{-3}$	0.0145				
3	$0.350x10^{-3}$	0.013				
4	$0.250x10^{-3}$	0.011				
5	$0.300x10^{-3}$	0.012				
6	$0.350x10^{-3}$	0.013				
7	$0.400x10^{-3}$	0.014				
8	$0.450x10^{-3}$	0.015				

9	$0.475x10^{-3}$	0.0155				
10	$0.500x10^{-3}$	0.016				
11	$0.550x10^{-3}$	0.017				
Average						

Calculations:

Volume of water Collected in tank (V) = 0.6 X 0.4 X Height of water Column in piezometer

Discharge, $Q = \frac{\textit{volume of water collected (V)}}{\textit{Time taken (t)}}$ m^3/sec

Velocity at section 1 $= Q/A_1$ m/s

Velocity head at section 1 = $V_1^2 / 2g$ m/s

Total head at section 1 = Pressure head + Potential head + Velocity head

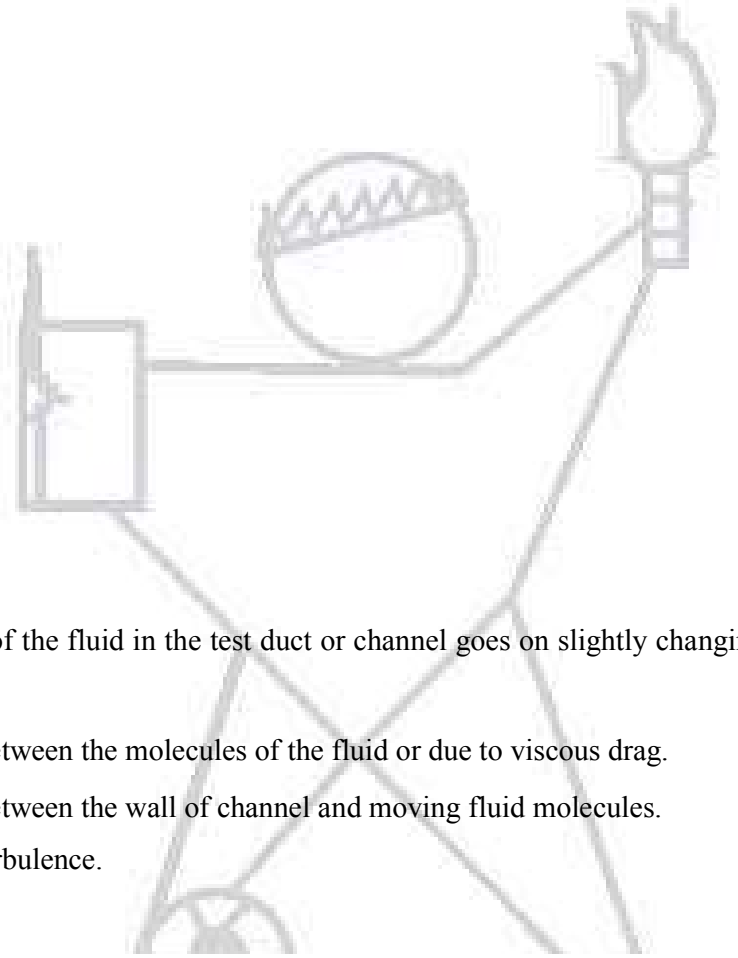
Head loss between sections 1 & 2 = H_1-H_2

Head loss between sections 2 & 5 = H_2-H_5

Head loss between sections 6& 9 = H_6-H_9

Head loss between sections 10 & 11 = H_{10}-H_{11}

Model Calculations:



Conclusion: -

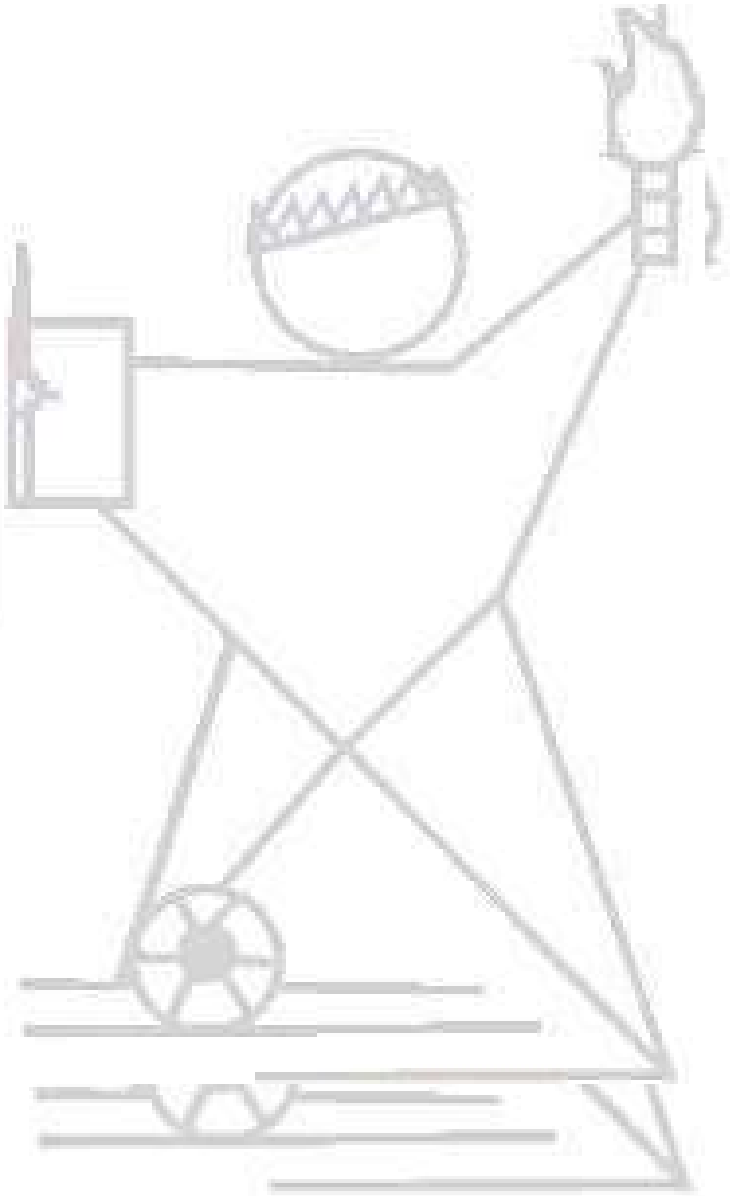
The total energy of the fluid in the test duct or channel goes on slightly changing due to the energy lost in:

1. Friction between the molecules of the fluid or due to viscous drag.
2. Friction between the wall of channel and moving fluid molecules.
3. Duct to turbulence.

Questions:

1. What is Bernoulli equation?
2. What are the assumptions used in Bernoulli Equation?
3. To which fluids is the Bernoulli equation applicable?

Blank space for Answers



Experiment No.3

Aim: - To study of four-stroke and two Stroke Petrol (SI) Engines.

Apparatus Used: - Model of Four-stroke and Two Stroke Petrol Engines.

Theory

Heat Engine: - The device which converts the chemical energy of the fuel into heat energy and this heat energy is further converted into mechanical work is termed as a heat engine.

Heat engines may be classified into two main classes as follows:-

1. **Internal combustion engine**: - The engine in which the combustion of fuel takes place inside the engine cylinder is known as internal combustion engine.
2. **External combustion engine**: - The engine in which the combustion of fuel takes place outside the engine cylinder is known as external combustion engine.

Main Parts of the Petrol Engine:

1. Cylinder & Cylinder Head
2. Piston
3. Piston Rings
4. Gudgeon Pin
5. Connecting Rod
6. Crank Shaft
7. Crank
8. Engine Bearing
9. Crank Case
10. Fly Wheel
11. Governor
12. Valves
13. Spark Plug
14. Carburettor
15. Cam & Cam Shaft

Working Process of Four Stroke Petrol Engine

In four stroke petrol engine or spark ignition engine all the events of the cycle i.e. suction, compression, expansion and exhaust take place in two revolutions of the crank shaft I.e. 720° of the crank rotation. Thus each stroke is of 180° crank shaft rotation. Therefore the cycle of operation for an ideal four stroke engine consists of the following four strokes:

Suction Stroke- The piston moves from Top Dead Centre (TDC) to Bottom Dead Centre (BDC). The inlet valve opens and a fresh charge of fuel and air mixture enters the cylinder. The

exhaust valve remains closed. When the piston reaches Bottom Dead Centre (BDC), the inlet valve also closed.

Compression Stroke- The piston moves from Bottom Dead Centre (BDC) to Top Dead Centre (TDC) position. Both the valves remain closed. The charge drawn during suction stroke is compressed in this stroke.

Expansion or Power or Working Stroke- Just before the piston completes its compression stroke, the charge is ignited by the spark plug and the rapid explosion takes place. The expansion of hot gases pushes the piston down to BDC position. Both the valve remains closed and the useful work is obtained from the engine.

Exhaust Stroke- The piston moves from BDC to TDC, the exhaust valve opens and the inlet valve remains closed. The piston pushes the exhaust gases out through the exhaust valve to the atmosphere till it reaches the TDC.

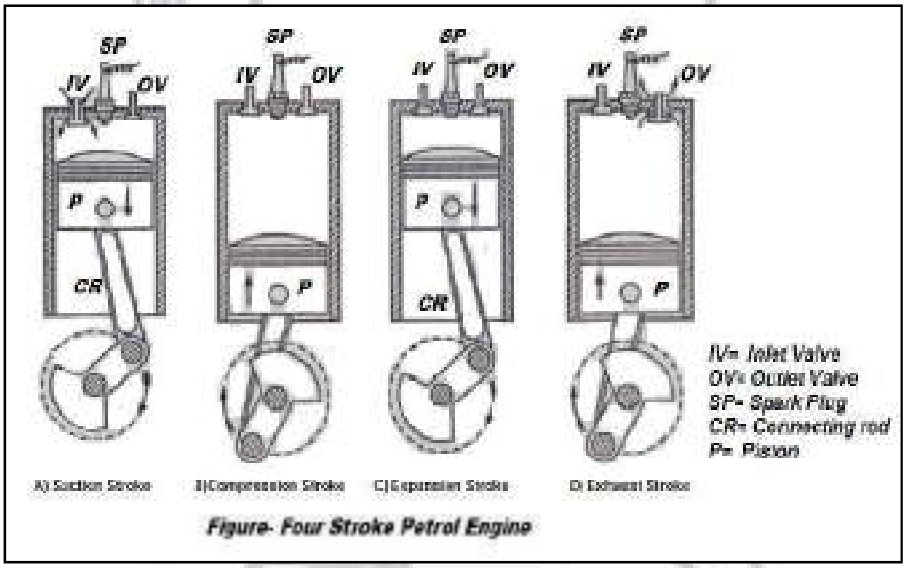


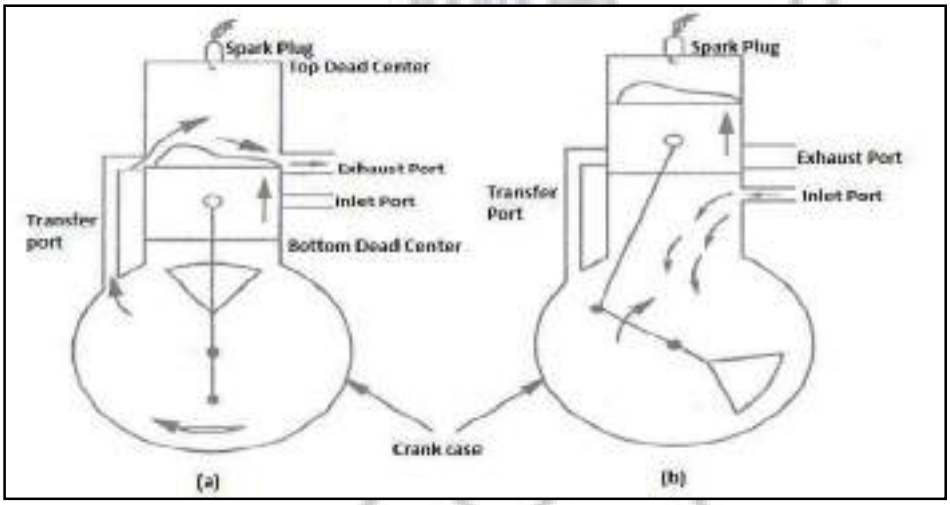
Fig. Working of Four Stroke Petrol Engines

Working Process of Two Stroke Petrol Engine:

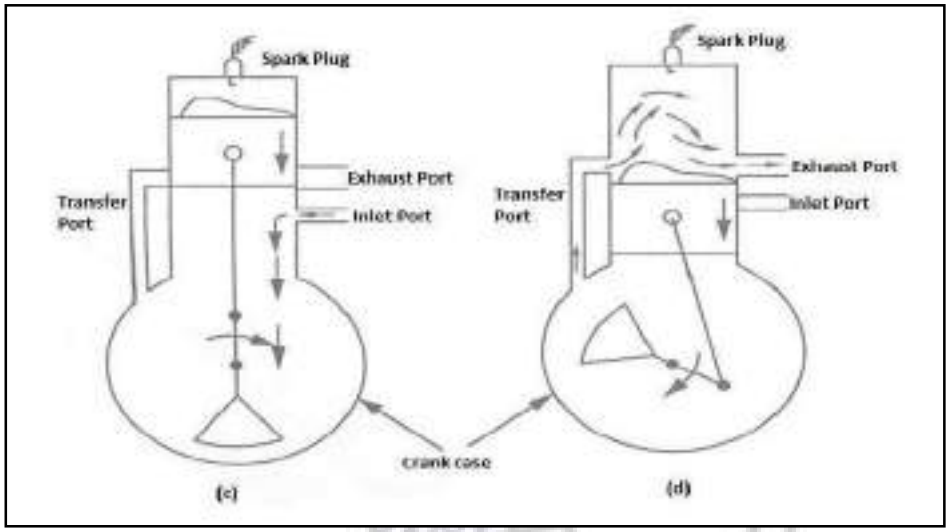
In two stroke cycle petrol engine, there are two strokes of the piston and one revolution of the crankshaft to complete one cycle. In two stroke engines ports are used instead of valve i.e. suction port, transfer port and exhaust port. These ports are covered and uncovered by the up and down movement of the piston. The top of the piston is deflected to avoid mixing of fresh charge with exhaust gases. The exhaust gases are expelled out from the engine cylinder by the fresh

charge of fuel entering the cylinder. The mixture of air and petrol is ignited by an spark produced at the spark plug. The two stroke of the engine are-

First Stroke- Assuming the piston to be at the BDC position. The inlet port is converted by the piston whereas the transfer port and exhaust. port are uncovered. The piston moves from BDC to TDC. The air petrol mixture enters the cylinder. On the upward movement of the piston, first of all the transfer port is converted and then immediately, the exhaust port is covered. Simultaneously the suction port also gets uncovered, the upward movement of the piston helps to compress the air fuel mixture at the top and creates partial vacuum at the bottom in the crankcase which gets filled with air fuel mixture by the atmospheric pressure. At the end of the stroke, the piston reaches the TDC position completing the compression stroke as shown in Fig. (a) and (b).



Second Stroke- Just before the completion of the compression stroke, the compressed charge is ignited in the combustion chamber, by means of an electric spark produced by the spark plug. Combustion of air fuel mixture pushes the piston in the downward direction, on the power stroke producing useful work. The movement of the power action is over, the exhaust port is uncovered. The exhaust gases escape to the atmosphere. Further movement of the piston covers the inlet port and the fresh charge is compressed in the crankcase. Simultaneously the transfer port is also uncovered. The compressed mixture of air fuel enters the combustion chamber. The deflected shape of the piston avoids inter-mixing of the fresh charge and exhaust gases i.e. the fresh charge rises to the top of the cylinder and pushes out most of the exhaust gases. Thus the three actions, power, exhaust and induction are completed from TDC to BDC position completing one cycle i.e. two stroke of the piston and one revolution of the crankshaft as shown in Fig. (c) and (d).



Applications:-

1. I.C. engine are used in all road vehicles i.e. automobiles trucks, tractors etc.
2. I.C. engine are widely used in rail road, aviation & marine.
3. I.C. engine are extensively used in lawn movers boats, concretes mining equipments etc.
4. Petrol engine are used in light motor vehicles.

Questions

1. Describe the working principle of 4-Stroke petrol Engine?
2. What is Suction Stroke?
3. What is compression Stroke?
4. Describe Expansion / Power Stroke?
5. Describe Exhaust Stroke?
6. What are the construction details of a four stroke petrol Engine?
7. Describe the working principle of 2-Stroke petrol Engine?
8. Describe What are the construction details of a four stroke petrol Engine?

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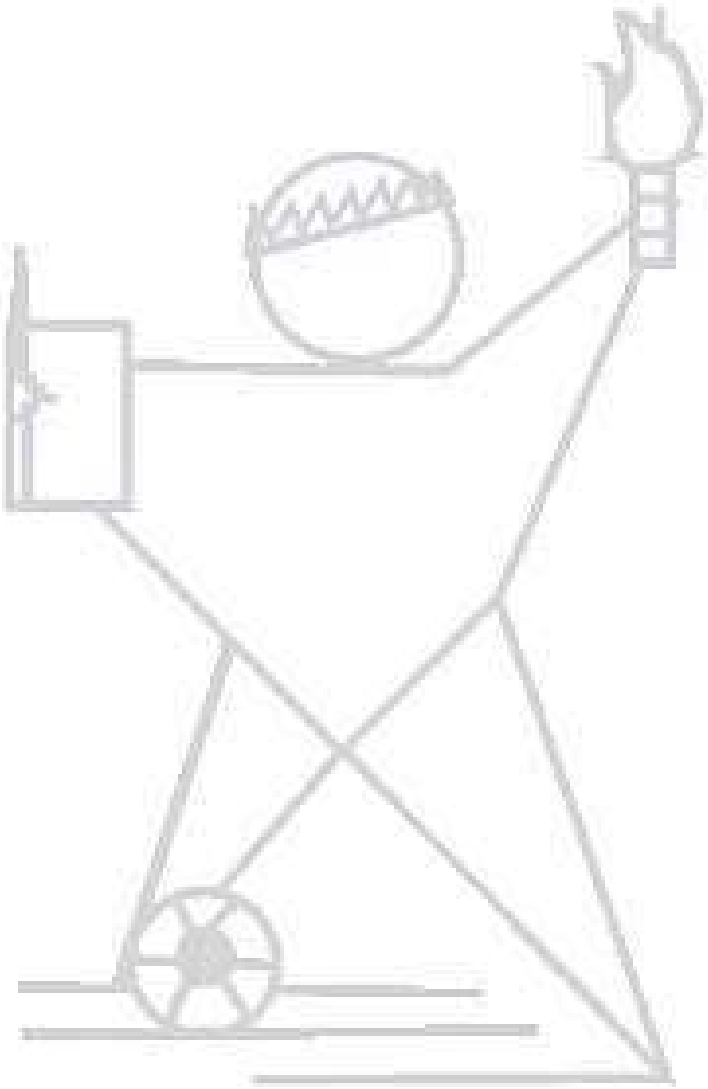

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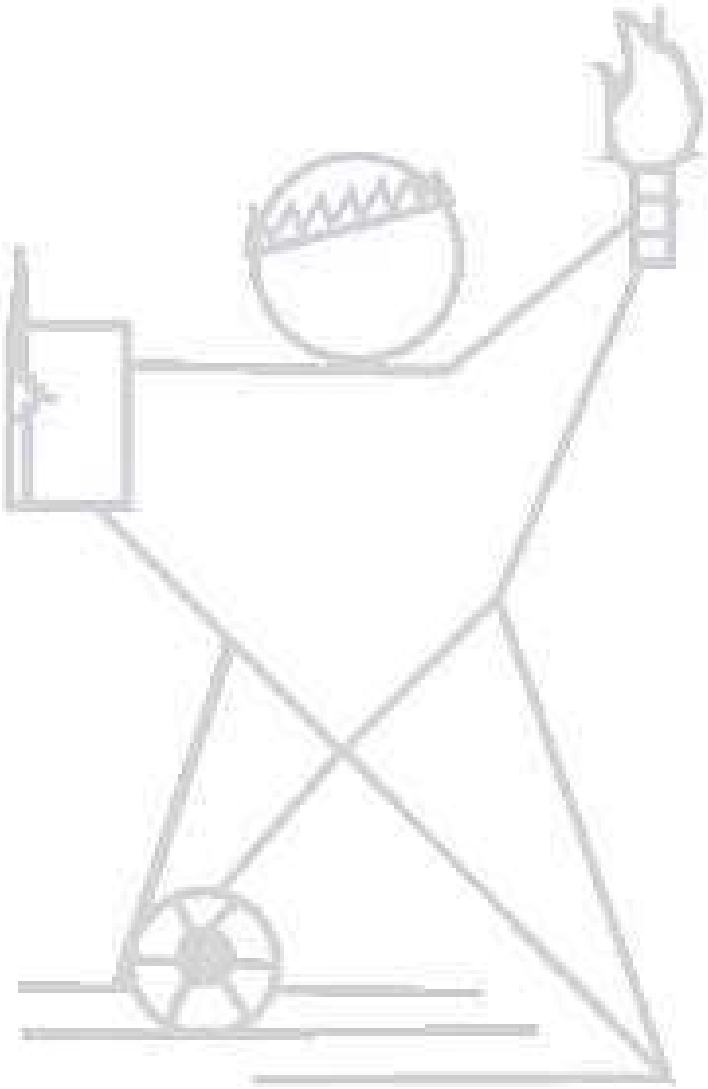

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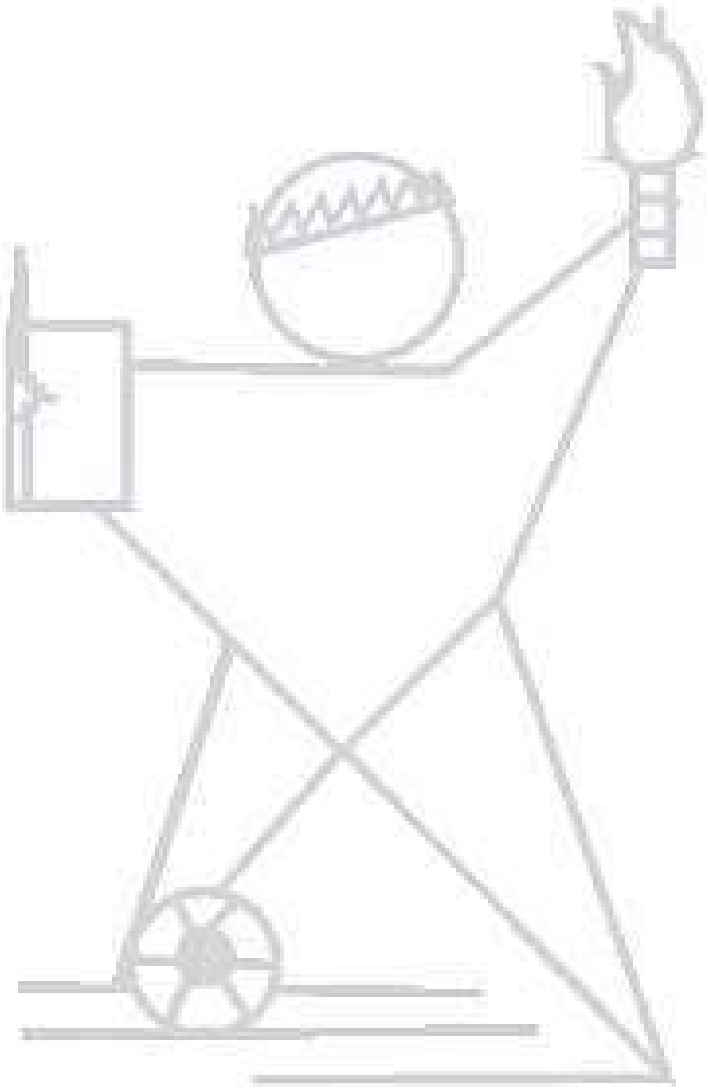


Experiment No. 4

Aim: - To study of Four-stroke and Two-stroke Diesel (CI) Engines.

Apparatus Used: - Model of Two-stroke & Four-stroke Diesel Engines.

Main Parts Of The Diesel Engine:

1. Cylinder & Cylinder Head
2. Piston
3. Piston Rings
4. Gudgeon Pin
5. Connecting Rod
6. Crank Shaft
7. Crank
8. Engine Bearing
9. Crank Case
10. Fly Wheel
11. Governor
12. Valves
13. Fuel Pump & Injector Unit
14. Cam & Cam Shaft

Working Process of Four Stroke Diesel Engines

Four-stroke cycle Diesel engine or Compression ignition engine or constant pressure cycle engine is meant for heavy duty applications, like heavy motor vehicles, stationary power plants, ships and big industrial units, train locomotive , tractor and bus application. In this the air compressed in the engine cylinder and fuel is injects through injector.

Suction Stroke-The inlet valve opens during this stroke and only air is sucked into the engine cylinder. The exhaust valve remains closed. When the piston reaches Bottom Dead Centre (BDC), the suction stroke is completed and inlet valve also closes as shown in Fig. (1).

Compression Stroke The piston moves from Bottom Dead Centre (BDC) to Top Dead Centre (TDC) position. Both the valves remain closed. The air drawn during suction stroke is compressed.

Expansion or Power or Working Stroke- Just before the piston completes its compression stroke, the diesel injected gets ignited and the rapid explosion takes place. The expansion of hot gases pushes the piston down to BDC position. Both the valve remains closed and the useful work is obtained from the engine.

Exhaust Stroke- The piston moves from BDC to TDC, the exhaust valve opens and the inlet valve remains closed. The piston pushes the exhaust gases out through the exhaust valve to the atmosphere till it reaches the TDC position and the cycle is completed.

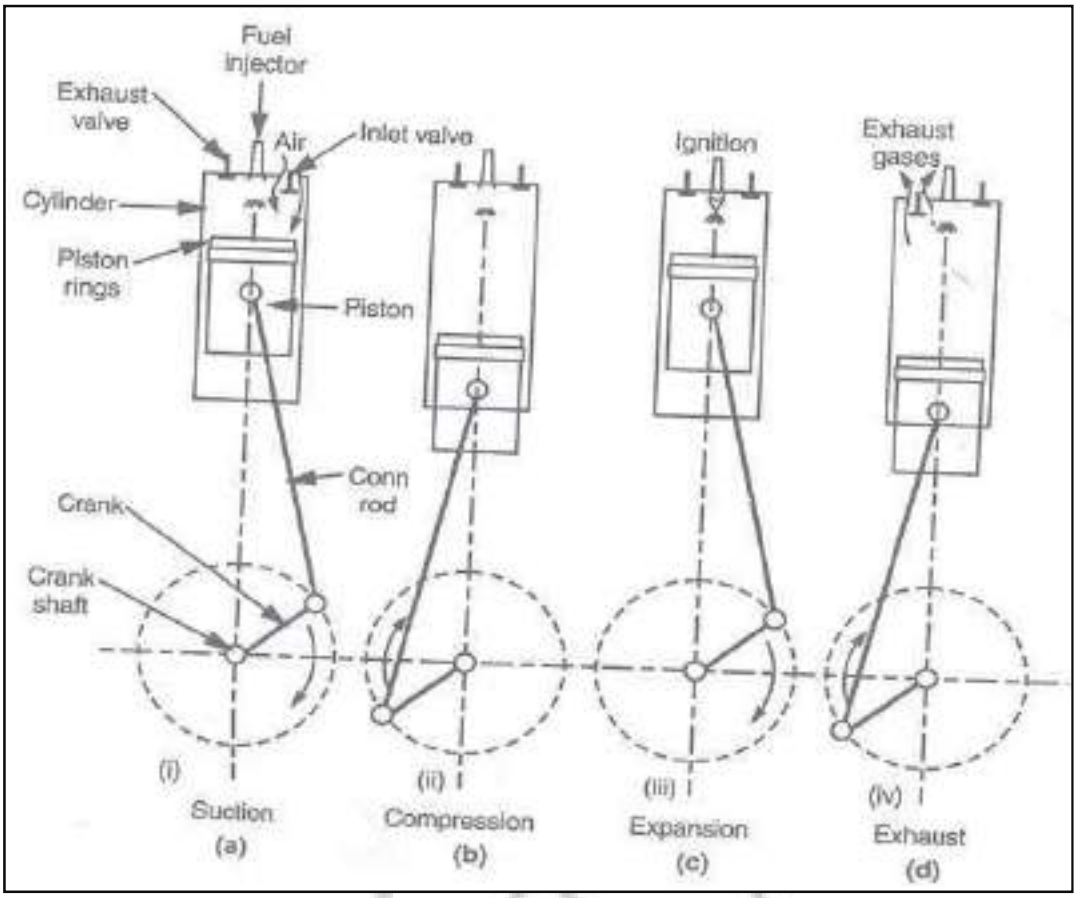


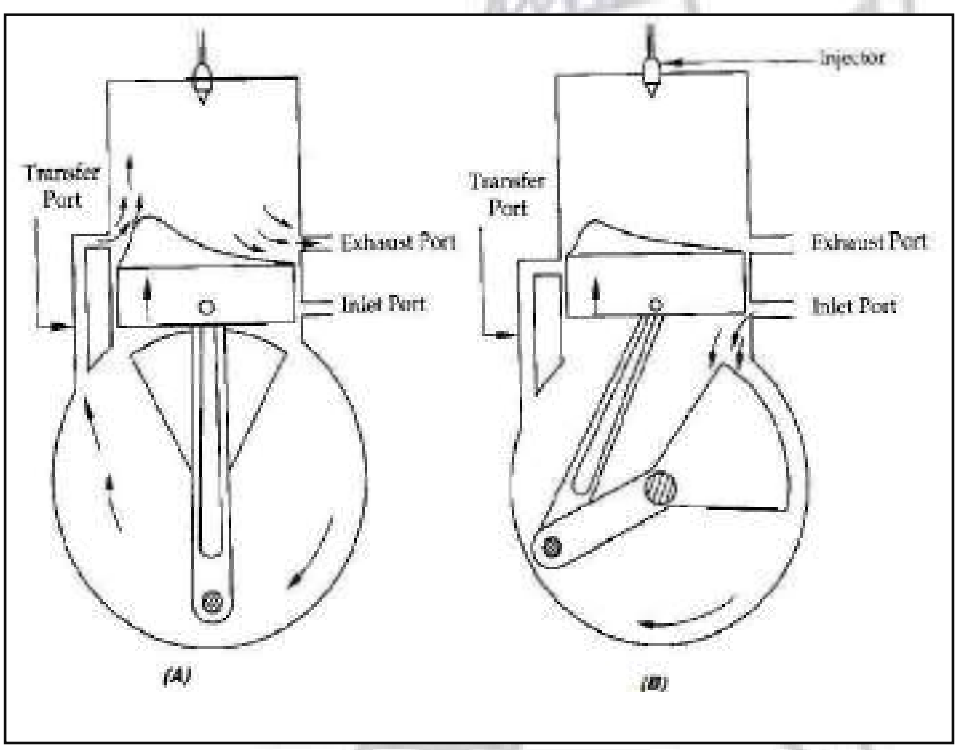
Fig. Working of Four stroke Diesel Engine

Working Process Of Two Stroke Diesel Engine:

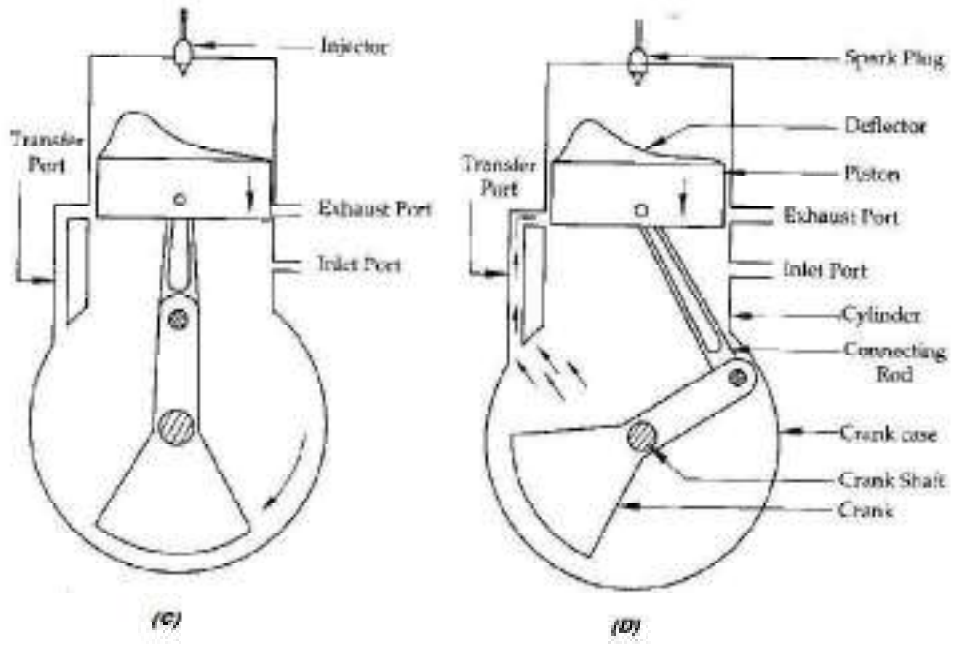
Two Stroke Diesel (C.I. Engine)

The working principle of a two stroke diesel engine is discussed below:

1st stroke: To start with let us assume the piston to be at its B.D.C. position (Fig.a). The arrangement of the ports is such that the piston performs the two jobs simultaneously. As the piston starts rising from its B.D.C. position, if closes the transfer port and the exhaust port. The air which is already there in the cylinder is compressed (Fig. b). At the same time with the upward movement of the piston, vacuum is created in the crank case. As soon as the inlet port is uncovered, the fresh air is sucked in the crank case. The charging is continued until the crank case and the space in the cylinder beneath the piston is filled (Fig. c) with the air. At the end of the stroke, the piston reaches the T.D.C. Position.



2nd stroke: Slightly before the completion of the compression stroke, a very fine sprays of diesel injected into the compressed air. The fuel ignites spontaneously. Pressure is exerted on the crown of the piston due to the combustion of the air and the piston is pushed in the downward direction producing some useful power (Fig. c). The downward movement of the piston will first close the inlet port and then it will compress the air already sucked in the crankcase. Just the end of power stroke, the piston uncovers the exhaust port and the transfer port simultaneously. The expanded gases start escaping through the exhaust port and at the same time transfer port (Fig. d) and thus the cycle is repeated again. The fresh air coming into the cylinder also helps in exhausting the burnt gases out of the cylinder through the exhaust port (Fig. d). This is known as scavenging.

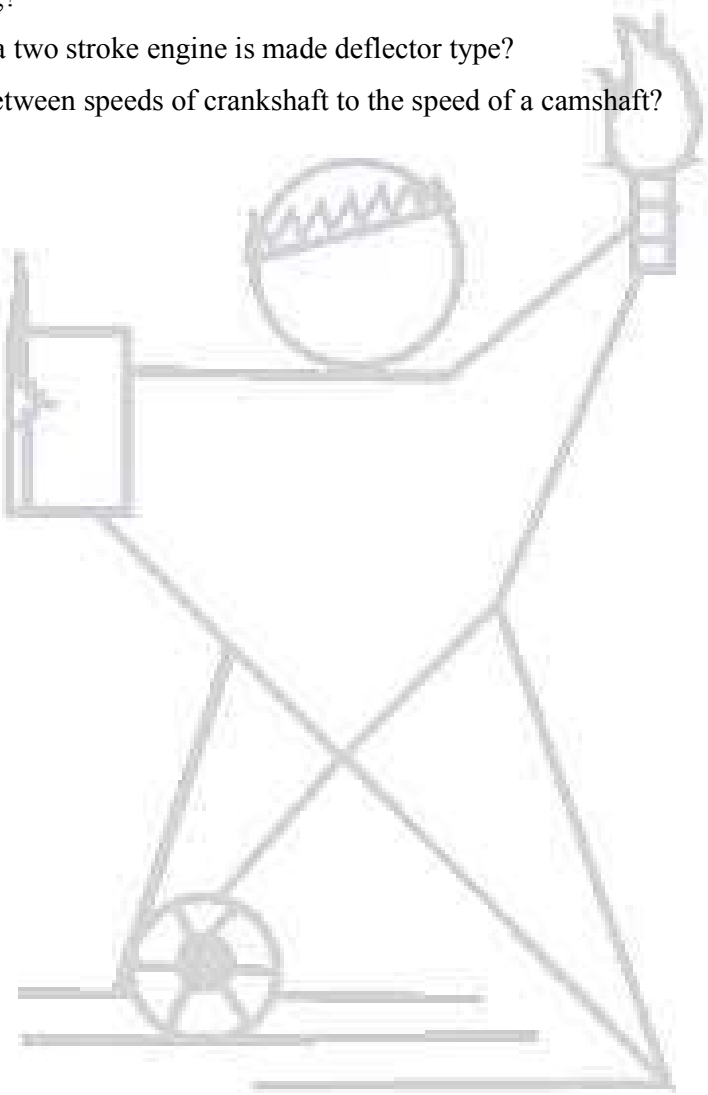


Applications:-

1. I.C. engine are used in all road vehicles i.e. automobiles trucks, tractors etc.
2. I.C. engine are widely used in rail road, aviation & marine.
3. I.C. engine are extensively used in lawn movers boats, concretes mining equipments etc.
4. Petrol engine are used in light motor vehicles.

Questions:-

1. What is compression ratio?
2. What is the range of compression ratio for SI and CI engines?
3. Why the compression ratio is higher in case of Diesel engines then Petrol engines?
4. Why the spark plug is not used in Diesel engines?
5. What is self ignition temperature?
6. What is scavenging?
7. Why the piston of a two stroke engine is made deflector type?
8. What is the ratio between speeds of crankshaft to the speed of a camshaft?



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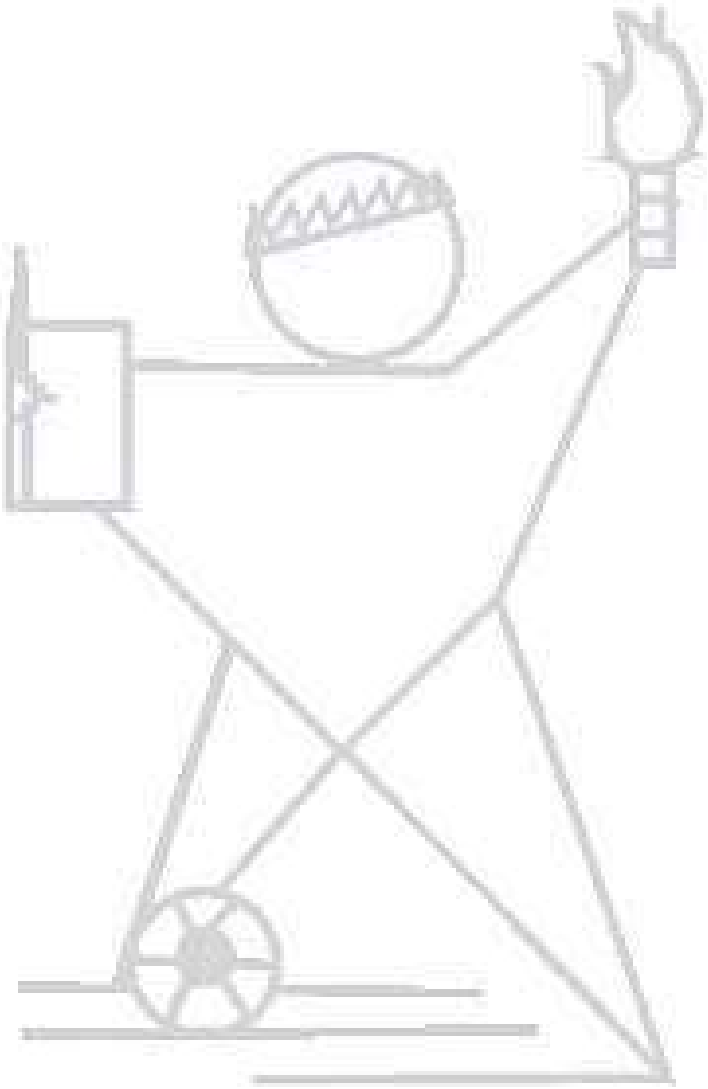

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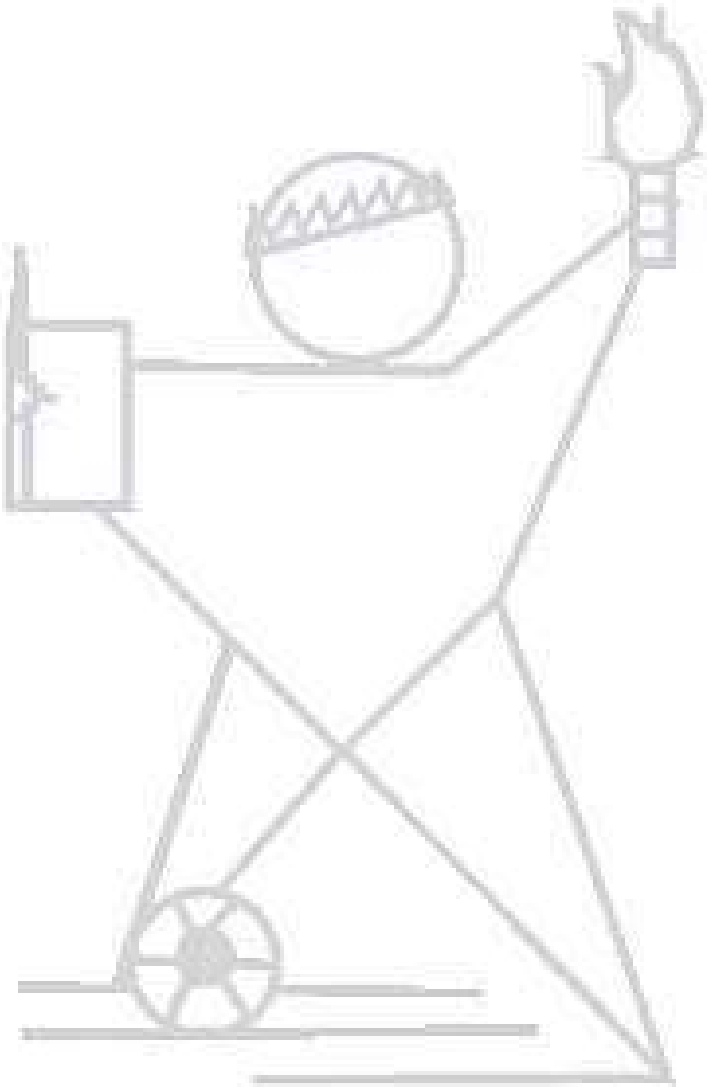

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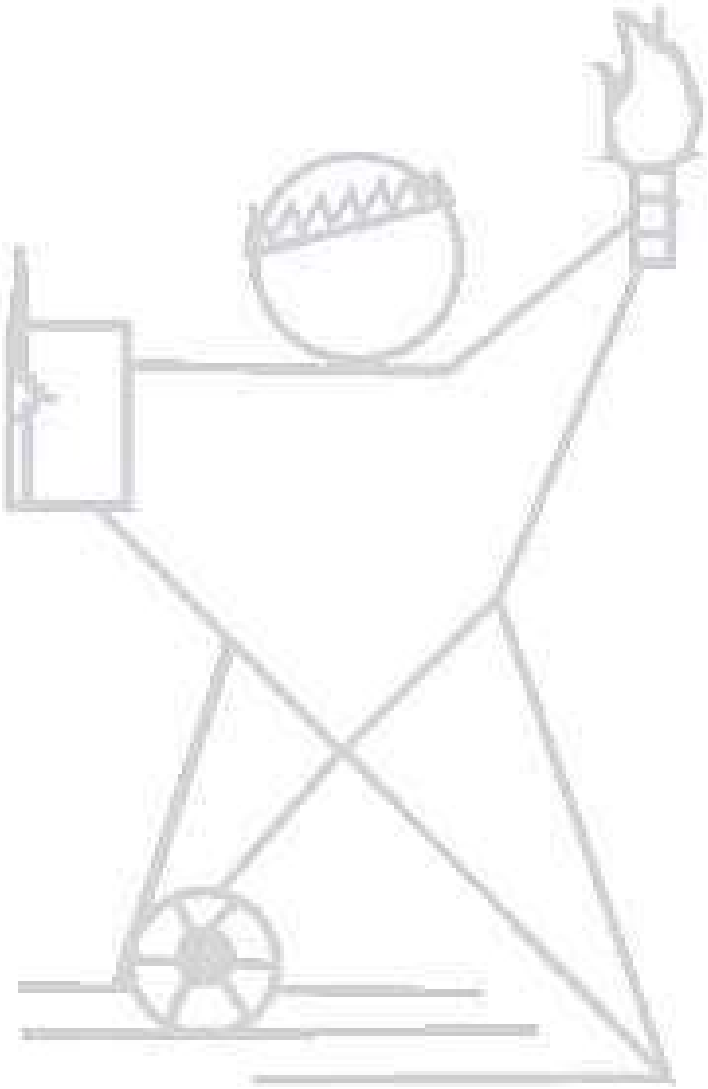


Experiment No: 5

Aim: - Study of Boilers, their Mounting and Accessories.

Apparatus: - Model of Cochran Boiler, Babcock & Wilcox Boiler, Model of Mountings and accessories of boiler

Theory:-

Boiler: - A steam boiler is a closed vessel in which steam is produced from water by combustion of fuel.

Classification of Boiler:

Boilers are classified on the basis of following-

1. According to contents in the Tube:

A) Fire tube boiler: In fire tube boilers, the flue gases pass through the tube and water surround them.

B) Water tube boiler: In water tube boiler, water flows inside the tubes and the hot flue gases flow outside the tubes.

2. According to the pressure of steam:

A) Low pressure boiler: A boiler which generates steam at a pressure of below 80 bars is called low pressure boiler. Example- Cochran boiler, Lancashire boiler etc.

B) High pressure boiler: A boiler which generates steam at a pressure higher than 80 bar is called high pressure boiler. Example- Babcock and Wilcox boiler etc.

3. According to method of circulation of water:

A) Natural Circulation: In natural circulation boiler, circulation of water due to gravity or the circulation of water takes place by natural convection current produced by the application of heat, example-Babcock and Wilcox boiler, Lancashire boiler etc.

B) Forced Circulation: In the forced circulation boiler, circulation of water by a pump to increase the circulation. Example- Lamont boiler etc.

4. According to the Position of the furnace:

A) Internally fired boilers: In this, the furnace is located inside the boiler shell. Example- Cochran, Locomotive and Lancashire boilers.

B) Externally fired boilers: In this, the furnace is located outside the boiler shell. Example- Babcock and Wilcox boiler etc.

5. According to the axis of shell:

A) Vertical boilers: If the axis of the shell of boiler is vertical so the boiler is called as vertical boiler.

B) Horizontal boilers: If the axis of the shell of boiler is horizontal so the boiler is called as Horizontal boilers.

C**) Inclined boilers:** If the axis of the shell of boiler is Inclined so the boiler is called as Inclined boiler.

COCHRAN BOILER

Cochran boiler is a vertical, multi-tubular, fire tube, internally fired, natural circulation boiler.

Construction:

Figure shows a Cochran boiler. It consists of a vertical cylindrical shell having a hemispherical top and furnace is also hemispherical in shape. The fire grate is arranged in the furnace and the ash pit is provided below the grate. A fire door is attached on the fire box. Adjacent to the fire box, the boiler has a combustion chamber which is lined with fire bricks. Smoke or fire tubes are provided with combustion chamber. These tubes are equal in length and arranged in a group with wide space in between them.

The ends of these smoke tubes are fitted in the smoke box. The chimney is provided at the top of the smoke box for discharge of the gases to the atmosphere. The furnace is surrounded by water on all sides except at the opening for the fire door and the combustion chamber. The smoke tubes are also completely surrounded by water.

Different boiler mountings and accessories are located at their proper place.

Working:

The hot gas produced from the burning of the fuel on the grate rises up through the flue pipe and reaches the combustion chamber. The flue gases from the combustion pass through the fire tubes and the smoke box and finally are discharged through the chimney. The flue gases during their travel from fire box to the chimney gives heat to the surrounding water to generate steam.

Specification of Cochran Boiler:

Diameter of the drum → 0.9 m to 2.75 m

Steam pressure → 6.5 bar up to 15 bar

Heating surface → 120m^2

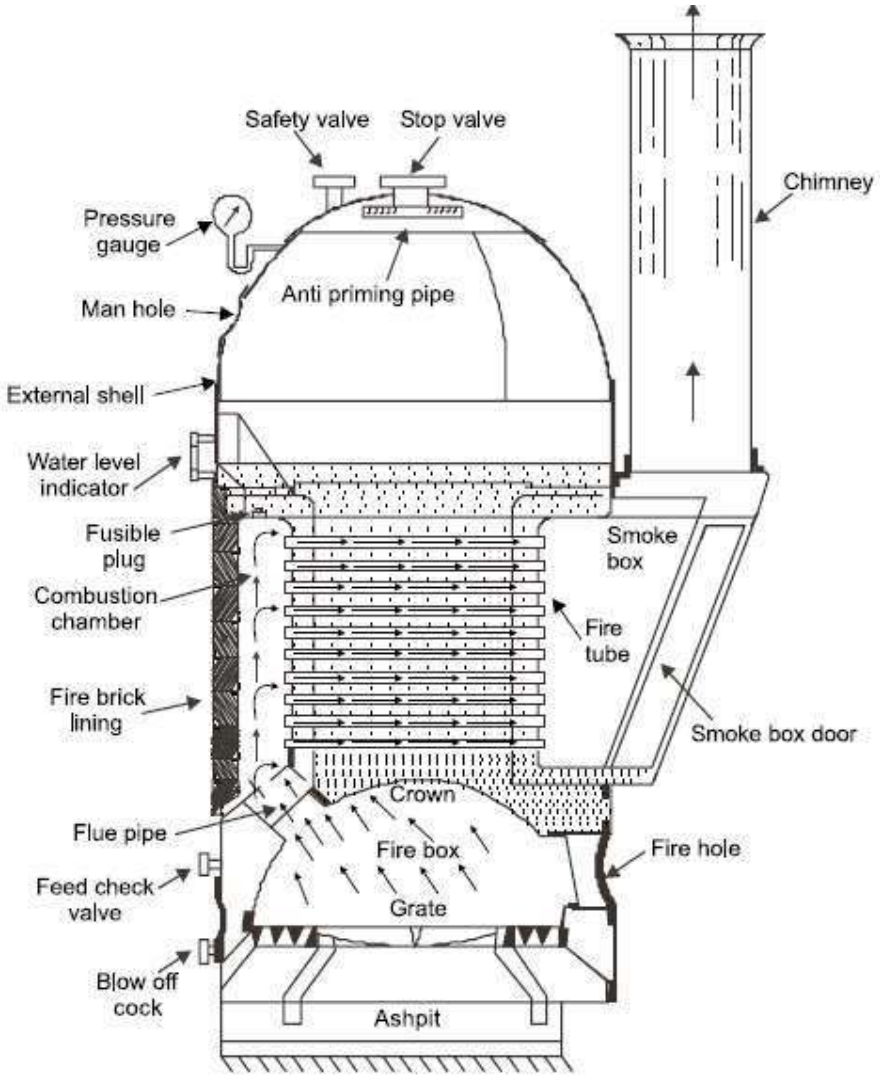
Maximum evaporative capacity → 4000 Kg/hr of steam

Height of the shell → 5.79m

No of tubes → 165

External diameter of flue tube → 62.5mm

Efficiency → 70 to 75%


Safety valve
Stop valve
Chimney
Pressure gauge
Anti priming pipe
Man hole
External shell
Water level indicator
Fusible plug
Smoke box
Combustion chamber
Fire tube
Fire brick lining
Smoke box door
Crown
Flue pipe
Fire box
Fire hole
Feed check valve
Grate
Blow off cock
Ashpit

Babcock & Wilcox Boiler:

Babcock and Wilcox boiler is a horizontal shell, multitubular, water tube, externally fired, natural circulation boiler.

Construction: Figure shows the details of a Babcock and Wilcox water tube boiler. It consists of a drum mounted at the top and connected by upper header and down take header. A large number of water tubes connect the uptake and down take headers. The water tubes are inclined at an angle of 5 to 15 degrees to promote water circulation. The heating surface of the unit is the outer surface of the tubes and half of the cylindrical surface of the water drum which is exposed to flue gases.

Below the uptake header the furnace of the boiler is arranged. The coal is fed to the chain grate stoker through the fire door. There is a bridge wall deflector which deflects the combustion gases upwards. Baffles are arranged across the water tubes to act as deflectors for the flue gases and to provide them with gas passes. Here, two baffles are arranged which provide three passes of the flue gases. A chimney is provided for the exit of the gases. A damper is placed at the inlet of the chimney to regulate the draught. There are superheating tubes for producing superheated steam. Connections are provided for other mounting and accessories.

Working:

The hot combustion gases produced by burning of fuel on the grater rise upwards and are deflected by the bridge wall deflector to pass over the front portion of water tubes and drum. By this way they complete the first pass. With the provision of baffles they are deflected downwards and complete the second pass. Again, with the provision of baffles they rise upwards and complete the third pass and finally come out through the chimney. During their travel they give heat to water and steam is formed. The flow path of the combustion gases is shown by the arrows outside the tubes. The circulation of water in the boiler is due to natural circulation set-up by Convective currents (due to gravity). Feed water is supplied by a feed check valve.

The hottest water and stem rise from the tubes to the uptake header and then through the riser it enters the boiler drum. The steam vapors escape through the upper half of the drum. The cold water flows from the drum to the rear header and thus the cycle is completed.

To get superheated steam, the steam accumulated in the steam space is allowed to enter into the super heater tubes which are placed above the water tubes. The flue gases passing over the flue tubes produce superheated steam. The steam thus superheated is finally supplied to the user through a steam stop valve.

Specification of Babcock and Wilcox Boiler:

Diameter of the drum → 1.22 m to 1.83 m

Length of the drum → 6.096 to 9.144 m

Size of water tubes → 7.62 to 10.16 cm

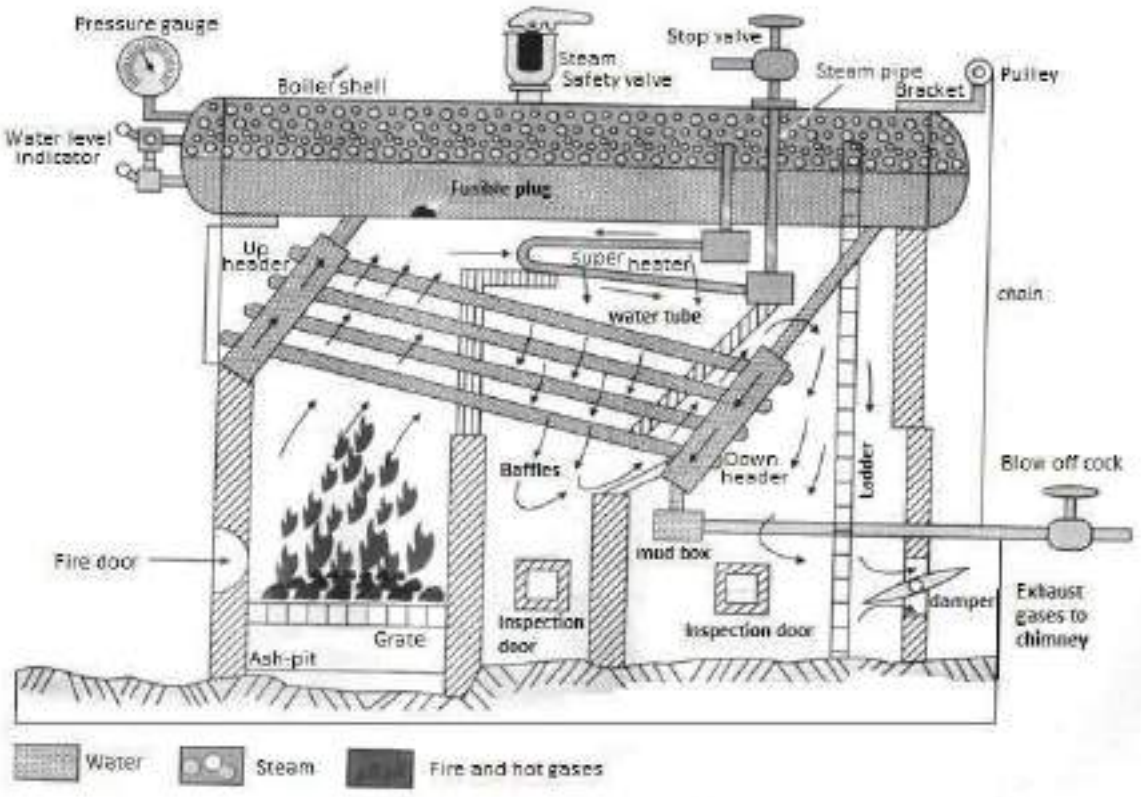
Size of super heater tube → 3.84 to n5.71 cm

Working pressure → 100bar

Steaming capacity → 40,000Kg/hr

(Maximum)

Efficiency → 60 to 80%



Babcock and Wilcox Boiler

Boiler Mountings:

The components which are fitted on the surface of the boiler for complete safety and control of steam generation process are known as boiler mountings. The following are the various important mountings of a boiler.

1. **Pressure Gauge-** It is usually mounted on the front top of the boiler shell. It is mounted on each boiler to show the pressure of the steam. Its dial is graduated to read the pressure in Kilograms per sq. centimeter. Bourdon's pressure gauge is commonly used as shown in Fig. The essential elements of this gauge are the elliptical spring tube which is made of bronze and is solid drawn. One end of this tube is attached by lines to a toothed quadrant and the other end is connected to a steam space.

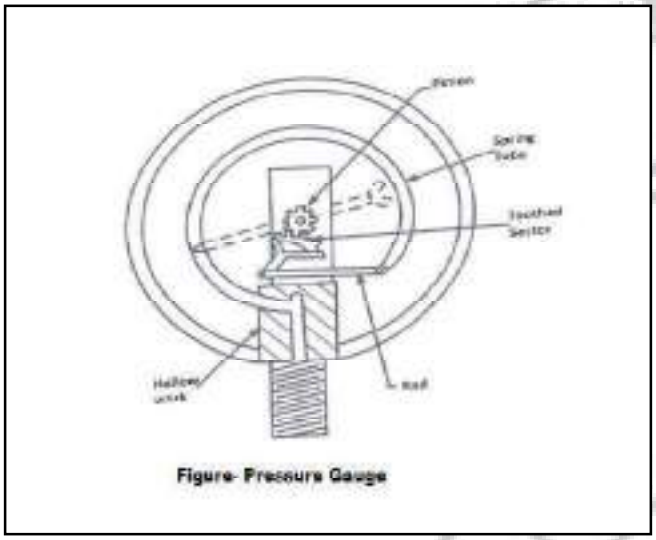


Figure- Pressure Gauge

2. **Safety Valves-** They are needed to blow off the steam when pressure of the steam in the boiler exceeds the working pressure. These are placed on the top of the boiler. There are four types of safety valves:

i. Dead weight safety valve
ii. Lever safety valve
iii. Spring loaded safety valve
iv. Low water high steam safety valve

Spring loaded safety valve- A spring loaded safety valve is mainly used for locomotives and marine boilers. In this type the valve is loaded by means of a spring, instead of dead weight. It consists of two valves, resting on their seats. Valve seats are mounted on the upper ends of two hallow valve chests, which are connected by a bridge. The lower end of these valves chests have common passage which may be connected to the boiler. There is a lever which has two pivots,

one of which is integral with it and the other is pin jointed to the lever. This pivot rests on the valves and forces them to rest on their respective seats with the help of a helical spring.

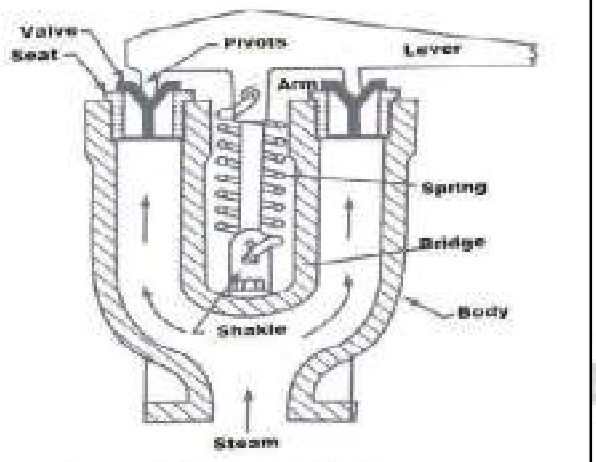


Figure- Spring Loaded Safety Valve

3. **Feed Check Valve**- A feed check valve is shown in Fig. The function of the feed check valve is to allow the supply of water to the boiler at high pressure continuously and to prevent the back flow the boiler when the pump pressure is less than boiler pressure or when pump fails. Feed check valve is fitted to the shell slightly below the normal water level of the boiler.

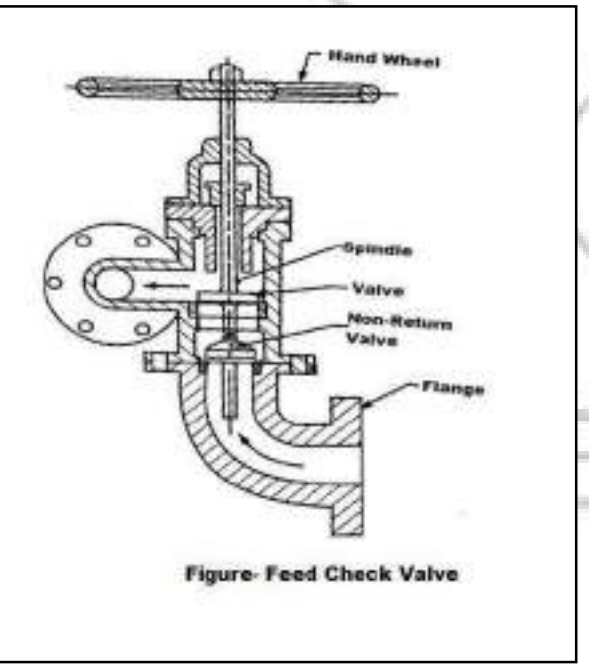


Figure- Feed Check Valve

4. **Fusible Plug-** It is fitted to the crown plate of the furnace of the fire. The function of fusible plug is to extinguish the fire in the fire box, when water level in the boiler comes down the limit and it prevents from blasting the boiler, melting the tube and overheating the fire-box crown plate. A

fusible plug is shown in fig. It is located in water space of the boiler. The fusible metal is protected from direct contact of water by gun metal plug and copper plug. When water level comes down, the fusible metal melts due to high heat and copper plug drops down and is held by gun metal ribs. Steam comes in contact with fire and distinguishes it. Thus it prevents boiler from damages.

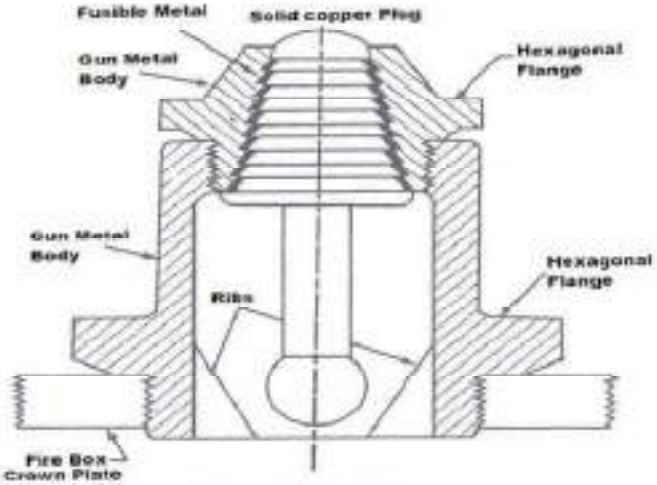


Figure- Fusible Plug

5. **Blow Off Cock-** The blow off cock as shown in fig., is fitted to the bottom of a boiler drum and consists of a conical plug fitted to body or casing. The casing is packed, with asbestos packing, in groves round the top and bottom of the plug. The asbestos packing is made tight and plug bears on the packing. Blow off cock has to principle function are:

    1. To empty the boiler whenever required.
    2. To discharge the mud, scale or sedimentation which are accumulated at the bottom of the boiler.

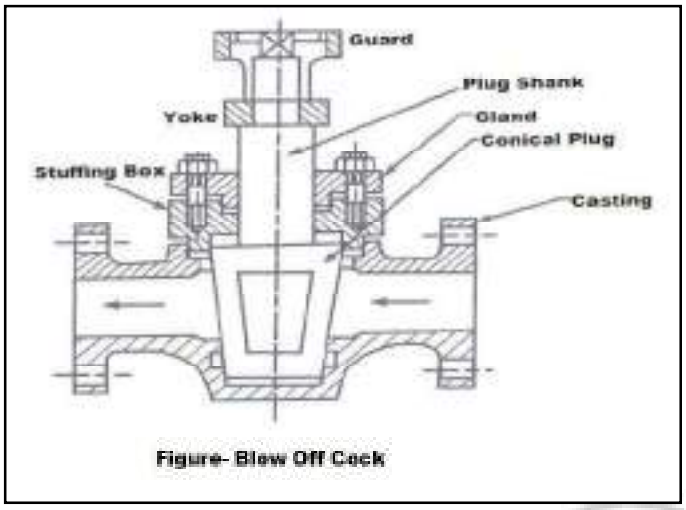


Figure- Blow Off Cock

6. **Water Level Indicator-** It is an important fitting, which indicates the water level inside the boiler to an observer. It is a safety device, up on which the correct working of the boiler depends. This fitting may be seen in froth of the boiler, and are generally two in number. The upper end of the valve opens in steam space while the lower end opens in the water. The valve consists of a strong glass tube. The end of the tube pass through stuffing boxes formed in the hollow casting. These casting are flanged and bolted to the boiler. It has three cocks; two of them control the passage between the boiler and glass tube, while the third one (the drain cock) remains closed.

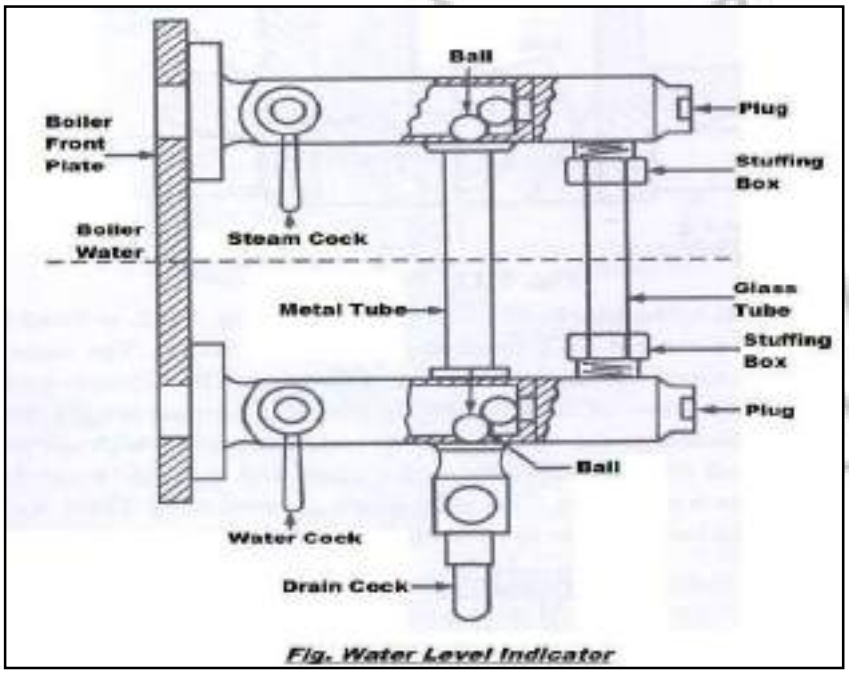


Fig. Water Level Indicator

7. **Steam Stop Valve-** A valve placed directly on a boiler and connected to the steam pipe which carries steam to the engine or turbine is called stop valve or junction valve. It is the largest valve on the steam boiler. It is, usually, fitted to the highest part of the shell by means of a flange.

   The principal functions of a stop valve are:

   1. To control the flow of steam from the boiler to the main steam pipe.
   2. To shut off the steam completely when required.

   The body of the stop valve is made of cast iron or cast steel. The valve seat and the nut, through which the valve spindle works, are made of brass or gun metal.

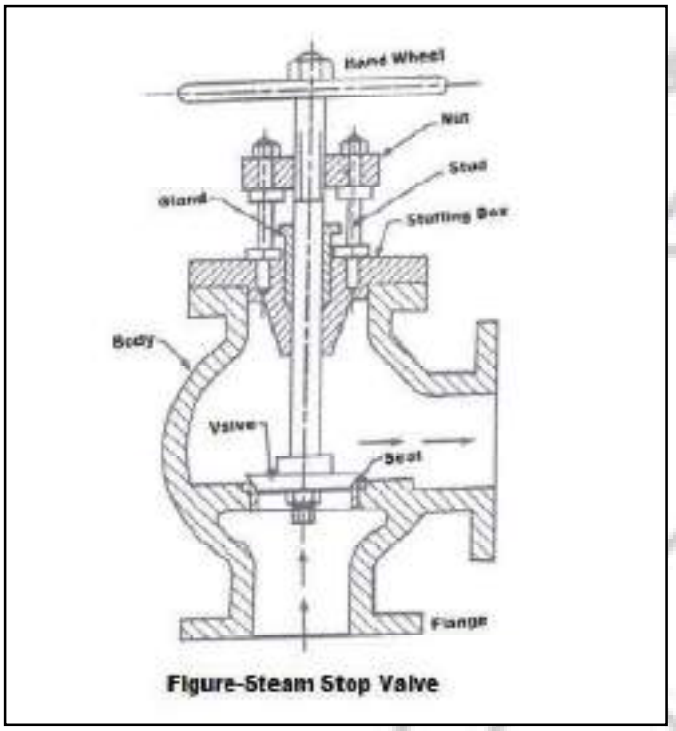


Figure-Steam Stop Valve

Boiler Accessories:

The appliances installed to increase the efficiency of the boiler are known as the boiler accessories. The commonly used accessories are:

1. **Economiser-** Economiser is a one type of heat exchange which exchanges the some parts of the waste heat of flue gas to the feed water. It is placed between the exit of the furnace and entry into the chimney. Generally economiser is placed after the feed pump because in economiser water may transfer into vapour partially, which creates a priming problem in feed pump water into the boiler drum. If economiser is used before feed pump it limits the temperature rise of water .It consists of vertical cast iron tubes attached with scraper. The function of scraper is to remove the root deposited on the tube, mechanically.

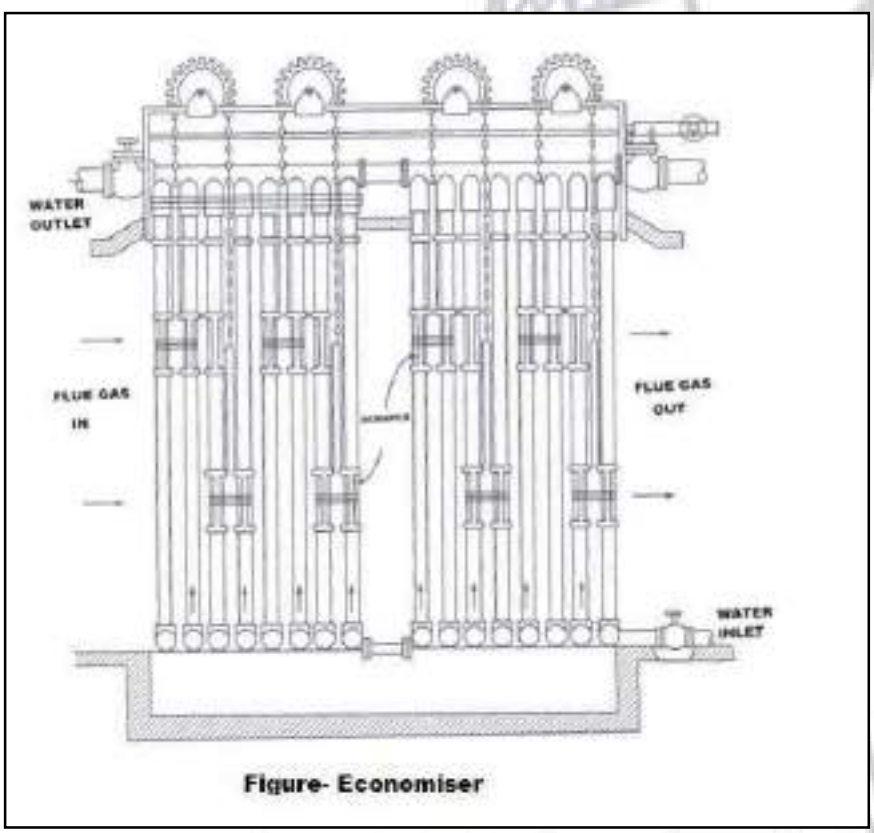


Figure- Economiser

2. **Steam Injector-** An injector is a device which is used to lift and force water into a boiler i.e. operating at high pressure. It consists of a group of nozzles, so arranged that steam expanding in these nozzles imparts its kinetic energy to a mass of water. There are many advantages of using injector such as they occupy minimum space, have low initial costs and maintenance cost. Though the steam required to operate the injector is much more than that in the feed pump for an equivalent duty; the injector has the advantage that practically the whole of the heat of the steam is returned back to the boiler.

3. **Super Heater-** An element of steam generating unit in which the steam is super heated, is known is super heater. A super heater is used to increase the temperature of saturated steam at constant pressure. It is usually placed in the path of hot flue gases and heat of the flue gases is first used to superheat the steam as shown in figure. The steam enters in the down-steam tube and leaves at the front header. The overheating of super heater tube is prevented by the use of a balanced damper which controls the flue gas. Steam consumption of turbine is reduced by about 1% for each 5.5°C of superheat.

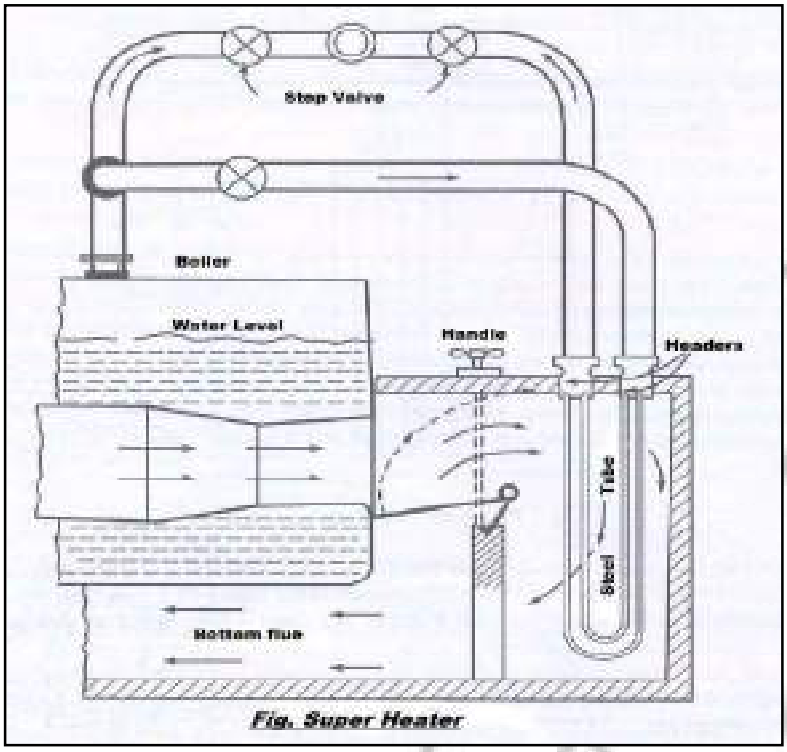


Fig. Super Heater

4. **Feed Pump-** The function of the feed pump is to pump the feed water to the boiler. The pumps may be rotary or reciprocating. The rotary pump is generally of high speed centrifugal type. They are driven by small steam turbine or by electric motor and are used when large quantity of water is to be supplied to boiler. The reciprocating pumps may be single or double acting. The most commonly used form of independent reciprocating feed pump is that in which the steam cylinder is directly connected to the rod or to the piston of the water cylinder.
5. **Air Pre-heater-** The function of air pre-heater is to increase the temperature of air before it enters the furnace. It is installed between the economizer and the chimney. The air required for the purpose of combustion is drawn through the air pre-heater and its temperature is raised when passed through ducts. The preheated air gives higher furnace temperature which results in more heat transfer to the water and reduces the fuel consumption. There are three types of pre-heaters:

1. Tubular type 2. Plate type 3. Regenerative type

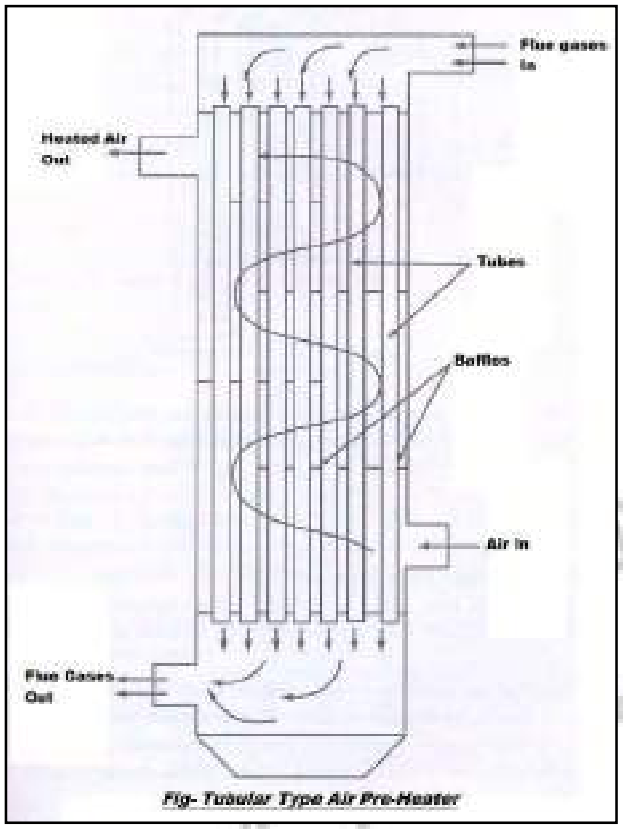


Fig- Tubular Type Air Pre-Heater

Indian Boiler Regulations:

Indian Boiler Regulations are the standards in respect of materials, design and construction, inspection and testing of boilers and boiler components for compliance by the manufacturer's and users of boilers in the country. These regulations are being updated regularly by amending them in line with fast changes in boiler technology by the Central Boilers Board. With the globalization of Indian economy and the competition it is facing with the foreign companies, it is prudent to impart the latest information about the international standards and technology without loss of time. Act, 1937. A Board called the Central Boilers Board was accordingly constituted in the year 1937

Steam Boilers are of very ancient origin. The introduction of famous James Watt's improved steam engine from 1769 to 1775 onwards resulted in great improvement in steam plants.

In the year 1863, a very serious boiler explosion occurred in Calcutta which caused the loss of several lives. As a result of this explosion, the necessity of inspection of boilers was widely recognized and a bill was introduced in the Bengal Council to provide for the inspection of steam boilers. In the year 1864, the Bengal Act VI of 1864 was passed which provided for the

inspection of steam boilers and prime movers in the town and suburbs of Calcutta. This is the beginning of boiler legislation in India.

Following the Bengal Act of 1864, each of the other provinces framed legislation. At that time there were seven different Acts and seven different sets of rules and regulations. Those Acts and rules & regulations were inconsistent with one another. As the differences in the Acts and rules and regulations among the various provinces in India gave rise to many difficulties and hampered the development of industries, the Central Government appointed a committee called "The Boiler Law Committee" in 1920 to examine and report on the general question of boiler legislation in India.

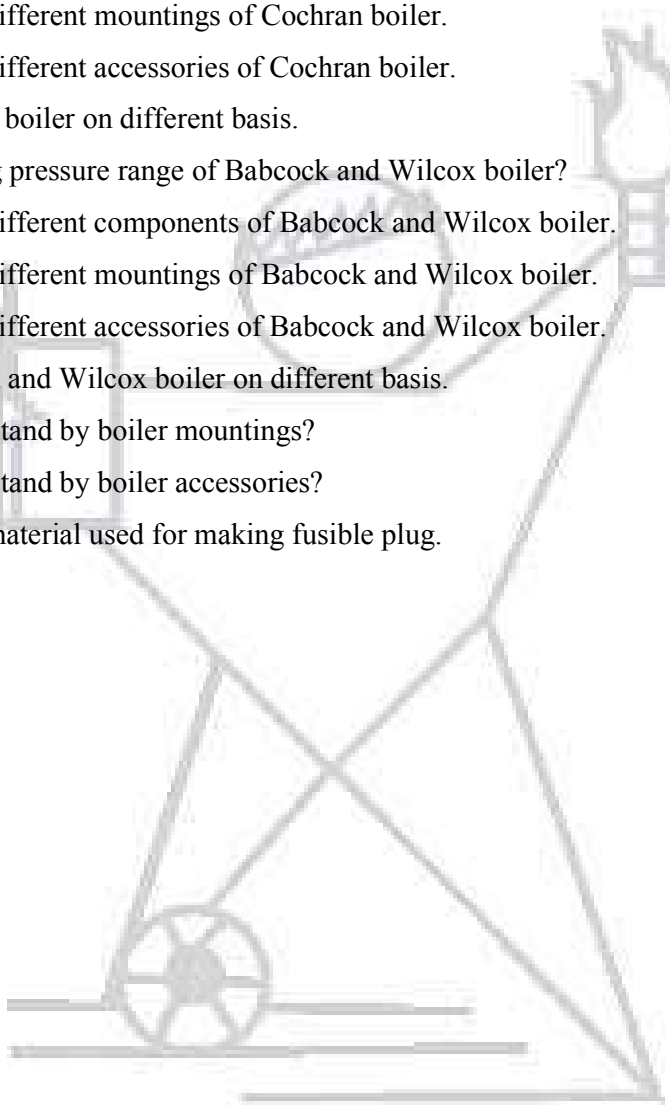
The Boiler Laws Committee, 1920-21, the first to review the boiler laws on a national scale reported in March, 1921. The report criticized the differences in the Acts, rules and regulations. The report also pointed out that in the inspection of boilers the personal element was a weighty factor, and the difference in regulations resulted in what was termed as "provincial jealousy". The report stressed that all provinces should be subject to the same regulations and work done in one province should be accepted as correct in another province. The Committee recommended that regulations to cover the standard conditions for material, design and construction of boilers should be framed by Government of India and make applicable to all the provinces. The report also pointed out that regulations were entirely of technical nature and there was no reason for which these regulations would be affected by local conditions. The Committee prepared a draft Act on the lines of which, the basic All-India Act was passed in 1923. The Boiler Laws Committee also prepared a uniform set of technical regulations and a model set of administrative rules. A sharp distinction was drawn between the regulations and the rules. The regulations referred entirely to technical matters where as the rules referred to questions concerning the administration of the Act. Indian Boiler act, 1923 provides for the safety of life and property of persons from the danger of explosion of boilers.

The Government of India Act, 1935 assigned the subject 'Boilers' to the concurrent field. The provision for constituting Central Boilers Board having the authority to make regulations consistent with the Act was made in the Indian Boilers (Amendment) Act, 1937. A Board called the Central Boilers Board was accordingly constituted in the year 1937.

The Central Boilers Board in exercise of the powers conferred under section 28 of the said Act, formulated regulations on boilers. The current version of these regulations is known as the Indian Boiler Regulations, 1950 with amendments up to 22nd February, 2005

Questions

1. Write the name of different components of Cochran boiler.
2. Write the name of different mountings of Cochran boiler.
3. Write the name of different accessories of Cochran boiler.
4. Categorize Cochran boiler on different basis.
5. What is the working pressure range of Babcock and Wilcox boiler?
6. Write the name of different components of Babcock and Wilcox boiler.
7. Write the name of different mountings of Babcock and Wilcox boiler.
8. Write the name of different accessories of Babcock and Wilcox boiler.
9. Categorize Babcock and Wilcox boiler on different basis.
10. What do you understand by boiler mountings?
11. What do you understand by boiler accessories?
12. Write the name of material used for making fusible plug.



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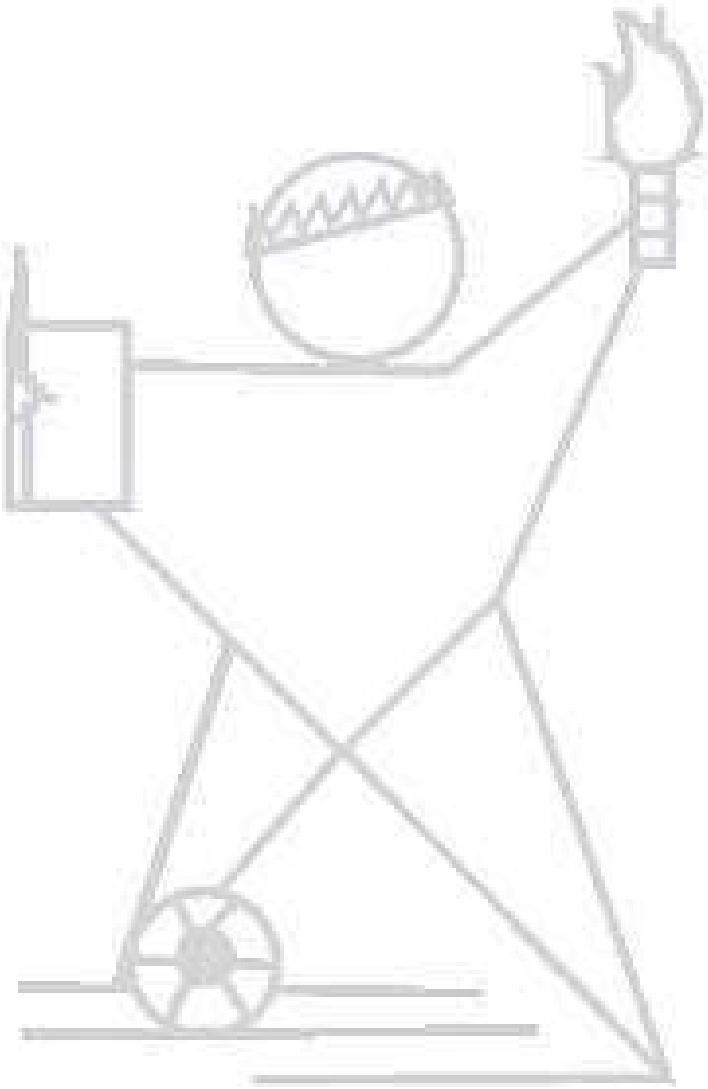

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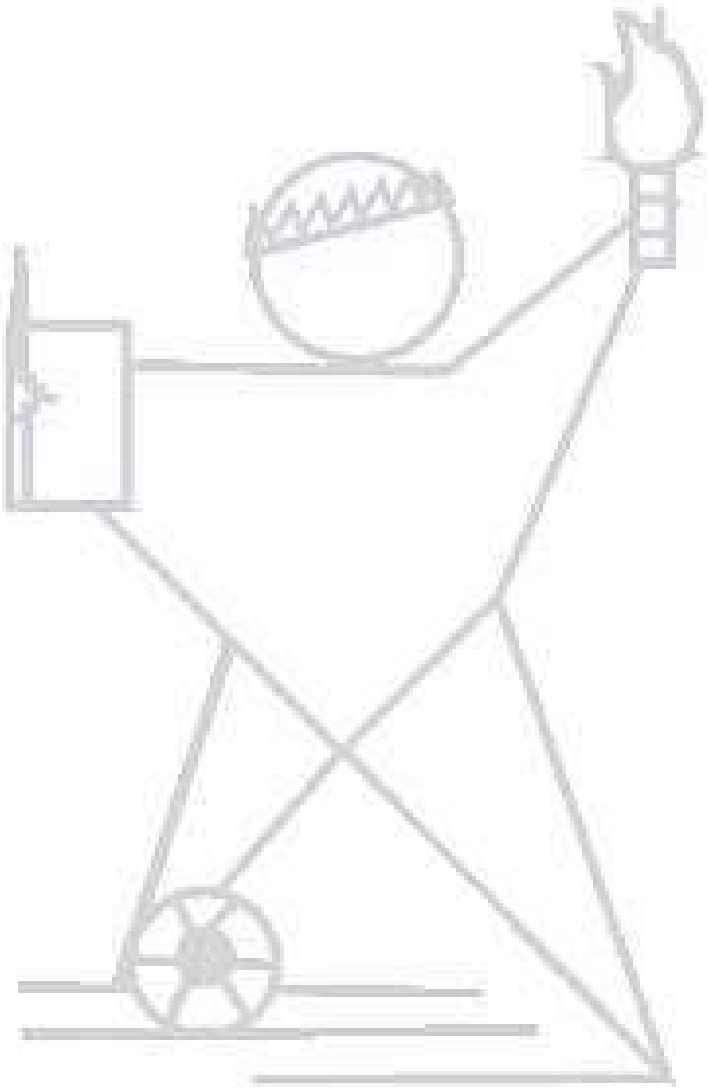

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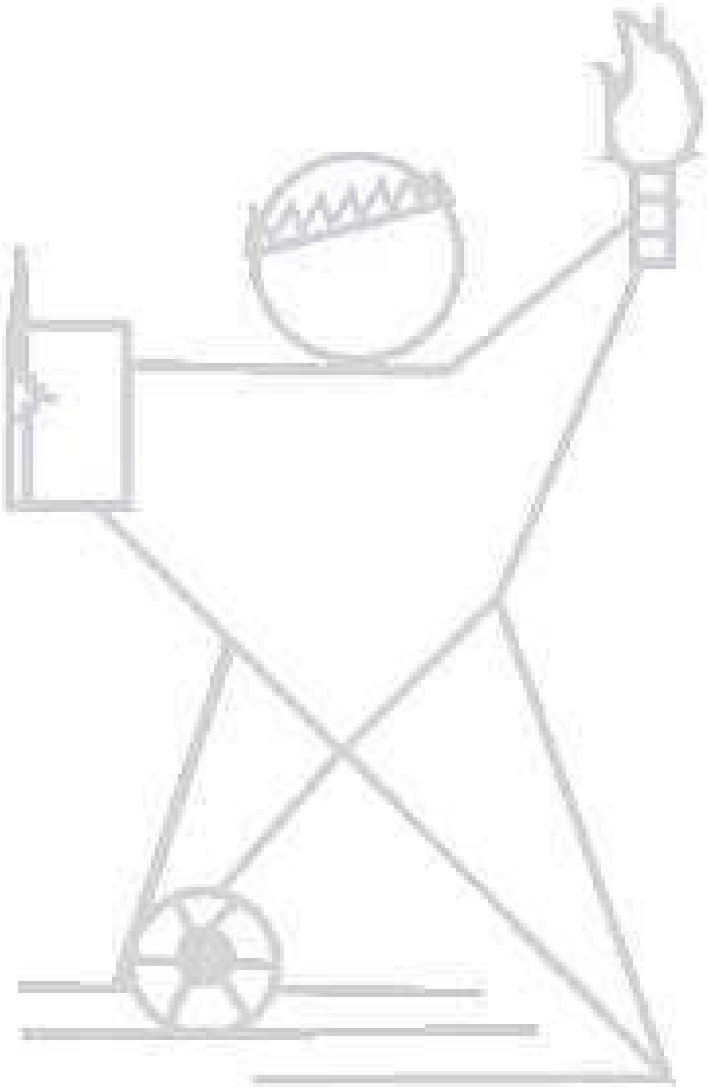


Experiment No: 6

Aim: - Study of Lathe & Drilling Machine.

Apparatus Used: - Lathe and drilling machine and related charts.

Theory

Introduction of Lathe

Lathe is considered as one of the oldest machine tools and is widely used in industries. It is called as mother of machine tools. It is said that the first screw cutting lathe was developed by an Englishman named Henry Maudslay in the year 1797. Modern high speed, heavy duty lathes are developed based on this machine.

The primary task of a lathe is to generate cylindrical work pieces. The process of machining a work piece to the required shape and size by moving the cutting tool either parallel or perpendicular to the axis of rotation of the work piece is known as turning. In this process, excess unwanted metal is removed. The machine tool useful in performing plain turning, taper turning, thread cutting, chamfering and knurling by adopting the above method is known as lathe.

Main parts of a lathe

Every individual part performs an important task in a lathe. Some important parts of a lathe are listed below

1. Bed
2. Headstock
3. Spindle
4. Tailstock
5. Feed mechanism
6. Lead screw
7. Feed rod
8. Carriage
   Saddle
   Apron
   Cross-slide
   Compound rest
   Compound slide
   Tool post
9. Thread cutting mechanism

1. Bed

Bed is mounted on the legs of the lathe which are bolted to the floor. It forms the base of the machine. It is made of cast iron and its top surface is machined accurately and precisely. Headstock of the lathe is located at the extreme left of the bed and the tailstock at the right

extreme. Carriage is positioned in between the headstock and tailstock and slides on the bed guide ways.

2. Headstock

Headstock is mounted permanently at the left hand side of the leg bed. The headstock houses a hollow spindle and the mechanism for driving the spindle at multiple speeds. The headstock will have any of the following arrangements for driving and altering the spindle speeds

(i) Stepped cone pulley drive

(ii) Back gear drive

(iii) All gear drive

3. Spindle

The spindle rotates on two large bearings housed on the headstock casting. A hole extends through the spindle so that a long bar stock may be passed through the hole. The front end of the spindle is threaded on which chucks, faceplate, driving plate and catch plate are screwed.

4. Tailstock

Tailstock is located at the right side of the bed opposite to the headstock. The body of the tailstock is bored and houses the tailstock spindle or ram. The spindle moves front and back inside the hole.

5. Carriage

Carriage is located between the headstock and tailstock on the lathe bed guide ways. It can be moved along the bed either towards or away from the headstock. It has several parts to support, move and control the cutting tool. The parts of the carriage are:

a) Saddle

b) Apron

c) cross-slide

d) Compound rest

e) Compound slide

f) Tool post

6. Feed mechanism

There are several mechanisms to make the carriage and crose-slide move automatically and to change the direction of their movement.

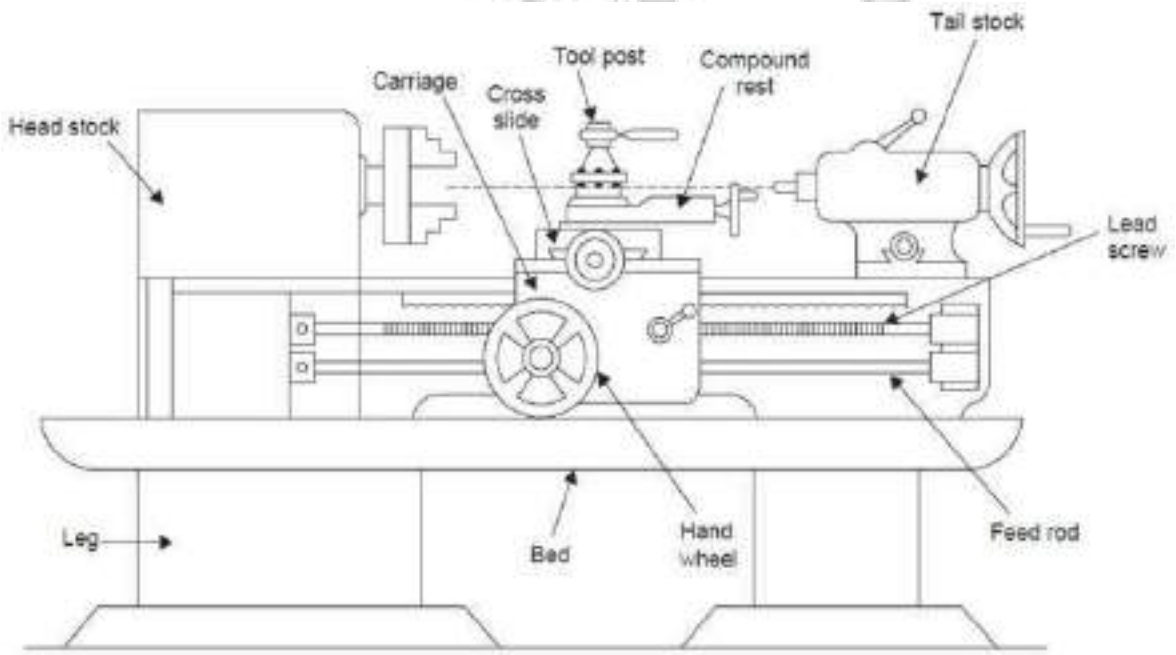
7. Lead screw

The lead screw is a long threaded shaft used as master screw. It is brought into operation during thread cutting to move the carriage to a calculated distance. Mostly lead screws are Acme

threaded. A half nut lever is provided in the apron to engage half nuts with the lead screw. Lead screw is used to move the carriage towards and away from the headstock during thread cutting.

8. Feed rod

Feed rod is placed parallel to the lead screw on the front side of the bed. It is a long shaft which has a keyway along its length. The power is transmitted from the spindle to the feed rod through gears and a gear train. It is useful in providing feed movement to the carriage except for thread cutting and to move cross-slide. A worm mounted on the feed rod enables the power feed movements.



Operations performed on a lathe

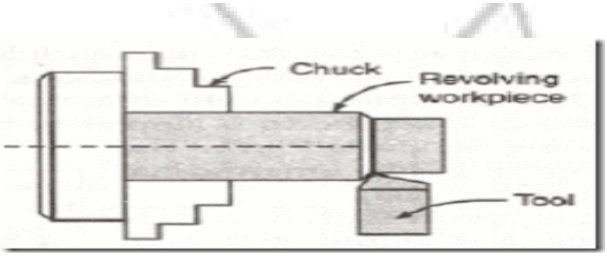
Various operations are performed in a lathe other than plain turning. They are

1. Facing	8. Eccentric turning
2. Turning	9. Taper turning
Straight turning	10. Thread cutting
Step turning	11. Drilling
3. Chamfering	12. Reaming
4. Grooving	13. Boring
5. Forming	14. Tapping
6. Knurling	
7. Undercutting	

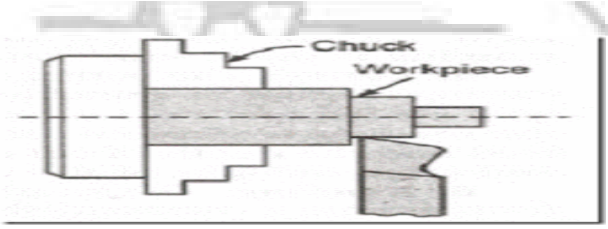
Lathe Operations

The engine lathe is an accurate and versatile machine on which many operations can be performed. These operations are:

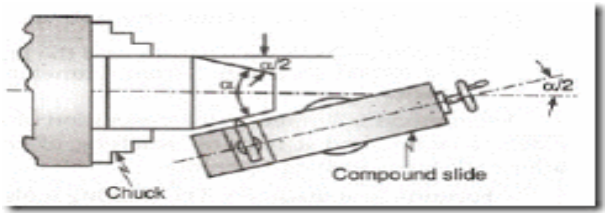
1. **Plain Turning**: Plain turning is the operation of removing excess amount of material from the surface of a cylindrical job.



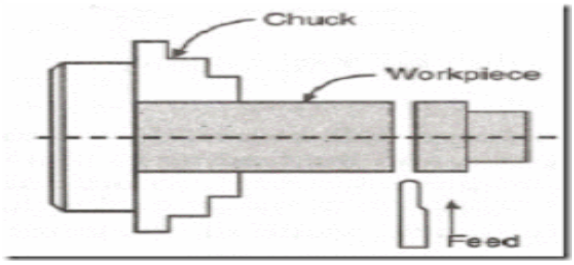
2. **Step Turning**: Step turning produces various steps of different diameters.



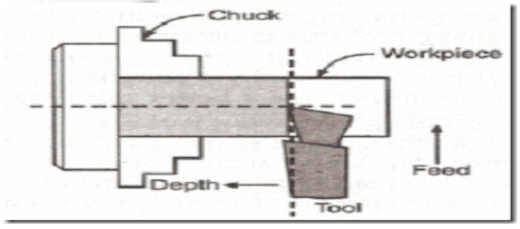
3. **Taper Turning**: The taper turning is an operation of producing a conical surface by gradual reduction in the diameter of a cylindrical work piece.



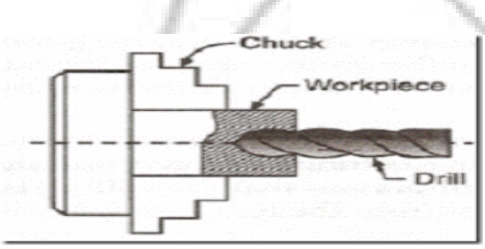
4. **Facing:** The facing is a machining operation by which the end surface of the work piece is made flat by removing metal from it.



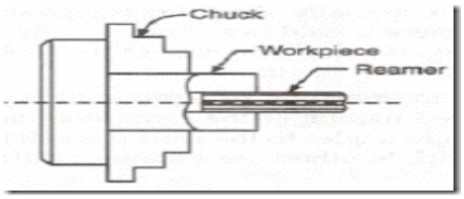
5. **Parting**: The parting or cutting off is the operation of cutting away a desired length of the work piece, *i.e.,* dividing the work piece in two or more parts.



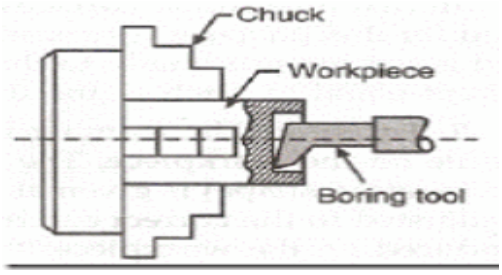
6. **Drilling**: Drilling is the operation of producing a cylindrical hole in the work piece.



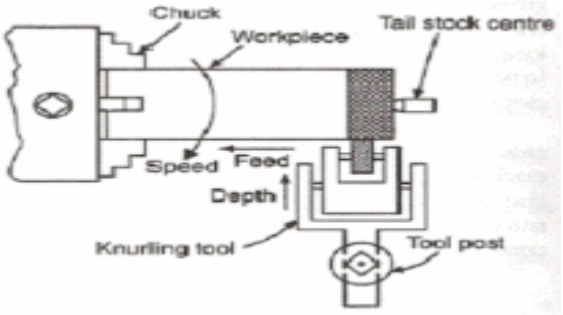
7. **Reaming**: The holes that are produced by drilling are rarely straight and cylindrical in form. The reaming operation finishes and sizes the hole already drilled into the work piece.



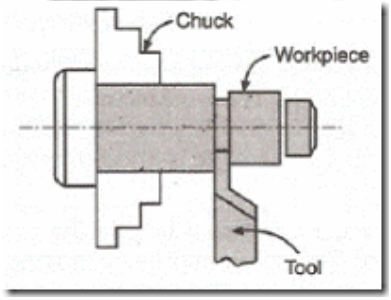
8. **Boring**: The boring operation is the process of enlarging a hole already produced by drilling.



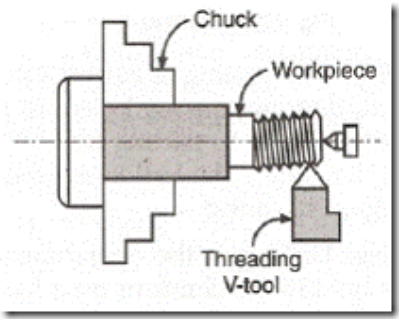
9. **Knurling**: The knurling is a process of embossing (impressing) a diamond-shaped or straight-line pattern into the surface of work piece. Knurling is essentially a roughening of the surface and is done to provide a better gripping surface.



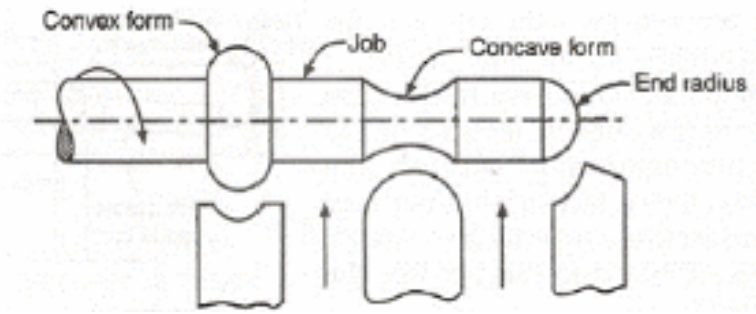
10. **Grooving**: Grooving is the act of making grooves of reduced diameter in the work piece.



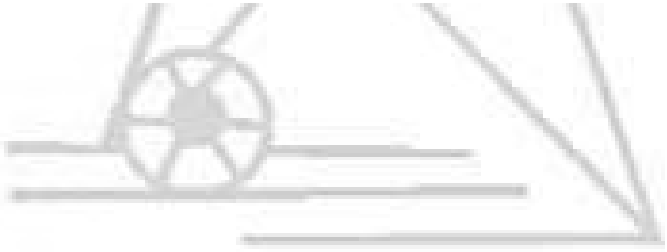
11. **Threading**: Threading is the act of cutting of the required form of threads on the internal or external cylindrical surfaces.



12. **Forming**: The forming is an operation that produces a convex, concave or any irregular profile on the work piece.



13. **Filing and Polishing:** The filing is the finishing operation that removes burrs, sharp corners and feed marks from the work piece. After filing, the surface quality is the work piece is improved by the polishing operation with the help of emery cloth of fine grades.
14. **Chamfering**: Chamfering removes the burrs and sharp edges, and thus makes the handling safe. Chamfering can be done by a form tool having angle equal to chamfer which is generally kept at 45°.



Drilling Machine

Introduction

Drilling machine is one of the most important machine tools in a workshop. It was designed to produce a cylindrical hole of required diameter and depth on metal work pieces. Though holes can be made by different machine tools in a shop, drilling machine is designed specifically to perform the operation of drilling and similar operations. Drilling can be done easily at a low cost in a shorter period of time in a drilling machine. Drilling can be called as the operation of producing a cylindrical hole of required diameter and depth by removing metal by the rotating edges of a drill.

The cutting tool known as drill is fitted into the spindle of the drilling machine. A mark of indentation is made at the required location with a center punch. The rotating drill is pressed at the location and is fed into the work. The hole can be made up to a required depth.

Construction of a drilling machine

The basic parts of a drilling machine are a base, column, drill head and spindle. The base made of cast iron may rest on a bench, pedestal or floor depending upon the design. Larger and heavy duty machines are grounded on the floor. The column is mounted vertically upon the base. It is accurately machined and the table can be moved up and down on it. The drill spindle, an electric motor and the mechanism meant for driving the spindle at different speeds are mounted on the top of the column. Power is transmitted from the electric motor to the spindle through a flat belt or a 'V' belt.

Main parts of a drilling machine

Base

The base is made of cast iron and so can withstand vibrations. It may be mounted on a bench or on the floor. It supports all the other parts of the machine on it.

Column

The column stands vertically on the base at one end. It supports the work table and the drill head. The drill head has drill spindle and the driving motor on either side of the column.

Table

The table is mounted on the vertical column and can be adjusted up and down on it. The table has 'T'-slots on it for holding the work pieces or to hold any other work holding device. The table can be adjusted vertically to accommodate work pieces of different heights and can be clamped at the required position.

Drill head

Drill head is mounted on the top side of the column. The drill spindle and the driving motor are connected by means of a V-belt and cone pulleys. The motion is transmitted to the spindle from the motor by the belt. The pinion attached to the handle meshes with the rack on the sleeve of the spindle for providing the drill the required down feed. There is no power feed arrangement in this machine. The spindle rotates at a speed ranging from 50 to 2000 r.p.m.

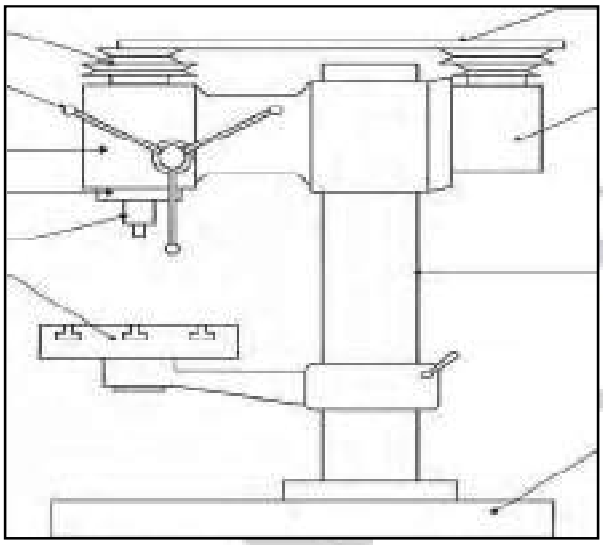


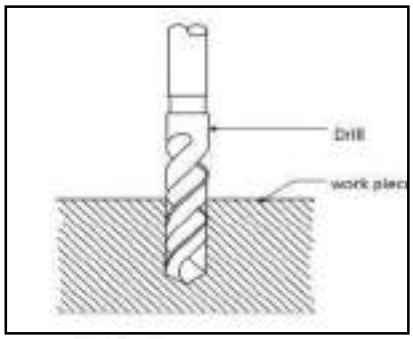
Fig. Sensitive drilling machine

Drilling machine operations

Though drilling is the primary operation performed in a drilling machine, a number of similar operations are also performed on holes using different tools. The different operations that can be performed in a drilling machine are:

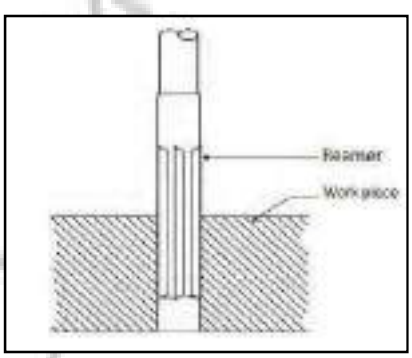
1. Drilling
2. Reaming
3. Boring
4. Counter boring
5. Countersinking
6. Spot facing
7. Tapping
8. Trepanning

1. Drilling



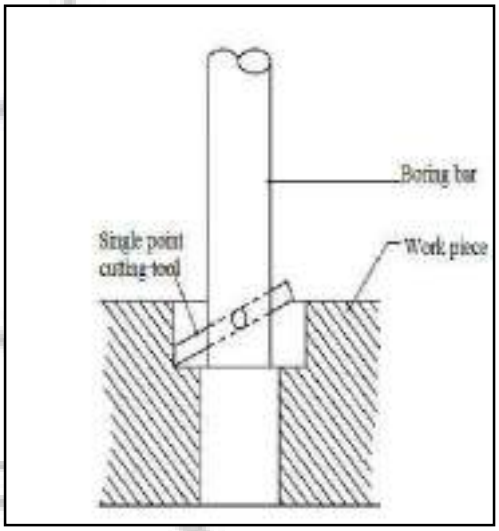
Drilling is the operation of producing a cylindrical hole of required diameter and depth by removing metal by the rotating edge of a cutting tool called drill. Drilling is one of the simplest methods of producing a hole. Drilling does not produce an accurate hole in a work piece.

2. Reaming



The size of hole made by drilling may not be accurate and the internal surface will not be smooth. Reaming is an accurate way of sizing and finishing a hole which has been previously drilled by a multi point cutting tool known as reamer.

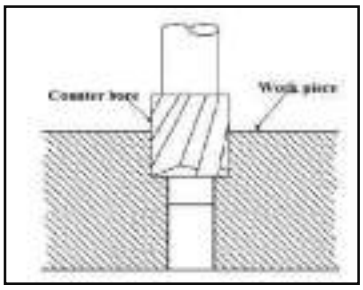
3. Boring



Boring is the operation enlarging the diameter of the previously made hole. It is done for the following reasons.

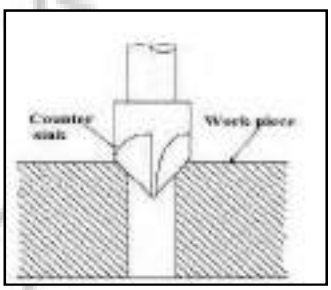
1. To enlarge a hole by means of an adjustable cutting tool. This is done when a suitable sized drill is not available or the hole diameter is so large that is cannot be ordinarily drilled.
2. To finish a hole accurately and bring it to the required size
3. To machine the internal surface of the hole already produced in casting
4. To correct out of roundness of the hole
5. To correct the location of the hole as the boring tool follows independent path with respect to the hole

4. Counter boring



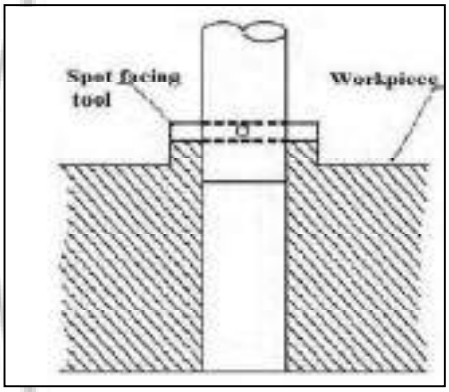
Counter boring is the operation of enlarging the end of the hole cylindrically. The enlarged hole forms a square shoulder with the original hole. This is necessary in some cases to accommodate the heads of bolts, studs and pins. The tool used for counter boring is known as counter bore.

5. Countersinking



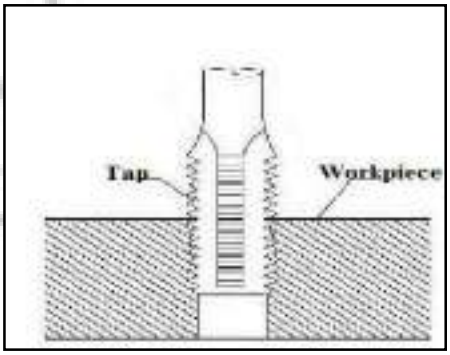
Countersinking is the operation of making a cone shaped enlargement at the end of the hole. The included angle of the conical surface may be in the range of 60° to 90°. It is used to provide recess for a flat headed screw or a counter sunk rivet fitted into the hole. The tool used for counter sinking is known as a countersink.

6. Spot facing



Spot facing is the operation of smoothing and squaring the surface around a hole. It is done to provide proper seating for a nut or the head of a screw. A counter bore or a special spot facing tool may be employed for this purpose.

7. Tapping

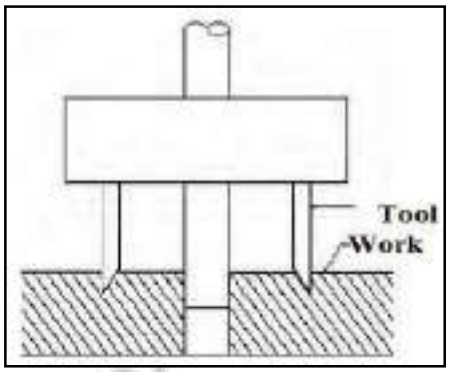


Tapping is the operation of cutting internal threads by means of a cutting tool called ‘tap’. Tapping in a drilling machine may be performed by hand or by power. When the tap is screwed into the hole, it removes metal and cuts internal threads which will fit into external threads of the same size.

8. Trepanning

Trepanning is the operation of producing a hole in sheet metal by removing metal along the circumference of a hollow cutting tool. Trepanning operation is performed for producing large

holes. Fewer chips are removed and much of the material is saved while the hole is produced. The tool may be operated at higher speeds. The speed depends upon the diameter of the hole to be made. The tool resembles a hollow tube having cutting edges at one end and a solid shank at the other to fit into the drill spindle.



Questions

1. What is the difference between drilling, boring and reaming.
2. What is lathe?
3. Name different types of lathes.
4. Name the principle parts of a lathe.
5. Name the principle parts of head stock.
6. What is the function tail-stock?
7. Name the principle parts of carriage?
8. Name the principle operations which can be performed on lathe?
9. Name the principle parts of a drilling machine.
10. List the different operations which can be performed on drilling machine.

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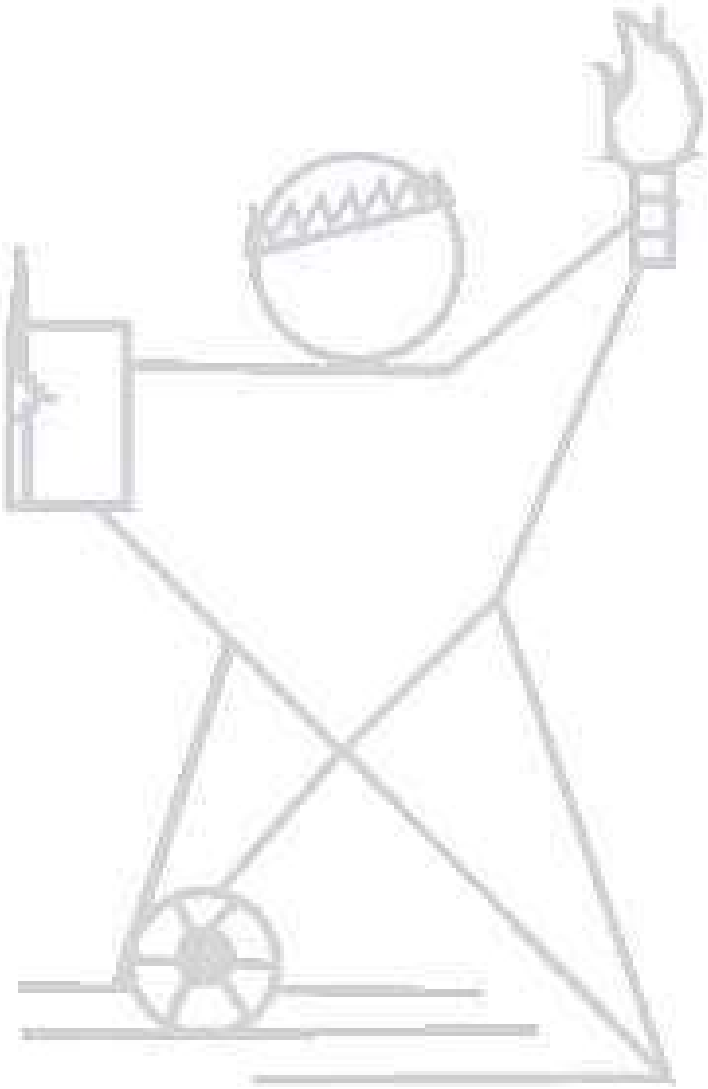

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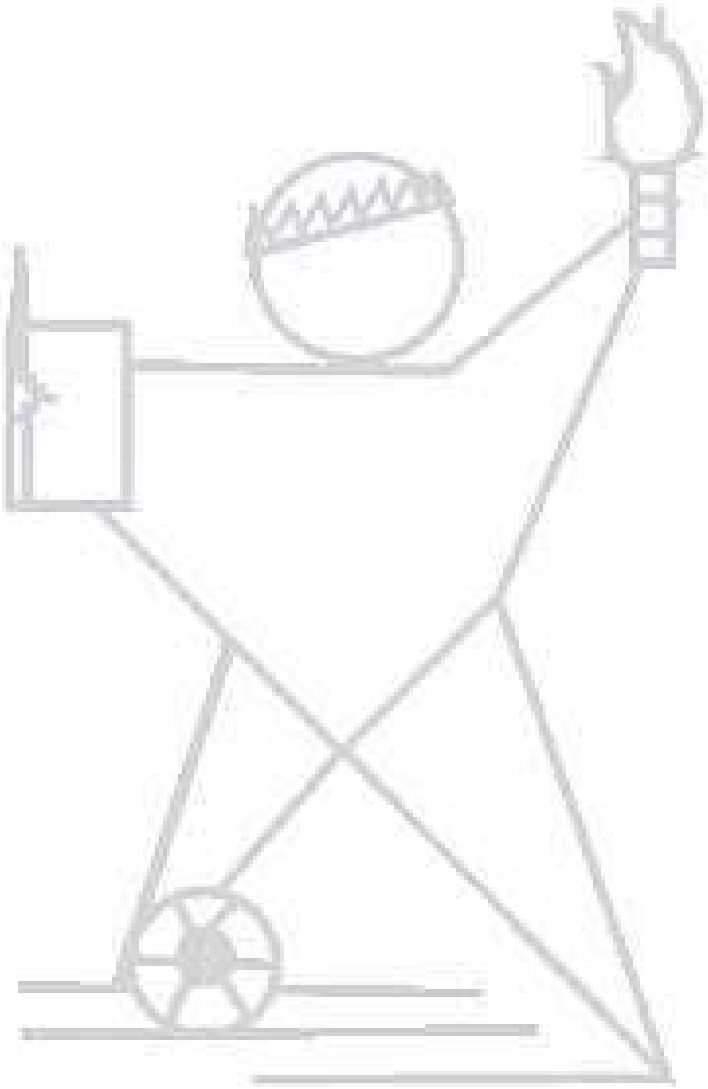

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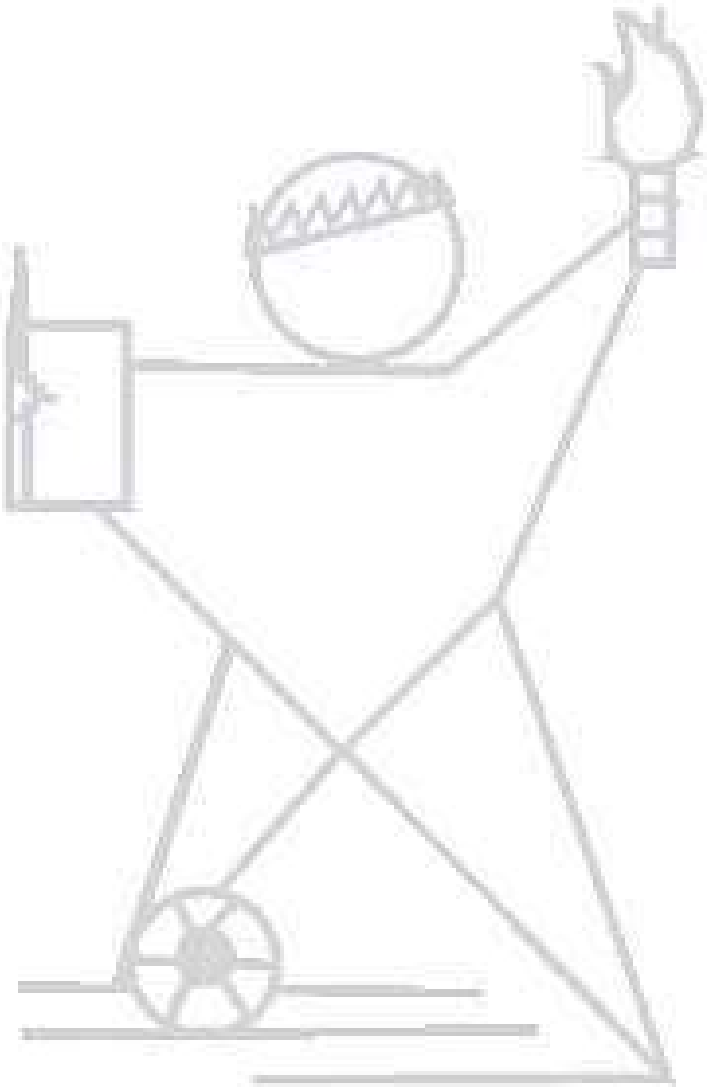


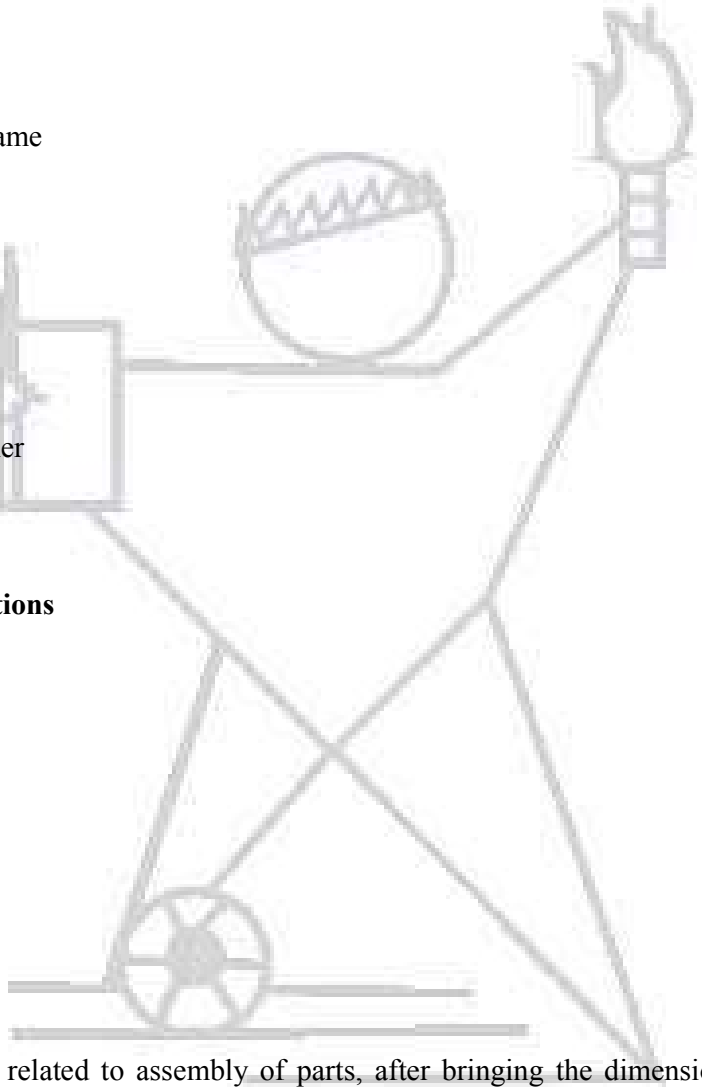
Experiment No: 7

Aim : To make a job in fiiting shop as per given drawing.

Materials required: mild steel flat plate (65*65*6mm).

Tools and equipment required:

1. 6”try square
2. 12”hack saw Frame
3. Blades (12 TPI)
4. 10”rough file
5. 10”smooth file
6. 10”Square file
7. Centre punch
8. Ball peen hammer
9. Steel Rule



Sequence of operations

1. Filling
2. Marking
3. Sawing
4. Punching
5. Drlling
6. Tapping

Introduction

The term *fitting*, is related to assembly of parts, after bringing the dimension or shape to the required size or form, in order to secure the necessary fit. The operations required for the same are usually carried out on a work bench, hence the term *bench work* is also added with the name *fitting.* The bench work and fitting plays an important role in engineering. Although in today's industries most of the work is done by automatic machines which produces the jobs with good accuracy but still it (job) requires some hand operations called fitting operations. The person working in the fitting shop is called fitter

Fitting Tools

- Fitting shop tools are classified as below:
- Work Holding Devices/ Clamping Tools.
- Measuring and Marking Tools.
- Cutting Tools.
- Striking Tools.
- Drilling Tools.
- Threading Tools.

Work holding devices /clamping tools:

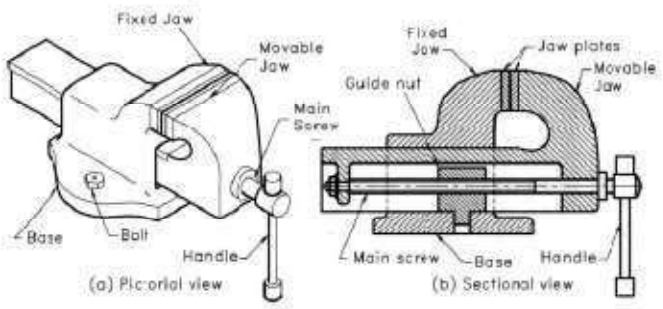
Work Bench

A fitting process can be done at various places, but most of the important operations of fitting are generally carried out on a table called *work bench*.

The work bench is a strong, heavy and rigid table made up of hard wood.

Bench Vice

It is firmly fixed to the bench with the help of nuts and bolts. It consists of a cast Iron body and cast iron jaws. Two jaw plates are fitted on both the jaws. The holding surface of the jaw plates is knurled in order to increase the gipping. Jaw plates are made up of carbon steel and are wear resistant. One jaw is fixed to the body and the second slides on a square threaded screw with the help of a handle. The jaws are opened upto required length; job is placed in the two jaws and is fully tightened with the help of handle. Handle is used to move the movable jaw



Measuring tools

Steel Rule

These are made up of stainless steel and are available in many sizes ranging from 1/2 ft. to 2 ft. These are marked in inches or millimetres. All the faces are machined true. The edges of steel rule should be protected from rough handling**.**

Steel Rule

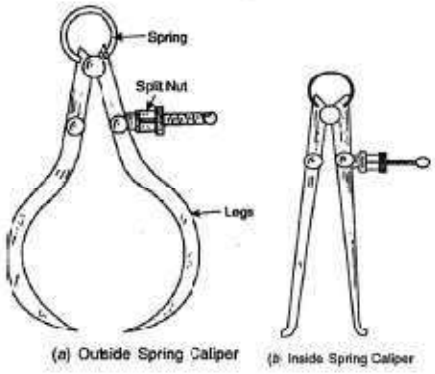
Calipers

These are generally used to measure the inside or outside diameters. Different types are:

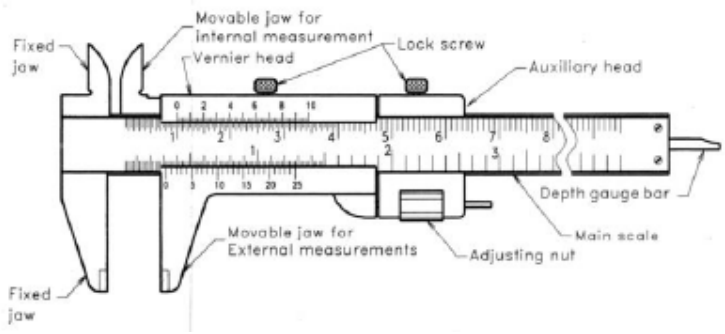
Outside Caliper: It is used to measure the outside dimensions.

Inside Caliper: It is used to measure the inside dimensions.

Spring Caliper: Spring is provided to apply the pressure and lock nut is provided to lock any desired position.



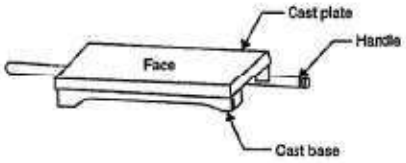
Vernier Caliper: It is used for measuring the outer dimensions of round, flat, square components and also the inner size of the holes and bore. A narrow blade is used to measure the depth of bar slots etc. The reading accuracy in metric system is 0.02 mm and British system it is 0.001". It is made of stainless steel.



Marking tools

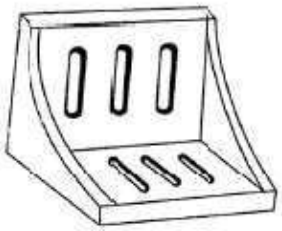
Surface Plate

It is used for testing the flatness, trueness of the surfaces. It is made up of cast iron or graphite. Its upper face is planned to form a very smooth surface. It is also used in scribing work. While not in use, it should be covered with a wooden



Angle Plate

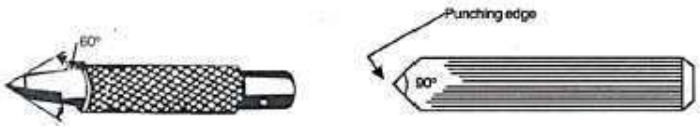
It is made up of cast iron in different sizes; it has two planed surfaces at right angles to each other and has various slots in each surface to hold the work by means of bolts and clamps. Never do hammering on the angle plate to fasten (lighten) the nuts and bolts**.**



Punches

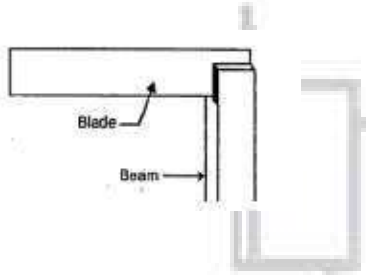
Punches are used for marking purposes. Dot punches are used for marking dotted line and centre punch is used to mark the centre of hole before drilling. Punches are made up of high carbon steel or high speed steels. One end is sharpened. Hammering is done on the second end while

working. For dot punch, angle of the punching end is 60 degree while in centre punch; angle of punching end is 90 degree.



Try Square

It is used for checking squareness of two surfaces. It consists of a blade made up of steel, which is attached to a base at 90 degree. The base is made up of cast iron or steel. It is also used to mark the right angles and measuring straightness of surfaces. Never use try square as a hammer.



Vernier Height gauge

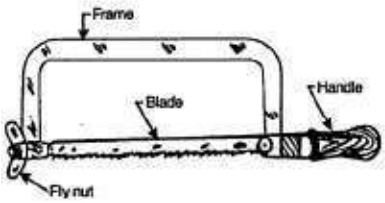
A Vernier height gauge consists of a heavy base, a graduated beam, a sliding head with Vernier sliding jaws holding the scriber and a fine adjustment clamp. It is similar to large Vernier calipers in construction, except that it consists of a heavy base which allows the gauge to stand upright instead of a fixed jaw in a Vernier. The movable jaw of Vernier height gauge consists of a projection or extension which is leveled to sharp edge for scribing lines at any required height.

Cutting tools

Hacksaw

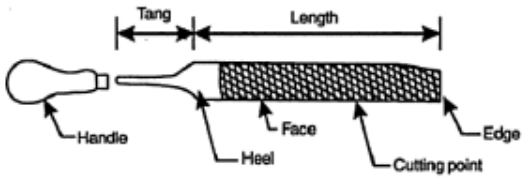
Hacksaw is used for cutting of rods, bars, pipes, flats etc. It consists of a frame, which is made from mild steel. The blade is placed inside the frame and is tightened with the help of a flange nut. The blade is made up of high carbon steel or high speed steel. The points of the teeth are bent in a zig-zag fashion, to cut a wide groove and prevent the body of the blade from rubbing or

jamming in the saw cut. The teeth of the blades are generally forward cut so in the case, pressure is applied in the forward direction only.



Files

Files are multi points cutting tools. It is used to remove the material by rubbing it on the metals. Files are available in a number of sizes, shapes and degree of coarseness.



Classification of files

On the basis of length

4",6",8",12"

On the basis of grade:

Rough (R)(20 teeth per inch)

Bastard (B)(30 teeth per inch)

Second cut (Sc) (40 teeth per inch)

Smooth file (S)(50 teeth per inch)

Dead smooth (DS)(100 teeth per inch)

Rough and bastard files are the big cut files. When the material removal is more, these files are used. These files have bigger cut but the surface produced Is rough.

Dead smooth and smooth files have smaller teeth and used for finishing work. Second cut file has degree of finish in between bastard and smooth file.

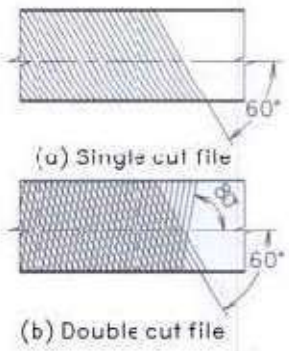
On the basis of number of cuts:

Single cut files.

Double cut files.

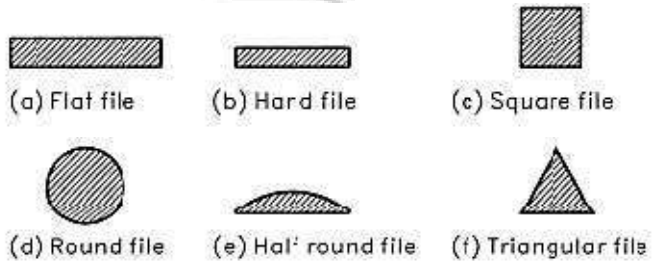
Rasp files.

In single cut files the teeth are cut in parallel rows at an angle of 60 degree to the face. Another row of teeth is added in opposite direction in case of double cut files. Material removal is more in case of double cut files.



On the basis of shape and size:

The length of the files varies from 4' to 14'. The various shapes of cross-section available are hand file, flat file, triangular, round; square, half round, knife-edge, pillar, needle and mill file.



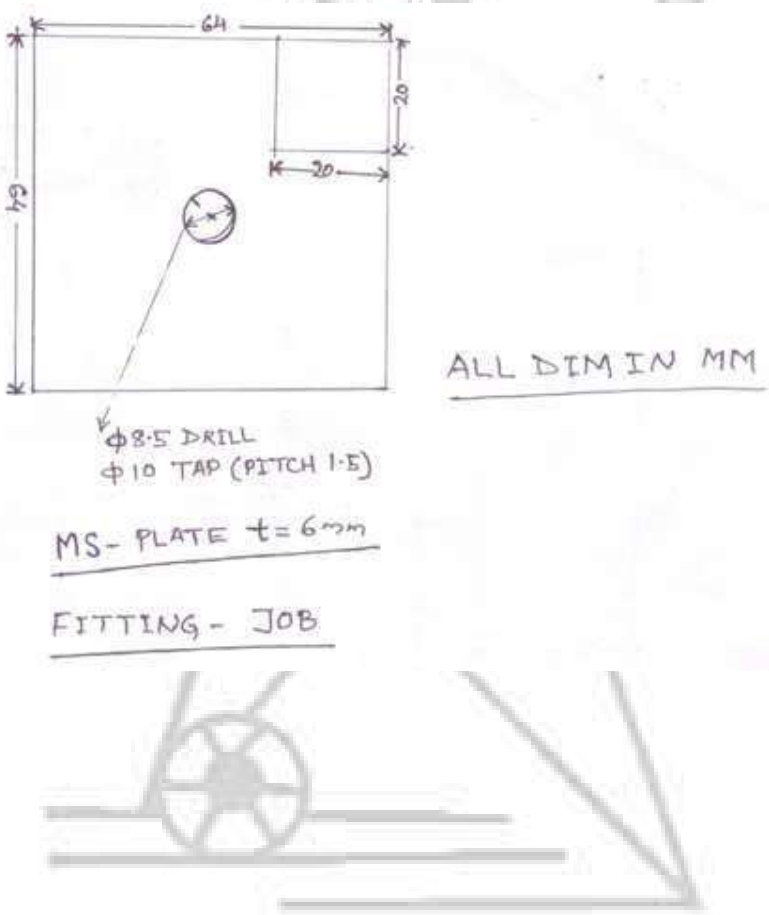
Procedure

1. The given mild steel flat piece is checked for given dimensions.
2. One edge of given is filled to straightness with rough and smooth files and checked with try square.
3. An adjacent is also filled such that is square to first edge and checked with try square.
4. Piece is cut with hack saw.
5. Filing is done in square slot.
6. Hole is marked with centre punch.
7. Drilling is done on bench drill with drill bit of dia 8.5 mm.
8. Tapping is done for internal threads of 1.5 mm pitch inside drilled hole.

Precautions:

1. The perpendicularity of face ends edges is checked perfectly by using try square.
2. Finishing is given by using only with smooth files.
3. Marking is done without parallax error.

Result: The Square cutting is done successfully



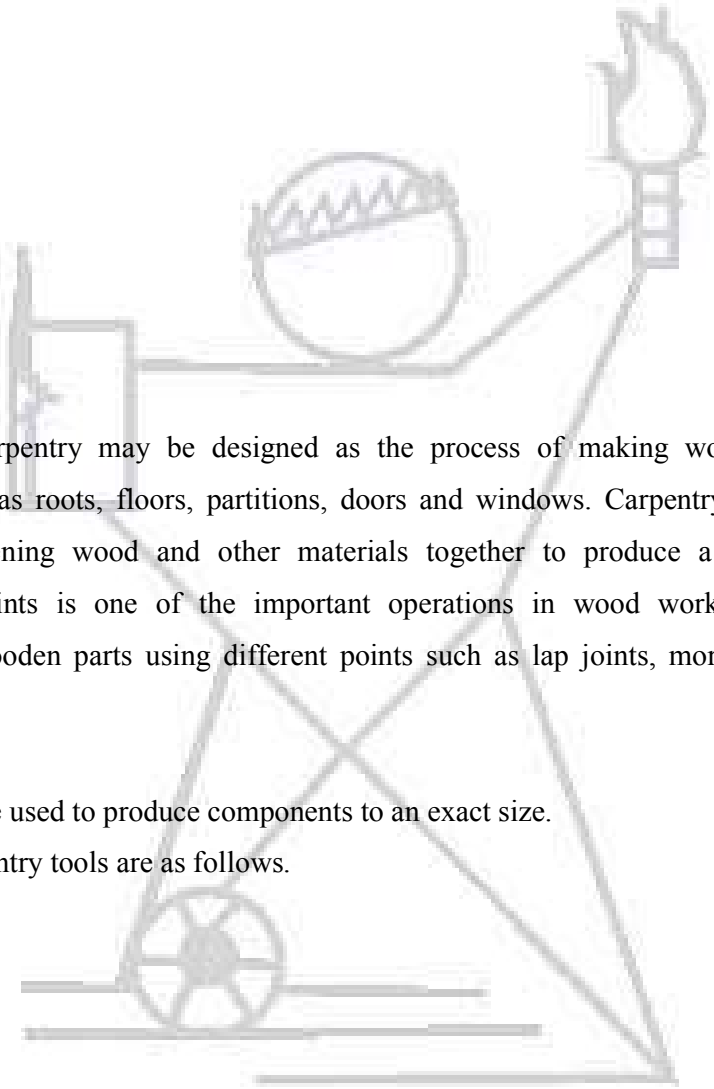
Experiment No: 8

Aim: To make the Lap Joint of required dimensions from the given work piece.

Material Required: Soft wood of size 100 x 30 x 30 mm.

Tools Required

1. Carpentry vice
3. Try square
4. Marking gauge
5. Steel rule
6. Tenon saw
7. Rip saw
8. Firmer chisel
9. Mallet



Introduction: Carpentry may be designed as the process of making wooden articles and components such as roots, floors, partitions, doors and windows. Carpentry involves cutting, shaping and fastening wood and other materials together to produce a finished product. Preparation of joints is one of the important operations in wood work. Joinery denotes connecting the wooden parts using different points such as lap joints, mortise and T- joints, bridle joints, etc.

Carpentry Tools

Carpentry tools are used to produce components to an exact size.

The types of carpentry tools are as follows.

1. Marking tools
2. Measuring tools
3. Holding tools
4. Cutting tools
5. Planning tools
6. Boring tools
7. Striking tools
8. Miscellaneous tools

Marking tools

It is used to marking lines parallel to the edges of a wooden piece. It consists of a square wooden stem with a sliding wooden stock on it. On the stem, a marking pin is attached which is made up of steel. This stem is provided with a steel nail to scratch the surface of the work. It consists of two pins; the distance between the pins is adjustable. It is used to draw parallel lines on the stock.

Measuring tools

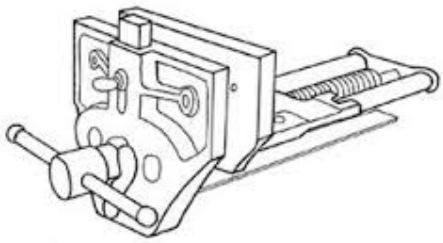
The carpentry measuring tools are classified as follows

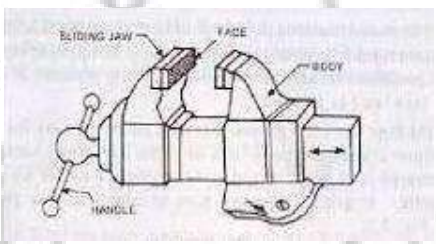
1. Steel tape
2. Steel rule
3. Caliper

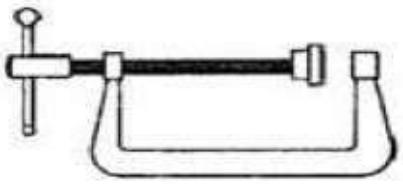
Steel tapes and steel rules are mainly used for measuring short and lengths in millimeters. A try square is used for testing squareness and marking of joints. A meter square is used for marking and measuring an angle of 45 degree. A bevel square is used for marking and listing angles between 0 degree to 180 degree.Calipers are used for the precision measurement of cylindrical surface. Inside calipers are used for measuring outside diameter and outside calipers are used to measure inner diameter of a pipe.

Holding tools

The carpentry holding tools are shown in fig.







G-clamp

Carpentry vice

A carpentry vice is the common work holding device. It consists of one fixed jaw and one movable jaw. Its one jaw is fixed to the side of the table while the other is movable by means of a screw and a handle.

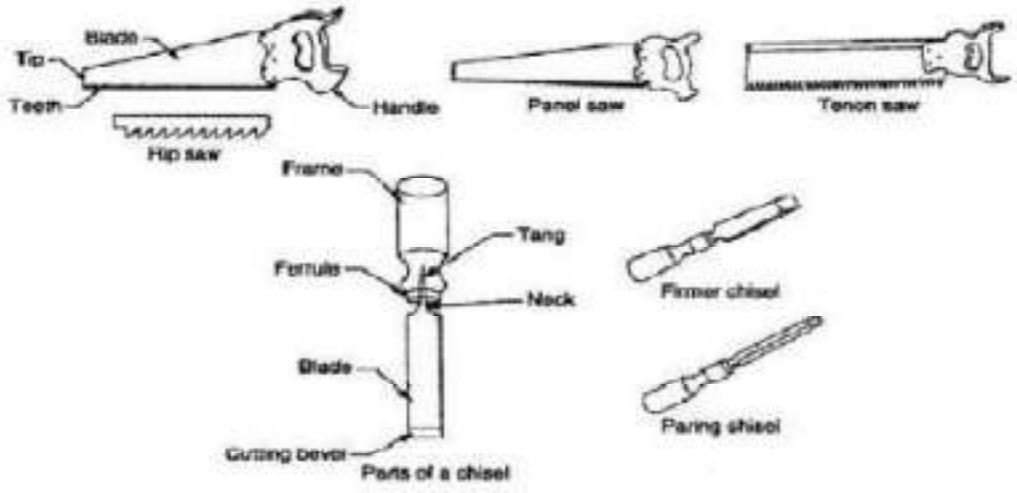
Bar clamp

The bar clamp (or) sash cramps are generally used in pairs in gluing up operations at the final assembly of joinery work. It is made up of a steel bar of T-section, wine malleable iron fittings and a steel screw.

G-clamp

G-clamp is made up of malleable iron with acme threads of high quality steel .It can be used for clamping small work when gluing up.

Cutting Tools



Saws

A saw is used to cut wood into pieces. There is different type of saws, designed to suit different purpose. A saw is specified by the length of its tooled edge. The following saws are used in the carpentry section.

Rip Saw

The blade of rip saw is either straight or skew-backed. The teeth are so set that the cutting edge of this saw makes a steeper angle about 60^0.

Cross Cut saw

This is similar in shape of a rip saw. It is used to cut across the grain of the stock. The correct angle for cross cutting is 450.The teeth are so set that the saw kerf is wider than the blade thickness. This allows the blade to move freely in the cut without sticking.

Tenon or back saw

A tenon saw is used for fine and accurate work. It consists of a very fine blade, which is reinforced with a rigid steel back. The teeth are shaped like those of cross cut saw.

Chisels

Chisels are used for cutting and shaping wood accurately. Wood chisels are made in various blade widths, ranging from 3 to 50mm .Most of the wood chisels are made into tang type, having a steel shank which fits inside the handle.

Firmer chisels

These are general purpose chisels and are used either by hand pressure or by a mallet. The blade of a firmer chisel is flat and their sloping face is at an angle 15degree to 52 degree.

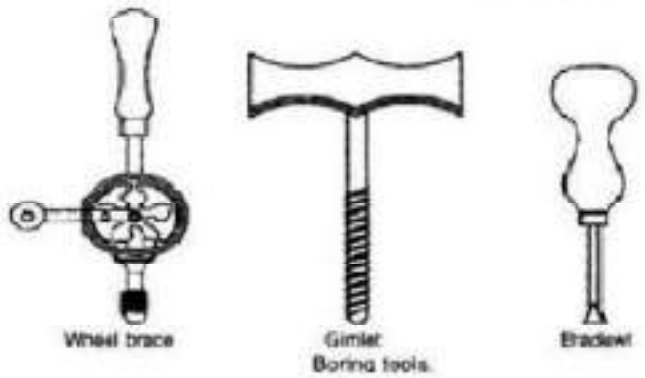
Boring Tools

Boring tools are used to make holes in wood .Common types of boring tools are as follows.

1. Bradawl
2. Gimlet
3. Brace
4. Bit and drill

A brace bolds and turns the bit and boring of a hole is obtained. A brace having two jaws is used for holing the bit in one end. It has two types, namely ratchet brace and wheel brace. A bradawl and a gimlet are used for boring small holes. These tools are hand operated.

Striking Tools



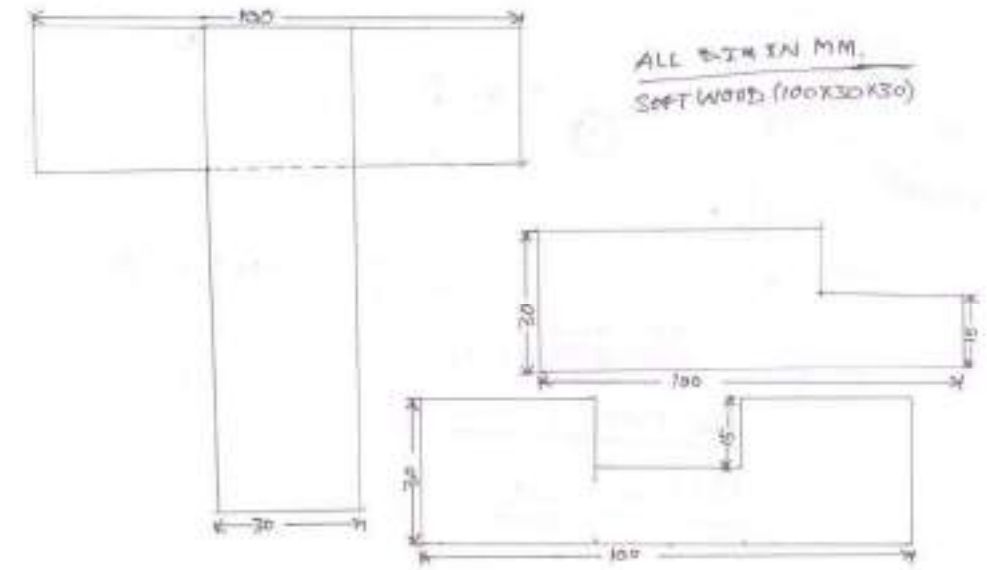
Procedure

1. The given work piece is firmly clamped in the carpentry vice and any two adjacent surfaces are planned to get right angles using the jack plane.
2. Using the try square, the right angles of planned faces are checked.
3. Now the other two surfaces are planned to get smooth surface.
4. The work piece is cut into two pieces by using the rip saw.
5. Using the steel rule and marking gauge, marking is done for Lap -joint on the two halves.
6. In one half, the unwanted portions of wood are removed by using the tenon saw and firmer Chisel. The same procedure is done for the other half of work piece.
7. Using the jack plane, the other two faces of work piece is planned to the required size.
8. The finished two pieces are assembled to getter to form the T-joint.
9. Finally, the finished job is checked for required size and shape using the steel rule and try square.

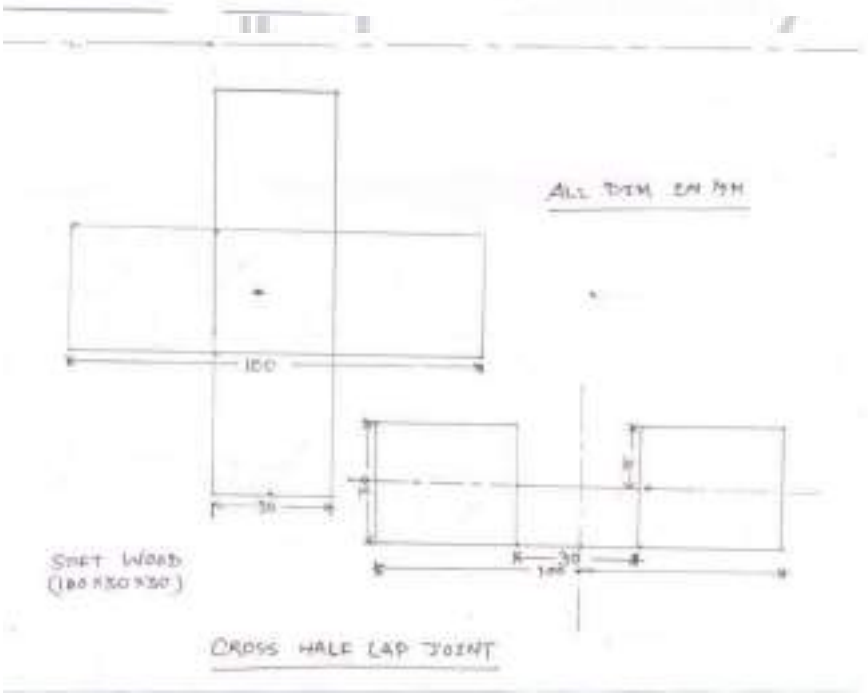
Precautions:

1. Wood should be free from moisture.
2. Marking is done without parallax error.
3. Care should be taken while chiseling.
4. Matching of T and X pieces should be tight.

Result: The T & X joint is made success fully.



HALF LAP JOINT



CROSS HALF LAP JOINT

Experiment No: 9

Aim: To make the S shape and Screw Driver in the required dimensions from the given MS round stock of 6 mm dia.

Material Required: Mild Steel round stock of 6 mm Dia. & 250 mm length.

Tools Required

1. Bench vice
2. Marking gauge
3. Steel rule
4. Hack Saw
5. Anvil
6. Hand Hammers
7. Files

Introduction: Blacksmithy or Forging is an oldest shaping process used for the producing small articles for which accuracy in size is not so important. The parts are shaped by heating them in an open fire or hearth by the blacksmith and shaping them through applying compressive forces using hammerThus forging is defined as the plastic deformation of metals at elevated temperatures into a predetermined size or shape using compressive forces exerted through some means of hand hammers, small power hammers, die, press or upsetting machine. It consists essentially of changing or altering the shape and section of metal by hammering at a temperature of about 980°C, at which the metal is entirely plastic and can be easily deformed or shaped under pressure. The shop in which the various forging operations are carried out is known as the smithy or smith's shop.

Hand forging process is also known as black-smithy work which is commonly employed for production of small articles using hammers on heated jobs. It is a manual controlled process even though some machinery such as power hammers can also be sometimes used. Black-smithy is, therefore, a process by which metal may be heated and shaped to its requirements by the use of blacksmith tools either by hand or power hammer.

Forging by machine involves the use of forging dies and is generally employed for mass-production of accurate articles. In drop forging, closed impression dies are used and there is drastic flow of metal in the dies due to repeated blow or impact which compels the plastic metal to conform to the shape of the dies.

Applications of forging Almost all metals and alloys can be forged. The low and medium carbon steels are readily hot forged without difficulty, but the high-carbon and alloy steels are

more difficult to forge and require greater care. Forging is generally carried out on carbon alloy steels, wrought iron, copper-base alloys, aluminum alloys, and magnesium alloys. Stainless steels, nickel-based super alloys, and titanium are forged especially for aerospace uses.

Forgeability

The ease with which forging is done is called forgeability. The forgeability of a material can also be defined as the capacity of a material to undergo deformation under compression without rupture. Forgeability increases with temperature up to a point at which a second phase, e.g., from ferrite to austenite in steel, appears or if grain growth becomes excessive.

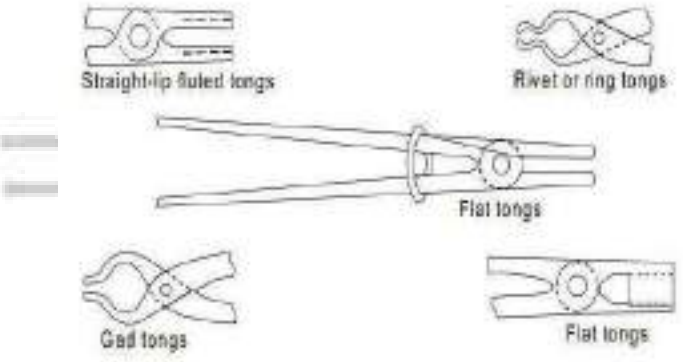
Common hand forging tools

For carrying out forging operations manually, certain common hand forging tools are employed. These are also called blacksmith's tools, for a blacksmith is one who works on the forging of metals in their hot state. The main hand forging tools are as under.

Tongs

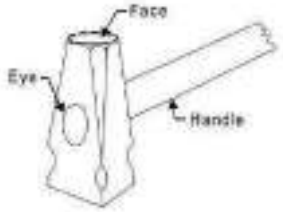
The tongs are generally used for holding work while doing a forging operation. Various kinds of tongs are shown in Figure.

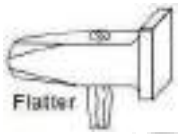
a) Straight-lip fluted tongs are commonly used for holding square, circular and hexagonal bar stock.
b) Rivet or ring tongs are widely used for holding bolts, rivets and other work of circular section.
c) Flat tongs are used for mainly for holding work of rectangular section.
d) Gad tongs are used for holding general pick-up work, either straight or tapered.



Flatter

It is commonly used in forging shop to give smoothness and accuracy to articles which have already been shaped by fullers and swages.





Swage

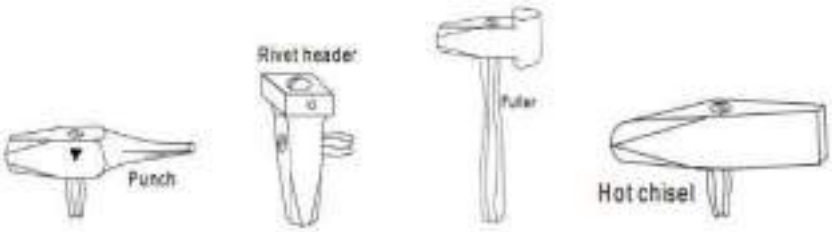
Swage is used for forging work which has to be reduced or finished to round, square or hexagonal form. It is made with half grooves of dimensions to suit the work being reduced. It consists of two parts, the top part having a handle and the bottom part having a square shank which fits in the hardie hole on the anvil face.

Fuller

Fuller is used in forging shop for necking down a forgeable job. It is made in top and bottom tools as in the case of swages. Fuller is made in various shapes and sizes according to needs, the size denoting the width of the fuller edge

Punch

Punch is used in forging shop for making holes in metal part when it is at forging heat.



Rivet header

Rivet header is used in forging shop for producing rivets heads on parts.

Chisels

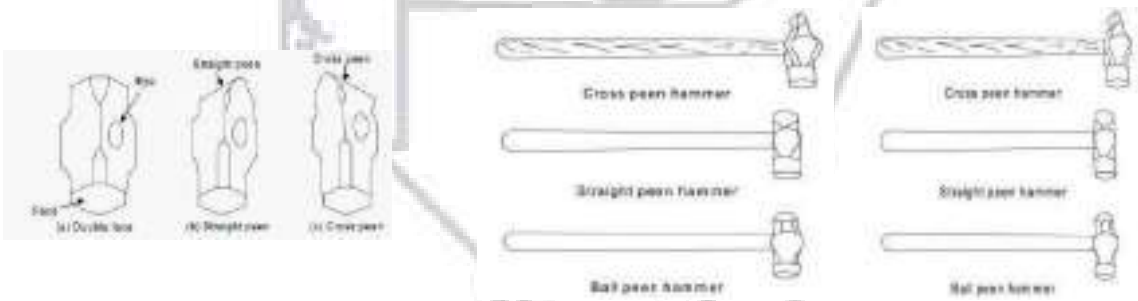
Chisels are used for cutting metals and for nicking prior to breaking. They may be hot or cold depending on whether the metal to be cut is hot or cold. A hot chisel generally used in forging shop is shown. The main difference between the two is in the edge. The edge of a cold chisel is hardened and tempered with an angle of about 60°, whilst the edge of a hot chisel is 30° and the hardening is not necessary. The edge is made slightly rounded for better cutting action.

Hand hammers

There are two major kinds of hammers are used in hand forging:

a. The hand hammer used by the smith himself and
b. The sledge hammer used by the striker.

Hand hammers may further be classified as (a) ball peen hammer, (b) straight peen hammer, and (c) cross peen hammer.



Sledge hammers may further be classified as (a) Double face hammer, (b) straight peen hammer, and (c) cross peen hammer.

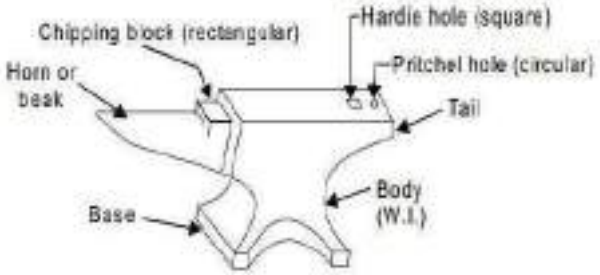
Hammer heads are made of cast steel and, their ends are hardened and tempered. The striking face is made slightly convex. The weight of a hand hammer varies from about 0.5 to 2 kg whereas the weight of a sledge hammer varies from 4 to 10 kg.

Set hammer

A set hammer generally used in forging shop is shown. It is used for finishing corners in shouldered work where the flatter would be inconvenient. It is also used for drawing out the gorging job.

Anvil

An anvil is a most commonly tool used in forging shop which is shown in. It acts as a support for blacksmith's work during hammering. The body of the anvil is made of mild steel with a tool steel face welded on the body, but the beak or horn used for bending curves is not steel faced. The round hole in the anvil called pritchel hole is generally used for bending rods of small diameter, and as a die for hot punching operations. The square or hardie hole is used for holding square shanks of various fittings. Anvils in forging shop may vary up to about 100 to 150 kg and they should always stand with the top face about 0.75 mt. from the floor. This height may be attained by resting the anvil on a wooden or cast iron base in the forging shop.



Forging operations:

The following are the basic operations that may be performed by hand forging:

1. Drawing-down:

Drawing is the process of stretching the stock while reducing its cross-section locally. Forging the tapered end of a cold is an example of drawing operation.

2. Upsetting:

It is a process of increasing the area of cross-section of a metal piece locally, with a corresponding reduction in length. In this, only the portion to be upset is heated to forging temperature and the work is then struck at the end with a hammer. Hammering is done by the smith (student) himself, if the job is small, or by his helper, in case of big jobs, when heavy blows are required with a sledge hammer.

3. Fullering:

Fullers are used for necking down a piece of work, the reduction often serving as the starting point for drawing. Fullers are made of high carbon steel in two parts, called the top and

bottom fullers. The bottom tool fits in the hardie hole of the anvil. Fuller size denotes the width of the fuller edge.

4. Flattering:

Flatters are the tools that are made with a perfectly flat face of about 7.5 cm square. These are used for finishing flat surfaces. A flatter of small size is known as set-hammer and is used for finishing near corners and in confined spaces.

5. Swaging:

Swages like fullers are also made of high carbon steel and are made in two parts called the top and swages. These are used to reduce and finish to round, square or hexagonal forms. For this, the swages are made with half grooves of dimensions to suit the work.

6. Bending:

Bending of bars, flats, etc., is done to produce different types of bent shapes such as angles, ovals, circles etc. Sharp bends as well as round bends may be made on the anvil, by choosing the appropriate place on it for the purpose.

7. Twisting:

It is also one form of bending. Sometimes, it is done to increase the rigidity of the work piece. Small piece may be twisted by heating and clamping a pair of tongs on each end of the section to be twisted and applying a turning moment. Larger pieces may be clamped in a leg vice and twisted with a pair of tongs or a monkey wrench. However, for uniform twist, it must be noted that the complete twisting operation must be performed in one heating.

8. Cutting (Hot and Cold Chisels):

Chisels are used to cut metals, either in hot or cold state. The cold chisel is similar to fitter's chisel, except that it is longer and has a handle. A hot chisel is used for cutting hot metal and its cutting edge is long and slender when compared to cold chisel. These chisels are made of tool steel, hardened and tempered.

Procedure

1. Check the tools and equipments required and see that they are in good working condition.

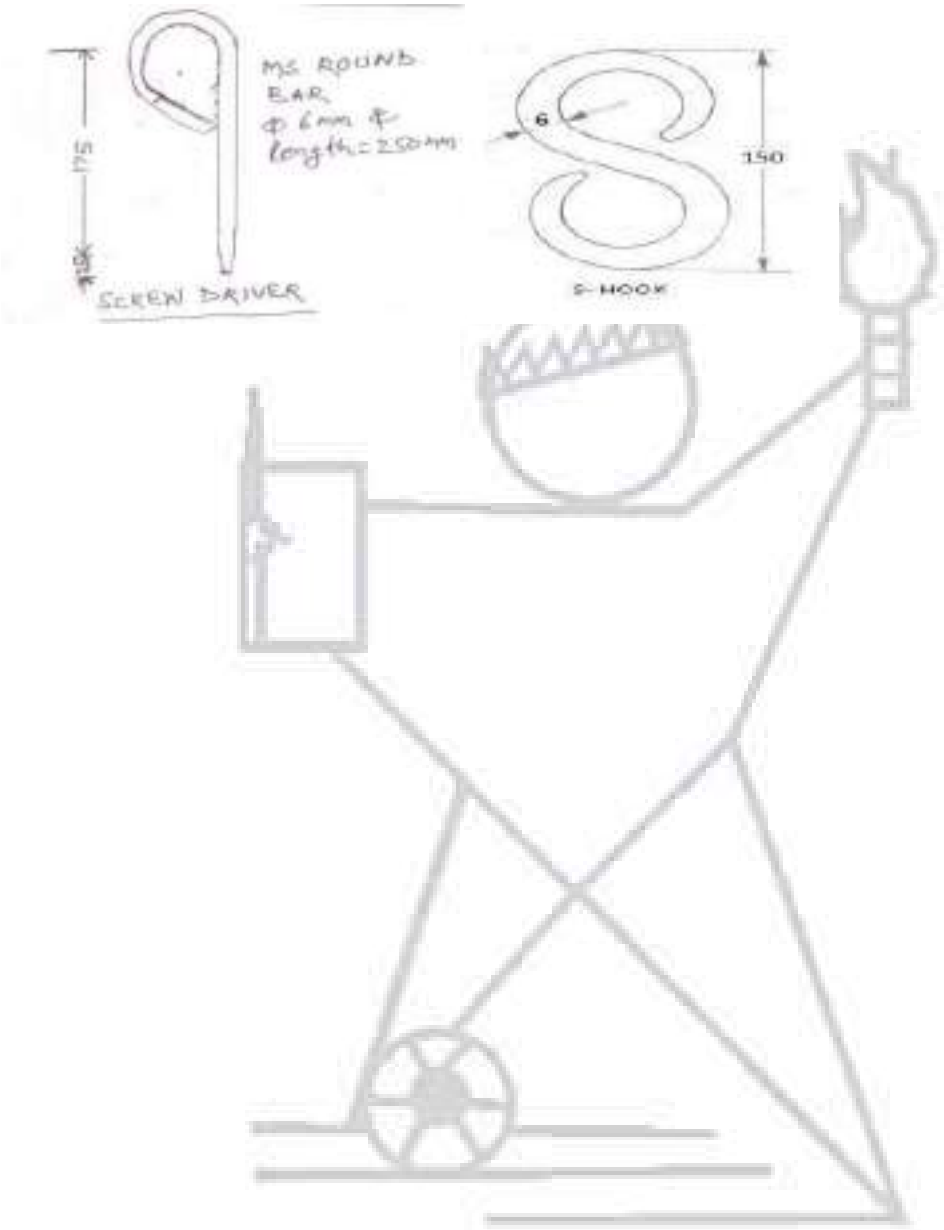
2. Do marking on the raw material by steel rule and cut the pieces as per dimension by clamping the work piece in bench vice with the help of hack saw.

3. After cutting operation use anvil and Ball peen hammer to bend the material.

4. Use the rough file to get the finished shape of the work piece.

Result:

Thus the required S hook, Screw driver is obtained.



Experiment No: 10

Aim: To weld two work pieces as a lap joint by arc welding.

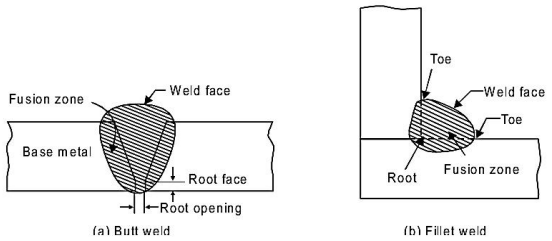
Tools required:

- Welding power supply
- Welding rod
- Electrode holder
- Gloves and apron
- Shield and goggles
- Flat file
- Chipping hammer
- Wire brush
- Earthing clamps

Introduction:

Welding is a process for joining two similar or dissimilar metals by fusion. It joins different metals/alloys, with or without the application of pressure and with or without the use of filler metal. The fusion of metal takes place by means of heat. The heat may be generated either from combustion of gases, electric arc, electric resistance or by chemical reaction.

Welding provides a permanent joint but it normally affects the metallurgy of the components. It is therefore usually accompanied by post weld heat treatment for most of the critical components. The welding is widely used as a fabrication and repairing process in industries. Some of the typical applications of welding include the fabrication of ships, pressure vessels, automobile bodies, off-shore platform, bridges, welded pipes, sealing of nuclear fuel and explosives, etc.



Types of welding

The welding process is divided into two main sub divisions.

Plastic welding

The pieces of metal to be joined are heated to the plastic state and then forced together by external pressure without the addition of filler material.

Forge welding

The work piece are placed in a forge or other appropriate furnace and heated within the area to be joined to the plastic condition. Then parts are quickly superimposed and worked into a complete union by hand or power hammering or by pressing together.

Resistance welding

In resistance welding, a heavy electric current is passed through the metals to be joined over limited area, causing them to be locally heated to plastic state and the welding is completed by the application of pressure for the prescribed period of time.

Fusion welding

In fusion welding, the metal parts to be joined are melted and then allowed to solidify pressure is not applied and filler metals may be used for this type of welding.

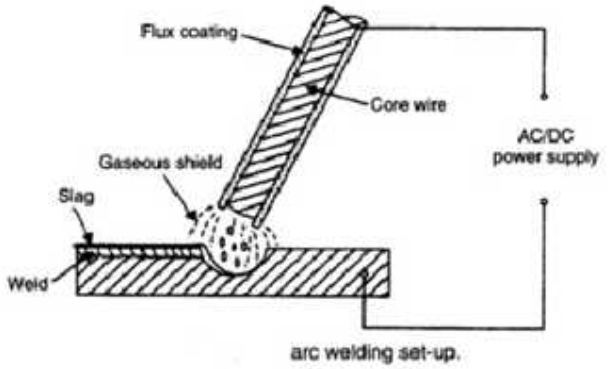
Gas welding

Gas welding is a process in which the required heat to melt the surfaces is supplied by a high temperature flame obtained by a mixture of two gases. Usually the mixture of oxygen and acetylene is used for welding purpose.

Electric Arc welding

Principle of operation

Electric arc welding is the process of joining two parts by melting their edges by an electric arc with ort without the application of pressure and with or without use of filler metals.



arc welding set-up.

Thermit welding

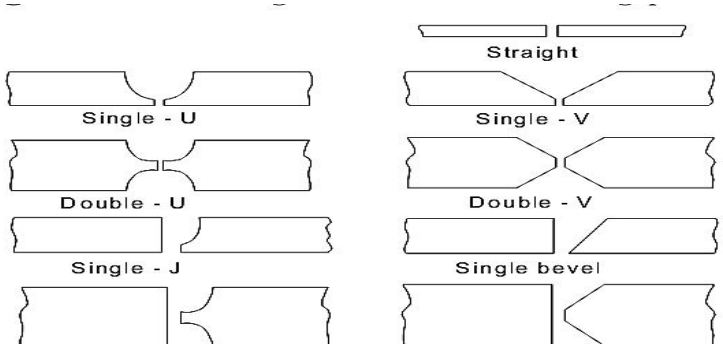
Thermit welding is a fusion process in which weld is effected by pouring super heated liquid thermit steel, around the parts to be united with or without the application of pressure.

Welding joints

Some common welding joints are shown in Figure. Welding joints are of generally of two major kinds namely lap joint and butt joint. The main types are described as under.

1. **Lap weld joint**

Single-Lap Joint -This joint, made by overlapping the edges of theplate, is not recommended for most work. The single lap has very little resistance to bending. It can be used satisfactorily for joining two cylinders that fit inside one another.



Double-Lap Joint

This is stronger than the single-lap joint but has the disadvantage that it requires twice as much welding.

Tee Fillet Weld

This type of joint, although widely used, should not be employed if an alternative design is possible.

2. Butt weld joint

a. Single-Vee Butt Weld

It is used for plates up to 15.8 mm thick. The angle of the vee depends upon the technique being used, the plates being spaced approximately 3.2 mm.

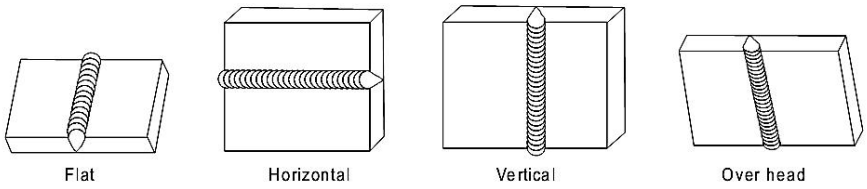
b. Double-Vee Butt Weld

It is used for plates over 13 mm thick when the welding can be performed on both sides of the plate. The top vee angle is either 60° or 80°, while the bottom angle is 80°, depending on the technique being used.

Welding Positions

As shown in Fig., there are four types of welding positions, which are given as:

a. Flat or down hand position
b. Horizontal position
c. Vertical position
d. Overhead position



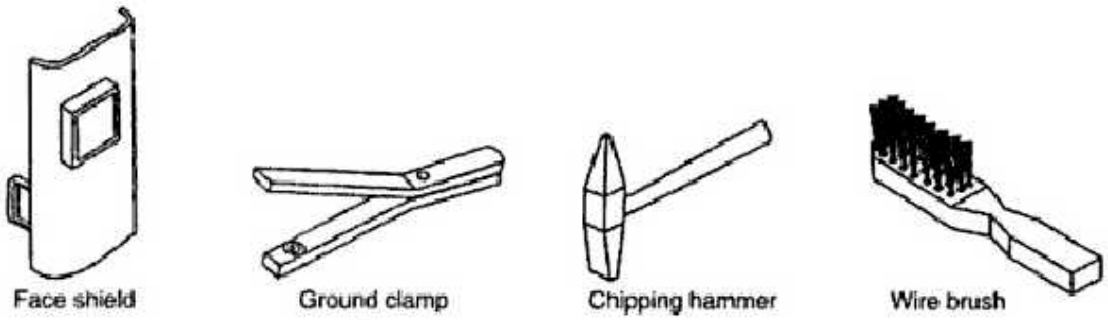
Welding Bead cleaning accessories

Chipping hammer

A chipping hammer is chisel-shaped one and it is used to remove the slag from the weld bead.

Wire Brush

A wire brush made up of stiff steel wire, embedded in wood, removes small particles of slag from the weld bead after the chipping hammer is used.



Hand Screen

It is a protective device used in arc welding. A hand shield is held in the hand of the welder and it is fitted with a suitable fitter lens.

Helmet

It is used for shielding and protecting the face and neck of the welder and it is fitted with a suitable fitter lens.

Tongs

Tongs are used to handle the hot metal-welding job while cleaning; they are also used to hold the metal for hammering.

Goggles

Chipping goggle is used to protect the eyes while chipping the slag. They are fitted while a plain glass to see the area to be cleaned.

Hand Gloves

Hand gloves are used to protect the hands from electrical shock, arc radiation and hot spatte

Material used: Mild Steel plates.

Procedure

1. First of all, the work pieces must be thoroughly cleaned to remove rust, scale and other foreign materials.

2. Then the given work pieces are placed on the table in such a way that one work piece is placed on the other work piece like the LAP joint is formed.

3. Appropriate power supply should be given to the electrode and the work pieces.

4. Now the welding current output may be adjusted.

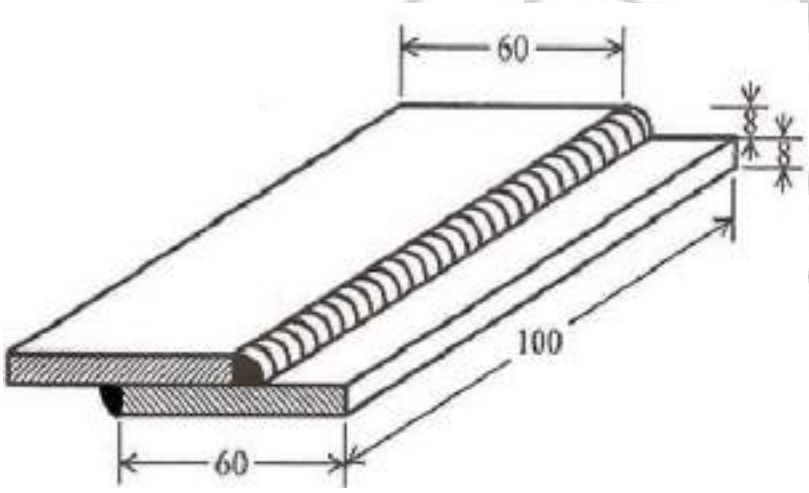
5. When current is passed, arc is produced between the electrode and work pieces.

6. Then the welding is carried out throughout the length.

7. As soon as the welding process is finished, switch off the current supply and allow the work piece to cool.

8. Slag is removed by chipping process with the help of chipping hammer.9. Finally using wire brush, welded portions are cleaned.

Result: Thus the given two work pieces are joined as a lap joint by arc welding.



Butt Joint

Safety Recommendations for ARC Welding

The beginner in the field of arc welding must go through and become familiar with these general safety recommendations which are given as under.

1. The body or the frame of the welding machine shall be efficiently earthed. Pipe lines containing gases or inflammable liquids or conduits carrying electrical conductors shall not be used for a ground return circuit All earth connections shall be mechanically strong and electrically adequate for the required current.
2. Welding arc in addition to being very is a source of infra-red and ultra-violet light also; consequently the operator must use either helmet or a hand-shield fitted with a special filter glass to protect eyes
3. Excess ultra-violet light can cause an effect similar to sunburn on the skin of the welder
4. The welder's body and clothing are protected from radiation and burns caused by sparks and flying globules of molten metal with the help of the following:
5. Gloves protect the hands of a welder.
6. Leather or asbestos apron is very useful to protect welder's clothes and his trunk and thighs while seated he is doing welding.

7. For overhead welding, some form of protection for the head is required
8. Leather skull cap or peaked cap will do the needful.
9. Leather jackets and 1ather leggings are also available as clothes for body protection.
10. Welding equipment shall be inspected periodically and maintained in safe working order at all times.
11. Arc welding machines should be of suitable quality.
12. All parts of welding set shall be suitably enclosed and protected to meet the usual service conditions.

Result:

The Lap joint is thus made, using the tools and equipment as mentioned.